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Sabine Ladstätter
Walter Prochaska
Vasiliki Anevlavi (eds.)

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ADVANCES IN PROVENANCE TECHNIQUES, METHODOLOGIES AND DATABASES

Vasiliki Anevlavi – Walter Prochaska – Sabine Ladstätter (†)

A PILOT STUDY OF THE ANCIENT WHITE MARBLE SOURCES IN THE EASTERN AEGEAN

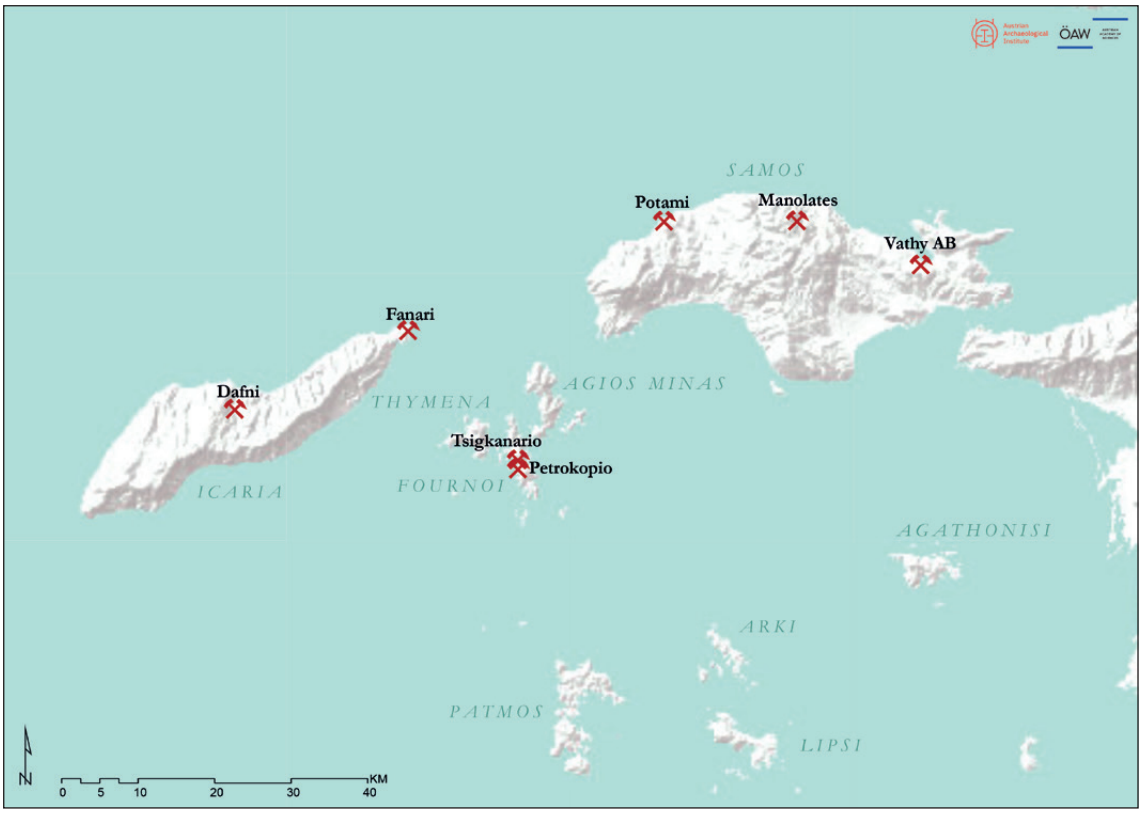
Abstract
This paper aims to explore, investigate and compare the ancient white marble quarries and outcrops of the northeastern Aegean Islands in Greece, most specifically the islands of Samos, Fourni and Ikaria, providing preliminary results. The major aim of this research is to distinguish the different marble types of these islands through petrographic and geochemical criteria, including quantitative approaches, comparing the data from the already studied quarries of the ancient world with the properties of the new samples. Eight locations were studied, and in total 120 samples were analysed with a petrographic microscope, stable isotopes analysis, fluids and inductively coupled plasma-mass spectrometry (ICP-MS) analysis. The results of the investigation of the northeastern Greek islands and the analytical data will be used in future research and add to the list of the white marble quarries of antiquity.

INTRODUCTION

In recent years there has been a substantial focus, from archaeometric projects around the world, on the identification of white marble quarries used in archaeological monuments and artworks. The main target was to create a reference collection that allows the origin of a marble object of historical and artistic value to be determined through multimethod chemical approaches. The goal of listing all the ancient quarries and outcrops has been attempted in the past, and in combination with various studies by international scholars, an overview of the quarries of Greece, in terms of history, archaeology, geology, etc., was prepared. In 1975, A. Dworakowska published her study »Quarries in Ancient Greece«, listing quarries throughout Greece[1]. One of the most recent publications is the »Corpus of Ancient Quarries« by G. Kokkorou-Aleura and colleagues[2]. In this attempt, a long list of stone quarries and archaeological sites is mentioned. In the meantime, B. Russell's »Gazetteer« refers to all the known stone quarries in the Roman World[3].

There are many small quarries and stone outcrops that have received less attention from the academic community. In recent years, more researchers have focused on local sources and explored regional trade and stone use, along with the possibilities of larger trading routes. Archaeometrical and archaeological studies showed new perspectives for the use of these local sources. Among different aspects, the material's properties, extraction techniques, distribution, etc. are studied[4]. In most cases, these quarries were small-scale operations, part of the local economy, and supplied the local urban centres[5]. However, it is not easy to date these various quarries, since no archaeological finds or traces of ancient tool-marks are preserved. Nevertheless, a precise dating could be proved through identification of the source of well-dated archaeological objects. In addition to the study of these quarries, extra attention is paid to the white marble and the coloured sources, for example, the coloured marble sources of Greece by L. Lazzarini[6].

1 Dworakowska 1975.
2 Kokkorou-Aleura et al. 2014.
3 Russell 2013b.
4 Russell 2019.
5 Russell 2013a.
6 Lazzarini 2007.



1 The islands of Ikaria, Fourni and Samos. The sampled locations are indicated (graphics: OeAI-OeAW/N. Math)

Research over the last years showed that the Greeks and the Romans used first-quality marble for many cases such as statuary or architecture. However, recent investigations revealed that lower ›second‹-quality marble quarries or outcrops were also mined and used as secondary building materials. These examples can be seen in the Greek Aegean Islands with the examples of Skyros, Fourni, Samos, Kos, etc.[7], as well as in Asia Minor. This paper aims to explore, investigate and compare the ancient white marble quarries and outcrops of the northeastern Aegean Islands, particularly the islands of Samos, Fourni, and Ikaria.

Studying the physicochemical properties of the ancient quarries can be beneficial in acquiring further information on the fingerprinting of locations that may have been used in antiquity. Ancient trade (land and sea routes) can be recorded, along with the way the material was transferred, the exchange of products, technicians and art. The small quarries could be equally important, or they could cover the need for raw materials on a local scale.

PREVIOUS INVESTIGATIONS

Previous investigations showed and recorded the existence of white marble quarries in the area of the northeastern Greek Aegean Islands[8]. The island of Fourni has been inhabited since ancient times. The marble quarry at the location of Petrokopio, in the southwest of the island, preserves a large quantity of ancient tool traces in good condition, as well as large unfinished architectural blocks[9]. More information was given by O. Rayet and A. Thomas in 1877, by mentioning a total

7 Varti-Matarangas – Matarangas – Lazzarini 2009; Lazzarini – Malacrino 2010.
8 Kokkorou-Aleura et al. 2014.
9 Kienast 2007.

Name of the quarry	Latitude	Longitude	Type
Samos Manolates	37.788073	26.816269	Marble
Samos Potami	37.789472	26.659600	Marble
Samos Vathy AB	37.747953	26.961289	Marble
Samos Kallithea	37.731973	26.577289	Limestone
Petrokopio Fourni (Fourni 1)	37.5608384	26.4882329	Marble
Tsigganario Fourni (Fourni 2)	37.566485	26.487994	Marble
Ikaria Fanari	37.6864943	26.3591747	Marble
Ikaria Dafni	37.611306	26.15725	Marble

Table 1 The table with the locations visited on each island, the coordinates and the type of material

of three locations of ancient quarries in the area of Fourni and the island's possible connection and trade with the ancient city of Didim, in Asia Minor[10]. Two locations in Ikaria bear traces of ancient extraction and they are in a location close to archaeological sites[11]. Furthermore, a large number of quarries and outcrops have been recorded on Samos Island. Due to the large size of Samos and its shape, ancient quarries can be found throughout the whole island, with the most characteristic quarries being the locations Manolates, Zoodochos Pigi, and Paleokastro[12].

Preliminary investigations of the characteristics of the marble quarries have been published by L. Lazzarini and S. Cancelliere, and by M. Varti-Matarangas and colleagues[13]. However, no systematic sampling was undertaken, and not all of the recorded quarries were analysed (isotopically, chemically, etc.). The lack of a complete scientific database of references from all the ancient quarries in those areas undoubtedly makes a complete investigation and research of all the ancient Mediterranean marble sources difficult.

THE EASTERN AEGEAN ISLANDS

Different bibliographical sources provide indications for various locations of ancient white marble quarries and outcrops. Four locations are indicated as ancient marble or limestone quarries on Ikaria Island, three on Fourni Island, and eight on Samos Island (fig. 1; tab. 1).

Samos

The locations of Manolates, Potami, and Vathy AB are marble quarries and outcrops. The areas of Kallithea, Agiades, Pountes and Zoodochos Pigi are limestone areas and ancient limestone quarries. The area of Paleokastro needs further investigation – no location of geological interest has been found at the moment. Three marble locations and one limestone source on Samos Island were visited. The Manolates quarry is located 1 km from the village of Manolates. It extends over a large area; the marble is white and grey, and the grain size is medium. No ancient toolmarks were observed. There is no modern marble extraction in this area. Due to the length of the main façade of the quarry, five groups of samples were created (Man 1 – Man 5) and a total of 26 samples were analysed. The second location, Potami, is located 3 km from the city of Karlovasi (fig. 2 a–b). It is a large hill next to the seaside. It consists of medium-grained marble, white and grey in colour with a characteristic layering. No ancient traces can be seen. This could be a result of weathering by the sea or the construction of the modern road (a few years ago). From this

[10] Rayet – Thomas 1877.
[11] Varti-Matarangas – Matarangas – Lazzarini 2009; Kokkorou-Aleura et al. 2014.
[12] Kienast 1992; Varti-Matarangas – Matarangas – Lazzarini 2009; Kokkorou-Aleura et al. 2014.
[13] Lazzarini – Cancelliere 2000; Varti-Matarangas – Matarangas – Lazzarini 2009.

2 a: The Fourni 1 quarry. b: The Samos-Potami quarry (photos: OeAI-OeAW/V. Anevlavi)

location, 16 samples were analysed. The third location, Vathy AB, is located 1 km outside Samos' capital (also known as Vathy). The marble is medium-grained with a dark-grey colour. The use of this outcrop may be exclusively modern. Eight samples from this location were studied. Despite the bibliographic reference about the existence of marble quarries in the area of Kallithea[14] and Zoodochos Pigi (no specific information), the locations could not be found or identified. Not far

[14] After communicating with the archaeologist Georgia Delli, the person responsible for hiking activities on Samos; Georgios Matthaiou; and the president of the community, Stavros Papageorgiou, in combination with an extended walking survey of the area, only outcrops of limestone of a grey colour were observed.

from the town of Vathy, there is one large modern marble quarry. Due to the refugee crisis on Samos Island, access was not possible.

Fourni

Fourni 1 and Fourni 2 are ancient marble quarries with no modern extraction. The location Ellidaki is a marble outcrop a short distance between these two locations. One of the most important locations for this project is Fourni Island and the marble quarries of Petrokopio (Fourni 1: fig. 2) and Tsigganario (Fourni 2). These ancient marble quarries have no signs of modern extraction.

A variety of tool-marks can be observed at Petrokopio at every level of the quarry, for example pick-marks, wedges, chisel-marks, drill-holes, and imprints of marble blocks. A large number of semi-worked artefacts such as capitals, columns, bases and sarcophagi have been left at the edge of the bay. The quarry has immediate easy access by sea. Large dumps of debris can be observed in the north of the quarry. 30 samples were studied. The marble is medium-grained in size and white in colour, with the same grey layers. The quarry of Tsigganario is located 2 km north of the quarry of Petrokopio. There are large dumps of debris towards the bay, which is located 2 km to the west. In the middle of the quarry, the ruins of a building can be found. According to the locals, these are the ruins of a very old building, but the dating is uncertain. No ancient tool-marks can be observed. 17 samples were studied. The marble is medium-grained in size with grey and white varieties.

Ikaria

The locations Drakano and Fanari refer to one actual location with a marble quarry and an archaeological site – the Hellenistic tower of Drakano – while the locations of Kampos and Dafni also refer to a single location of a marble quarry and the Kampos archaeological area. The ancient tower of Drakano in the area of Fanari was visited. Around Fanari large outcrops of grey to greyish-coloured, coarse-grained, low-quality marble can be observed. The tower of Drakano is possibly made from this local marble type. 17 samples were analysed. No tool-marks or any other indications for ancient use could be found.

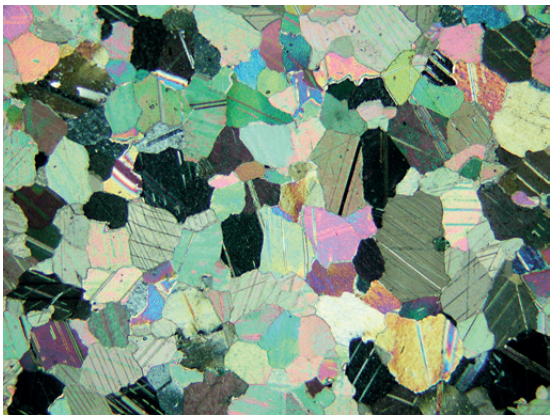
The second location on Ikaria is the area of Dafni, near the archaeological site of Kampos. A small outcrop of low-quality, coarse-grained, white-coloured marble can be observed. Debris and larger weathered blocks can be observed at the river under the hill. Ten samples were collected.

METHODS AND METHODOLOGICAL APPROACH

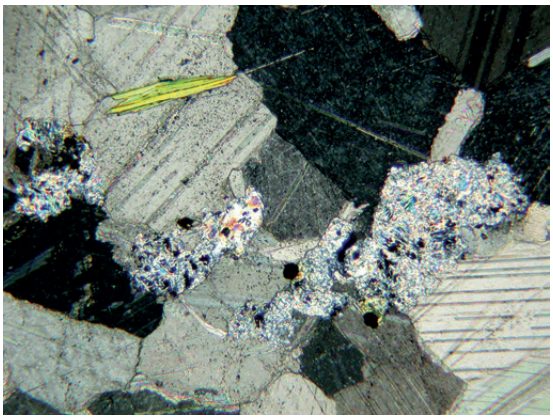
The major aim of this research consists of distinguishing the different marble types of these islands by means of petrographic and geochemical criteria, including quantitative approaches, comparing the data from the already studied quarries of the ancient world with the properties of the new samples, identifying the fingerprint of these quarries. The methods used for this project are the following:

- Stable isotope analysis ($^{13}C/^{12}C$ and $^{18}O/^{16}O$)[15]
- Petrographic analysis[16]
- Trace element analysis[17]
- Analysis of the fluid inclusions[18]
- ICP-MS analysis

[15] Attanasio – Brilli – Ogle 2006.
[16] Maniatis 2004.
[17] Attanasio et al. 2018.
[18] Prochaska – Grillo 2010.



3 Microphoto of a Samos-Manolates quarry sample under polarised light. The texture is homoeoblastic with isometric calcite grains with relatively straight grain boundaries. The length of the image is 6 mm (sample Man 4/3) (photo: OeAI-OeAW/W. Prochaska)



4 Pseudomorphs of matted aggregates of sericite, epidote and opaque matter after an unknown precursor mineral. The length of the image is 1.2 mm (sample Man 4/3) (photo: OeAI-OeAW/W. Prochaska)

The detailed data are the following: magnesium (Mg), chromium (Cr), vanadium (V), cadmium (Cd), barium (Ba), iron (Fe), manganese (Mn), strontium (Sr), yttrium (Y), lanthanum (La), cerium (Ce), ytterbium (Yb), uranium (U), $\delta^{18}O$, and $\delta^{13}C$. For the statistical treatment, a large database of the most important quarries of antiquity is used, in combination with the extensive collection of samples and analysis of the new quarries in the pertinent areas[19]. These results provide additional data and complete the databases on marble provenance analysis. The individual data will be included in an extensive databank. The already existing databank, with currently about 5,500 quarry samples, covers the most important marble quarries of antiquity.

The collected samples were analysed at the Department of Geosciences and Geophysics at the University of Leoben, Austria, and at the Technical University of Vienna, Austria.

PETROGRAPHY

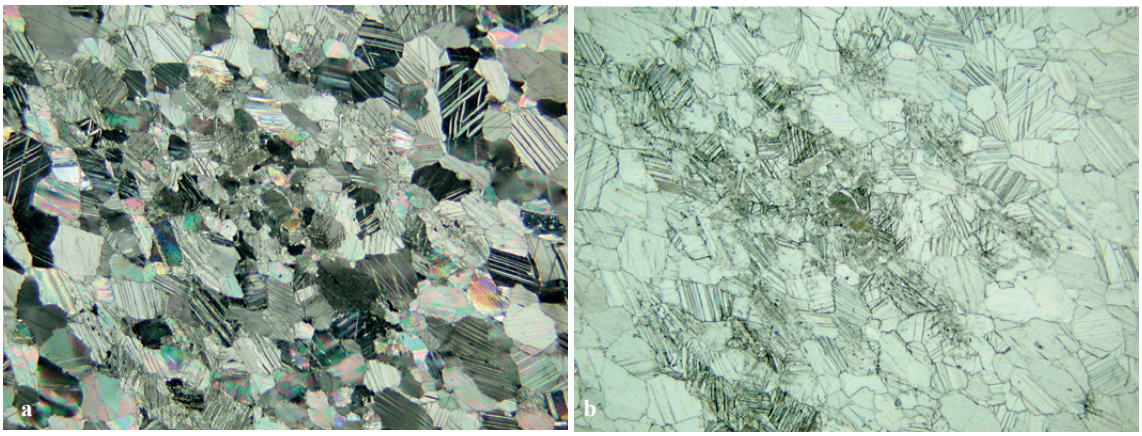
Selected samples were investigated with the petrographic microscope. It has to be mentioned that some features described below occur sporadically and can be seen in large thin sections when investigating quarry samples. However, in the very small samples usually available from artefacts, these peculiarities cannot be detected.

Samos Manolates

The typical microscopic fabric is a more or less homoeoblastic texture with slightly embayed boundaries to the calcite grains. The maximum grain size (MGS) is occasionally 2 mm; however, the most frequent grain size (MFG) is 0.5–1 mm. Thus, the general appearance is that of a fine- to medium-grained marble of white to greyish colour.

Calcite is by far the dominating mineral and only sporadically can small clusters of dolomite crystals be detected. This is in accordance with the low Mg content proved by the chemical analyses. Very small poikiloblastic inclusions of quartz crystals with very smooth extinction occur frequently. On the grain boundaries of the calcite crystals, mica (0.2–0.4 mm) with a light brownish-greenish extinction occurs subordinately. Aggregates of matted sericite and chlorite

[19] For detailed information on the instrumentation and the sample preparation procedure, see Prochaska – Attanasio 2021; Prochaska – Attanasio 2022.



5 a: Microphoto of a typical fine-grained Fourni marble under polarised light. A slight schistosity is omnipresent. The image length is 6 mm (sample Fourni 1/19). b: Microphoto of a typical fine-grained Fourni marble under transmitted light. A slight schistosity is omnipresent. The image length is 6 mm (sample Fourni 1/19) (photos: OeAI-OeAW/W. Prochaska)

(sometimes with epidote) up to a size of 1 mm can occasionally be found. The precursor mineral of these pseudomorphs can no longer be determined (figs. 3–4).

Fourni Quarries

The macroscopic appearance of the Fourni marbles is that of very white, granular, fine- to medium-grained rock. Sometimes the marble exhibits a slightly linear structure due to layers of stronger deformation and a reduction of the grain size. A further important feature of these layers is the drastic increase in very small fluid inclusions testifying to the percolation of late fluids along these shear planes. Here blasts of dolomite crystals with a dull core (fluid inclusions) and a clear rim, free from inclusions, can be observed. These very features can also be observed in the marbles of the Potami quarry (see below) and in the Ephesos I quarries in the region of Ephesos. In general, the MGS of these marbles is well below 1 mm (fig. 5 a–b).

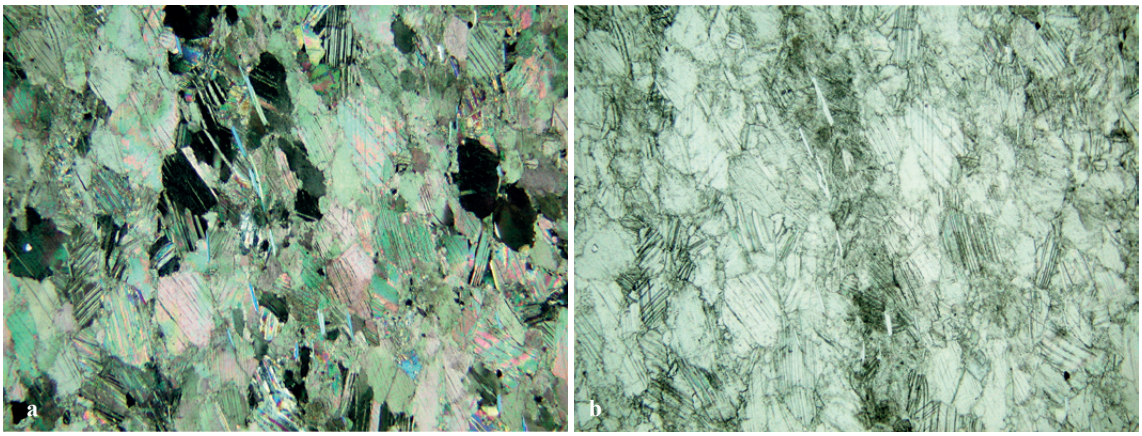
Samos Potami

As mentioned above, the textures of the marbles of this quarry very much resemble those of the Fourni marbles. The texture is characterised by a fine grain and slight schistosity (fig. 6 a–b). The linear structures along which fluid evidently percolates that were described in the Fourni marbles are also present here. Very small fluid inclusions in these areas are abundant, and mica also occurs along these structures. Bigger dolomite blasts without twin lamellae, which are bound to these areas, are filled with small inclusions and characterised by a narrow inclusion-free rim (fig. 7).

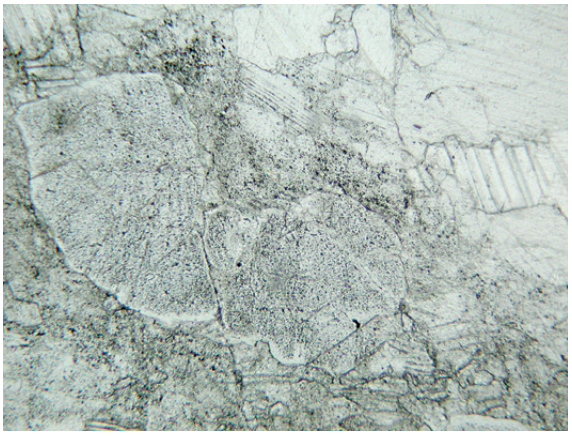
The marble is fine-grained with a MGS of about 1 mm or less. The grain boundaries are straight to slightly embayed. Undulatory extinction and deformation of twin lamellae are omnipresent.

ANALYTICAL DATA

A case study of the Archaic temple of Teos, Asia Minor, was used for testing the applicability and accuracy of the data. There is evidence of an Archaic temple preceding the Hellenistic one. The measurements of the cella are 38.46 × 7.3 m, similar to the Samian Heraion Hekatompedos temple in the proportion of 1 : 5. The remains of the superstructure of this earlier temple in white marble with narrow egg-and-dart reliefs were found in the southwest of the temenos. The Teos Hekatompedos temple was built by levelling the bedrock and filling the area over 3 m on one side.



6 a: Microphoto of the Samos-Potami quarry samples 1/6 under polarised light. Mica formation along the schistosity-forming planes is ubiquitous. The length of the image is 6 mm. b: Microphoto of the Samos-Potami quarry samples 1/6 under transmitted light. The dull, fluid inclusion-rich planes are clearly visible. The length of the image is 6 mm (photos: OeAI-OeAW/W. Prochaska)



7 Microphoto of the Samos-Potami quarry samples 1/6 under transmitted light. Two dolomite grains showing a dull, inclusion-rich core occur in the fluid-rich planes. The outermost rim is inclusion free. The length of the image is 1.2 mm (photo: OeAI-OeAW/W. Prochaska)

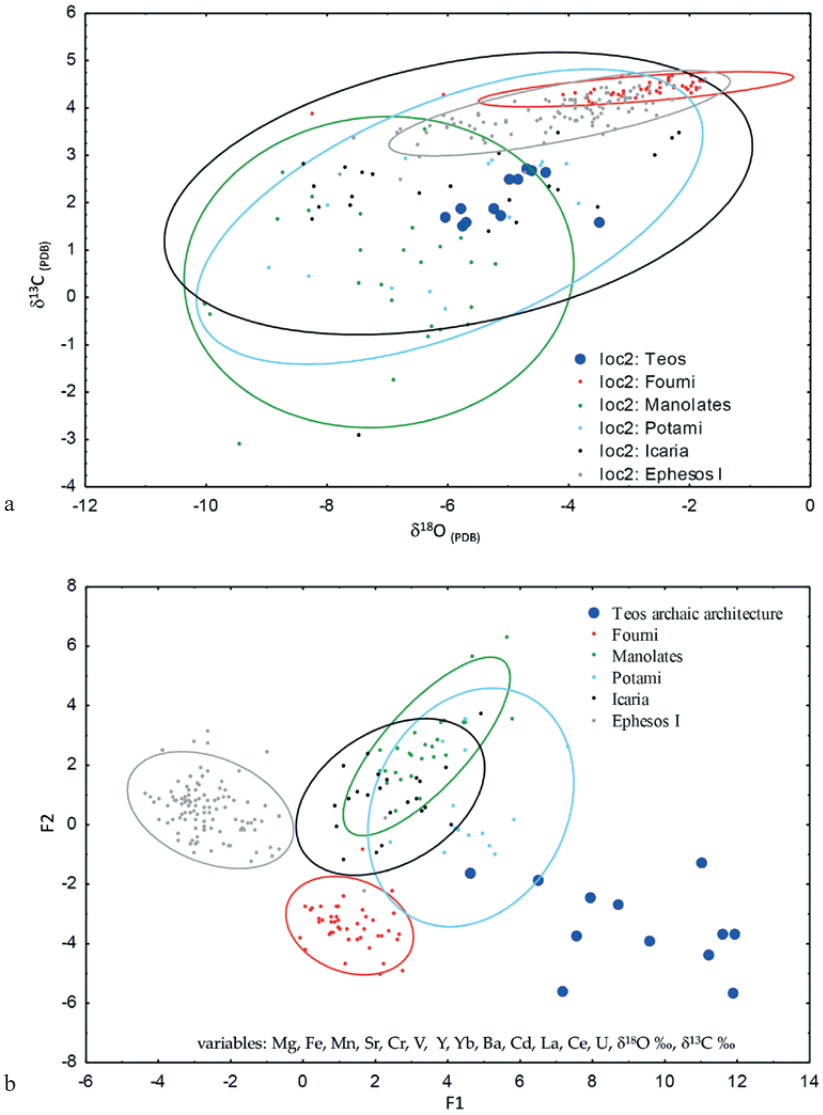
Despite the use of local sources for various buildings throughout Teos, the white marble of the Late Archaic Ionic temple at the site did not match with any known quarries on the Ionian mainland[20].

The isotopic diagram displays the different clusters, with the Teos samples forming a separate cluster far from the ellipses of the quarries. The locations of Manolates, Ikaria and Potami overlap and are scattered across the diagram, while the Ephesos I and Fourni quarries create more distinct fields with only a slight overlap (fig. 8 a–b). The multivariate diagram using Mg, Fe, Mn, Sr, Cr, V, Y, Yb, Ba, Cd, La, Ce, U, $\delta^{18}O$ ‰, $\delta^{13}C$ ‰ as variables showed clear discrimination between the quarry areas and the samples. The samples do not fit to the specific fields. Some quarries can be clearly separated, for example Fourni and Ephesos I, while the rest of the quarries still show a slight overlap. However, the macroscopic characteristics (colours, texture, etc.) can assist the separation (see above).

	Fourni	Manolates	Potami	Ikaria	Ephesos I	Total
Fourni	43	0	1	0	0	44
Manolates	0	26	0	0	0	26
Potami	0	1	12	1	0	14
Ikaria	1	1	1	20	0	23
Ephesos I	1	0	0	1	102	104

Table 2 The numerical probability shows that the quarries can be clearly distinguished. The numbers refer to the analysed samples from each location

[20] Kadıoğlu 2016.



8 a: The isotopic analysis of the Archaic architecture of Teos. b: The multivariate analysis of the Archaic architecture of Teos (graphics: OeAI-OeAW/W. Prochaska, V. Anevlavi)

	Fourni	Manolates	Potami	Ikaria	Ephesos I	Total
Fourni	97.7	0.0	2.3	0.0	0.0	100
Manolates	0.0	100	0.0	0.0	0.0	100
Potami	0.0	7.1	85.7	7.1	0.0	100
Ikaria	4.3	4.3	4.3	87.0	0.0	100
Ephesos I	1.0	0.0	0.0	1.0	98.1	100

Table 3 The numerical probability shows that the quarries can be clearly distinguished. The numbers refer to the percentage of discrimination of each source

The numerical probability (by using SPSS) shows that the quarries can be clearly separated. Table 2 shows the analysed samples from each location. Table 3 shows the percentage of discrimination of each source, up to 100 %. Future analysis and comparison with archaeological samples will provide greater clarity.

CONCLUSION

The studies on smaller quarries are filling the gaps in the research on stone quarries and aiding understanding of stone used in different periods[21]. By knowing the main source of marble and the provenance of an object or a monument, several aspects of the research on these artefacts can be elucidated. Through studying the provenance of the material, information on the connection between the cities in terms of religion, the economy and servitude relations is provided. The values of the societies and the robustness of the community can also be distinguished. Studying the actual ancient quarries and the traces of the tool-marks can help to acquire further information on technological knowledge and the corresponding progress in each period. Ancient trade (land and sea routes) can be recorded, along with the way the material was transferred, the exchange of products, technicians and art[22]. Comparing these sources to the ancient building projects will enable us to understand the microregional extraction of stone for building.

In addition, for other types of artefacts, the material for these small-format reliefs, such as the case study of the Meter/Kybele votive object, has hardly been examined so far. Groundbreaking new insights into regional production and trade patterns can be expected for this particular group. Determining the provenance of the marble used provides essential hints regarding the location of the workshops/production centres either in the quarries and their surroundings or in the area of the sanctuaries, especially in the case of medium-sized artisanal products[23]. As a second part of this pilot study, ultimately, a comprehensive analysis of the material of the Meter/Kybele reliefs of Samos will be sampled and analysed. This step will aim to investigate the importance of regional distribution patterns and thus the impact on regional sanctuaries.

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21 Russell 2019.
22 Maniatis 2003.
23 Anevlavi – Ladstätter – Prochaska 2023.

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STRATIGRAPHIC DATABASE FOR DETERMINATION OF THE PROVENANCE OF LIMESTONE USED IN COLONIA IULIA EMONA (REGIO X, ITALIA)

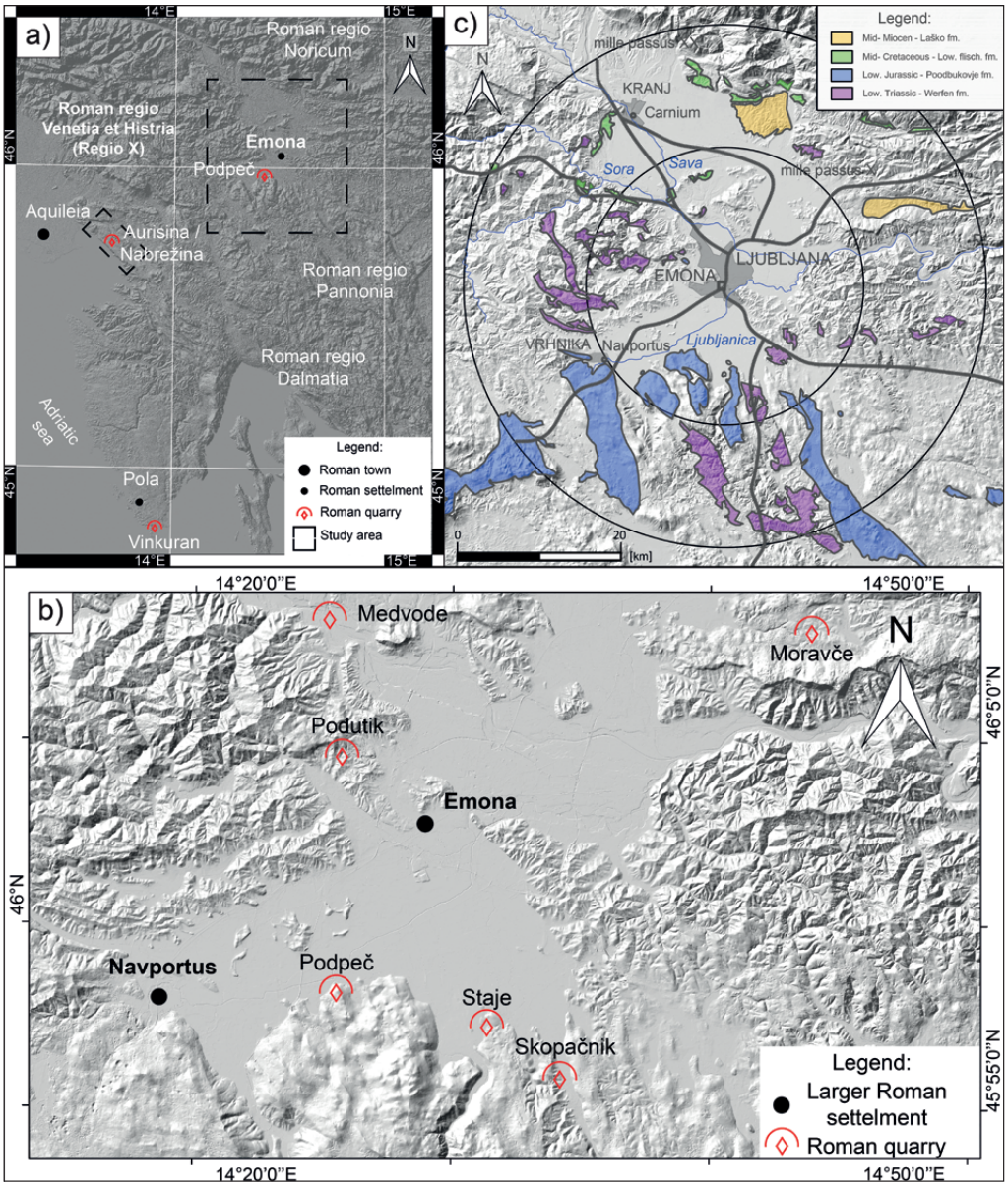
Abstract
Colonia Iulia Emona was a Roman town in Regio X and is today modern Ljubljana, located in central Slovenia. Several limestone quarries used by the Romans have been proposed, ranging stratigraphically from the Lower Triassic to the Miocene in age. Various stone products were examined using a multilevel approach. The examination began with the lithological properties of the rock. If the stratigraphic position could not be determined on the basis of macroscopic observations (e.g. the presence of larger and diagnostic fossils), microfacies analysis and determination of microfossils from thin sections followed. Failing that, mineralogical (X-ray diffraction [XRD]) and geochemical (inductively coupled plasma-mass spectrometry [ICP-MS]) analysis, cathodoluminescence analysis, and analysis of the isotopic values of carbon ($\delta^{13}C_{total}$), oxygen ($\delta^{18}O_{total}$), and strontium ($^{87}Sr/^{86}Sr$) isotopes subsequently followed. Using this kind of approach, we can distinguish all limestone types and classify them with greater certainty into lithostratigraphic units.

INTRODUCTION

The research that is part of the present work relates to the ancient (Roman) settlement of Colonia Iulia Emona, situated in the northeastern area of Regio X – Venetia et Histria (fig. 1 a–b) between the 1st century BC and the 6th century AD[1]. During this period, both the status and the importance of Emona changed significantly, which is also reflected in its stone trade and production.

Research on the provenance of the limestone used in Emona dates back to the 19th century. A. Müllner[2] mentioned areas of still-active quarries of Lower Jurassic limestone at Podpeč (Pliensbachian Lithiotid Limestone Member) and Podutik (Middle Sinemurian Krka Limestone Member) as possible sources of limestone and suggested use of the Cretaceous limestone from the Karst area (Upper Cretaceous limestones) and the Miocene limestone from Moravče (Laško Formation, Lithothamnium Limestone Member). Cooperation between the archaeological and geological disciplines began to increase in the 1990s. In addition to the previously mentioned sites, A. Ramovš[3] suggested the hill of St. Ana above Podpeč (Middle Jurassic Laze Formation), the surroundings of Staje near Ig (Middle Sinemurian Krka Limestone Member), Skopačnik near Želimlje (Lower Triassic Werfen Formation), and the Aurisina/Nabrežina area (Lipica Formation) as source areas for these limestones[4]. These source areas are also mentioned in the catalogue of quarries in the Roman Empire[5]. In addition, recent studies have identified a new source area belonging to the mid-Cretaceous Lower Flyschoid Formation that was likely sourced near the town of Medvode[6]. Possible lithostratigraphic units in local and regional radii are presented

1 Šašel Kos 2012; Gaspari 2014.
2 Müllner 1879.
3 Ramovš 1990.
4 Ramovš 1990; Šašel Kos 1997; Ramovš et al. 2000; Ramovš 2002.
5 Russell 2013.
6 Brajkovič et al. 2023.



1 Presentation of the research area. a: Wider geographical and historical setting with the main Roman cities/settlements and their main quarries. b: Emona and its immediate surroundings with the presumed locations of Roman quarries (after Russell 2013, pl. 1, 3–62). c: Lithostratigraphic source units in local and regional radii (graphics: R. Brajkovič, © GeoZS)

in figure 1 c. In addition to the various types of limestone discussed in this study, other types of natural stone were also used in the Emona area in Roman times[7]. These include the local carboniferous sandstone from the nearby Castle Hill, Oligocene tuff and conglomerates, and various types of marble, which are not the subject of interest in the present work.

Previous studies of stone products and presumed sources show that individual lithostratigraphic units, especially the Lower Jurassic limestone succession, contain macro- and microscopically similar facies that can be distinguished only by fossils, if present. In the absence of fossils, it is not possible to assign the individual stone products to a specific area of origin (from known and

7 Djurić – Rižnar 2017.

potential Roman quarries). The lithostratigraphic classification of fine-grained limestones (especially of carbonate mudstone type) has been a particular issue of interest for previous researchers[8]. In cases of facially similar limestones, it is necessary to use a multimethod approach in order to determine the provenance of these limestones[9].

The aim of this work is to establish indicative criteria for provenance analysis of stone products found in Emona using a multimethod approach. The approach presents a hierarchical sequence of determining steps, from macroscopic and microscopic lithological examination of the limestone, following the determination of microfossils, mineralogy, geochemistry, and isotopic signals, until an unambiguous lithostratigraphic affiliation of the limestone used to produce the stone products from the Roman period is established.

METHODS AND MATERIALS

The first step of the analysis is a macroscopic description of the rock. This is followed by a microscopic description, mineralogical and geochemical analysis, and analysis of the oxygen ($\delta^{18}O_{total}$), carbon ($\delta^{13}C_{total}$), and strontium isotope values ($^{87}Sr/^{86}Sr$).

Macroscopic (Facies) Description

Stone products from lapidaries and museum collections (Ljubljana Museums and Galleries – marked with MGML and inventory number; National Museum of Slovenia – marked with NMS and inventory number; Emona Archaeological Park – marked with MAX or KL and inventory number; stone products found in buildings around Ljubljana – marked with LJ and inventory number) were macroscopically described on-site. A total of 286 Roman stone products were included in the macroscopic inventory. The colour of the rock was determined using a standardised colour scale[10].

Microscopic (Microfacies) Analysis

Representative samples for thin sections and for geochemical analysis were taken from damaged areas on the selected stone products under the supervision of curators. Stone products of special importance and/or undamaged products were not sampled in order to minimise our impact on the collections. The stratigraphic positions of those were determined on the basis of macroscopic analysis. When no previously damaged surface was available for sampling, a Milwaukee DD 3-152 handheld drill with an 18 mm-diameter diamond core and water connection was used. Limestone microfacies were classified according to the updated Dunham classification system[11]. The range of age of the foraminifera assemblage was determined according to relevant publications[12]. A total of 101 stone products were microscopically described.

Cathodoluminescence

Cathodoluminescence analysis was performed on all samples using a CITLCL 8200/MK4 TECHIJOSIN cold cathode microscope. The microscopy was performed at a standard voltage

8 Šmuc et al. 2017; Djurić – Gale – Brajkovič 2022.
9 Galán – Carretero – Mayoral 1999.
10 Geological Rock Colour Charts 2011.
11 Dunham 1962; Lokier – Al Junaibi 2016.
12 Nagymarosy – Miiller 1988; Fugagnoli – Loriga Broglio 1998; Fugagnoli 2004; Velić 2007; Gale 2014; Gale – Klemen 2017; BouDagher-Fadel 2018; Gale – Barattolo – Rettori 2018; Sevillano et al. 2020.

of 16 kV, an electric current of 450 mA, and a vacuum current of 15 μA. The results were documented using a Nikon Eclipse E 600 camera at 50 × magnification and a 4-second exposure time.

Mineralogical and Geochemical Analysis

Using the Chicago Pneumatic Tools with Air Line precision crushing and drilling equipment, all secondary fills were removed (corrosion voids, secondary sediment-filled voids, calcite veins, and recrystallised shells) from the samples (only the primary matrix was sampled) intended for mineralogical and geochemical analysis. Samples were homogenised under 100 μm. All drilled samples were also investigated in thin sections. The mineral composition of the stone samples was determined using X-ray powder diffraction (XRPD) on a Philips PW3710 X-ray diffractometer with CuKα1 radiation and a secondary graphite monochromator. Data was collected at 40 kV and a current of 30 mA at a rate of 3.4° 2θ per minute over a recording range of 2–70° (2θ). Diffraction patterns were analysed with X'Pert Highscore Plus 4.6 diffraction software using the PAN-ICSD database. Concentrations of major, minor and trace elements were measured using fusion inductively coupled plasma-mass spectrometry (F-ICP-MS). Precision of the measurements was ensured by observing certified laboratory standards, and accuracy by making duplicate measurements. All reported values deviated by less than 2.15 % from replicate samples.

Isotopic Analysis

Isotopic values for total oxygen ($\delta^{18}O_{total}$) and total carbon ($\delta^{13}C_{total}$) were measured for 38 samples (weight 1 g) of stone products using a Gasbench II coupled to a ThermoFisher Delta V Plus mass spectrometer[13]. Results are reported in δ ‰ (per mil) versus the standard Vienna Peedee Belemnite (VPDB). The reported repeatability of the calibration standards was 0.04 SD for $\delta^{18}O_{total}$ and 0.05 SD for $\delta^{13}C_{total}$ measurements. The effect of diagenesis on isotopic values was checked by cross-plotting $\delta^{18}O_{total}$ and $\delta^{13}C_{total}$ values and comparing them with previously reported values[14].

In total, 22 samples were analysed for strontium isotopes ($^{87}Sr/^{86}Sr$). Measurements were performed using a multi-collector inductively coupled plasma-mass spectrometer (MC-ICP-MS) according to a published laboratory procedure[15]. Each sample was measured three times. All reported $^{87}Sr/^{86}Sr$ ratios were normalised to SRM 987 $^{87}Sr/^{86}Sr = 0.710248$[16]. The external repeatability of $^{87}Sr/^{86}Sr$ in SRM 987 yielded a value of 0.710251 ± 0.000025 (2SD, number of measurements = 30). Strontium isotope ratios were plotted using the locally weighted regression scatterplot smoother (LOWESS) approach[17]. The reliability of the method was confirmed through the analysis of samples collected from outcrops and for which stratigraphic positions were determined using lithostratigraphy and microfossils (e.g. foraminifera).

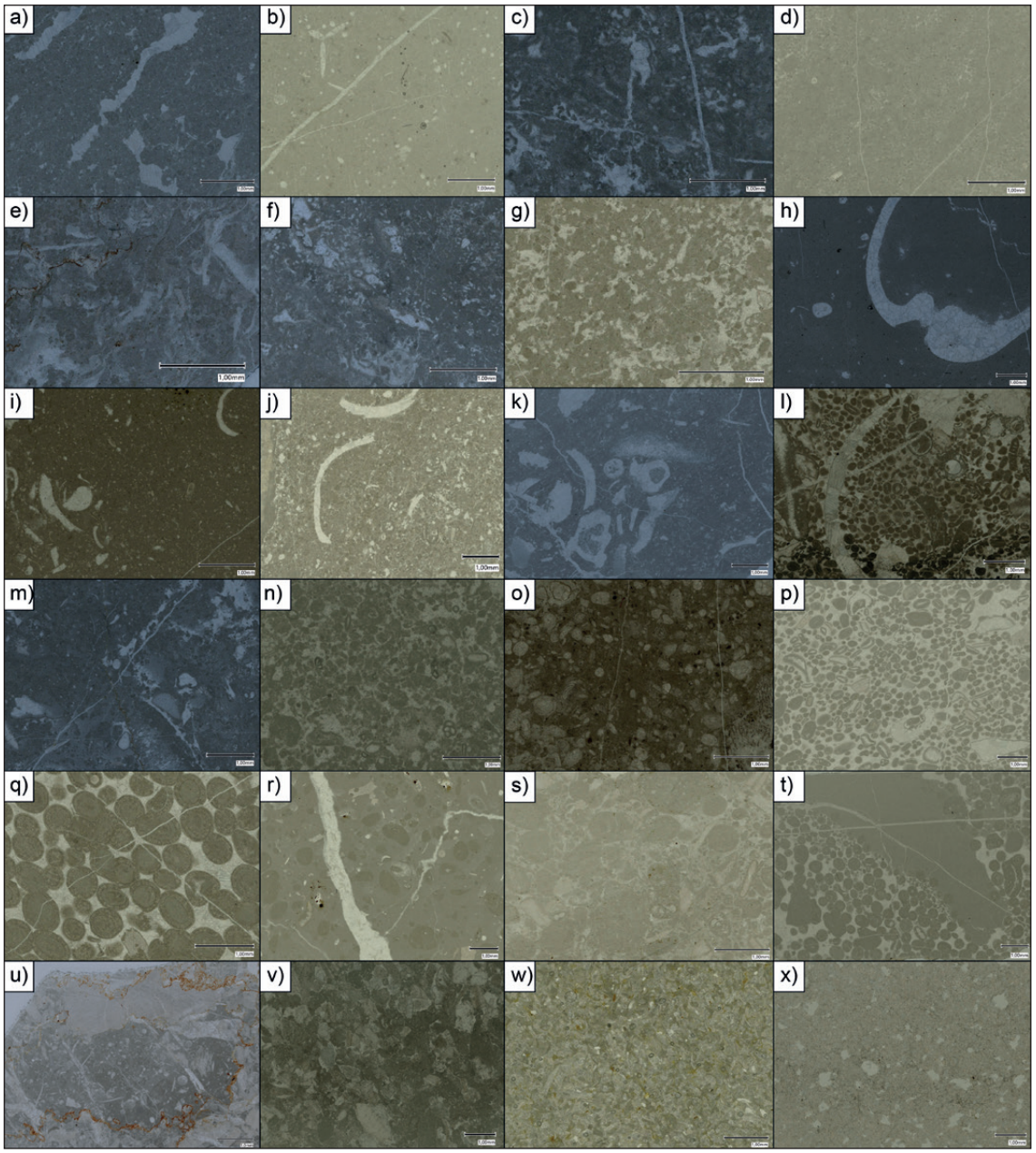
RESULTS

Characterisation of Facies (F) and Microfacies (MF)

The 101 sampled stone products were divided into 7 facies and 32 microfacies types (fig. 2). Three samples contained two or more microfacies types in a single thin section.

Among the stone products, the following facies were determined (fig. 3): calcarenite (F4), i.e. limestone predominantly made of sand-size particles, is the most common, observed in 38 % of all stone products. 33 % of all products are assigned to F1 (fine-grained limestones, i.e. limestone

[13] Rosenbaum – Sheppard 1986; Kim – Mucci – Taylor 2007.
[14] Veizer et al. 1999; Jenkyns et al. 2002; Hamon – Merzeraud 2007.
[15] Romaniello et al. 2015.
[16] McArthur – Howarth – Shields 2012.
[17] McArthur – Howarth – Shields 2012.



2 Microfacies types identified in stone products (graphics: R. Brajkovič, © GeoZS)

composed mostly of grains invisible to the naked eye but clearly recognisable in thin sections). The most common microfacies of this group are MF 1.2 (medium-grey to light-olive carbonate mudstone) and MF 1.6 (peloidal packstone with rare fossils). Bioclastic limestones (F3) are characteristic of 16 % of the studied products, with MF 3.3.1 (light- to dark-grey megalodontid limestone with a carbonate mudstone matrix) being the most common. The other facies groups are only subordinately represented: namely F2 (oncoidal limestones: 6 %), alternation of F1 (fine-grained limestones), F3 (bioclastic limestones) and F4 (calcarenites: 5 %), F6 (dolomites: 1 %) and F5 (lithoclastic limestones: less than 1 %).

Based on the macroscopic lithological characteristics (facies determination), we were able to determine middle Lower Jurassic (Pliensbachian) limestone (presence of lithiotid bivalves), late Lower Jurassic nodular limestone (Toarcian), Middle Jurassic porous dolomites (Aalenian [?]), late Upper Cretaceous biogenic limestones with rudist fragments (Santonian – Campanian) and Middle Miocene Lithothamnium limestone (Laško Formation – presence of coralline red

Age of litho-stratigraphic unit	T_3^{2+3}	J_1^3	J_1^4	$K_{1,2}$	K_2^{4+5}	M_1^2
Biostratigraphie criteria for provenance determination	Foraminifera zone *Triasina hantkeni* (Velić 2007)	Foraminifera zone C_1 (Velić 2007)	Opportunistic foraminifera assemblage and/or species *Mesoendothyra croatica* (Gušić)	Foraminifera zone *Mesorbitolina texana* (Velić 2007)	Foraminifera zones *Keramosphaerina tergestina* in *Calveziconus lecalvezae* (Velić 2007)	Foraminifera families' assemblages Lonatulus, Bolivina, Cibicides, Globigerina, Globigerinoides, Elphidium in Amfistegina

3 Biostratigraphic criteria for provenance determination of microfacies determined in stone products from Emona (data: R. Brajkovič, © GeoZS)

algae, pectinid bivalves, bryozoans). At the microscopic level (see fig. 2 for microfacies names), diagnostic microfacies types are MF 2.1.1, MF 2.1.2, MF 3.2.1, MF 3.2.2, MF 3.3.1, MF 3.3.2, MF 3.3.3, MF 1.2/MF 3.2.1, MF 1.2/MF 3.3.1, MF 1.2/MF 4.3/MF 3.2.1 for the Pliensbachian succession; MF 4.9, MF 4.10, MF 5.2 for the Albian-Cenomanian succession; and MF 4.12 for the Middle Miocene succession.

Biostratigraphic Analysis

Benthic and planktonic foraminifera were identified in thin sections (fig. 4). Based on the occurrence of stratigraphically characteristic foraminifera species and foraminifera assemblages, Late Triassic (Norian – Rethyan), Early Jurassic, Early to Late Cretaceous (Late Aptian – Early Cenomanian) and Late Cretaceous (Late Santonian – Campanian) rocks were identified (fig. 4). Only the families of foraminifera were identified in the stone products belonging to MF 4.12. Determination of the age of the foraminifera assemblage suggests that the rock used for the stone products dates to the middle Miocene.

Cathodoluminescence Analysis

Cathodoluminescence analysis did not provide any further indicative properties for determination of provenance. Only MF 4.6, MF 4.7, and MF 4.8 show uniformly increased luminescence in the matrix and grains. The luminescence spectra belong to manganese (Mn^{+3}) and iron (Fe^{+3}) cathodoluminescence colours, suggesting a redox environment during sedimentation[18] and a common lithostratigraphic origin in the Toarcian succession, as previously determined through macro- and microscopic examinations.

Mineralogical and Geochemical Characterisation

Only the mineral calcite was identified by XRD analyses, indicating the absence of significant terrigenous input or the predominant influence of carbonate production. The geochemical data and basic values of the elements above the detection limit are shown in figure 5. Based on Pearson's linear correlation coefficient, we have divided the major oxides into two components: the carbonate (Ca) component includes CaO, MgO, Na_2O, and MnO, while the non-carbonate component includes SiO_2, Al_2O_3, Fe_2O_3, K_2O, and TiO_2. Based on the differences in the content of the major oxides, only the products of MF 4.6 and MF 4.7 can be significantly distinguished from the others, as these show indicative values for the major oxide SiO_2 in the range of 1.09–1.20 wt %. Moreover, the trace element cerium (Ce) shows an increased mean value for both microfacies (mean value for all stone products together 1.65 mg kg^{-1}; mean value only for MF 4.6 and MF 4.7–5.4 mg kg^{-1}).

18 Flügel 2004; Hiatt – Pufahl 2014.

Age / Element [wt%]		SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	LOI	Sr	Zr	U	Ce
		[wt%]										[mg kg^{-1}]			
	Max.	1.00	0.61	0.29	0.01	1.09	57.39	0.06	0.17	0.03	43.47	490	7.00	4.70	6.20
J_1^2	Min.	0.13	0.06	0.04	0.00	0.41	53.34	0.03	0.01	0.00	41.36	108	2.00	0.40	0.20
+	Aver.	0.44	0.24	0.11	0.00	0.62	55.03	0.04	0.05	0.01	42.49	170	3.85	1.63	2.27
J_1^3	Mean	0.37	0.19	0.09	0.00	0.60	54.86	0.04	0.04	0.01	42.79	149	3.00	1.35	1.65
	Max.	1.20	0.58	0.24	0.01	0.69	56.63	0.04	0.15	0.029	41.65	257	8	2.3	5.8
	Min.	1.09	0.16	0.07	0.01	0.53	55.14	0.03	0.03	0.007	41.18	128	3	0.6	4.5
J_1^5	Aver.	1.16	0.32	0.15	0.01	0.62	55.79	0.04	0.08	0.015	41.43	177	5	1.4	5.2
	Mean	1.19	0.22	0.15	0.01	0.63	55.59	0.04	0.05	0.010	41.45	147	3	1.4	5.4

4 Basic statistical values of geochemically analysed stone products (data: R. Brajkovič, © GeoZS)

Isotopic Characterisation

Values for $\delta^{18}O_{total}$, $\delta^{13}C_{total}$, and $^{87}Sr/^{86}Sr$ are shown in figure 6. All analysed samples show little to no influence of diagenesis on the primality of the isotopic record, as they are all within documented values for Jurassic shallow-water limestones[19] (fig. 6 a). Comparing the analysed maximum and minimum of $\delta^{18}O_{total}$ and $\delta^{13}C_{total}$ values, we note that their ranges overlap between both facies and microfacies. More important for determining the origin is the statistical mean of the $\delta^{13}C_{total}$ values of the individual microfacies. This is 2.94 ‰ for MF 4.6 and 2.52 ‰ for MF 4.7, while the mean value for the other microfacies is, for example, 1.42 ‰ for MF 1.1 (the lowest mean among the defined microfacies), 1.60 ‰ for MF 1.2, 1.59 ‰ for MF 1.5, 1.85 ‰ for MF 1.6, and 2.02 ‰ for MF 3.1.

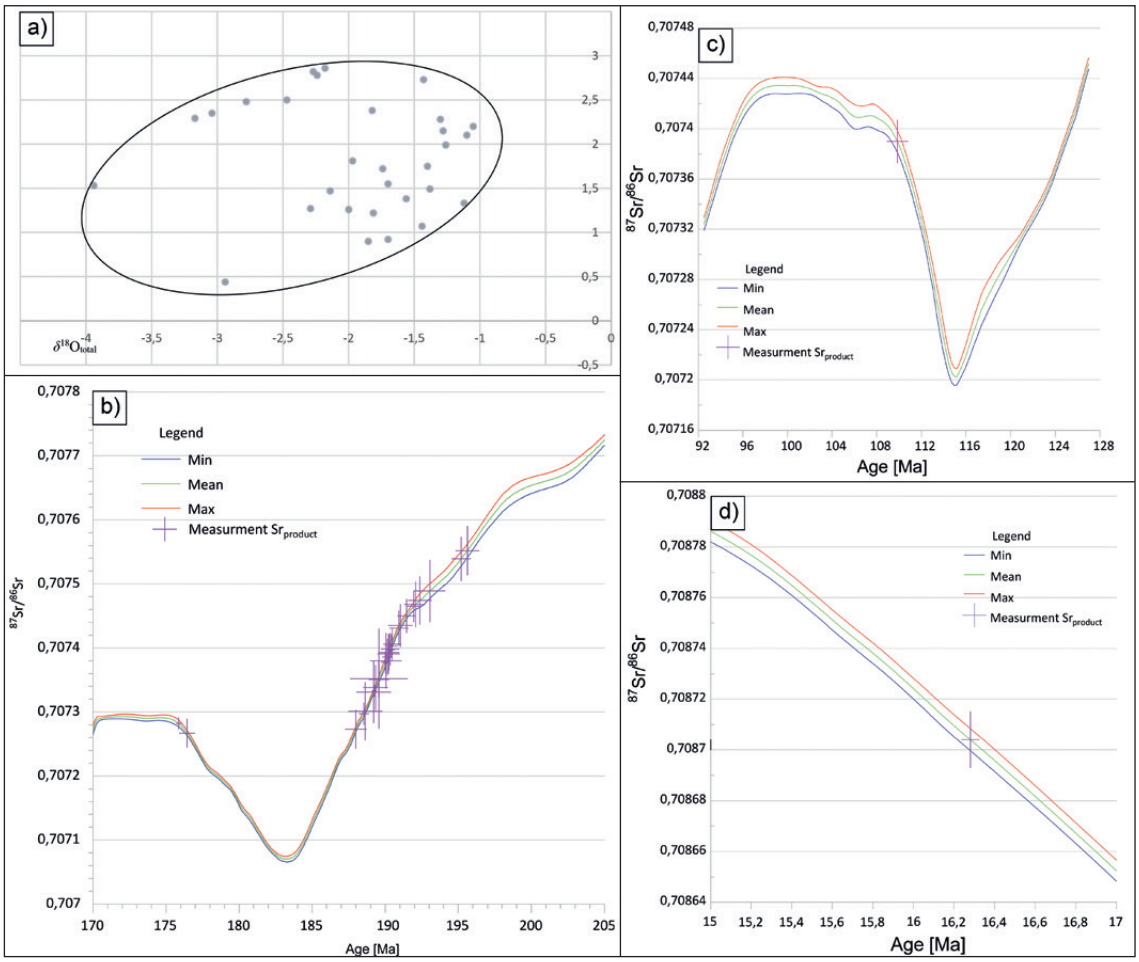
For samples that failed to show any distinction from other samples in the previous steps of the multimethod analysis, determination of strontium isotope values proved to be the only way to determine their stratigraphic position. Such samples are those of F1 (fine-grained limestone) in particular. The strontium values show a distinct grouping of stone products within the Sinemurian – Toarcian part of the Lower Jurassic samples. A large portion of the analysed samples is grouped in the Early Pliensbachian succession based on Strontium isotope stratigraphy (SIS), while smaller groups are identified in the Middle Sinemurian, Middle Pliensbachian, and Toarcian successions (fig. 6 b). Furthermore, we were able to constrain the age of the stone product MGML S0079977 better, biostratigraphically defined as Late Aptian – Early Cenomanian, and the age of the stone product MGML 52835, placed in the Middle Miocene; the former was placed in the Albian (fig. 6 c) and the latter as Early Badenian in age (fig. 6 d).

DISCUSSION

Criteria Used to Distinguish the Provenance of the Studied Stone Products in the Lithostratigraphic Units

The criteria used to classify the studied stone products into specific lithostratigraphic units are presented in figure 7. They follow the proposed multimethod methodology and are based on macroscopic and microscopic examination as the first step, biostratigraphy and cathodoluminescence in the second steps, and geochemical factors in the third step. This provides criteria for the lithostratigraphic classification of F1 (fine-grained limestones), F2 (oncoidal limestones), F3

19 Veizer et al. 1999; Jenkyns et al. 2002; Hamon – Merzeraud 2007.



5 $\delta^{13}C_{total}$ and $\delta^{18}O_{total}$ measurements, plotted on a scatter plot and global LOWESS curve from J. M. McArthur (McArthur – Howarth – Shields 2012; McArthur et al. 2016) with placement of the analysed stone products according to $^{87}Sr/^{86}Sr$ measurements. Each $^{87}Sr/^{86}Sr$ result shows the standard deviation of the measurement on the x-axis and the calculated confidence in the measurement on the y-axis. a: $\delta^{13}C_{total}$ and $\delta^{18}O_{total}$ values of stone products. Grey circles represent individual samples. Grouping is shown by the best-fit ellipse. b: Placement of products from the Early Jurassic age. c: Placement of analysed product from the Mid-Cretaceous age. d: Placement of analysed product from the Miocene (Badenian) age (graphics: R. Brajkovič, © GeoZS)

(biogenic limestones), F4 (calcarenite), F5 (lithoclastic limestones), and F6 (dolomites) used to produce the Roman stone products in Emona.

Interpretation and Discussion of the Provenance of the Studied Stone Products

The lithostratigraphic provenance of each stone product studied is shown in figure 8.

For the first time, we were able to identify one product (MGML 62779) made from Upper Triassic Dachstein limestone. The source of this limestone remains unknown. However, the Dachstein limestone outcrops in the immediate vicinity of the possible ancient quarries at Podutik, so this area could consequently represent the potential source.

None of the stone products is placed in the Early Jurassic (Hettangian – Early Sinemurian) limestone succession. Five stone products (1.7 %) are classified in the Middle Sinemurian based

Lithostratigraphic units	Indicative values identified to distinguish between lithostratigraphic units detected in Roman stone products						
	Facies	Microfacies	Biostratigraphy	Cathodo-luminescence	Mineralogy	Geochemistry	Strontium isotopes
Late Triassic Dachstein limestone –T_3^3	Indicative macroscopic properties not identified	MF 4.1	Foraminifera zone *Triasina hantkeni* (Velić 2007)	The grains have a bright orange and the matrix a dark brownish red luminescence	Indicative values not identified	Indicative values not identified	0.707709–0.707673
Hettangian to Middle Sinemurian limestone – $J1^{1,2}$	Indicative macroscopic properties not identified	Indicative microfacies not identified	Indicative foraminifera not identified	Indicative values not identified	Indicative values not identified	Indicative values not identified	0.707633–0.707537
Middle to Late Sinemurian limestone – J_1^2	Indicative macroscopic properties not identified	Indicative microfacies not identified	Indicative foraminifera not identified	Indicative values not identified	Indicative values not identified	Indicative values not identified	0.707537–0.707430
Late Sinemurian to Early Pliensbachian limestone – $J_1^{2,3}$	Sedimentary grains: small megalodontid bivalve	MF 2.1.2; MF 2.1.3; MF 3.2.1; MF 3.2.2; MF 3.2; MF 3.3.1; MF 3.3.2; MF 3.3.3	Foraminifera zone C_1 (Velić 2007)	Conar recrystallisation of larger biogenic shells	Indicative values not identified	Indicative values not identified	0.707430–0.707315
Pliensbachian limestone – J_1^3	Sedimentary grains: small megalodontid bivalve	MF 2.1.2; MF 2.1.3; MF 3.1; MF 3.2.1; MF 3.2.2; MF 3.2; MF 3.3.1; MF 3.3.2; MF 3.3.3	Foraminifera zone C_1–C_2 (Velić 2007)	Conar recrystallisation of larger biogenic shells	Indicative values not identified	Indicative values not identified	0.707315–0.707245
Toarcian limestone – J_1^4	Nodular bedding	MF 4.5; MF 4.6; MF 4.7	Opportunistic foraminifera assemblage and/or species *Mesoendothyra croatica* (Gušić)	Uniform orange-yellow luminescent colour both in the grains and in the matrix	Indicative values not identified	SiO_2> 1.09%	Indicative values not identified
Middle Jurassic dolomite and limestone – J_2	Dolomite	MF 6.1	Indicative foraminifera not identified	Indicative values not identified	Indicative values not identified	Indicative values not identified	No analyses carried out
Lower Flyschoid Formation – $K_{1,2}$	Colour: N6 and 5YR 6/1 Sediment grains: black rudists fragments up to 1 mm in size	MF 4.8; MF 4.9	Foraminifera zone *Mesorbitolina texana* (Velić 2007)	Indicative values not identified	No analyses carried out	No analyses carried out	No analyses carried out
Upper Cretaceous Lipica Formation – $K_2^{4,5}$	Bioclasts of rudists and crinoids stand outon weathered surfaces	MF 4.10	Foraminifera zones *Keramosphaerina tergestina* in *Calveziconus lecalvezae* (Velić 2007)	Indicative values not identified	No analyses carried out	No analyses carried out	0.707522–0.707429 (Maritan 2003)
Badenian Lithotamnian limestone – M_2^1	Colour: 5Y 7/2 – IOYR 8/2 Sediment grains: Lithotamnian algae	MF 3.4; MF 4.11	Foraminifera families' assemblages Lonatulus, Bolivina, Cibicides, Globigerina, Globigerinoides, Elfidiji in Amfistegine	Indicative values not identified	No analyses carried out	No analyses carried out	No analyses carried out

6 Indicative properties or values useful for classifying Roman stone products into lithostratigraphic units. The green colour denotes an indicative property/value that can be used to identify provenance while the red colour indicates analyses that did not yield indicative values/properties useful for identifying the origin of the investigated limestone products (data: R. Brajkovič, © GeoZS)

on their unique chemostratigraphic values. Possible quarries for these limestones are Podutik[20] or Staje[21]. However, the limestone succession at Podutik does not yield corresponding chemostratigraphic values[22]. A large portion of the products previously assigned to the Hettangian to

20 Ramovš 1990.
21 Rožič et al. 2018.
22 Brajkovič – Žvab Rožič – Gale 2021.

Lithostratigraphic units	Inventory numbers of the studied stone products	
Dachstein limestone – T_3^{2+3}	MGML62779	
Upper Triassic to Lower Jurassic limestone – $T_3 – J_1$	MGML 61457; NMS L56; NMS L227; KL 2; KL 4; KL 6; MGML EMN 22; MGML 60204; MGML EMN 7; MGML 57730	
Lower Jurassic limestone – J_1	NMS Ll66; NMS Ll60; NMS L225; NMS L228; NMS L253; NMS L255; NMS LI; NMS L5; NMS L4; KL 8; LJ 8; LJ 19; NMS Ll87; LJ 24; MGML 97928; MGML D0008711; MGML 52830; MGML 48557; MGML 51185; LJ 26; MGML EMN 12; MGML 59818; NMS L84; NMS L36; NMS L58; NMS L48; NMS L42; NMS L226; NMS U2b_L77; NMS L258; NMS L260; NMS L269b; NMS L252; NMS Lorica6; MGML EMN 5; MGML 57735; MGML EMN 8; MGML EMN 6	
Lower to middle Sinemurian limestone – $J_1^{1,2}$	Facies, microfacies and biostratigraphy	Multimethod
	/	MGML 52832; MGML 60205; MGML 60177; NMS L250-pokrov; MGML 51187
Upper Sinemurian to Lower Pliensbachian limestone – $J_1^{2,3}$	Facies, microfacies and biostratigraphy	Multimethod
	MGML 42248; MGML 60176; MGML 48593; MGML 52171; MGML 60213; NMS L250-skrinja; NMS L236; NMS L229-kapitel; NMS L231; NMS L259; NMS L265-skrinja; NMS L270; NMS L271; NMS L272; KL 5; NMS L201; NMS L62; NMS Ll98; MGML PN 6044 3/3; MGML S0078887; NMS Ll41; NMS L78; NMS L40; NMS L239; NMS L229-steber; LJ 23; MGML 59816; MGML 48560; MGML 52833; NMS Ll88; LJ 25; MGML EMN 2; MGML PN 6048; MGML 42024; MGML 48566; MGML 60207; MGML 60183; MGML 59824; NMS L35; NMS L35A; NMS L54; NMS L85; NMS L83; NMS L71; NMS L31; NMS L235; NMS Ll91; MAX 4; KL I; LJ 16; LJ 18; GM 1; NMS 76; MGML 57722; MGMLEMN l; MGMLEMN 13A; MGMLEMN 13B; MGML EMN 4; MGML D0008724; MGML PN 7050 (2); MGML 57729; MGML 57724; MGML 57733; MGML PN 6060; MGML PN 6061 2/2; MGML PN 6061 1/2; MGML PN 6050; MGML 57728; MGML EMN 26; MGML 57731; MGML 47125; MGML 60203; NMS Ll44; NMS L39; NMS L209; LJ 9; LJ 20; MGML 57725; MGML 57727; MGML 60209; MGML 63840; NMS Ll23; NMS L203; NMS L88; NMS L87; NMS L239-pokrov; NMS L210; MGML plošča grob 3031 (3402); NMS L192; NMS LI 89; NMS Lorica2; NMS Lorica3; NMS Lorica7; LJ 12; LJ 27; GM 2; MGML 60210; MGML 48565; MGML 62390; NMS Ll47; NMS Ll64; NMS L257; NMS L261; NMS L267; MGML PN6056; MGML 60182; MGML 60191; MGML 60180; NMS L32; NMS L37; NMS L224; MAX 1; MAX 2; MAX 3; KL 7; MGML 60184; MGML 60175; MGML 60202	MGML 48592; MGML 51180; MGML 60216; MGML 5118l; NMS L25 l; MGML 48572
Pliensbachian limestone – J_1^3		MGML 62786
Toarcian limestone – J_1^4	MGML 61457-pokrov; NMS L45; NMS L208; MGML 52831; MGML 51182; MGML 60174; MGML 60189	
Middle Jurassic dolomite and limestone – J_2	NMS L63; NMS L34; NMS L61; NMS L60; MGML EMN 20_pN 6043; MGML EMN 42_5998	
Mid- Cretaceous Lower Flischoid Formation – $K_{1,2}$	MGML 60206; MGML 59817; MGML 51183; MGML 53255; MGML 48568; MGML 60192; MGML 51179; MGML 55255; MGML 61375; NMS L64; NMS L70; NMS L67; NMS L49; NMS L230; NMS L232; NMS U2a_L77; NMS L256; NMS L256a; NMS L265-pokrov; MGML 57721; MGML EMN 34; MGML SOi 11023; MGML S0106043; NMS L254; NMS L268; NMS Ll65; MGML PN9102/l; MGML PN 9102/2; MGML PN 9102/3; MGML PN 9102/4; MGML PN 9101; MGML S0079972; MGML 57736; MGML 59819; MGML 60208; KL 3; MGML S0097931; MGML 48569; MGML 57726; NMS L263; NMS L264	
Upper Cretaceous Lipica limestone – $K_2^{4,5}$	MGML 60206; MGML 59817; MGML 51183; MGML 53255; MGML 48568; MGML 60192; MGML 51179; MGML 55255; MGML 61375; NMS L64; NMS L70; NMS L67; NMS L49; NMS L230; NMS L232; NMS U2a_L77; NMS L256; NMS L256a; NMS L265-pokrov; MGML 57721; MGML EMN 34; MGML SOi 11023; MGML S0106043; NMS L254; NMS L268; NMS Ll65; MGML PN9102/l; MGML PN 9102/2; MGML PN 9102/3; MGML PN 9102/4; MGML PN 9101; MGML S0079972; MGML 57736; MGML 59819; MGML 60208; KL 3; MGML S0097931; MGML 48569; MGML 57726; NMS L263; NMS L264	
Badenian Lithotamnian limestone – M_2^1	NMS L79; MGML 61613; MGML 51184; MGML 79966; MGML 59823; MGML 42079; MGML 52834; MGML 52835; NMS L80; NMS L44; NMS L59; LJ 10; LJ 15.1; LJ 15.2; LJ 15.3; LJ 15.4; LJ 15.5; LJ 15.6; LJ 15.7	
Lithostratigraphic undetermined stone products	MGML 48567; MGML 48575; NMS L52; NMS L38; NMS L47	

7 Lithostratigraphic provenance of stone products found in Emona. a: Proportion of each lithostratigraphic unit represented in the stone products. b: List of lithostratigraphic provenance of the investigated stone product (data: R. Brajkovič, © GeoZS)

Middle Sinemurian succession at Podutik[23] was reassigned to the Lower Flyschoid Formation based on microscopic and biostratigraphic studies[24]. The results presented in this paper show that a small proportion of F1 (fine-grained limestones) also originate from this part of the succession, as shown using the SIS approach. Even if the stone products found in Emona include some stone products from the Podutik area, their share in the whole of the corpus is far smaller than previously thought – which fact refutes the larger role of the possible Roman Podutik quarries in supplying Emona with stone.

As much as 44 % of the studied stone products can be placed in the Late Sinemurian – Early Pliensbachian limestone succession. The possible source of this limestone is the quarry located in today's village of Podpeč, where the succession contains the same set of facies and microfacies, and bears the same isotopic imprint[25], while new quarries in the area, previously only suspected[26], can be proposed based on the groupings of the $^{87}Sr/^{86}Sr$ values in the Middle and Upper Pliensbachian. The analysis also revealed that the Toarcian parts of the successions were used to produce stone products. These parts of the Lower Jurassic succession outcrop only in an easily accessible location in the Podpeč area, and therefore overwhelmingly represent the most probable area of origin in the entire local and regional radius. Only one stone product found in Emona (MGML 62786) was classified as part of the Pliensbachian succession, while seven stone products (2.1 % of all studied stone products) found in Emona were determined as having their origin in the Toarcian part. As indicated in the publication by B. Djurić[27], quarrying also likely took place in the upper part of the succession in Podpeč, which belongs to the Middle Jurassic (2.1 % of all studied stone products). This was recognised for stone products of porous dolomite, which are indicative of the Middle Jurassic lithostratigraphic unit.

The closest known outcrops that correspond in terms of facies to the studied mid-Cretaceous limestones detected in the stone products are connected to Emona via the navigable part of the river Sava[28] and are located near the town of Medvode[29]. Some 15 % of all studied stone products belong to this group, the age of which was further constrained to the Albian using the SIS approach. The age correlation using the SIS approach shows a better agreement with the newly re-examined biostratigraphic data from the Lower Flyschoid Formation[30].

The investigated products originating in the Upper Cretaceous age correlate closely with the lower parts of the Lipica Formation (upper part of the Aurisina limestone). Almost 10 % of the products are placed in this succession, and likely originate from the known Roman quarry sites in Aurisina/Nabrežina[31].

Doubts about the origin of the Roman stone products from the Moravče area were raised in work by B. Djurić and I. Rižnar[32] based on the absence of facies algal floatstone to the bindstone present in stone product NMS L79. In the same work, they also show a polygon-like area suitable for Roman exploitation observed in the Moravče area. Preliminary geological investigations carried out as part of this work have shown that both facies detected in the Roman stone products found in Emona also occur in the Moravče area. They are predominantly made of lithic limestones of Middle Miocene (Lower Badenian) age and represent 7 % of all stone products studied. The origin of these facies in the Tunjice area was excluded based on previous studies[33]. Alternatively,

23 Šašel Kos 1997.
24 Brajkovič et al. 2023.
25 Brajkovič – Gale – Djurić 2022; Djurić – Gale – Brajkovič 2022.
26 Djurić – Gale – Brajkovič 2022.
27 Djurić – Gale – Brajkovič 2022.
28 Umek 1986; Gaspari 2012.
29 Brajkovič et al. 2023.
30 Schlagintweit – Gerčar – Rožič 2024.
31 Previato 2018.
32 Djurić – Rižnar 2017.
33 Vrabec 2000; Vrabec – Brajkovič – Skaberne 2014.

both facies could originate from the Tuhinj Valley or from outcrops several kilometres east of the Moravče area, though this interpretation seems less plausible as such excavation work would require longer transport times and thus involve higher costs.

Only 17 % of all studied stone products were not placed in a specific lithostratigraphic unit. These products were only studied at the macro- (due to sampling limitations) or microscopic levels (due to financial limitations). A multimethod approach should be used in the future in order to place them in a unique lithostratigraphic unit.

CONCLUSIONS

In the systematic inventory of Roman stone products, all facies and microfacies limestone types in the collections of the Ljubljana Museums and Galleries, the National Museum of Slovenia and products exhibited in the open air (or incorporated into buildings) were logged. The lithostratigraphic origin has been successfully determined for all stone artefacts studied, and the certainty of said determinations is greatly increased by the use of the proposed multimethod approach. In this paper, the indicative factors used to determine provenance are presented, ranging from macroscopic and microscopic to geochemical and isotopic factors.

Those stone products that were previously determined as originating from the Podutik area were largely assigned to the Lower Flyschoid Formation present in Medvode and to the Pliensbachian lithostratigraphic unit present in the Podpeč area. Only two products have strontium isotope values that could be expected in the Podutik area. One stone product was assigned with increased certainty to the succession of the Dachstein limestone lithostratigraphic unit that outcrops in the Podutik area; however, it could also have originated in another, unknown location. This disproves the larger role of the Podutik quarry in supplying Emona with stone, as was previously suggested by A. Müllner[34] and A. Ramovš[35].

The origin of the stone products from the Podpeč area has been methodologically proven. The methodologically supported determinations also allow us to classify them within the Pliensbachian succession of this area. For the first time, we have determined the origin of the stone products from the lithostratigraphic unit of the Toarcian limestones and the Middle Jurassic.

The origins of the Cretaceous rock(stone [?]) products in Emona are not uniform. The first group belongs to the Lower Flyschoid Formation, likely from a Roman quarry near Medvode, while the second comes from known Roman quarries in Aurisina/Nabrežina, which belong to the lower part of the Lipica Formation.

The lithostratigraphic unit of Lithotamnian limestone was also used to produce stone products. Based on the data obtained, the Moravče area represents a probable to very probable quarrying area of the Badenian lithic limestone for the supply of stone to Emona, although the exact quarrying area cannot be specified based on the data obtained thus far.

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[34] Müllner 1879.
[35] Ramovš 1990.

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LICHENOMETRIC DATING OF ROCK SURFACES IN ANCIENT QUARRIES

A CASE STUDY ON TINOS ISLAND (GREECE)

Abstract
Lichenometry is a method that provides age estimates for the exposure of various substrata like rock surfaces or stone constructions. Dating surfaces by measuring radial growth rates of lichens was developed in the 1950s by the Austrian botanist Roland Ernst Beschel. By establishing a growth curve using measurements of lichen thalli on substrates of known age (bridges, gravestones, abandoned farms, etc.), the growth rate of a species can be calculated and used to estimate the age of a lichen on a surface of unknown age. This method of dating stone and rock surfaces has the potential to answer archaeological questions, such as the last activities in abandoned quarries. A case study in an ancient quarry of serpentinite on the Greek island of Tinos will be presented to evaluate the lichenometric dating method. The results are preliminary, as the research is still ongoing.

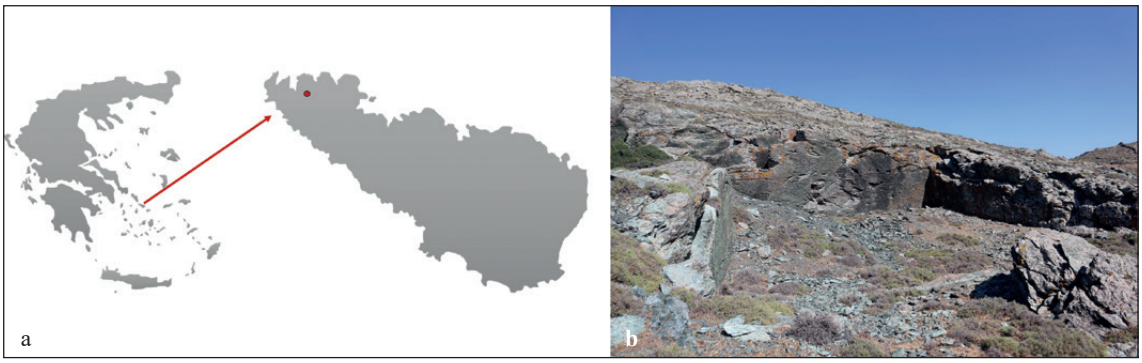
INTRODUCTION

Lichens are symbiotic associations, comprising a fungus and a photosynthetic partner in the form of green algae or cyanobacteria. These organisms inhabit various substrates, such as soil, tree bark or rock surfaces. Their morphology differs greatly, and three main growth forms can be differentiated: fruticose, with a shrub-like appearance; foliose, with a leafy thallus (body); and crustose, with the thallus adpressed on the substrate[1]. Many crustose lichens inhabit rock surfaces, where water is limited and thus their growth rate is very slow. Life spans of centuries and even a few thousand years can be reached, especially in alpine, arctic or arid climates[2].

Longevity and radial growth of lichens on rock surfaces is the prerequisite for age estimations – a method called lichenometry. Lichenometric dating is based on the following hypothesis: the largest lichen on a rock is, potentially, the oldest individual, having the same age as the exposure of the rock surface. By establishing a growth curve using measurements of lichens on substrates of known age (bridges, gravestones, abandoned farms), the growth rate of a species can be calculated and used to estimate the age of a lichen on a surface of unknown age[3].

Lichenometric dating was developed in the 1950s by the Austrian botanist Roland Ernst Beschel. The initial objective was to date glacial rock deposits (moraines)[4]. Soon afterwards, it was used in many other disciplines, such as the dating of earthquake-generated rock falls[5], fault

1 Masuch 1993.
2 Beschel 1950; Armstrong – Bradwell 2010; Armstrong 2015.
3 See e.g. Beschel 1950; Beschel 1955; Beschel 1961; Locke – Andrews – Webber 1979; Innes 1985a; Armstrong 2016.
4 Beschel 1950.
5 Bull – Brandon 1998; Pérez-López et al. 2019.



1 a: Tinos Island, with the location of the Ras quarry indicated by the red dot. b: Overview of the Ras serpentinite quarry (graphics and photo: T. Jakobitsch)

scarp formations[6], and sea-level changes[7], as well as in archaeology for dating stone-made monuments and structures[8], or for dating the last activities in quarries[9].

Lichenometry is based on the biological fact that certain lichen species soon colonise rock surfaces that have suddenly been exposed[10]. After an establishment phase, a relatively fast-growing period starts (›great period‹), which is finished after a few decades. What follows is a slow but constant radial growth, lasting for centuries[11]. It has been observed that growth rates are mostly influenced by water supply and that substrate lithology and the orientation of the thallus (vertical or horizontal) do not influence growth[12].

Useful measurements for lichenometry are evaluating the single largest lichen (LL) on a surface, the mean of several largest lichens, percentage-cover measurements or size-frequency distribution[13]. Since lichen population dynamics, mortality in lichens and factors influencing their growth are still not fully understood, many scholars have agreed that lichenometry is not suited to giving an absolute chronology for an exposed surface but rather an estimation of the minimum age of exposure. However, this method could still provide an estimate when no other method can be applied[14].

For studying ancient quarries, lichenometric dating might be a helpful tool to estimate the time of their last extraction phase[15]. It is especially useful when no other indications for the last use such as tool-marks, tools, or stone artefacts are present. After the exposure of an extracted rock surface in a quarry, lichen species might colonise the rock if it remains undisturbed, as is the case when a quarry has been abandoned.

In this paper, we present the use of lichenometry in an ancient serpentinite quarry on Tinos Island in Greece. The quarry lacks datable traces (tools), and so far no artefacts from this location have been found or identified. The rock surfaces in the quarry are inhabited by different lichen species, of which one has been chosen for measurements, and this will be calibrated against lichen size measurements from surfaces of known age.

6 De Guidi et al. 2019.
7 Birkenmajer 1981.
8 Follmann 1965; Broadbent – Bergqvist 1986; Meyer 2021.
9 Benedict 2009.
10 Masuch 1993; Armstrong – Bradwell 2010; Armstrong 2016.
11 Beschel 1950; Beschel 1955; Innes 1985a; Benedict 2009.
12 Innes1985b; Benedict 2009.
13 Innes 1985a; Masuch 1993; Benedict 2009; Armstrong 2015.
14 Osborn et al. 2015; Rosenwinkel et al. 2015.
15 Benedict 2009.

MATERIALS AND METHODS

Study Area

The quarry under investigation is situated on Tinos Island in the Cyclades archipelago in Greece (37°39‘34“ N, 25°0‘34“ E; 220 m asl) (fig. 1 a–b). With a surface of 197 km², Tinos is the third biggest island of the Cyclades complex. The geology of the island is dominated by metamorphic rocks and igneous rocks, and quaternary sediments also occur[16]. The climate in Tinos is characterised by very low precipitation (465 mm), yet Tinos still has a higher level of humidity during the arid period than other islands in the Cyclades (e.g. Naxos: 366.8 mm). The relative humidity varies from 65 % to 70 %. Northern winds prevail on the island throughout the year, and wind frequency is at its highest during the summer[17].

In the case of Ras quarry, only two pits can be observed, and no modern activity can be seen. Pit A is the larger, and it is the one with the surviving tool-marks, examples of which will be mentioned below. Pit B is smaller, and no extraction traces (ancient or modern) can be observed. The northern façade of Pit A is one of the best-surviving areas with ancient tool-marks of the whole quarry. Parallel pick-lines can be observed. However, it is very interesting that the lines follow the natural rock characteristics, and the marks change their orientation according to this aspect. The approximate length of the wall is 10.5 m and the maximum height is 2 m. A line of holes can be observed at approx. 2.5 m from the surface. These marks on the eastern wall were possibly made for a scaffolding mechanism. Two piles of debris can be seen in the southwestern part of the pits. The transport would have been completed by sea or land. The great advantage of quarries that are closer to the sea is that both long-distance and short-sea shipping is cheaper than transport over land[18].

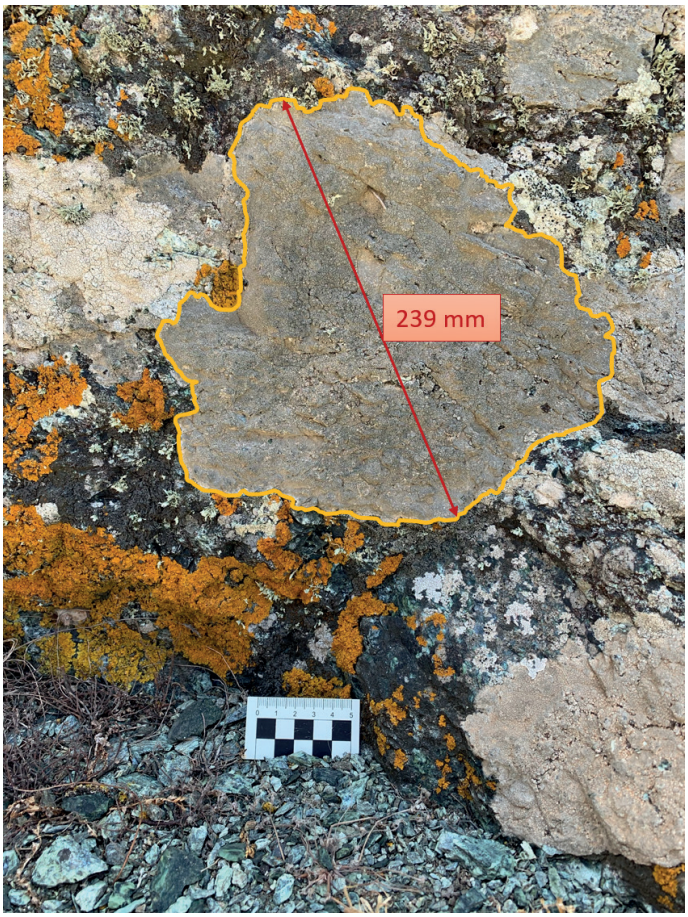
Measurements

The quarry was visited in June 2021 and June 2022. After an overview recording of lichen species and percentage cover of lichens on the quarry’s façades, the largest lichen specimen (LL) was determined. It was crucial that the chosen specimen be of circular or near-circular shape to exclude multiple thalli that have grown together and appear as one single thallus. Another precaution to exclude composite thalli was investigating the specimen with a hand lens, looking for regular patterns in the areolae. When a suitable specimen was found, the maximum diameter (longest axis) was measured, following the methodology of J. L. Innes[19]. Lichens can be slowed down in their expansion in one direction, but the growth can never be sped up. It therefore makes sense to measure the largest diameter[20]. For measurements, a digital caliper was used. The LL was identified using field identification literature[21], and a small sample of thallus tissue was taken for later laboratory identification (microscopic and chemical) in order to verify the field identification.

To evaluate the growth rates of the species, surfaces of known age were chosen from locations near the quarry. This part of data collection is still in progress. Nevertheless, preliminary results will be presented below.

Suitable surfaces in the immediate vicinity of the quarry are rare, and only two gravestones have been found[22]. In order to establish secure results, a comparison with surfaces from other islands was undertaken, i.e. two surfaces from Naxos Island. The LL on the reference surfaces of known age

16 Evelpidou et al. 2005.
17 Theocharatos 1978.
18 For a detailed geological and archaeological study, see A. Sideridis – V. Anevlavi – C. Hauzenberger – S. Tombros – V. Boumpoulis – P. Koutsovitis – A. Aggelopoulou, in this volume.
19 Innes 1985a.
20 Locke – Andrews – Webber 1979.
21 See e.g. Asta et al. 2016.
22 Further data from the island of Tinos are constantly being collected in order to refine the growth model.



2 Measurement of the largest lichen (LL), in this case of the species *Aspicilia intermutans*, which is present on the northern façade of the quarry (photo: T. Jakobitsch)

were measured and the data were entered in an age-size plot. The linear trend line in the plot gives an estimation of the lichen growth rate for the species[23]. Assuming that the growth rate stays more or less constant, the age of the LL in the quarry can be estimated using the known growth rate.

RESULTS

At the quarry, heavy lichen growth is present on the north-facing vertical surface, as well as on horizontal surfaces. The south- and east-facing surfaces are mostly free of lichens. The percentage cover of lichens on the north-facing vertical surface is at a minimum of 50 %[24].

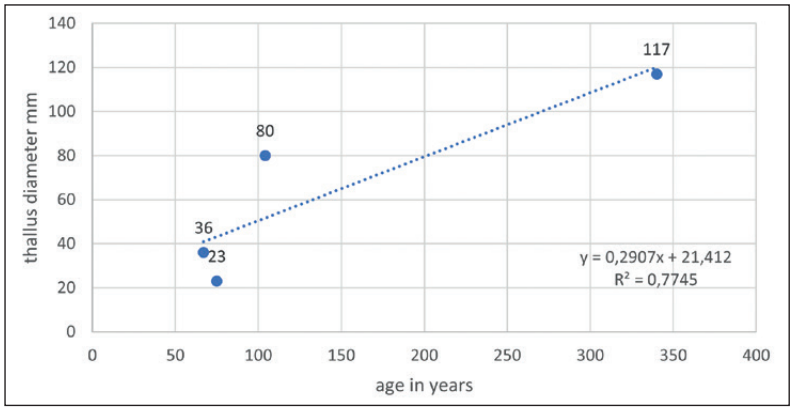
The largest lichen specimen within all quarry façades was measured with a maximum diameter of 239 mm (longest axis) (fig. 2). The lichen measured was identified as *Aspicilia intermutans* in the field as well as in the laboratory. Reference measurements (LL) of the same species on surfaces of known age are shown in table 1.

The linear trend line in the age-size plot for *Aspicilia intermutans* is shown in figure 3. It gives an estimate of the radial growth rate per year ($RGRa^{-1}$) of 0.29 mm. Therefore, a calculated age of the LL in the quarry would be about 822 years, or roughly estimated 800 years.

[23] See e.g. Maas – Macklin 2002.
[24] For determination, see appendix I in Locke – Andrews – Webber 1979.

	Aspicilia intermutans	
	Diameter (mm)	Age (yrs)
Tinos: Ismail 1 (gravestone)	80	104
Tinos: Ismail 2 (gravestone)	23	75
Naxos: Apano Kastro (boundary stone)	36	67
Naxos: Kalamitsia (monastery roof)	117	340

Table 1 Reference measurements (LL) of *Aspicilia intermutans* on surfaces of known age. Ongoing research will add more data to establish a more precise growth curve



3 The linear trend line in the age-size plot for *Aspicilia intermutans*, based on four reference measurements. It gives a preliminary (!) estimation of the radial growth rate per year of 0.29 mm, assuming relatively constant growth (graphics: T. Jakobitsch)

DISCUSSION AND CONCLUSIONS

Following the statement by J. B. Benedict[25] that the method of the largest lichen (LL) is the best-suited one to date the last activities in quarries, the results of this study would suggest the last use of the Ras serpentinite quarry at least 800 years ago. In theory, the quarry has remained untouched at least since the 13th century AD. However, some considerations have to be evaluated, in combination with the addition of new data, to make this statement acceptable.

The climate of Tinos (and of the Cyclades in general) is arid, with precipitation being low, especially during the summer months[26]. Since water is the limiting growth factor, high life spans of centuries or even more can be reached in arid climates[27]. The climatic growth limitation makes the study area suitable for lichenometric dating.

Lichen growth in the quarry seems to be best on surfaces that retain moisture best, which are the north-facing façade and horizontal surfaces. South- and east-facing vertical surfaces are lichen-free due to immediate water run-off and direct solar irradiation resulting in drought (and probably heat stress). Indeed, water seems to be the main limiting factor affecting growth. However, this also implies a problem with the method: since only one façade of the quarry shows

25 Benedict 2009.
26 Theocharatos 1978.
27 Beschel 1950; Armstrong – Bradwell 2010; Armstrong 2015.

lichen growth and two façades are lichen-free, the result of the age estimation applies to the lichenised façade only. Quarrying could still have been practised on the other façades. Including lichenometric dating of the extraction debris around the quarry could be one possible way to overcome this problem[28]. It will be considered in future data collection.

More data are a desideratum in this case study in general, as already mentioned above. In particular, reference measurements of surfaces of known age are needed. In future, further measurements should be taken in the close vicinity of the quarry, or at least solely on Tinos Island, since precipitation varies from island to island in the Cyclades (Tinos: 465 mm; Naxos: 366.8 mm)[29]. Growth rates in different environments may vary and are not applicable for establishing a growth curve for age estimations in another environment[30]. The need for regional homogeneity in reference measurements for establishing a growth curve has also been observed by P. D. Hughes[31].

In consideration of the factors mentioned above, this study will be continued. Many research studies have successfully shown the value and applicability of lichenometric dating[32], and results have also been verified in combination with other dating methods, such as dendrochronology[33], or radiocarbon dates and artefact chronologies[34].

It can be stated that lichens are a useful relative age discriminator, which can be used for the estimation of minimum surface ages when no other methods can be applied. Lichenometry could therefore be an appropriate method to be added in multi-approach dating for quarries, or, as it is in the case of the Ras quarry, the only applicable method providing estimates of the time of last extraction.

ACKNOWLEDGEMENTS

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Following the (α)[35] relevant decision with which the undersigned, together with the Curator of Antiquities of Tinos, Dr. Anastasia Angelopoulou, were permitted to study and publish the current study of Ras, Tinos Island.

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28 Benedict 2009.
29 Theocharatos 1978.
30 Osborn et al. 2015.
31 Hughes 2007.
32 See e.g. Beschel 1950; Bull – Brandon 1998; Hughes 2007; Benedict 2009; De Guidi et al. 2019; Pérez-López et al. 2019.
33 Maas – Macklin 2002; Kluthe – Guiccioni – Stephenson 2018.
34 Meyer 2021.
35 α). ΥΠΠΟΑ/ΓΔΑΠΚ/ΔΙΠΚΑ/ΤΕΕΑΕΙΣΘΔΣΟ/232868/24-6-2021.

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Aurora Peţan

LOST IN THE FOREST AND FOUND BY LiDAR

THE PRE-ROMAN LIMESTONE QUARRIES AT MĂGURA CĂLANULUI (ROMANIA)

Abstract
The limestone quarries on Măgura Călanului Hill (Romania) were the main source of stone for the capital of the Dacian kingdom and the fortresses around it, which functioned from the middle of the 1st century BC to the beginning of the 2nd century AD. Although they are among the most impressive and best-preserved pre-Roman quarries in Europe, they are almost completely unknown. The difficult access, the forest cover and the lack of archaeological research have all contributed to the very low scientific and cultural visibility of this topic until now. This situation has recently changed thanks to the airborne LiDAR technology which has revealed the real extent and complexity of these quarries. The results of the analysis of the LiDAR-derived digital terrain model (DTM) open up important perspectives in the research of the site at Măgura Călanului and will contribute to a deeper understanding of the mechanisms and resources of this power centre in the Șureanu Mountains. Furthermore, they support the inclusion of this topic in the broader research field of Late Iron Age quarries in Europe.

THE LOST QUARRIES OF THE DACIANS

In a synthesis from 1983 on quarries in the Roman provinces in which all known pre-Roman stone quarries are mentioned, it is said: »We know nothing at all about pre-Roman quarries in Dacia, Moesia and Thrace. […]. There is no doubt on the point that in these areas, stone began to be widely used first under the Romans.«[1] Forty years later, the situation has not changed much, at least as far as Dacia is concerned. Nevertheless, there were important limestone and andesite quarries in pre-Roman Dacia which supplied the large construction sites of the Dacian fortresses in the area of the capital of the Dacian kingdom and whose traces are well preserved. They have not yet benefited from systematic archaeological research, and very little has been written about them so far. For this reason, they have remained unknown to researchers outside of Romania.

The great quarries have always been related to great construction projects. It is true that apart from Egypt, Greece, Asia Minor and northern Africa, where there were long traditions of stone exploitation, in other territories conquered by the Romans, no important active quarries have been found. The only exception is represented by zones that had close connections with Greek culture such as southern Gaul or Thrace[2]. Pre-Roman Dacia met several conditions: the emergence of elites capable of concentrating power and resources and the existence of contacts with the Greeks (through the colonies on the Black Sea shores). They adopted the Greco-Roman trends of the time and wanted to show off their status through the constructions that they erected[3].

The Dacian power centre in southwestern Transylvania, with its capital at Sarmizegetusa Regia in the Șureanu Mountains, functioned from the first half of the 1st century BC until the beginning of the 2nd century AD, when it was conquered and destroyed by the Romans. One of its main forms of expression of power was the monumental ashlar architecture (defensive and retaining walls,

1 Dworakowska 1983, 20.
2 Dworakowska 1983, 10 f.
3 Rustoiu – Ferencz 2022, 122 f.

1 a: Location of the quarries (graphics: A. Peţan). b–d: Ashlar walls. b: Grădiștea de Munte-Fețele Able. c: Costești-Blidaru. d: Costești-Cetățuie (photos: A. Peţan)

towers, temples, etc.), which was the result of a mixture of local traditions and Greek and Roman influences[4]. The fortresses were built in a mountainous area, at altitudes of up to 1,100 m, and were residences of the king and of noblemen who controlled the surrounding settlements. Six of these fortresses (Grădiștea de Munte-Sarmizegetusa Regia, Costești-Cetățuie, Costești-Blidaru, Piatra Roșie, Bănița and Căpâlna) were inscribed on the World Heritage List in 1999 (fig. 1).

The impressive stone walls led the ancient authors to say that the Dacians »walled up their mountains« (ὄρη ἐντετειχισμένα)[5]. In order for these constructions to be built, a particular type of limestone was needed, which could be fashioned into rectangular blocks. Since the local stone did not have the requisite qualities, a quarry complex was opened far from the fortresses, on Măgura Călanului Hill, from where oolitic limestone was extracted, shaped and then transported with huge efforts over long distances on ridge roads. Most of the fortresses probably used this stone, but for some of them, petrographic determinations have not yet been undertaken.

Quarrying probably began in the 1st century BC and continued throughout the period of the Dacian kingdom. After the conquest of Dacia, the Romans probably also extracted limestone from the same area (but not necessarily from the same quarries). The hill is now covered by forest, and the quarries have been very well preserved, given that stone extraction stopped during antiquity. The site is not easily accessible, and therefore in the Middle Ages and in more recent times, the locals quarried stone from more accessible areas, albeit with lower quality. As a result, the ancient quarries have remained untouched until the present time. Dozens of quarry faces, up to 8 m high, numerous semi-finished blocks and large amounts of waste are spread over an area of more than

4 Stefan 1995.
5 Cass. Dio 68, 9, 3.

2 Quarries at Măgura Călanului. a: Quarry face with tool-marks (photo: M. Bajusz). b: Greek letter on a quarry face (photo: A. Pețan; bottom left corner after Moraru – Pârvu 1988–1991, 650 fig. 5). c: Waste heaps (photo: A. Pețan). d: Sockets in a dressed quarry face (photo: A. Pețan)

30 ha in the forest. Tool-marks and traces of detaching and processing are visible everywhere, as well as sockets, holes and other kinds of marks (fig. 2). The landscape was shaped by arranging terraces, slideways, loading ramps and roads. A circular fortification and two large vallums seem to date from earlier times, since they were affected by the Dacian stone exploitation.

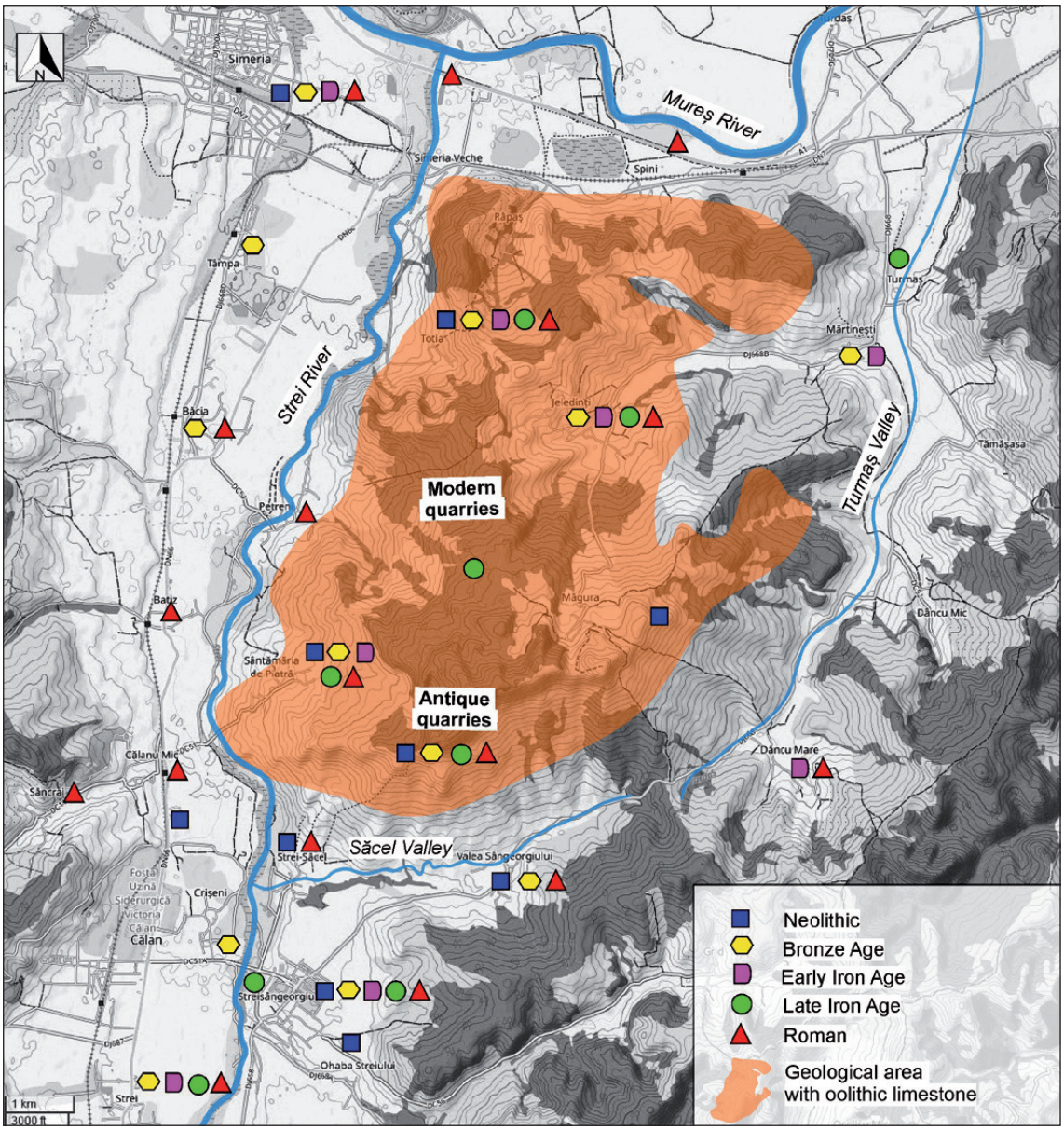
The archaeological interest in this site is recent and the quarries were given the status of an archaeological site only in 2010. Nevertheless, they have not yet been granted the status of historical monument, which would have ensured them greater protection.

GEOLOGICAL SETTING AND HISTORIC CONTEXT

The traces of quarrying are not limited to Măgura Hill but are spread over a surface of about 2,500 ha, which coincides with the geological area of the oolitic limestones of Sarmatian age from the lower course of the river Strei, in Hunedoara County (fig. 3). The number of points bearing traces of stone extraction is very large and it represents the result of more or less organised activities of limestone quarrying, starting in antiquity and continuing up to the 20th century.

The pre-Roman quarries are on the top of Măgura Hill, which is located approximately at the centre of this large area. The hill has an elongated shape, and it is oriented north-northeast-south-southwest. It has a steep face towards the south, 3 km long, with several branches of decreasing height towards the north. The highest point is in the easternmost part of the hill, on Măgura Peak, at 592 m. One can notice a series of large platforms and artificial terraces created on the hillocks at the foot of the hill. The quarries are in the southwestern corner of the hill (main group) and on its southern edge (outcrops group) (fig. 4).

The area belongs to the sedimentary gulf Hațeg, of Miocene age, which is a branch of the Mureș Corridor. The geological formations of the basin are made up of Badenian deposits (detrital, carbonate rocks) and inferior Sarmatian (Volhynian) deposits, (oolitic, organogenic and sandy limestone with microorganisms, thin inclusions of marlstone and marls). Măgura Hill is made of a succession of layers 80–100 m thick, that can be seen along the southern slopes, but

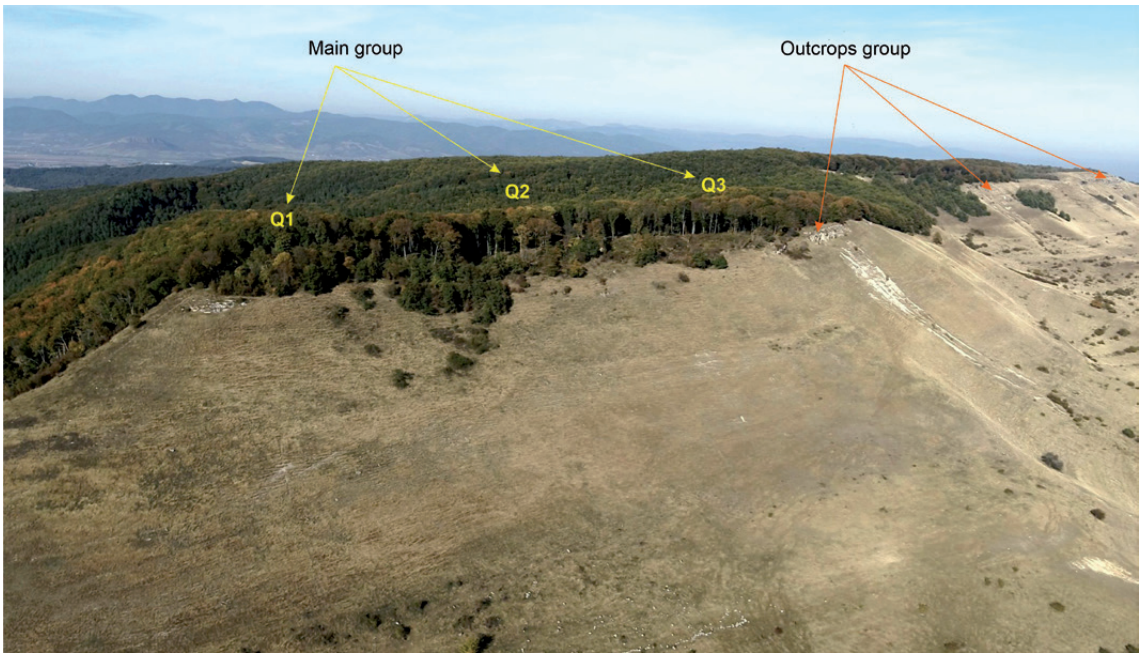


3 Geological area with oolitic limestones on the Lower Strei and traces of ancient habitation (graphics: A. Peţan)

also elsewhere. At the base, there is sandy limestone, followed by oolitic and organogenic layers, in distinct bands of 30–40 cm at the bottom and 0.5–1 m (sometimes, up to 2 m) thick at the upper part. The existence of these layers enabled exploitation and their slight northward inclination determined the orientation of the quarry faces, towards the south in many cases. At the bottom, there are insertions of slightly cemented sands or carbonate sandstone, while in the upper part, one can find thin layers of marlstone and sometimes sands rich in fossils (gastropods) in associations that are characteristic of the early Sarmatian (Volhynian) age[6].

The territory around Măgura Călanului has been intensely inhabited since early times and up to the present day due to the favourable relief conditions, the natural resources and its position with respect to the communication routes. Field surveys on Măgura Hill itself have led to the identification of ceramic sherds from the Neolithic (Turdaș Culture), the Eneolithic (Coțofeni

6 Mârza 1995, 202 f.



4 The two groups of quarries on Măgura Hill. Aerial view (photo: A. Ranta)

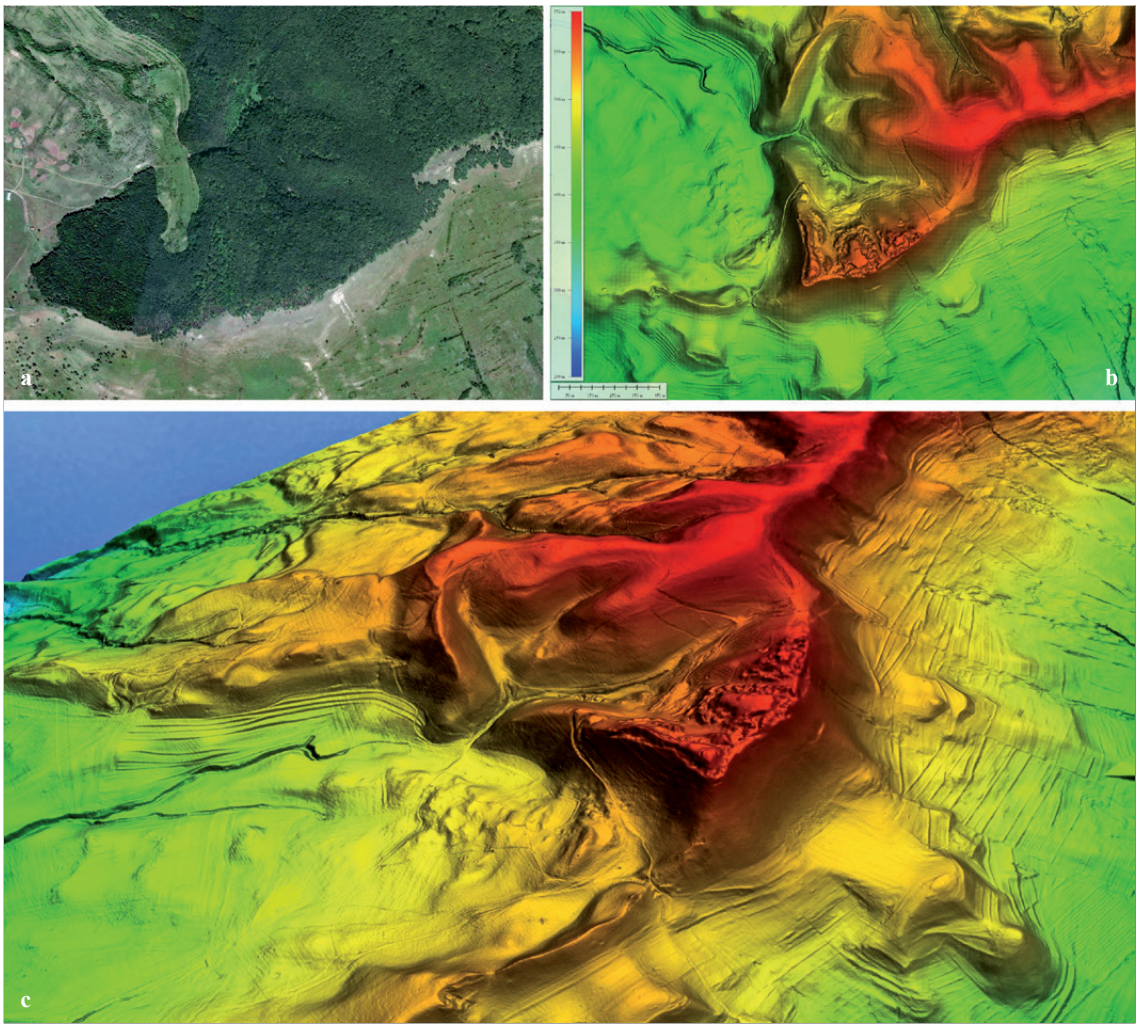
Culture) and the Middle Bronze Age (Wiettenberg Culture) and of large earthworks and a circular fortification prior to the Dacian era. Traces of the Late Iron Age were found within the territories of almost all the villages around the quarries[7]. This zone was very attractive for the Romans as well. Aside from the spa town of Aquae (Călan), there were several rural settlements in this area, and the presence of stonemasons is confirmed by an inscription by a certain Diogenes Lapidarius, discovered on the territory of Aquae[8]. In the vicinity of the ancient quarries there were a rich *villa romana*, temples and a necropolis[9]. Since the Middle Ages, the area has been intensively and permanently inhabited.

HISTORY OF THE INVESTIGATIONS

The first information concerning ancient exploitations on Măgura Călanului Hill was mentioned in the 19th century, in the context of the discovery of the Dacian fortresses, whose walls were made of blocks of oolitic limestone which was different from the limestone found in the area of the respective fortresses[10]. The field surveys and the investigations carried out at that time, which also involved experts in geology and mining[11], resulted, among other things, in identifying the source of the stone used in building these fortresses.

The first field survey on the hill was carried out at the end of the 19th century, and the first geologists who wrote about the limestone from Măgura and made stone identifications went into the area at the turn of the 20th century[12]. However, it was not until 1995 that the first comparative petrographic analyses were published, which demonstrated beyond any doubt that the Dacian fortresses at Costești-Blidaru, Costești-Cetățuie and Sarmizegetusa Regia were built with

7 Pețan 2022a, 117–120.
8 CIL III 7895.
9 Pețan 2022b.
10 Cetean – Pețan 2017, 807–809; Pețan 2018, 379.
11 Pețan 2021.
12 Mateescu et al. 2021, 38–40.

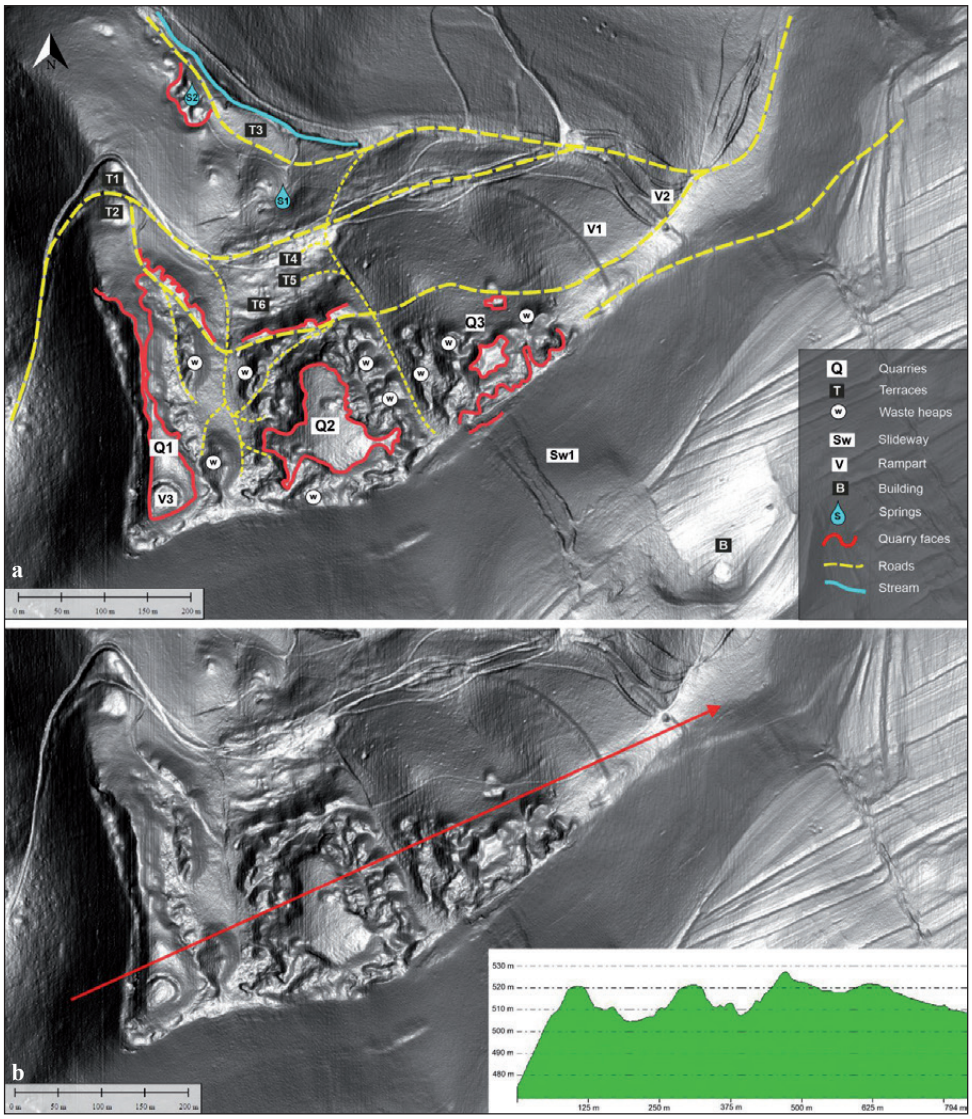


5 Măgura Hill. a: Satellite image. b: LiDAR-derived DTM. c: 3D LiDAR view from the southwest (graphics: A. Peţan)

limestone from Măgura Călanului[13]. More recent analyses have shown that the building stone in the Alun-Piatra Roșie fortress came from the same source[14]. The same type of shaped oolitic limestone seems to have also been used in some Roman sites, but comparative analyses are needed to confirm this supposition.

Archaeologists have not shown much interest in this topic. Only two articles have been published so far, as a result of short field surveys during which they identified some of the quarries, but these limited investigations did not allow them to capture the true extent and complexity of the site[15]. To these can be added a partial inventory of the quarries from all periods, including those of the Dacian period, based on LiDAR data, which has recently been published[16]. Lately, the site has attracted the interest of geologists, who have conducted mineralogical analyses on samples from Măgura Călanului[17] as well as geo-physical explorations of the quarries area.

13 Mârza 1995, pls. 5, 1; 7.
14 Cetean – Peţan 2017.
15 Glodariu 1985/1986; Mateescu et al. 2021.
16 Peţan 2022a.
17 Cetean – Peţan 2017; Cetean – Peţan – Stancu 2022.



6 LiDAR DTM with the main group of quarries. a: The components of the quarries. b: Altimetric profile (graphics: A. Pețan)

LiDAR-DERIVED DIGITAL TERRAIN MODEL UNVEILS THE QUARRIES

Satellite images and limited field surveys have only provided a partial picture of the site. This situation has recently changed thanks to airborne LiDAR technology that has finally revealed what was hidden in the forest[18]. The LiDAR-derived digital terrain model (DTM) shows that the quarrying area is much larger than previously thought (fig. 5).

Main Group

The main group (fig. 6) of quarries is situated in the southwestern part of Măgura Hill. The area is triangular, with steep slopes towards the south and west and is limited to the north by a stream.

18 The data used in this paper cover an area of 16 km² and were collected by the Primul Meridian company in 2018 at a density of 9–12 points/m². A LiDAR-derived DTM with a resolution of 1 × 1 m has recently been made public by the National Agency for Cadastre and Land Registration of Romania for the entirety of Hunedoara County.

It consists of four ridges separated by shallow valleys extending from the southern crest and sloping down towards the north. Three of them have been turned into quarries (Q1–Q3); only the easternmost one was left untouched.

This area is bordered to the east by two large vallums (V1–V2), almost parallel, about 8 m wide, over 2 m high and each with a preserved length of 165 m. The average distance between the two vallums is 75 m. From the southern end of V1, an old road slopes down and crosses aslant the hillside going down the valley. It could have been used for quarry Q3, and the fact that its construction led to the destruction of the end of V1 shows that the vallum preceded the quarry.

The western extremity has a particularly advantageous position, being easy to defend and offering wide-ranging visibility. At its highest point there is a circumvallation from a period preceding the Dacian exploitations (V3). The fortification has been partially destroyed by the southern and western work faces of the western quarry (Q1). Neither the vallums nor the circumvallation have ever been subject to archaeological investigations. There is no evidence that these fortifications were contemporary, but this area may have been of interest during several periods. More than half of the area has been destroyed by the quarries.

The three large quarries (Q1–Q3) grouped in a compact area of about 30 ha. The natural configuration of the land, consisting of hill ribs separated by small valleys descending to the north, was used most effectively. The extraction faces are around these hill ribs, and the routes used for collecting and transporting the stone were established in the valleys. The exploitation was done from the free faces of the hill (the crests and the ravines) towards the interior all around the perimeter, and it almost completely consumed Ridge 1 and Ridge 2 and partially consumed Ridge 3.

Today there are several roads leading to the quarries, most of which are logging routes. However, there are still visible antique roads, sometimes overlapped by the modern roads, but sometimes well-preserved. They were also used to transport stone, each of them being used for particular sections of the quarry. Numerous branches led inside towards the exploitation fronts, but also outwards, to the processing, loading and transport areas.

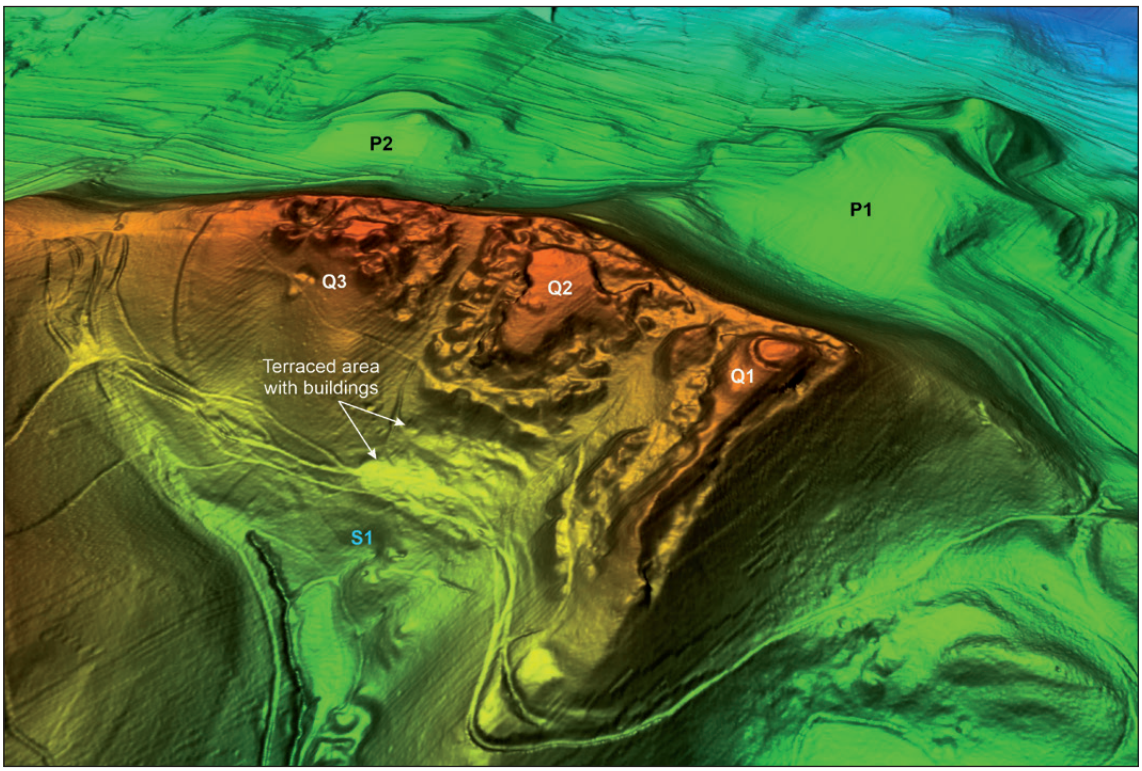
The western quarry (Q1) is located on the western face of the hill. The quarried surface is about 3.2 ha. The quarry faces are on the western, eastern, and southern sides. On the western side can be found the best-organised exploitation of the entire area, and also the longest and highest quarry face: about 280 m long and up to 8 m high. Although nowadays the face seems to be interrupted by landslides and by the overgrown vegetation, it is continuous, as can be clearly seen on the DTM. In fact, it is a vertical exploitation with small, juxtaposed quarries, a technique also used in other areas[19], which allowed several teams to work simultaneously and in a coordinated manner. The exploitation started on the hill ridge and advanced inwards, to a depth of about 20 m. The technique consisted of dislocating large pieces of stone (2–4 m in width and height) that were rolled down to the foot of the hill, where they were split with the help of wedges into the desired dimensions. The wedge holes were usually arranged in V-shaped grooves. These grooves were 20–25 cm deep, and the upper opening was 30–40 cm; their role was both to lead the cracking and to transfer the force of the blows as deep as possible (fig. 7).

As the exploitation advanced towards the interior of the hill, a space was created in front of the work faces and the large pieces of stone could be carved there. Numerous such blocks are still to be found along this ›lane‹, and they show traces of wedges. At the foot of the slope there is a large quantity of chunks of stone, blocks in various stages of processing and waste.

The eastern quarry face is 200 m long. It has lower walls than the western one because of the natural slope of the hill. The quarrying was done in the same way, vertically and in small, juxtaposed quarries. In the course of processing, the waste, the refuse and the blocks were stored to the east, towards Q2, and the pieces meant to be transported were removed from the quarry either on the main roads (for the northern area of the quarry face), or they were brought down to

[19] E.g. in Petra, Jordan, see Bessac 2003, 28.

7 Wedge sockets placed in V-shaped grooves (photos: A. Pețan)



8 3D LiDAR view from the northwest (graphics: A. Pețan)

the foot of the hill (for the southern area), where there was a large terrace which was probably a loading platform (P1). The two faces are very close to each other in the middle of the quarry, where the remaining crest is just 1–2 m wide. At the extremities, the distance between the faces varies between 20 m and 40 m. In this area, traces of sawing can be seen in several places.

The southern quarry face is a continuation of the western face; it is 60 m wide, and clearly the blocks removed from here were amassed at the foot of the hill.

The quarrying on the western and southern sides removed 15–20 m of the hill, so it seems that quarry Q1 must have partially destroyed the circular fortification mentioned above.

Q1 was still in use when it was abandoned, as suggested by the large number of rock pieces bearing wedge traces, ready to be split, found in front of the western face, as well as the immense quantity of semi-finished blocks found in the eastern quarry face area.

The second ridge of the hill has a surface of about 5.5 ha, and it has two distinct zones: the quarry Q2 on the southern half and a terraced area with buildings on its northern half (fig. 8). It is possible that the latter was an exhausted quarry which was later reorganised into terraces. The resulting three terraces were positioned on alternate steps (T4–T6), on which were built a few small constructions with rectangular stone foundations. At the northern extremity there is a spring built with stone slates (S1) – possibly a basin used by a blacksmith. The terraces have small surfaces (T4 about 1,500 m², T5 and T6 about 500 m² each). Most probably the buildings had a function related to the organisation and operation of the quarries. The entire area extended over 1.5 ha.

The initial surface of the southern zone was about 4 ha, of which only 0.8 ha are left following the perimeter exploitation. The quarry faces are irregular, and the *loci* are both semicircular and linear. The technique is also that of vertical walls with juxtaposed quarries. The waste heaps are also ranged along the perimeter. The eastern quarry face is the best preserved and it is 8 m high in the southern half. On an eastern face there is a carved and framed Greek letter (Φ or Ψ) (fig. 2 c)[20].

The eastern quarry (Q3) occupies a surface of 1.5 ha and looks different from Q1 and Q2. The southern ridge of the hill was spared, and the exploitation was organised in polygonal pits. The quantity of blocks that were left on the surface is much smaller than at the other two quarries.

Outcrops Group

Other quarries are on the southern ridge of the hill, where there are numerous outcrops. They have common characteristics. Quarrying traces are located along the entire length of the hill edge, with a greater concentration at four points. In all these spots, wedge holes are visible both in the quarries and on the blocks rolled to their foot. The quarries were arranged in steps, and below them, slideways were built for lowering stones down the slope. The stone extracted from outcrops was of poorer quality than the stone in the main quarries, and the exposed areas are heavily affected by weathering.

The most impressive is the easternmost quarry, which is over 300 m long. The outcrops there were quarried in a sequence of narrow steps totalling about 30 m in height, starting from the crest of the hill.

The remains of the slideways used to bring down the stones are still clearly visible. The image of slideway Sw1 shows two deep ditches with a length of approx. 170 m each and a maximum opening of 5 m, crossing the hillside down to the foot. The distance between them is approx. 9 m and they converge towards the foot of the hill.

[20] Moraru – Pârvu 1988–1991; Glodariu 1997, 78. 82 fig. 7.

CHRONOLOGICAL OUTLINE

The dating of the earliest Dacian ashlar constructions in the first half of the 1st century BC (or rather towards the middle of the century) implies that the quarry was opened at this date. The Hellenistic-inspired construction technique used at the fortresses, as well as the existence of Greek letter marks on the blocks and in the quarry, has led to the hypothesis that Greek stonemasons were present, brought from the western shore of the Black Sea, both at the opening of the quarry and at the raising of the stone constructions. This early phase is difficult to distinguish in the quarry today due to the exploitations that continued until the beginning of the 2nd century AD, which erased the older traces. On the other hand, it must be taken into account that markings with Greek letters do not necessarily imply the presence of Greeks, since the Dacians also used the Greek alphabet (even if this is only attested in a few instances, on ceramic vessels).

For the 1st century BC, the commercial, cultural and political relations of the Dacian kingdom with the Hellenistic world are well documented. As a consequence, an early phase of Greek tradition is plausible. The unskilled workers and the auxiliary ones (blacksmiths, carpenters, etc.) were undoubtedly natives, but the architects, engineers and highly skilled stonemasons were probably Greek. However, since the quarries functioned during an entire century and a half, it is very likely that skilled Dacian workers were trained[21].

At the beginning of the next century, there was a reorientation of interests towards the west, and the Roman influences greatly intensified in the last two decades of the 1st century AD, when, following the peace treaty with Domitian, numerous Roman craftsmen arrived in Dacia. As a result, under King Decebalus (reign AD 87–106), an unprecedented development of this power centre took place. It is very likely that the andesite quarries in the proximity of the present-day city of Deva were also open during this period. The Roman quarrying technique on the western side of quarry Q1, with wedge sockets placed in V-shaped grooves, seems to date from this period[22], as well as the use of the saw on the eastern side of this quarry. A stonemason's toolkit was recently discovered by chance in the quarry area of Q1, probably hidden around the time of the wars with the Romans and dating to the end of the Dacian kingdom[23].

Continuation of quarrying in the Roman era is unlikely for the hillsides, as there were Roman settlements, necropolises and temples at the foot of the hill[24]. The Romans either opened other quarries or continued quarrying in the northern area of the hill.

In order to confirm this chronological outline and to obtain more precise data, archaeological excavations are needed, even if this kind of research inside the quarries usually brings to the surface poor material. It is necessary to also investigate the adjacent zones, where stonemasons' settlements, administrative buildings, workshops, etc. could have existed.

PERSPECTIVES

The DTM opens up important perspectives for future investigations. Thus, one of the directions is represented by the calculation of the volume of stone extracted, so far considered as the only source of limestone for the Dacian fortresses. Since the loss percentage was about 55 %,

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21 The Dacian stonemasons must certainly have existed even before the opening of the great quarries. They knew the methods of levelling artificial terraces, of building retaining and defence walls with raw or semi-finished stone; they knew how to quarry stone for querns or other household objects, and they had advanced tools for performing the necessary operations, see Iaroslavschi 1997, 26 f.

22 There are Roman analogies for this technique e.g. at Luni, Italy (Dolci 1988, 81), or Spitzelofen and Treffen, Austria (Bayer – Karl 2022; Karl – Lozić – Prochaska 2022). The detachment of blocks with the help of V-grooves, but without wedges, can be found in Roman quarries in northwestern Spain, see Gutiérrez Garcia-Moreno 2012, 671.

23 Peţan (forthcoming).

24 Peţan 2022b.

whether the volume resulting from these calculations in reality covers all the constructions believed to owe their material to this source or if there could have been other quarries must be checked. An approximate calculation of the volume of dressed stone used for the walls and towers of the most important five fortresses resulted in a total[25] of at least 16,000 m³. A recent calculation pointed out the volume of stone used for the Dacian fortress Alun-Piatra Roșie (for the visible and reconstitutable structures alone): at least 24,000 blocks were used in this fortress, i.e. over 2,000 m³, weighing almost 4,500 t[26]. Starting from these calculations, one can also determine the work volume needed both in the quarries and for building the fortresses and implicitly, the human, financial and technical resources available to the kings and chieftains of those times[27].

The quarries at Măgura Călanului belonged to the kings and chieftains. They furnished stone for monumental public or private constructions, located at considerable distances: approx. 15 km to Costești-Cetățuie and Blidaru, 25 km to Piatra Roșie and more than 40 km to Sarmizegetusa Regia, with uneven relief and very large differences in level[28]. The routes on which the stone was transported to the fortresses are not known, and this topic remains one of the most challenging questions. An attempt to identify the routes from the quarries to the Dacian fortresses, made recently through field analyses on a 25 m-resolution DTM, showed that no natural path leads from the quarries towards the fortresses. The easiest path generated from the quarries to Costești-Cetățuie includes several slopes of over 10°, and the route from Costești to Sarmizegetusa Regia encounters slopes of 20°–25° or even more[29]. Although the stone blocks transported by the Dacians were generally of medium size (200–400 kg), their transport must have remained very difficult, which illustrates the power and resources of the Dacian chieftains.

There are debates about the dating of the Dacian ashlar walls: some scholars believe that the oldest structures of this kind could date to before the time of Burebista (reign 82/81–44 BC), while others dispute the dating of the retaining walls in the 1st century BC and believe that such extensive works could only have been possible towards the end of the next century[30]. Future archaeological research inside and around the quarries may bring to light important clarifications in this regard.

The picture shown by these quarries, revealed by the LiDAR-based DTM, is very impressive and exceeds by far what was previously known about the stone quarrying in the area of Măgura Călanului. Although identified long before, it is only now that we can understand the true extent and complexity of the quarries. The existence of such a complex system of quarrying, transport and use of stone implies a central authority capable of organising, supervising, and imposing its execution[31]. Therefore, future research on these quarries will contribute to a more accurate view of the power centre in the Șureanu Mountains and its relations with the Greco-Roman world. At the same time, it will require a reassessment of the topic of stone quarrying in the Late Iron Age in Europe. In order to get closer to these goals, a well-articulated interdisciplinary project is necessary.

25 Glodariu 1985/1986, 100.

26 Cetean – Peţan – Stancu 2022.

27 See some examples in Kozelj 1988, 36–39; Schaaff 2011, 539; Russell 2018, 736.

28 By comparison, in southern Gaul, except for Marseilles, where the blocks were transported by sea, at other Hellenistic sites, the land distance between quarries and building sites rarely exceeded 1 km. The stone source was chosen based on proximity not quality. The situation would change only after the arrival of the Romans, who developed the terrestrial infrastructure, see Bessac 1988, 62 f.

29 Dima 2021, 209–222. Research into the transport of stone from Roman quarries has shown that a slope of more than 5 % (either uphill or downhill) would have made transport very demanding and dangerous, see Russell 2013, 100 f.

30 See e.g. Sion 1985, 11; Strobel 1998, 210 f. 215.

31 Glodariu 1985/1986, 102.

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SOLVING AMBIGUITIES AMONG COARSE-GRAINED GREY GRANITE THROUGH NON-DESTRUCTIVE SOURCING TECHNIQUES APPLIED TO ANTIQUITY

Abstract
Among the quarries used to manufacture granite shafts used in Mediterranean antiquity, besides the classic coarse-grained grey granite of Mons Claudianus, other similar-looking sources have been described: South Corsica, Andalucia and Nicotera (Calabria). How to discriminate between these sources using non-destructive techniques is not well established. Here we present a scheme using, besides visual inspection, magnetic susceptibility and trace element analyses based on portable X-ray fluorescence. To confirm our non-destructive scheme, we also investigate the ability of the strontium isotopic ratio to discriminate between Mons Claudianus and the Corsican sources. Our survey in various countries (Spain, France, Germany, Italy, Tunisia) confirms that use of Mons Claudianus stone, at least in the form of shafts, was mostly restricted to Rome. On the other hand, the Corsican source has been identified in Tarragona, Die, Lyon, Pisa, Rome, Carthage and Uthina. This proves a wider diffusion of this granite than previously thought. Nicotera shafts also appear to have been exported outside of Calabria, to Rome, Arezzo and Pisa. Finally, we surmise that the use of granite shafts from Andalucia remained local.

INTRODUCTION

Use of granite shafts in monumental architecture spread during the time of the Roman Empire as well as in the European Middle Ages. In antiquity, few source quarries are known around the Mediterranean Sea and identification of these sources may shed light on the geographic and historic determinants involved in this use[1]. The most famous source, also used for Egyptian obelisks, is the pink Aswan granite. Among the more abundant grey granites used for shafts, the vast majority of them come from three sources: the Troad and Mysia in Türkiye, and two Tuscan islands (Elba and Giglio, hereafter grouped under the term »Elba«). In her review of more than 1,000 shafts around the Mediterranean Basin, O. Williams-Thorpe[2] found that these three sources provide 73 % of the grey granites she studied. In the Gallia Narbonensis province, this figure reaches 97 % (based on 276 shaft fragments)[3]. These three sources are characterised by a fine-grained matrix, containing a variable amount of large feldspar crystals. This amount varies from zero in Mysia, to minor in Elba and major in the Troad, and is also characterised by a greyish-violet

1 Lazzarini 2004.
2 Williams-Thorpe 2008.
3 Rochette et al. 2022a.

1 Coarse-grained grey granite shafts exemplifying the measuring techniques discussed here. a: Mons Claudianus in Magdeburg with susceptibility measurement. b: Corsica in Die with pXRF measurement (note the column has been partly sliced for *opus sectile*). c: Nicotera in the Diocletian Baths of Rome compared with a freshly sliced quarry sample. d: Spain II in Ecija street (photos: P. Rochette)

tinge to its large crystals. Besides these fine-grained granites, other sources with a coarse-grained matrix have been described, the most famous being the Mons Claudianus Egyptian granite, quite abundant in Rome, leading to its synonym »Forum granite«[4]. In the Williams-Thorpe database[5], Mons Claudianus accounts for 11 % of all grey granites, but this figure is 0 % in Narbonensis. Other Mediterranean sources of coarse grey granites have been described by various authors based on the identification of antique quarries but previously assumed to have very limited diffusion outside their close vicinity. These sources are:

- the southern Corsican islands[6] (Cavallo, San Bainzo, Lavezzi)
- three different sources in Spain[7] (named Spain I to III)
- the Calabrian granites of Nicotera and Parghelia[8]
- possibly northern Sardinian quarries that are not well distinguished from their Corsican counterparts on the other side of the Strait of Bonifacio[9]

4 Peacock et al. 1994.
5 Williams-Thorpe 2008.
6 Wilson 1988; Clerbois et al. 2020; Triantafyllou – Mattielli – Clerbois 2021.
7 Williams-Thorpe – Potts 2002.
8 Antonelli – Lazzarini – Cancelliere 2010; Cirrincione et al. 2013.
9 See discussion in Williams-Thorpe – Rigby 2006.

Our understanding of the literature on granite shaft sourcing is that there is a clear need for improvement of the methodology to discriminate between these coarse-grained grey granite sources, reported to be hard or nearly impossible to distinguish visually[10]. As an example of the uncertainties in source assignment produced by this situation, one can consider the contradictory assessments of sources published for the Baetica province (Andalucia, Spain) in the literature. While concluding that several Mons Claudianus shafts were present in Ecija and Seville[11], Williams-Thorpe opted for identifying all these shafts as Spain II or III sources[12]. As a consequence, the important conclusion[13] that the exportation of Mons Claudianus shafts outside Egypt was restricted to Rome (with the exception of Diocletian's Palace in Split) would either be invalidated or not. Similarly, the report of Mons Claudianus shafts in Carthage[14] deserves further scrutiny.

Previously proposed methods using laboratory techniques (petrology and geochemistry) on rock chips detached from the shaft are not practical for routine use, as they are tedious and destructive. They cannot be used systematically but only on a restricted subsample of a shaft corpus. We will thus put forward here identification methods based on rapid non-destructive *in situ* techniques, namely magnetic susceptibility and trace element measurements, as already illustrated in O. Williams-Thorpe, P. J. Potts and M. West, and A. Triantafyllou and colleagues[15].

The scope of the paper will be restricted to the above-mentioned Mons Claudianus, Corsica, Spain I–III and Nicotera sources (see examples of studied shafts in fig. 1). We will propose a protocol to distinguish between them and present the present state of knowledge on their geographic diffusion, based on literature and our ongoing survey in western Mediterranean countries.

The Felsberg source in Germany has been described as very similar to Mons Claudianus[16]. However, as it is a diorite, devoid of quartz crystals and distinctively darker than the granites discussed here, it is excluded from the present contribution. Note that in this paper the term »granite« is used in its wide sense, including all granitoids in the geological sense. For the Parghelia source in Calabria as well as the Sardinian grey granite sources, the evidence we have is too scarce to discuss it in the present contribution. In parallel to the more well-known pink varieties, the grey North Sardinian granites were mentioned in D. Poggi and L. Lazzarini as well as in O. Williams-Thorpe and I. J. Rigby[17], but the method for distinguishing these sources with respect to the more well-known South Corsica source is not well established. We therefore acknowledge that some shafts assigned as originating from South Corsica may come from similar granites outcropping on the other side of the Strait of Bonifacio (following Williams-Thorpe)[18].

METHODS

Volumic magnetic susceptibility (K) was determined using the portable SM30 instrument, more modern and sensitive but of the overall same geometrical design as the KT5 instrument used by Williams-Thorpe in her publications. The sensor diameter is ca. 5 cm and probes the material down to a depth of a few centimetres; however, the first centimetre already provides 69 % of the total signal[19]. At least three K measurements were obtained by applying the sensor as smooth as possible to several cylindrical surfaces. Measurements take about a minute. Relative variability among repeated measurements of the same shaft usually does not exceed 20 %. The instrument

10 See references cited above.
11 Pensabene 2006; Turbay et al. 2019.
12 Williams-Thorpe 2008.
13 Peacock et al. 1994; Williams-Thorpe 2008.
14 Younes – Lazzarini 2023.
15 Potts – West 2008; Williams-Thorpe 2008; Triantafyllou – Mattielli – Clerbois 2021.
16 Röder 1992.
17 Poggi – Lazzarini 2005; Williams-Thorpe – Rigby 2006.
18 Williams-Thorpe 2008.
19 Lecoanet – Leveque – Segura 1999; Gattacceca et al. 2004.

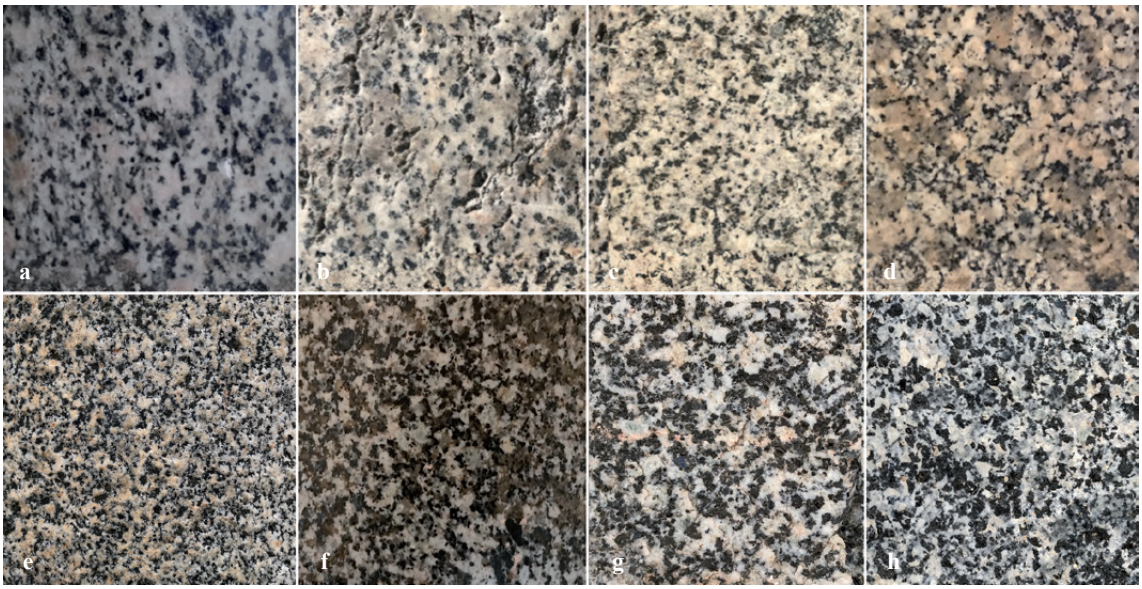
being calibrated for a perfectly flat surface, a correcting factor F is needed to account for the shaft curvature (i.e. diameter D) and the unevenness of the surface (U), estimated visually in millimetre. F increases with increasing U and decreasing D. F values are provided in O. Williams-Thorpe and R. S. Thorpe[20] as well as in the user's manual of the SM30 and KT5. For example, F of a 40 cm-diameter shaft with unevenness of 0, 1 or 2 mm is 1.10, 1.17 or 1.24, respectively. Corrected mean K for a given shaft is thus the averaged raw K measurement multiplied by F, tabulated using the international system (SI) dimensionless unit 10^{-3}. For rock samples, we were not able to use the SM30 but obtained samples of a few tens of grams, measured in the laboratory using the MFK1 kappabridge.

For portable X-ray fluorescence (pXRF) we have used the Bruker tracer IV in trace element mode, with a counting time of 90 s. It shows a sensitivity for rubidium (Rb) and strontium (Sr) contents of the order of 5 ppm and an analysis spot size of the order of 1 cm. The methodology for such measurements has recently been detailed in Triantafyllou and colleagues[21]. For coarse-grained granite, one has to be aware that it is necessary to average a large number of individual measurements (16 is proposed in Triantafyllou and colleagues[22]) to overcome the mineralogical variability at centimetre scale. Manufacturer calibration was used. To check the validity of this calibration, we compared average data obtained on shafts with average data obtained on sawn surfaces of rock samples obtained in different quarries (Cavallo Island in Corsica, San Piero in Elba, Okzular in Mysia, Nicotera in Calabria). We also compared our results with published geochemical results[23].

Finally, for the present study we tested a new destructive technique based on the determination of $^{87}Sr/^{86}Sr$ isotopic ratio. Its principle is based on the fact that a radiogenic isotope such as ^{87}Sr will be controlled by the Rb/Sr ratio (see below) and the magmatic age of the rock: while the panafrican Mons Claudianus granite is dated at 660 Ma[24], Hercynian granites such as the ones from Corsica and southern Spain are dated in the 290–340 Ma range[25] and have a higher Rb/Sr ratio. Consequently, the $^{87}Sr/^{86}Sr$ whole rock ratios reported for Mons Claudianus and South Corsica granites are in the ranges 0.703–0.704 and 0.709–0.710, respectively. We collected chips of rock measurning a few grams from the shafts (or geological sample) to analyse. They were gently ground to below 500 µm and cleaned in an ultrasonic bath and concentrated hydrochloric acid (HCl). Only the > 200 µm size fraction was used for the analyses. This procedure was meant to minimise the bias generated by weathering products.

Aliquots of ~20 mg and ~100 mg for each sample powder were used to challenge heterogeneity in the > 200 µm size fraction. Aliquots were digested in closed Teflon beakers with a HNO_3-HF mixture at ~120°C until complete visual dissolution. After careful evaporation and conversion to 3N HNO_3, any remaining undissolved particles (most likely composed refractory minerals) were discarded by centrifugation. Solutions were then loaded on Sr Spec to separate and purify Sr from the matrix. Samples were analysed on an inductively coupled multicollector plasma mass spectrometer (MC-ICP-MS) Thermo Scientific Neptune Plus using about 100 ng of Sr. To correct for instrumental mass bias, $^{87}Sr/^{86}Sr$ were first normalised internally to a $^{88}Sr/^{86}Sr$ of 8.375209 after correcting for any Rb and krypton (Kr) interferences. Thereafter, the samples $^{87}Sr/^{86}Sr$ were corrected by bracketing every three samples with the NBS987 isotopic standard solutions ($^{87}Sr/^{86}Sr$ = 0.710248). External reproducibility on NBS987 measurements is better than 30 ppm.

20 Williams-Thorpe – Thorpe 1993.
21 Triantafyllou – Mattielli – Clerbois 2021.
22 Triantafyllou – Mattielli – Clerbois 2021.
23 Rochette et al. 2022a; Rochette et al. 2022b.
24 Abdel-Rahman 2019.
25 E.g. Poli – Ghezzo – Conticelli 1989.



2 Representative close-up pictures of coarse-grained grey granite sources discussed here. The vertical side is 10 cm high in all pictures. a–b: Mons Claudianus from Pisa and Lyon. c–d: Corsica from Lyon and Die. e: Nicotera from the Diocletian Baths in Rome. f–g: Spain II. h: Spain III (photos: P. Rochette)

SOURCE ASSIGNMENT SCHEME

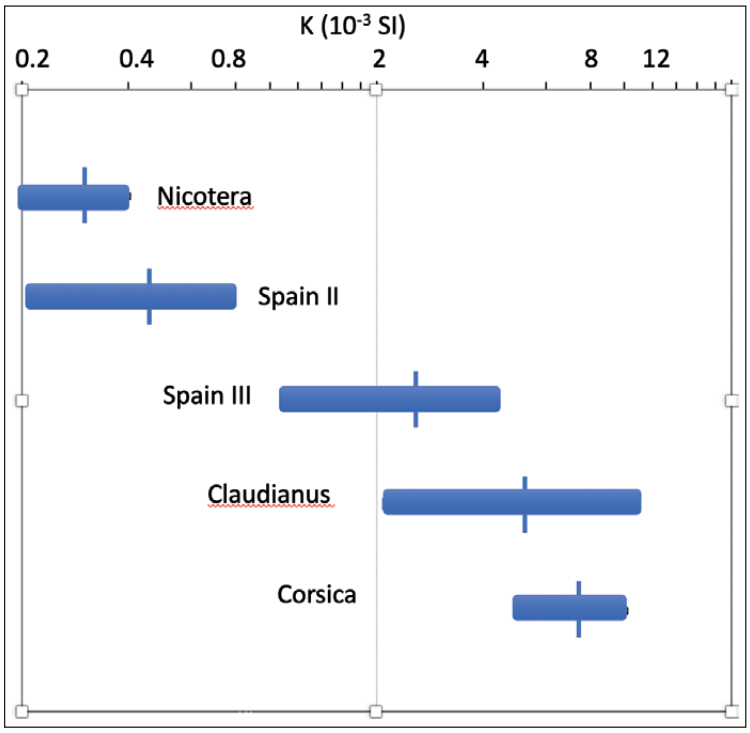
The first step, based on visual inspection, is to place the observed material in the pertinent coarse-grained granite category. The absence of black crystals easily characterises Spain I granite (based on Williams-Thorpe and our observation of two such shafts in Córdoba). It will thus be set apart in the following discrimination scheme. Figure 2 presents examples (from shafts) of what the other sources look like. Overall, they show similar grain size and colour contrasts, their aspect being largely controlled by light, polish, weathering and dirtiness conditions. In the case of clean, well-polished surfaces, a skilled observer can distinguish between Corsica and Mons Claudianus sources based on the foliation and black and white colours typical of Mons Claudianus, while Corsica shows intermediate colours and no foliation. However, when the surface is heavily weathered or blurred by dirt or plaster cover, this visual distinction becomes hazardous (fig. 2 b–c), considering that the lack of observed foliation may be due to the plane of observation. Note that we have observed foliated Spain II and III shafts, so that this character is not unique to Mons Claudianus.

The second step makes use of the rather narrow K ranges exhibited by the different sources (tab. 1; fig. 3). It appears that K values allow us to separate a low-susceptibility group below 0.8 10^{-3} (Nicotera and Spain II) from a high-susceptibility group above 2 10^{-3} (Mons Claudianus, Corsica and Spain III), although some shafts from Spain III are intermediate. In fact, the discrimination between Spain II and III proposed by Williams-Thorpe and Potts[26] is mostly based on K values, although they initially proposed the thorium (Th) content determined by gamma ray spectrometry for that. The magnetic method leaves some overlaps: between Nicotera and Spain II shafts below 0.4, between Spain III and Mons Claudianus in the 2.1–4.4 range, and between Mons Claudianus and Corsica above 5. Note that Spain I is also set apart from any other granites by its K value, which is well below 0.1.

Therefore, to solve the remaining ambiguities, a third step makes use of Sr and Rb contents determined using pXRF (tab. 2; fig. 4). For the high-susceptibility group (fig. 4 a)[27], the ability

26 Williams-Thorpe – Potts 2002.

27 Rochette et al. 2022a; Rochette et al. 2022b.



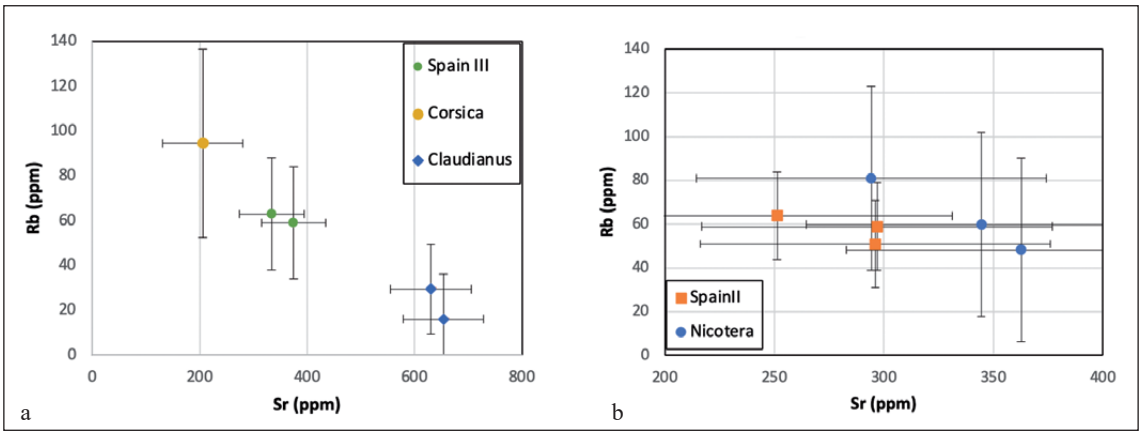
3 Range of magnetic susceptibility K for the different granites discussed as per table 1. The mean is indicated with vertical lines and the range with boxes (graphics: P. Rochette)

	Quarry K values			K values	
Granite	Range quarry	Mean K	s. d.	Range shaft	Visual features
Mons Claudianus	1–12	5.2	2.2	2.1–10.4	Black and white, foliation
Corsica	3–11.2	7.4	2.1	5.0–10.1	No foliation
Spain I	< 0.1	0.07	0.02	0.02–0.11	Very light colour, no megacrystals
Spain II	–	0.45	0.15	0.21–0.78	Large biotite bluish-grey matrix foliation
Spain III	–	2.6	1.0	0.86–4.4	Numerous large biotite bluish-grey matrix; some foliation
Nicotera	0.2–0.4			0.15–0.25	Large biotite, white matrix no foliation

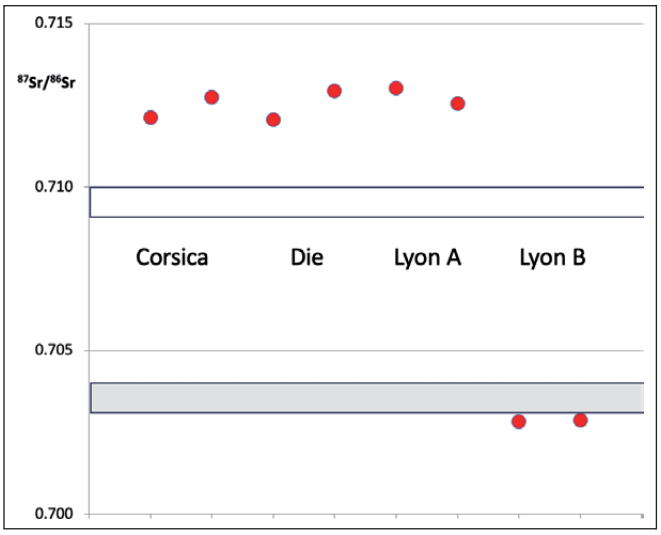
Table 1 Magnetic susceptibility and visual characteristics of the different sources; s. d. = standard deviation

Granite	Rb	Rb*	Sr	Sr*	Note
Mons Claudianus	36±25	20–50	651±113	440–780	Black and white, foliated
Corsica	95±42	50–140	206±75	180–270	No foliation, intermediate colours between black and white
Spain I	185±72	n. d.	118±55	n. d.	Very light colour, no dark crystals
Spain II	63±23	n. d.	333±86	n. d.	Large biotite bluish-grey matrix, some foliation
Spain III	59±35	n. d.	379±78	n. d.	Numerous large biotite bluish-grey matrix, some foliation
Nicotera	59±41	45–90	297±53	220–320	Large biotite, white matrix no foliation

Table 2 Typical strontium (Sr) and rubidium (Rb) range or mean with s. d. for the different source based on pXRF data and quarry literature data*; n. d. = not determined



4 pXRF Rb versus Sr data obtained on geological samples (Mons Claudianus, Corsica and Nicotera) and shafts (Spain II and III). a: High susceptibility group. b: Low susceptibility group (graphics: P. Rochette)



5 Sr isotopic ratio obtained on a geological sample from Corsica and three shafts from Die and Lyon. Two independent measurements per sample are shown. The range for literature data is indicated by a white or grey box for Corsica and Mons Claudianus, respectively (graphics: P. Rochette)

of this technique to discriminate between Corsica and Mons Claudianus sources based on very different Rb and Sr contents has already been exemplified. Even though weathering may decrease these contents, the difference is large enough to resolve any ambiguity. Concerning Spain III, data presented here clearly discriminate it from Mons Claudianus (fig. 4 a). Spain III can also be discriminated from Corsica by its pXRF signature, although the K values are already diagnostic. For the low-susceptibility group (fig. 4 b) the pXRF signatures of Nicotera and Spain II are only slightly different and may not be easily distinguished taking into account the measurement uncertainty and weathering effects. Discrimination between the two will thus be complemented by geographic considerations (see below).

To provide an independent test of our scheme to discriminate Mons Claudianus and Corsica sources, we measured the Sr isotopic ratio in samples from two shafts from Lyon, previously identified as Mons Claudianus and Corsica sources, one shaft from Die identified as the Corsica source, and rocks from Cavallo Island studied by J. Gattacceca and colleagues[28].

Figure 5 shows that the geological and shafts samples from Corsica yield the same $^{87}Sr/^{86}Sr$ ratio, much higher than the one from the shaft identified as Mons Claudianus. The obtained

28 Gattacceca – Eisenlohr – Rochette 2004.

ratios are only consistent with the literature data for Mons Claudianus[29]. The observed discrepancy for Corsica may be due to the fact that South Corsica data[30] may not be representative of the Lavezzi quarries[31].

DIFFUSION OF THE COARSE GREY GRANITE SOURCES

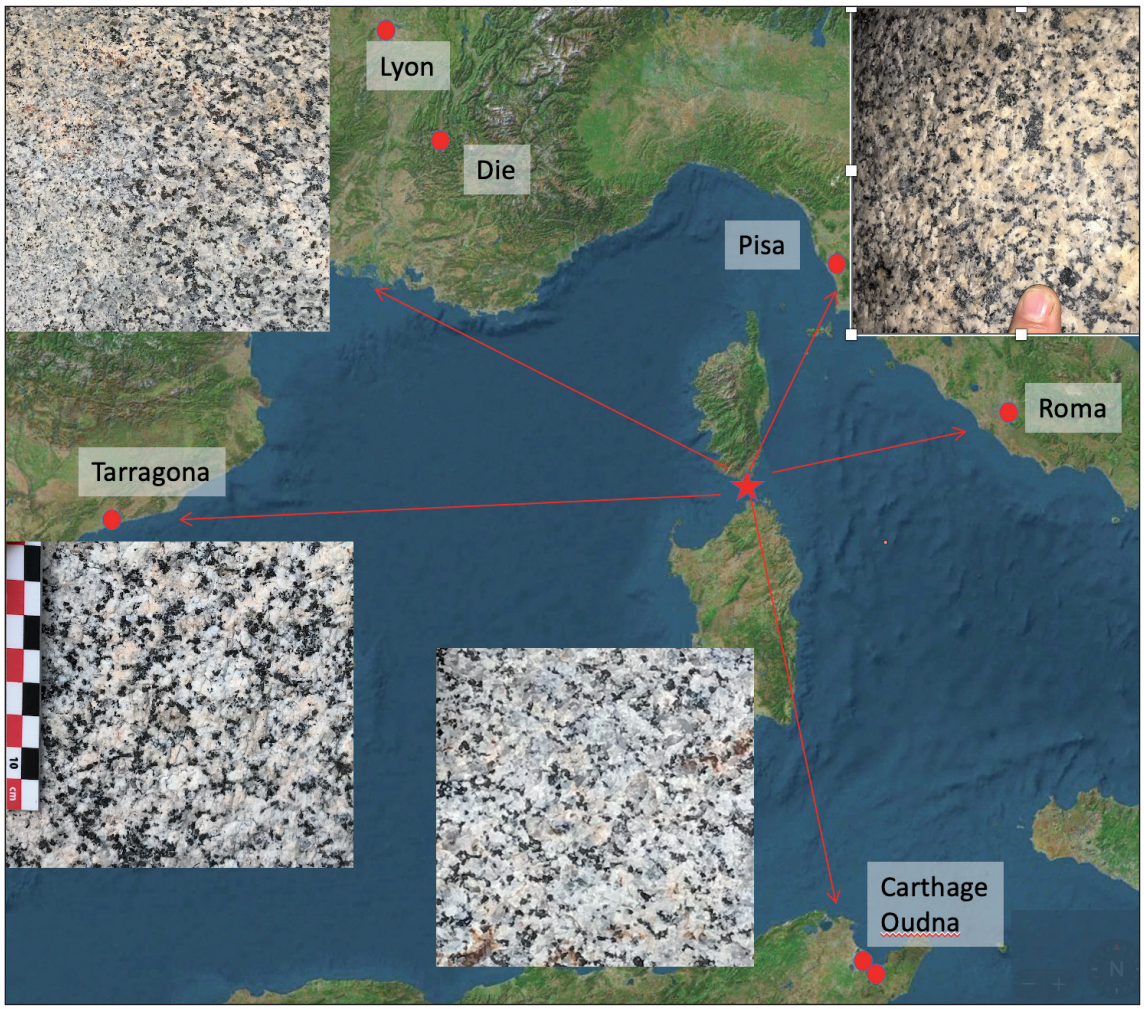
Mons Claudianus

This granite is emblematic of the imperial architecture of the city of Rome and its vicinity (e.g. Hadrian's Villa in Tivoli). Williams-Thorpe[32] counted 105 shafts there, most of them of large diameter (> 100 cm). Mons Claudianus shafts were positively identified outside Rome and Egypt by D. Peacock and colleagues[33] only in Diocletian's Palace in Split (Croatia), with six shafts. Their suggestion that the very large roundel in the floor of the Haghia Sophia in Istanbul may be from Mons Claudianus is not confirmed by our observation: although we were not able to measure its susceptibility, its grain size and colour appears rather typical of the Mysia source. We also confirm that no positive identification of Mons Claudianus remains solid in Spain. In Italy we have identified Mons Claudianus in Ravenna, Pisa and its surroundings, Sienna and Florence (for these last two occurrences we have no susceptibility measurement, so our visual identification is not confirmed). However, all these occurrences in Italy north of Rome are in a medieval to modern context. Textual evidence and historical arguments strongly suggest that the importation of these shafts in their present locality postdates antiquity, as spolia likely coming from Rome. On the other hand, F. Antonelli and colleagues reported positive identification, based on the petrography and chemical composition of Mons Claudianus in Roman ruins in Teano (Campania, 140 km southeast of Rome)[34].

One single shaft from France was confirmed to be from Mons Claudianus[35]. It is currently installed in the skene of the Roman theatre of Fourvière in Lyon, but its origin is not documented. Its importation to Gallia during antiquity is likely but cannot be taken as certain. In Germany, our systematic survey (publication in preparation) revealed that Mons Claudianus shafts are present only in Magdeburg. The observed three shafts must have been brought from Italy in medieval times, as already pointed out by Peacock[36]. In Spain, our survey of shafts in Ecija and Córdoba does not confirm the presence of Mons Claudianus, based on pXRF measurements on high-susceptibility shafts. In fact, we surmise that previous reports of Mons Claudianus shafts in Andalucia correspond to misidentified Spain II or III sources.

Overall, our survey confirms the previous conclusions[37] of a quasi-exclusive usage of this prestigious source in Rome and imperial palaces during antiquity. These conclusions contradict the inventory drawn up by Lazzarini[38] that indicates the presence of Mons Claudianus outside Italy in Orange (France), Italica and Córdoba (Andalucia), Thisdrus (Tunisia), Leptis Magna and Sabratha (Lybia) and Caesarea Maritima (Israel), as well as various sites in Greece and Türkiye (including Ephesos, Thessaloniki and Corinth). We feel that a large number of these citations are either related to *opus sectile* rather than shafts or dubious, possibly related to the limited knowledge of the alternative sources of Nicotera, Corsica and Andalucia at the time of identification by the author or the cited references. We have first-hand evidence that there is no Mons Claudianus

[29] Abdel-Rahman 2019.
[30] Poli – Ghezzo – Conticelli 1989.
[31] See Gattacceca et al. 2004; Triantafyllou – Mattielli – Clerbois 2021.
[32] Williams-Thorpe 2008.
[33] Peacock et al. 1994.
[34] Antonelli – Lazzarini – Cancelliere 2010.
[35] Rochette et al. 2002b.
[36] Peacock 1997.
[37] Peacock et al. 1994; Williams-Thorpe 2008.
[38] Lazzarini 2004 (cited in Antonelli – Lazzarini – Cancelliere 2010).



6 Diffusion map of Corsican granite shafts with examples of granite texture (10 cm square image) for each site (graphics: P. Rochette)

shaft in Orange[39] and Córdoba (this work and unpublished observations). Detailed study of the Italica and Caesarea shafts by Williams-Thorpe[40] also failed to reveal Mons Claudianus shafts. Peacock and colleagues[41] reported no Mons Claudianus shafts from Ephesos, Thessaloniki or Corinth (only Mysia and Troad), nor from Tunisia. In Tunisia, Corsican shafts may have been misinterpreted as Mons Claudianus (see below).

South Corsica

The present contribution puts forward a quite different view of the diffusion of Corsican granite with respect to previous authors who suggested that this source was poorly exported outside of Corsica-Sardinia: e.g. Williams-Thorpe reported Corsican shafts only in Rome, Ostia and Arezzo[42]. We confirm this identification for a few shafts we observed in Rome. In Italy, we further identified 20 shafts from Corsica in Pisa and its surroundings.

39 Rochette et al. 2022a.
40 Williams-Thorpe 2008.
41 Peacock et al. 1994.
42 Williams-Thorpe 2008.

In France, we identified five shafts in Die and four shafts in Lyon. In Spain, we identified four shaft fragments (possibly coming from three full shafts) and two large roundels in Tarragona (Catalonia). Williams-Thorpe and Potts[43] put forward the possibility that their Spain III source was in fact imported from Corsica, but we did not confirm this suspicion. In Tunisia[44], Corsican granite was identified in the Justinian Rotunda at Carthage. The report by A. Younes and L. Lazzarini of Mons Claudianus shafts in Byrsa[45] (Carthage), based solely on visual inspection, would need a revisit to exclude a misidentification of the Corsican source. We have also identified (visually and using magnetic susceptibility) five shaft fragments of similar diameter in Uthina's Roman ruins, likely representing at least two shafts. As hypothesized by S. Clerbois and colleagues[46], based on field evidence on quarry sites, the Corsican granite has been widely diffused at the scale of the western Mediterranean basin outside Rome (fig. 6), in fact more than Mons Claudianus granite.

Andalucia and Nicotera Granites

The two coarse-grained granites Spain II and III identified in Andalucia by Williams-Thorpe[47] seem to have been used only locally. We revisit here the evidence for possible exportation of Spain II granite put forward by Williams-Thorpe[48]. Based on their susceptibility and coarse grain character, the four shafts hypothesised to be from Spain II in Rome (Diocletian Baths and Ostia) also fit Nicotera granite. Our ongoing study in Rome (in preparation) seems to support this alternative. Together with the positive identification of Nicotera granite in Pisa, this suggests a significant diffusion of Nicotera granite in Italy beyond Calabria[49]. This is geographically much more sound than the hypothesis of an importation of the Spain II source in Rome, based on the long distance and complex navigation from Betics to Rome, compared to the distance from Nicotera to Rome along a single coastal route (470 versus 2,000 km). The Andalucia quarries for Spain II and III types are not yet clearly identified but they are likely located between Sevilla and Córdoba based on geological maps. Their transport to Rome thus involves a fluvial transport on the Guadalquivir of at least 100 km, and then maritime transport over 130 km along the Atlantic coast, more demanding than Mediterranean navigation along the coast from Nicotera to Rome.

DISCUSSION AND CONCLUSIONS

The coarse-grained grey Egyptian granite of Mons Claudianus was a highly prized source for monumental shafts in Roman antiquity, as demonstrated by its considerable use in Rome (in particular in various forums and the Pantheon). This prestigious material may not have been available outside Rome due to limited supply related to logistics issues and imperial restrictions. This situation likely led to the development of alternative sources of other coarse-grained grey granites that resemble Mons Claudianus, such as the ones found in western Mediterranean quarries from South Corsica, Calabria (Nicotera) and Andalucia. They could have been considered as an ersatz for Mons Claudianus, in parallel with the use of pink Sardinian granite as an ersatz for Aswan. We also note that on average, Mons Claudianus provides larger diameter shafts compared to the alternative sources, and that this diameter specialisation may have played a role in confining use of Mons Claudianus to Rome. These alternative sources have rarely been researched systematically to evaluate their diffusion, in particular due to the lack of non-destructive techniques to discriminate them from the Mons Claudianus source. Here we provide a scheme based on visual

43 Williams-Thorpe – Potts 2002.
44 Williams-Thorpe – Tindle 2001.
45 Younes – Lazzarini 2023.
46 Clerbois et al. 2020.
47 Williams-Thorpe 2008.
48 Williams-Thorpe 2008.
49 See Antonelli – Lazzarini – Cancelliere 2010.

observation, as well as *in situ* magnetic and trace element measurements, allowing us to positively identify these sources. It follows that the South Corsican source has been exported outside Corsica-Sardinia all around the western Mediterranean (to Italy, France, Spain, Tunisia) with a few dozens of shafts identified in nine localities. Taking into account the shafts that are missing from our record due to reuse and loss, it is likely that the production of the antique Corsican quarries amounts to more than a hundred shafts. The diffusion of Nicotera shafts outside Calabria is established for the first time, with identifications in Rome, Ostia, Pisa and likely Arezzo. This source clearly deserves more investigations to further evaluate its diffusion in Italy and possibly elsewhere. On the other hand, we surmise that the Andalucia granites were not exported.

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QUARRIES AND GEOLOGY: QUARRYING TECHNIQUES, ORGANIZATION, TRANSPORT OF STONES, NEW QUARRIES, STONE CARVING AND DRESSING, HAZARDS TO AND PRESERVATION OF QUARRIES

Fabiano Fiorello Di Bella

THE BAIAE CASTS ONCE AGAIN

Abstract
The excavation in 1954 of more than four hundred plaster fragments at Baiae on the Gulf of Naples was a turning point for the study of ancient copying techniques, which was previously based on literary sources and Roman marble copies. Many of the moulds found at Baiae come from Greek masterpieces of the 5th and 4th centuries BC. They were employed in an important workshop of copyists in order to create life-size marble copies for rich Roman patrons. The main object of the research is to reopen the debate on the technique of making casts through autopsy of the casts themselves, conducted by the author in the storeroom of the Museo Archeologico dei Campi Flegrei, and to rethink attributions. This is the case of the plaster cast inv. 174.482 and the head Acr. 2344 (›Miltiades‹).

TECHNIQUE OF COPYING

The history of plaster casts is long and elaborate. The use of plaster to create copies of works of art has its basis in the idea of the technical reproducibility of art, in the words of Walter Benjamin[1], long before photography and cinema took this concept for granted. The cast represents the starting point for making marble copies of ancient statues. According to Gisela Richter[2], the large number of reproductions of the same iconographic subject in Roman times implies plaster casts as models. The spread of copies is thus linked to the trade of plaster casts in the Mediterranean area, since the mould or its ›positive‹ could easily be transported to different destinations. The cast is indeed the vehicle for disseminating entire repertoires of art. In ancient times, the technique of plaster casting has its origins in Egypt. There, in fact, mortar and plaster-based materials predominate[3]. For Classical antiquity, we can date the introduction of the use of casts to the late 4th century BC based on literary evidence and archaeological finds. In this respect, I would like to point out Plutarch's account of the journey of Soteles and Dionysos along the shores of the Black Sea during the reign of Ptolemy I[4]:

ἱστοροῦσι δὲ καὶ τοὺς πεμφθέντας εἰς Σινώπην ὑπὸ Πτολεμαίου τοῦ Σωτῆρος; ἐπὶ τὴν Σαράπιδος κομιδήν, Σωτέλη καὶ Διονύσιον, ἀπωσθέντας ἀνέμῳ βιαίῳ κομίζεσθαι παρὰ γνώμην ὑπὲρ Μαλέαν, ἐν δεξιᾷ Πελοπόννησον ἔχοντας, εἶτα ῥεμβομένους καὶ δυσθυμοῦντας αὐτοὺς προφανέντα δελφῖνα πρῴραθεν ὥσπερ ἐκκαλεῖσθαι καθηγούμενον εἰς τὰ ναύλοχα καὶ σάλους μαλακοὺς ἔχοντα τῆς χώρας καταμένειν ἀσφαλεῖς, ἄχρι οὗ τοῦτον τὸν τρόπον ἄγων καὶ παραπέμπων τὸ πλοῖον εἰς Κίρραν κατέστησεν. ὅθεν ἀναβατήριον θύσαντες, ἔγνωσαν ὅτι δεῖ δυεῖν ἀγαλμάτων τὸ μὲν τοῦ Πλούτωνος ἀνελέσθαι καὶ κομίζειν τὸ δὲ τῆς Κόρης ἀπομάξασθαι καὶ καταλιπεῖν.

»Soteles and Dionysius, the men sent by Ptolemy Soter to Sinope to bring back Serapis, were driven against their will by a violent wind out of their course beyond Malea, with the Peloponnesus on their right. When they were lost and discouraged, a dolphin appeared by the prow and, as

1 Benjamin 1963.
2 Richter 1962.
3 Recent discussion in Frederiksen 2010.
4 Plut. mor. 984A–B; cf. Plut. mor. 361F.

it were, invited them to follow and led them into such parts as had safe roadsteads with but a gentle swell until, by conducting and escorting the vessel in this manner, it brought them to Cirrha. Whence it came about that when they had offered thanksgiving for their safe landing, they came to see that of the two statues they should take away the one of Pluto, but should merely take an impress of that of Persephone and leave it behind.«[5]

The king sent his men to Sinope to carry off two statues. However, a violent storm blew the ship off course. It was only with divine help that they managed to retreat to the harbour of Delphi at Kirrha. There the ambassadors decided to take a cast of the statue of Kore and left the original in place. This passage, perhaps undervalued, clearly expresses some important features of the copying practice: official patronage, a commercial function due to the better handling of the cast, quick manufacture, and equivalence between the cast and the original. Thus, already between the 4th and 3rd centuries BC, the art of copying was the most practical way to popularise a statuary model[6]. Plutarch also confirms the ancient literary sources about Lysistratos, the brother of Lysippus, who first made casts of statues[7]. This means that casts became very common and led to the adoption of preparatory models in clay before shaping the statue in bronze or marble. The activity of copying surely grew out of this trend of making casts[8]. In fact, mechanical copying was not understood by the ancients in terms of a faithful reproduction of the archetype that resembles the original. The copy is clearly the result of a process, albeit mathematical, of transferring measurements to the block, casting and recasting, but the copyist does not rigorously seek extreme faithfulness to the model. On the contrary, the prototype is rethought and updated in some details, according to the style of the time of production. Roman copies of Greek art communicate an illustrious past, whereas their patrons cultivate knowledge of the Greek world and promote their civic and moral qualities through the mirror of the copies[9].

From a technical point of view, marble is a high-cost material that requires a certain amount of expertise in manufacturing. Consequently, creating a sculpture directly from the marble block is not recommended. Therefore, sculptors could use sketches and drawings, but in many cases the original and the copy share the same measurements, confirming that the model is taken from plaster. The ancient copyist did not work by using a mechanical point-based procedure, as the modern one does, but by establishing individual measurements freely, which can still be seen in some copies. As a result, many variants arise and the copyist's reinterpretation of the model is clearly visible. The copyists could deliberately alter the originals to improve them, mitigating their harshness or, conversely, increasing their severity.

Although we do not know exactly how copying techniques worked, we can engage in informed speculation[10]. Inside the workshop, the sculptors use the dot system or ›stitching‹ to create a full-scale sculpture from a model by taking a few measured points on the original and transferring them to the copy. First, the copyist needs a marble block large enough to contain the subject. After taking a life-size mould of the original statue *in situ*, the copyist places the cast next to the stone block and fixes three points using a three-armed compass. The points are the first step in rough-hewing the block. A large number of points means greater fidelity to the model. The rest of the statue is carved directly into the stone and the excess is removed with the chisel until the desired surface is revealed. In the Hellenistic and Roman periods, the technique of copying led to the creation of the ›industry of copies‹[11], in which different parts of a statue are carved separately

5 Translation after Cherniss – Helmbold 1957, 471 f.
6 Overview in Ridgway 1984, 5–14.
7 Plin. nat. 35, 153.
8 See now Calcani 2010 with bibliography.
9 Recently Anguissola 2015b; fundamental: Gazda 1995a; Gazda 1995b; Gazda 2002; Gazda 2011.
10 On the work of ancient copyists, see Boschung – Pfanner 1990 and now Pfanner 2015 with bibliography.
11 See Bianchi Bandinelli 1973, 12.

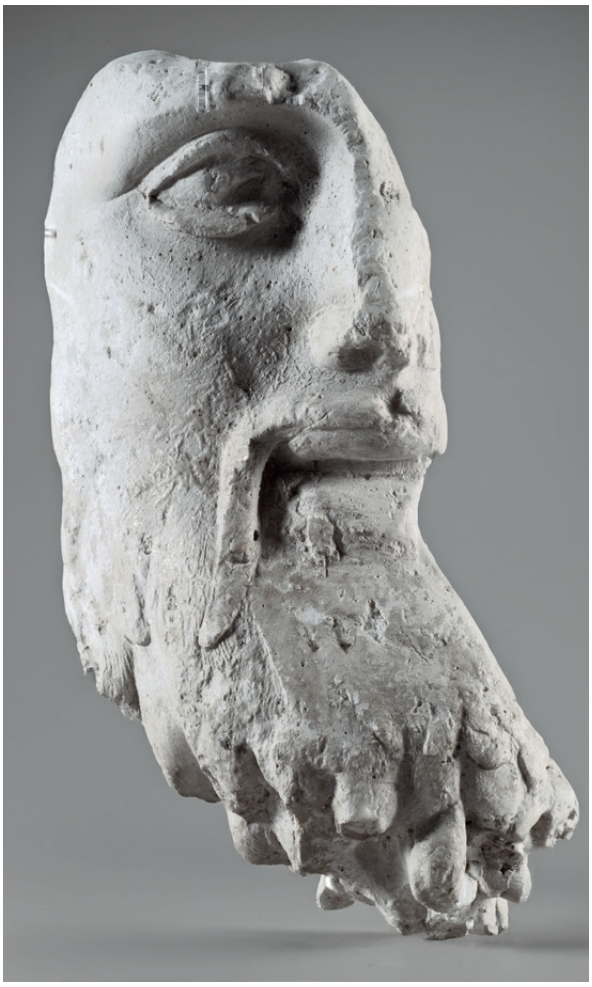
1 Lancellotti Discobolus (head). Rome, Roman National Museum, Palazzo Massimo alle Terme, inv. 126371 (photo: S. Sosnovskiy, CC by SA 2.0)

on the basis of fixed models and mounted with metal pins. The execution or finishing of the most important parts, such as the face, could come from the hands of the master, while other body parts were the work of assistants. We can still see traces of the reference points on some Roman copies of Greek originals, consisting of small protuberances, generally on the top of the head, as in the well-known case of the Antonine copy of the Lancellotti Discobolus after a mid-5th-century BC original (fig. 1)[12]. It seems clear that the models for this process are plaster casts due to their technical properties. Plaster, sometimes calcium sulphate, is indeed easy to produce, easy to handle when wet, and also, it flows easily and hardens quickly when poured into a mould. In addition it seems to have been fairly cheap to obtain[13].

THE IMPORTANCE OF THE BAIAE CASTS

It seems clear that the role of plaster casts in ancient sculpture is absolutely central. Although the art of copying dates back at least to the Hellenistic period, the crucial evidence comes from the plaster casts discovered by chance in a room under one of the terraces belonging to the sumptuous Baths of Sosandra at Baiae[14]. This Roman city is located on the Gulf of Naples, not far from Puteoli, the modern Pozzuoli, and has been best known as a resort since the 1st century BC. In 1954, the excavation by Mario Napoli of 430 plaster fragments of anatomical parts including faces and draperies was a turning point for the study of the ancient copying technique during the Roman period[15], which was previously based on literary sources and the visual evidence of Roman

12 Rome, Roman National Museum, Palazzo Massimo alle Terme, inv. 126371; see Anguissola 2018, 606 f. with other examples.
13 Cf. Frederiksen 2010, 13 f.
14 For the history of the research, see Miniero 2017.
15 Napoli 1954, 10.



2 Plaster cast of Aristogeiton. Baiae, Museo Archeologico dei Campi Flegrei, inv. 174.479 (photo: Parco Archeologico dei Campi Flegrei)

marbles themselves. The building was found full of rubble during excavation, including life-sized plaster fragments. Given the small size of the room, there is no doubt that the plaster statues could not have been erected there, nor could the building have served as a workshop. The plaster casts were merely used as part of the fill in a basement room. The chronology of the workshop, namely between the 1st century BC and the 2nd century AD[16], confirms the presence of marble workers along the *ripa puteolana* already suggested by epigraphic evidence[17].

The history of research on the Baiae fragments owes much to Walter-Herwig Schuchardt[18]. He began studying them at the beginning of 1970, sixteen years after their discovery, though not without some problems due to the absolute uniqueness of the find. Schuchardt was followed by his collaborator Christa von Hees-Landwehr, to whom we also owe the comprehensive edition of the fragments in 1985[19]. The reason for this long silence lies in the complexity of the fragments and their delicacy, although this does not explain the low profile of recent scientific literature about this discovery. The fundamental achievements of von Hees-Landwehr made it possible to explore the secrets of a workshop of copyists in the age of Augustus and Hadrian.

The casts, or duplicates, essentially repeat the form of the originals. In this respect, many of the moulds found at Baiae were from Greek bronze masterpieces of the 5th and 4th centuries BC. They were employed in a workshop of copyists in order to create life-size marble copies for rich Roman patrons. Von Hees-Landwehr estimated that the fragments belonged to at least 24 and at most 33 statues. She catalogued 293 fragments, of which 174 were most significant for identifying the original model. Of these, only 67 were attributed to twelve sculptures already known in Roman copies, among them the Tyrannicides (Aristogeiton and Harmodios), the Amazons of Ephesos (Sosikles, Sciarra and Mattei type), Eirene carrying Ploutos, the Athena Velletri and the Aphrodite Borghese. Before that, Gisela Richter, who worked on the casts in 1963, correctly identified one of the fragments with the

16 For the chronology of this workshop, see von Hees-Landwehr 1985, 188.

17 Most recently Demma 2010. C. Avillius December is *redemptor marmorarius*, namely a contractor for construction, decoration and marble works (CIL X 1549); A. Arrius Chrysantus, on the other hand, is *Augustalis* and *marmorarius* in the 2nd cent. AD (CIL X 1873); A. Flavius Pitheas *marmorarius* dedicated his works to the Emperor Commodus in AD 183 (CIL X 1648).

18 von Hees-Landwehr 1985, IX–XIV.

19 von Hees-Landwehr 1985.

right half of a bearded male face including eye, nose, mouth, and beard (H 21.6 cm, W 10.7 cm), namely Aristogeiton from the Tyrannicides group (fig. 2)[20]. With the help of the sculptor Walter Hancock, Richter noted some characteristics of the plaster cast which are still very instructive for understanding the level of realism of the casts and the debate about the originals. With regard to the cast of Aristogeiton, the unnaturally prominent eyelids drew Richter's attention. Her explanation was that the original statue had bronze eyelashes, which had to be protected during modelling by a coating of clay or wax, thereby creating a sort of thickening on the cast. However, the motif of unusually strong eyelids could be related not only to a wax reinforcement but also to the original itself, namely the first group of the Tyrannicides by Antenor[21]. This work can thus be interpreted as transitional with eclectic elements[22]. The face fragment indicates a greater adherence to the formal conventions of the Late Archaic period in the shape of the convex pupil and in the stylisation of the long, thin moustache, arranged with a slight undulation at the sides of the mouth. The eye, however, is less prominent and more closely connected to the face, as in the Delphi Charioteer. Even the beard follows the new expressive canons of the Severe Style: the compact wedge-shaped mass articulated by short snail-like curls has been replaced by a more organic form, with the hair welded directly to the epidermis, arranged in tufts with a pointed tip and separated from each other by thin incisions. In the coexistence of new and old, the plaster fragment of Aristogeiton refers to a formal language typical of a transitional phase between the Archaic and Early Classical periods.

As Carlo Gasparri points out[23], during the Augustan period, the plaster workshop of the Baiae casts produced copies of mythological subjects and divinities of the second half of the 5th century BC such as the Aphrodite Borghese, the Amazons of Ephesos, and Eirene and Ploutos. The period of Pericles' Athens was indeed a model of civilisation for Augustus. The subjects of the Hadrianic copies, on the other hand, are statues from the Early Classical period – the Tyrannicides, the Persephone of Corinth, the Hestia Giustiniani and perhaps the Aphrodite Sosandra, whose cast fragments have not been found – namely the period between the end of the Persian Wars (477 BC) and the rise of Pericles and Phidias, which probably reflects the panhellenic notion of Hadrian's empire.

Now, I draw attention to the casts in the Severe Style, copied for the first time under Hadrian. These replicas are certainly a sign of a different taste compared to the time of Augustus, and of different aesthetic interests, but above all, of a new politics of images. As is well known, the reign of Hadrian promoted an artistic production that aimed at imitating the models of the past, after the pause in the Flavian and Trajanic periods, although this time in a very eclectic manner. In fact, there was a renewal of the repertoire of models available in the copyist workshops operating at Rome or connected with the capital. The artistic creations date back to the age after the victory of the Greeks over the Persians, a choice inspired by an emperor himself strongly engaged in the eastern half of the empire in an effort to reinforce the political and cultural unity of the provinces of Greece and Asia[24].

The final section of this overview concerns a group of marble sculptures of outstanding quality that was found at Baiae and its surroundings, reflecting the products of the workshop that owned the casts. It is no coincidence, indeed, that among the known replicas of the Aphrodite Borghese, as many as five come from the Phlegraean area[25]. The first of these statues, by

[20] Baiae, Museo Archeologico dei Campi Flegrei, inv. 174.479: Richter 1970 and recently Anguissola 2015a, 223 no. 43 with bibliography.

[21] On the two groups, the oldest by Antenor and the one by Kritios and Nesiotes, see recently Stewart – Frischer – Abdelaziz 2022 with bibliography.

[22] Cf. von Hees-Landwehr 1985, 30–34 no. 1 pls. 4–7; for an excellent summary of the matter, see Capaldi 2009.

[23] Gasparri 2008, 85–87.

[24] For Hadrian's empire between East and West, see now Carandini – Papi 2019.

[25] Cf. Gasparri 2008, 84.

the sculptor Aphrodisios Athenaios, dates to the 1st century AD[26]. Thus, these statues found at Baiae have been repeatedly linked with the activity of an exquisite Attic workshop that used Pentelic marble and must have had a plaster cast of the bronze original. A fragment of this type (torso with chiton: H 19 cm, W 12.3 cm) has, in fact, been recorded among the Baiae casts[27]. Outside the Phlegraean area, Gasparri identifies some similarities in copying style between the later casts and sculptures of the imperial family, including Hadrian's Villa in Tivoli, the Horti Sallustiani, the Imperial Residence on the Palatine, as well as the Colosseum and the Villa of Herodes Atticus[28]. This allows us to characterise this group of sculptors as of high standing and closely linked to imperial patronage. The value of the marble copies made from casts is also meaningful in this respect. In fact, the cost of the operations for making and transporting the casts must have had a not insignificant impact on the market value of the reproductions compared to creations made directly by sculptors *in situ*.

CASTING PROCESS

Through the examination of all fragments and the verification of attributions using the method of »Einpassung«, namely the insertion of plaster reproductions of the original fragments into the casts of the marble copies to which they belonged, von Hees-Landwehr, with the help of the sculptor and restorer Silvano Bertolin, established that the Baiae casts were plaster counterforms obtained from a hollow form, the matrix or mould cast by Roman copyists directly on the surface of Greek bronze originals[29]. The technical process is summarised as follows:

1. The *gypsarus* or plaster modeller plans how to connect the various pieces
2. An ›edge‹ built around the piece is modelled with soft clay
3. Plaster powder mixed with water is spread on the surface
4. After the plaster has set, the mould is detached from the piece
5. The side in contact with the surface of the statue bears the imprint
6. All parts of the cast are assembled and shipped to a workshop of sculptors (*marmorarii*)

In addition, it is worth underlining some other elements based on autopsy:

1. Some plaster fragments do not consist solely of the positive, but also of the plaster moulds taken from the Greek bronze statue still attached (negatives). This shows that the moulds would probably have travelled to Italy from Greece better than the positives
2. The casting process was carefully executed in sections (head, arms, torso, etc.), whereas small anatomic pieces and draperies were cast separately or in multi-piece moulds (fig. 3)
3. The sculptor joined the pieces together with removable plaster caps for the casting process
4. The casts were reinforced with armatures of bone and wood, several pieces of which remain (fig. 4)[30]. The inside of the casts sometimes shows that the moulds were rolled, so that the liquid plaster adhered to all surfaces. There are also many examples of hollow parts that could possibly be filled with clay to allow for undercutting

Sculptors preferred bronze models for the casting process, because marble statues had a polychrome finish that would be damaged by direct casting. The *gypsarus* chose the statue to be copied and removed the parts that create undercuts. Then he covered the surface with oils of

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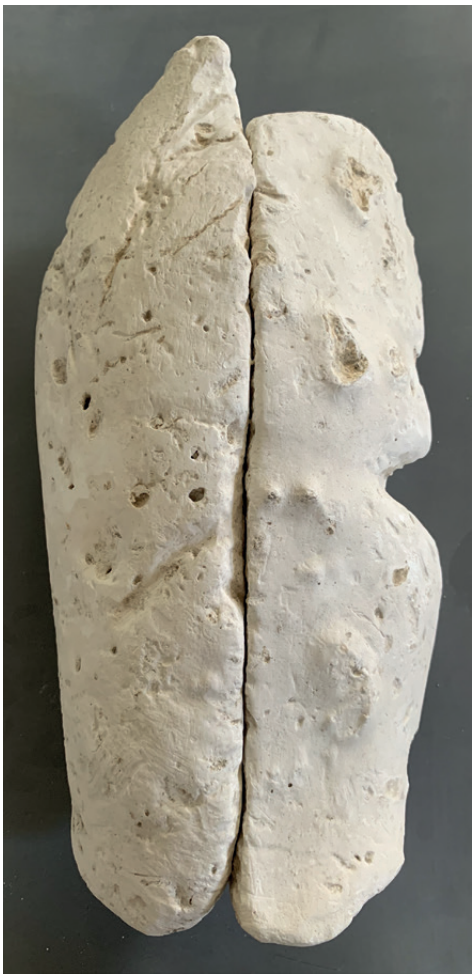
26 Baiae, Museo Archeologico dei Campi Flegrei, inv. 150383; see von Hees-Landwehr 2010, 38.
27 Baiae, Museo Archeologico dei Campi Flegrei, inv. 174.720; see von Hees-Landwehr 1985, 90 f. no. 53 pl. 55.
28 Cf. Gasparri 1995, 182 f.
29 The first account of this method is in von Hees-Landwehr 1982, 16.
30 Cf. Richter 1970, 296.



4 Plaster cast. Baiae, Museo Archeologico dei Campi Flegrei, inv. 174.479 (photo: F. Di Bella)

3 Plaster casts (drapery). Baiae, Museo Archeologico dei Campi Flegrei, inv. 174.571a–b (photo: F. Di Bella)

animal or vegetable origin that helped the plaster form detach. He divided the plaster form into different parts, depending on the complexity of the subject, while he adapted the design of the different sections with clay. A mixture of plaster and water was spread within the clay perimeter, and sand was added to the outer layers. The number of layers for the Baiae casts is calculated at between three and five[31]. Imprinting of the different parts was undertaken using spatulas, blades and cloth to protect the workers' hands. At the end of this operation, each mould, thus obtained, was treated with a separating substance. The sculptor created the positives from the negatives using the reverse procedure, namely the filling of the matrix. He used supporting materials such as wood, reeds, bone, or iron to assemble the various pieces made from the positive and ensure their stability on the pedestal. The entire plaster figure was thus ready to serve as a model for new bronze castings or to be copied in marble using the system of triangulation by points.

The Baiae casts demonstrate that in most cases the copyists adhered quite closely to the original measurements and proportions. Indeed, the casts belong to a workshop that made 1 : 1 scale copies. However, in many cases the surface details of the plaster fragments exceed those of the extant copies. In some cases, e.g. the Westmacott Athlete, the proportions of the marble statue coincided with those of the original in terms of height, but were more massive in volume. The copyist tended to thicken the proportions of the limbs, perhaps to prevent breakage, at least for

31 Cf. Calcani 2010, 50.

5 Plaster cast. Baiae, Museo Archeologico dei Campi Flegrei, inv. 174.482 (photo: Parco Archeologico dei Campi Flegrei)

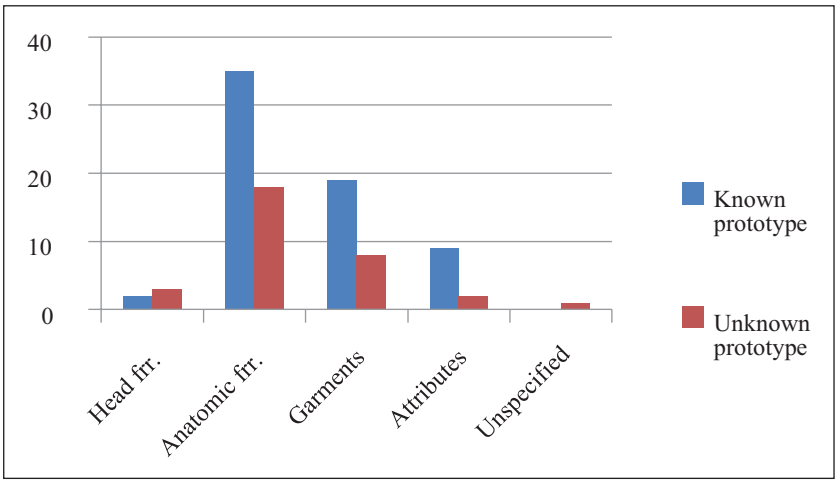


Diagram 1 Baiae casts and attributions

more fragile figures like a male nude[32]. Nevertheless, a copy is a product of its era and reveals peculiarities of style, such as the rendering of details or facial expressions, which give a sense of uniqueness to each copy. To sum up, the copyists did not expect to be able to reproduce an exact copy of the Greek original.

NEW ATTRIBUTIONS

In-depth analysis of the casts allows us to identify the unknown prototype of relevant plaster fragments as well. Indeed, the most interesting part of the research was the attribution of fragments to a Greek original known only through marble copies (diagram 1). Of five fragments of the faces,

[32] Cf. Gasparri 2008, 84.

6 Head of ›Miltiades‹. Athens, Acropolis Museum, inv. 2344 (photo: F. Di Bella)

7 Head of Athena. Athens, Acropolis Museum, inv. 2338 (photo: F. Di Bella)

only two can be attributed to known originals (not without some doubts), while three still remain ›nameless‹[33]. I discuss here a new proposal, which concerns the plaster fragment of the right half of a bearded male face with ear and braid (H 11.5 cm, W 15.7 cm; fig. 5)[34].

This fragment comes from an Early Classical bronze, where the meticulous chasing of the original statue is revealed by braided hair. The locks are divided by narrow grooves, attesting to the level of detail in the shaping of the wax. In front of the ear, the hair is well trimmed and arranged in spiral curls. The sideburn locks are important for the attribution. The particular rendering of the hair and beard, as well as the life-sized dimensions, find comparanda in the head of the so-called Miltiades found on the Athenian Acropolis, an Antonine copy after an Early Classical bronze original, identified by Giorgios Despinis only in 2001 (H 21.5 cm; fig. 6)[35]. Two other heads[36] that share the same workmanship may be the Roman copies of Athena (H 17.8 cm; fig. 7) and Apollo (H 30 cm, W 197 cm) from the Marathon Monument in Delphi mentioned by Pausanias[37]. The fragmentary state of preservation is due to the fact that the heads were reused in a wall. All have polished flesh surfaces in areas which have eluded weathering. They share the same chronology (early Antonine period), material (Thasian marble), and scale. In particular, the heads of ›Miltiades‹ and Athena are cut off at the crown in the same way, suggesting the attachment of a Corinthian helmet. The round surface of the plaster fragmentary head could also receive a helmet, arguing in favour of this hypothesis. The size of the sculptures is also similar, with the two deities on a slightly larger scale than ›Miltiades‹. The latter, in particular, is preserved in the best condition. The wrinkles on the forehead characterise

33 Baiae, Museo Archeologico dei Campi Flegrei, inv. 174.479 (Aristogeiton), 174.481. 174.482. 174.483. 174.486 (Herakles [?]).

34 Baiae, Museo Archeologico dei Campi Flegrei, inv. 174.482; see von Hees-Landwehr 1985, 112–114 no. 68 fig. 65 a.

35 Acr. 2344, see Despinis 2001. The head bears numerous similarities to the portrait of Herodes Atticus in Marathon, Archaeological Museum, inv. BE 11; see Rausa 2002.

36 Acr. 2338 (Athena) and Athens, Agora Museum, inv. S 898+722 (Apollo); see Despinis 2001; Harrison 2001.

37 Paus. 10, 10, 1.

8 Plaster cast. Baiae, Museo Archeologico dei Campi Flegrei, inv. 174.481 (photo: Parco Archeologico dei Campi Flegrei)

it as a portrait, while the incised pupils are an addition by the copyist that follows the style of the contemporary portraiture. Moreover, the translation from bronze to marble is faithful. The short, flat locks of hair, arranged in a crown below the braid that encircles the head at the nape of the neck, are also found in the head of the Kassel Apollo, with four braids converging into a bun at the back. Even the details of the eyes, such as the eyelids or the lachrymal caruncula, show the excellent level reached by the Roman copyist. The plastic effect of the individual locks of the beard, worked separately and then soldered, is achieved by dividing the tufts with drill grooves, while those on the upper row of the cheeks adhere to the metal surface. In this respect, another plaster fragment of a possibly female head could replicate the statue of Athena on the same monument (fig. 8)[38]. It consists of the lower part of the face, preserved from the nose to the chin (H 10.5 cm, W 11.8 cm). The whole figure, according to the proportions of the preserved fragment, must have measured 230 cm in height. If this hypothesis is correct, we would have the first copy of the Marathon Monument by Phidias, whose copying process was justified in the age of Hadrian by the emperor's desire to express the triumph of civilisation over barbarians.

OUTCOME AND FUTURE RESEARCH

The paper highlights the fact that the Roman industry of copying required highly-skilled artisans that took the moulds directly from the bronze originals. The cost of labour and the transport of plaster casts from Greece to Italy must also be quantified as part of an expensive manufacturing process. Since elastic materials such as silicon for making moulds were unknown in antiquity, this process was time-consuming. Concerning the copyists of the Baiae workshop, there is no reason to stress the creative elements in their work. The high quality of the details of the Baiae casts probably demonstrates that they were the very first casts taken from a specific mould, especially for Severe Style-period originals. In this respect, the art of copying assumes a more complex status and the Roman copyist became an artisan who was able to duplicate even the finest detail of a Classical or Hellenistic work. The manufacturing process also sheds light on the plaster fragments that have not yet been identified, which should be carefully examined in the light of new archaeological discoveries.

The creation of a virtual database of Baiae casts using 3D models is the next step in the research. This will help us to collect all the cast fragments and propose new virtual reconstructions. The results will also be accessible to non-specialist museum visitors. 3D modelling and the application of augmented reality will be integrated in order to obtain a complete reconstruction of

[38] Baiae, Museo Archeologico dei Campi Flegrei, inv. 174.481; see von Hees-Landwehr 1985, 117 no. 72 fig. 68 g.

the lost original, even if the cast is highly damaged and fragmented. The first part of the future research aims at reconstructing the original appearance of an unfinished sculpture, using photogrammetry techniques based on standard-resolution photos and software in order to obtain an initial model. Then, the model will be integrated with other 3D digital data from other sculptures of the same period or with 3D modelling based on sources about sculptures dating from the same time of production.

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ASHLAR QUARRYING AND CARVING IN DIACHRONIC CITY-BUILDING NARRATIVES

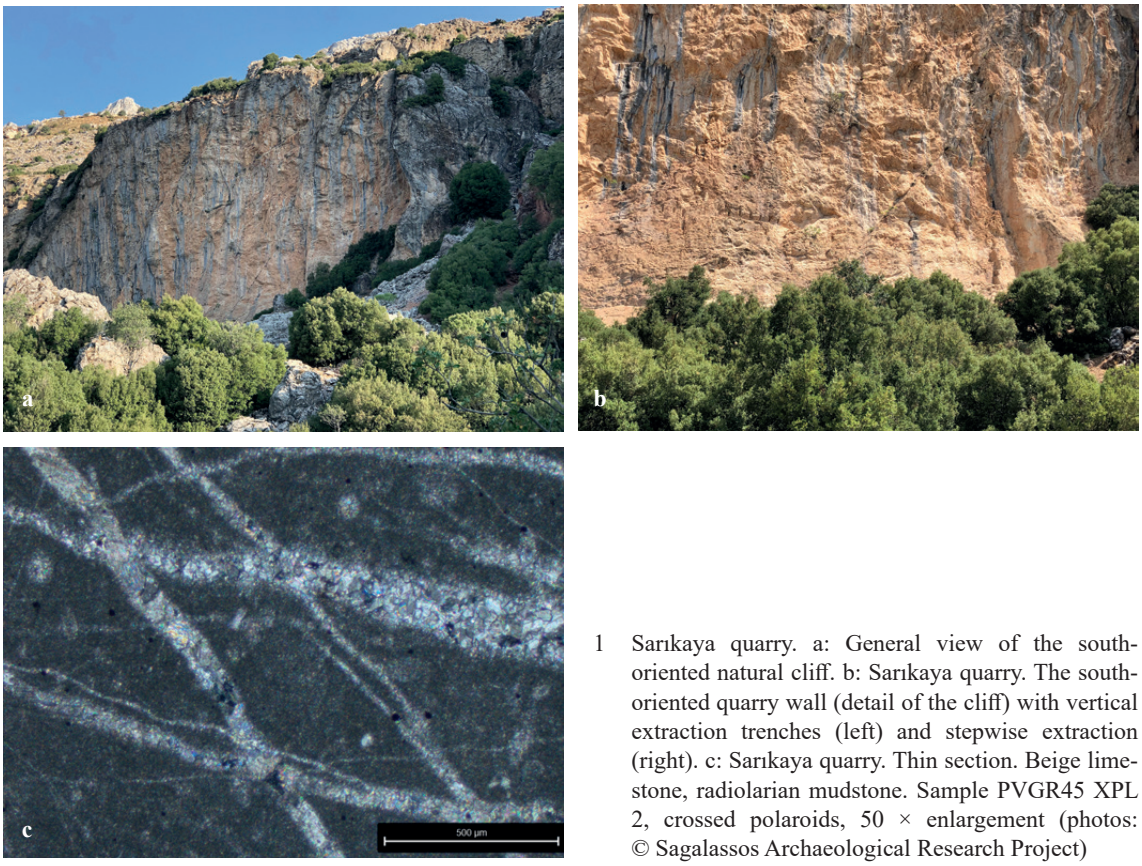
THE CASE OF ANCIENT SAGALASSOS AND THE SARIKAYA QUARRY (SOUTHWESTERN ANATOLIA)

Abstract
This paper provides a detailed interpretation of the extraction traces at the Sarıkaya quarry (southwestern Anatolia, west of Sagalassos) and of the traces of the stone carving techniques on the facings of the ashlars extracted from that quarry. This quarry and the corresponding buildings were selected because the chronology of the extraction covers a relatively lengthy period from the middle/late Hellenistic period (2nd cent. BC) until early Roman Imperial times. Additionally, all of the buildings concerned proved to be public, urban and religious, allowing reflections on why precisely this quarry was selected. The stone-carving chronology established at Sagalassos was entirely applicable to the ashlars originating from the Sarıkaya quarry. In particular, the identification of the traces observed during the early Roman Imperial period allowed us to identify a large city building site composed of the Doric temple and its propylon, part of the bouleuterion and an heroon, this last probably dedicated to the benefactor who drove the whole project.

INTRODUCTION

The tools for carving ashlars, and thus their traces left on the facing surfaces, changed over time[1]. Still much remains to be learned in this domain for classical archaeology: what was the role and effect of quarries, and can analysis of stone carving identify diagnostic tool traces, used in specific frameworks of time and/or space? In order to address these research questions, an archaeological site had to be chosen with buildings and monuments covering a sufficiently long period of time with attested changes in stone-carving technologies, and presenting fresh/newly excavated ashlar facing surfaces, allowing the identification of carving traces and tools in detail. Ancient Sagalassos, located in the Pisidian Taurus Mountain range of southwestern Anatolia, is one such site, investigated by KU Leuven for more than 30 years. As things stand, the archaeological record documents the presence of a community at Sagalassos between the late 5th century BC and the 13th century AD. The period during which buildings and monuments were erected with ashlar masonries, with their corresponding quarries, is situated between middle/late Hellenistic (2nd cent. BC) and Roman Imperial times. Apart from analysing the masonries themselves and documenting the quarries, most buildings and quarries in and around Sagalassos were also sampled in order to determine the provenance of the ashlars used[2]. The most frequently used quarries were those located in the *necropoleis* surrounding the ancient city, and two quarries at a few kilometres to the northwest and west, i.e. the quarries at the Ağlasun Dağları Pass and at Sarıkaya (according to the local toponomy). The Sarıkaya quarry was selected for this case study because technological interpretation of the extraction traces is possible and the corresponding city buildings cover the period from middle/late Hellenistic into early Roman Imperial times. The monuments discussed include the Agora Building, the northern fortifications, the southern fortification, the bouleuterion,

1 Doperé 2018.
2 Degryse et al. 2008b.



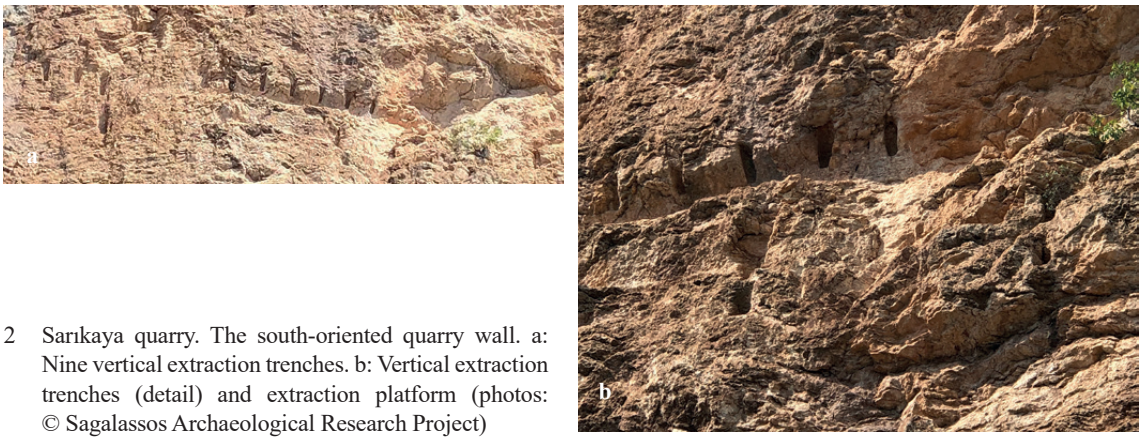
1 Sarıkaya quarry. a: General view of the south-oriented natural cliff. b: Sarıkaya quarry. The south-oriented quarry wall (detail of the cliff) with vertical extraction trenches (left) and stepwise extraction (right). c: Sarıkaya quarry. Thin section. Beige limestone, radiolarian mudstone. Sample PVGR45 XPL 2, crossed polaroids, 50 × enlargement (photos: © Sagalassos Archaeological Research Project)

and the Doric temple. These were major urban constructions, allowing reflections on possible political and/or socio-economic motivations for the selection of this quarry. This series of buildings further allows us to look at some other quarries to check on the motivations behind simultaneous extraction at more than one quarry. This paper starts with a description of the Sarıkaya quarry and the interpretation of its extraction technologies, followed by a description of the stone-carving traces on the mentioned buildings. This corpus feeds technological, chronological, political and socio-economic considerations on the position of the Sarıkaya quarry in the building narrative of the monumental centre of Sagalassos.

THE SARIKAYA AREA AND QUARRY

The Sarıkaya quarry was first identified during the archaeological survey campaign of 1994 by the presence of quarrying traces on the wall of a high natural limestone cliff (37°40'60" N, 30°28'43" E) north of the village of Yesilbaşköy[3]. Four isolated elongated natural limestone rocks are now positioned southwest of this cliff and subparallel to it. The isolated position of these rocks is the consequence of their slumping on the underlying ophiolithic material[4]. The major part of the yellow surface of the now visible south-oriented wall of the Sarıkaya quarry cliff is a natural fault plane[5]. As the breaking faces of the cliff are still yellow, without a grey patina, the southward movement of the slumped blocks must have occurred in comparatively recent times, at least 2,000

3 Waelkens et al. 1997, 46; Loots 2001, 22; Degryse – Muchez – Waelkens 2006, 11; Degryse et al. 2007, 37. 47 f.; Degryse et al. 2008b, 278–281.
4 Verstraeten et al. 2000, 790–795.
5 Similox-Tohon et al. 2008, 112–120.



2 Sarıkaya quarry. The south-oriented quarry wall. a: Nine vertical extraction trenches. b: Vertical extraction trenches (detail) and extraction platform (photos: © Sagalassos Archaeological Research Project)

years ago[6]. This chronology was proposed based on the late Hellenistic construction dates then attributed to the bouleuterion and the Doric temple (both built with Sarıkaya radiolarian limestone) and of the early Roman Imperial Sagalassos Red Slip Ware found in front of the cliff[7]. Although some of these dates have since been adapted following the results of new archaeological excavations and soundings, the proposed general chronology for the extraction in this quarry remains, allowing for some fine-tuning.

Only the lower eastern part of the cliff was quarried (fig. 1 a–c). The maximum height of the quarried zone was estimated at 20 m and its length at 50 m, based on the location of the traces[8]. The clearly visible traces are limited to nine vertical cavities (the highest traces) and a lower three-stepped extraction trace[9]. Overhangs of the natural cliff indicate the maximum height of the quarried wall, much higher than the visible traces, and another rock wall, also exposed along a natural fault, but perpendicular to the cliff, the eastern limit of the quarrying activities. Given the actual state of the quarry wall, it is not possible to provide exact dimensions, as the bottom of the quarry is not accessible, covered by erosion material[10].

The nine vertical rectangular cavities, cut at regular distances, are the oldest extraction artefacts on the quarry wall because they are in the highest position (fig. 2 a–b). Starting downwards from the overhang of the natural cliff, these artefacts are the first showing a carefully planned extraction technology. These cavities were interpreted by previous researchers as vertical extraction trenches[11]. Although we adhere to this interpretation, the details of the extraction technology need a more detailed description. Vertical extraction trenches were cut with a quarry pick along planned blocks, the quarry worker standing before or above them[12]. The platform in which these trenches were cut, and the lower part of the trenches themselves, disappeared together with the extracted blocks. Nevertheless, the rectangular cavities indicate that these trenches projected into the quarry wall. A new platform now indicates the location of these extracted blocks below the six cavities on the right. This indicates that they were, at least partially,

6 Verstraeten et al. 2000, 790–795; Similox-Tohon et al. 2008, 112.

7 Degryse et al. 2008b, 279–281.

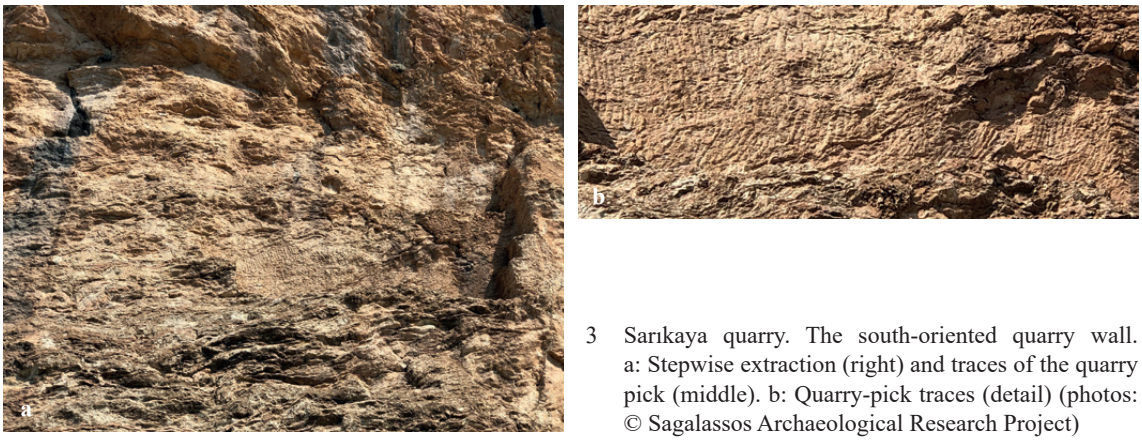
8 Degryse et al. 2008b, 280. Substantially larger dimensions (H 40 m, L 80 m) were previously proposed by Waelkens et al. 1997, 46.

9 Waelkens et al. 1997, 46; Loots 2001, 22; Degryse – Muchez – Waelkens 2006, 11; Degryse et al. 2007, 37. 47 f.; Degryse et al. 2008b, 278–281.

10 Degryse et al. 2008b, 280 proposed an estimation of a maximum of 3,000 m³ of extracted rock and 2,000 m³ of usable quarried blocks.

11 Waelkens et al. 1997, 46; Loots 2001, 22; Degryse – Muchez – Waelkens 2006, 11; Degryse et al. 2007, 37. 47 f.; Degryse et al. 2008b, 278–281.

12 Bessac 2002; Bessac – Vacca-Goutoulli 2002; Bessac 2004, 21–23; Bessac 2008; Abdul Massih – Bessac 2009, 181. 253. 515.



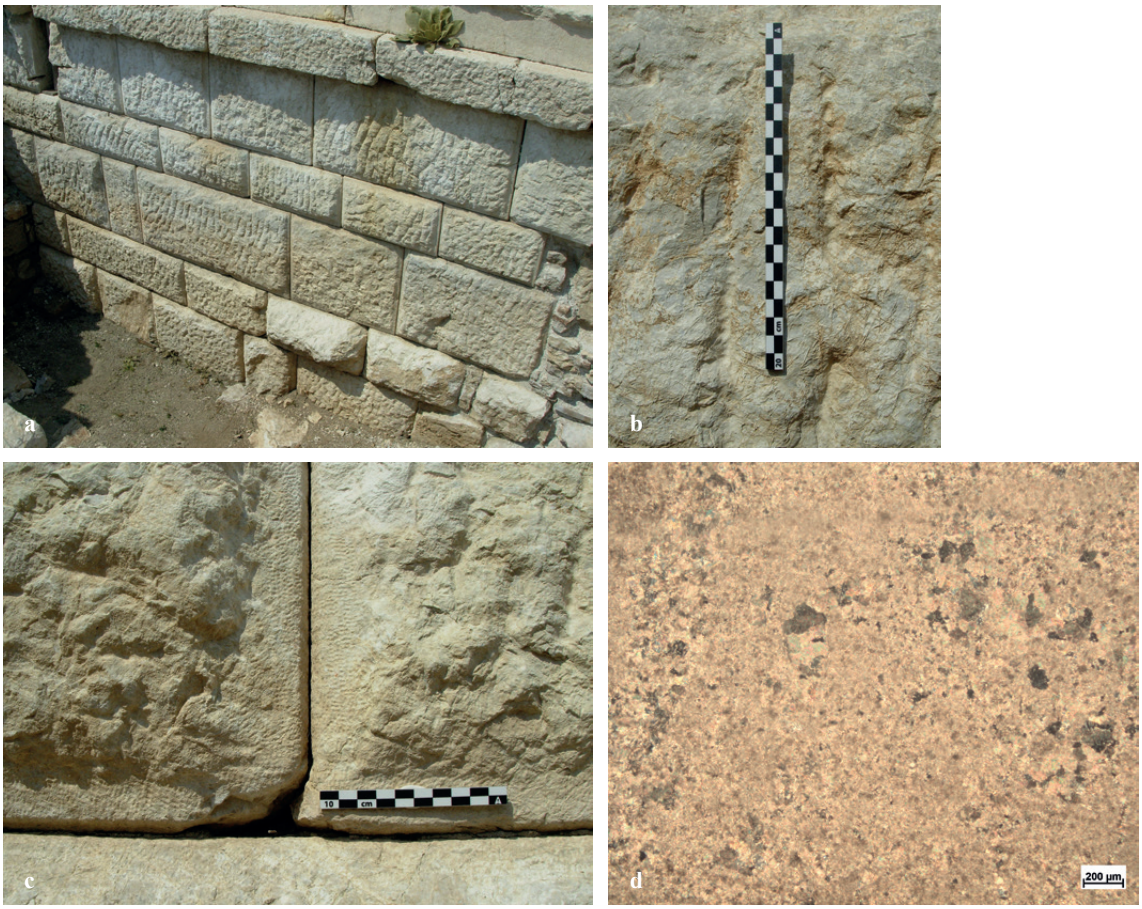
3 Sarıkaya quarry. The south-oriented quarry wall. a: Stepwise extraction (right) and traces of the quarry pick (middle). b: Quarry-pick traces (detail) (photos: © Sagalassos Archaeological Research Project)

extracted from within the quarry wall. This also explains why the upper parts of the trenches are only left over in the roof overhanging the new platform. At least five blocks of identical dimensions were extracted above this platform, between the six extraction trenches. Therefore, another vertical extraction trench must have been cut along the back wall of the long space between the platform and the overhang. The most convincing evidence is visible between the group of six and the three cavities, where traces of the quarry pick point to the cutting of an extraction trench in the prolongation of the longitudinal space below the overhang. However, working with a quarry pick under an overhang was difficult. The irregular surface of the back wall indicates that another method was used to cut it. The question of why blocks were extracted within the quarry wall, under an overhang, while in other parts of the same quarry wall the quarry pick was used in an open air context should therefore be asked. One of the possible explanations is a need for specific blocks of larger dimensions, while a local zone of higher-quality limestone could also have encouraged such deep quarrying.

Traces of the quarry pick, used to cut an extraction trench between a planned block and the quarry wall are also visible below the described platform. Similar traces can be linked to a three-step extraction in the eastern part of the quarried wall, lower than the previously described extraction traces and thus younger (fig. 3 a–b). Most of the quarried surface of the wall does not show evident traces of extraction, although some smoothened and faceted areas seem to be linked with quarrying. Extraction with a lever or other adapted tools seems to have been normal practice, and this is also the case in the Sarıkaya quarry[13].

Below the eastern part of the quarried wall, several carved and moulded building blocks were uncovered during an illegal excavation. In 1994, »the remains of a walled structure to the East of the quarry face were recorded« but »when the site was revisited in 1997, illegal excavations had obliterated this structure«[14]. These blocks apparently belonged to a collapsed building. The finding in 2021 of a finely carved decorated orthostat with heads of a lion and a bull linked by vegetable and fruit garlands additionally points to a high-quality (religious/funerary [?]) building. The positioning of these blocks close to the quarry wall indicates that this building was erected after the quarrying activities had come to an end. The traces of a pointed claw chisel with five teeth on three of the excavated blocks point to a chronology in the 1st/2nd century AD[15]. The orthostat decorated with garlands shows a strong relationship with garland sarcophagi, which were stylistically dated to the first half of the 2nd/beginning of the 3rd century AD[16]. The construction of this Sarıkaya building can likely be dated to the 2nd century

13 Doperé – Degryse – Poblome (forthcoming).
14 Degryse – Muchez – Waelkens 2006, 12; Degryse et al. 2007, 37; Degryse et al. 2008b, 278.
15 Doperé 2020.
16 Köse 2005, 98. 108.



4 Agora Building, eastern wall. a: External facing. b: Detail of ashlar rustication with linear traces carved with a pointed chisel. c: Detail of ashlars with rustications and double drafted margins, carved with a pointed claw chisel with ten teeth. d: Thin section. Beige limestone, radiolarian mudstone. Sample YB22-55-5 XPL, crossed polaroids, 50 × enlargement (photos: © Sagalassos Archaeological Research Project)

AD, which also functions as a terminus ante quem for the duration of the quarrying activities, explaining the attested absence of 2nd-century AD constructions built with Sarıkaya radiolarian limestone at Sagalassos[17].

THE BUILDINGS AND MONUMENTS AT SAGALASSOS BUILT WITH SARIKAYA RADIOLARIAN LIMESTONE

The Agora Building

The Agora Building is located between the eastern border of the (later) Upper Agora and a down-sloping eastern area. Its actual name refers to its location, albeit without a chronologically validated link with the Upper Agora, and without reference to its original function, which remains unknown[18]. Of the original building, only a part of its eastern wall (fig. 4 a. d) and the southern wall with its two corners are preserved.

17 Degryse et al. 2008b, 279 f.
18 Slotman 2022, 22 f.

The foundations were put in place at some point during the 2nd century BC, as indicated by the filling of the foundation trenches, with pottery as datable materials[19]. The external facings of the eastern and the southern wall show a pseudo-isodomic structure, which is not the case for the internal facing of the eastern wall. The external facings of both walls show pronounced rustications covered with short linear traces produced by a pointed chisel, the ›broached dressing‹, or with negative traces of flaking produced by a pick or pointed chisel, the ›punched dressing‹. The identification of the pointed chisel for producing these short linear traces is justified by the presence of precise successive punctiform impacts within these linear traces (fig. 4 b). In 13 cases, the pointed chisel was moved upwards over the surface of the rustications of the eastern wall and downwards in six other cases. There are also two cases where the movement of the tool shows a horizontal direction and two ashlars with upward and downward carving. Similar pictures of pluri-directional movements of the pointed chisel are visible on the southern wall, and on the internal facing of the eastern wall. This indicates that this final stage of work occurred before the positioning of the ashlars in the wall. The negative traces of flaking (punched dressing) do not allow us to distinguish between the use of a pick or a pointed chisel. Besides the negative traces of the flakes, point impacts are evenly distributed over the surface without any linear trace. The relative distribution of both techniques on the rustications of the ashlars of the Agora Building is remarkably similar on the external facings of the eastern and the southern wall: the proportion of broached dressing/punched dressing is 77/20 % for the eastern wall and 75/25 % for the southern wall. This observation allows not only the contemporaneity of both walls but also the possible collaboration of two (groups of) stonemasons, each possibly preferring one type of stone carving technique/tool, to be confirmed. This also shows that the linear traces visible on more than 75 % of the rusticated ashlars should not be considered as intentionally carved aesthetic features.

Most of the ashlars in both external facings are characterised by a double drafted margin, an internal, flat or slightly sloping edge, forming a frame around the rustication, and an external, much narrower edge, but sloping significantly at 45° or even more, and thus penetrating the common joint between two ashlars (fig. 4 c). The strongly sloping external drafted margin precludes it being finished after the positioning of the ashlars in the wall. This observation confirms the complete finishing of all ashlar carving before the installation of the blocks. Both parallel drafted margins were carved with a pointed claw chisel with ten teeth. The external drafted margin sloping at 45° or more was carved with the pointed claw chisel being moved along the border of the ashlar. This external drafted margin seems to have been added to eliminate the relatively vulnerable almost right angles of the internal drafted margin and thus to avoid damage during the placement of the ashlars. Nevertheless, the deeply penetrating drafted margins also produce a shadow effect which underlines the perfectly regular ashlar carving of this building, thus creating an additional quality/aesthetic effect. This additional work increased the time needed to produce each ashlar and consequently also the required budget.

The Northern Fortifications, Western Section

The city wall was originally dated during the Hellenistic period, based on the pseudo-isodomic masonries[20]. Looking at the internal structure of the tower in the western section, this description can be specified further as a pseudo-isodomic masonry with stretchers and head-on bonding blocks[21]. The facing surface of the ashlars shows a punched dressing, and the single drafted margin was carved with a pointed claw chisel.

19 Claeys – Karakurt – Lamberts 2015; Talloen – Poblome 2016, 118 f.; Claeys – Alper – Arnauts 2017.
20 Loots – Waelkens – Depuydt 2000, 598.
21 Martin 1965, 400–406.

A small part of the outer side of this western section was excavated in 2015. The lowest layer of the foundation trench contained pre-100 BC pottery[22]. This provided a chronology of construction of around the end of the 2nd/beginning of the 1st century BC[23]. The lowest visible ashlar course contains rectangular ashlars in beige limestone, extracted either from the quarries in the *necropoleis* or from the Sarıkaya quarry[24]. The ashlars show rustications with a broached dressing and a single drafted margin, sloping at 45°, carved with a chisel. A part of a tower laid out perpendicularly to this section of the city wall contains ashlars in a secondary position. Two of these show stone-carving characteristics compatible with a late Hellenistic chronology[25]. The first ashlar shows a rustication and a drafted margin sloping at 45°, carved with a pointed claw chisel. A second ashlar also has a rustication with a broached dressing and a drafted margin, sloping at 45°, carved with a chisel.

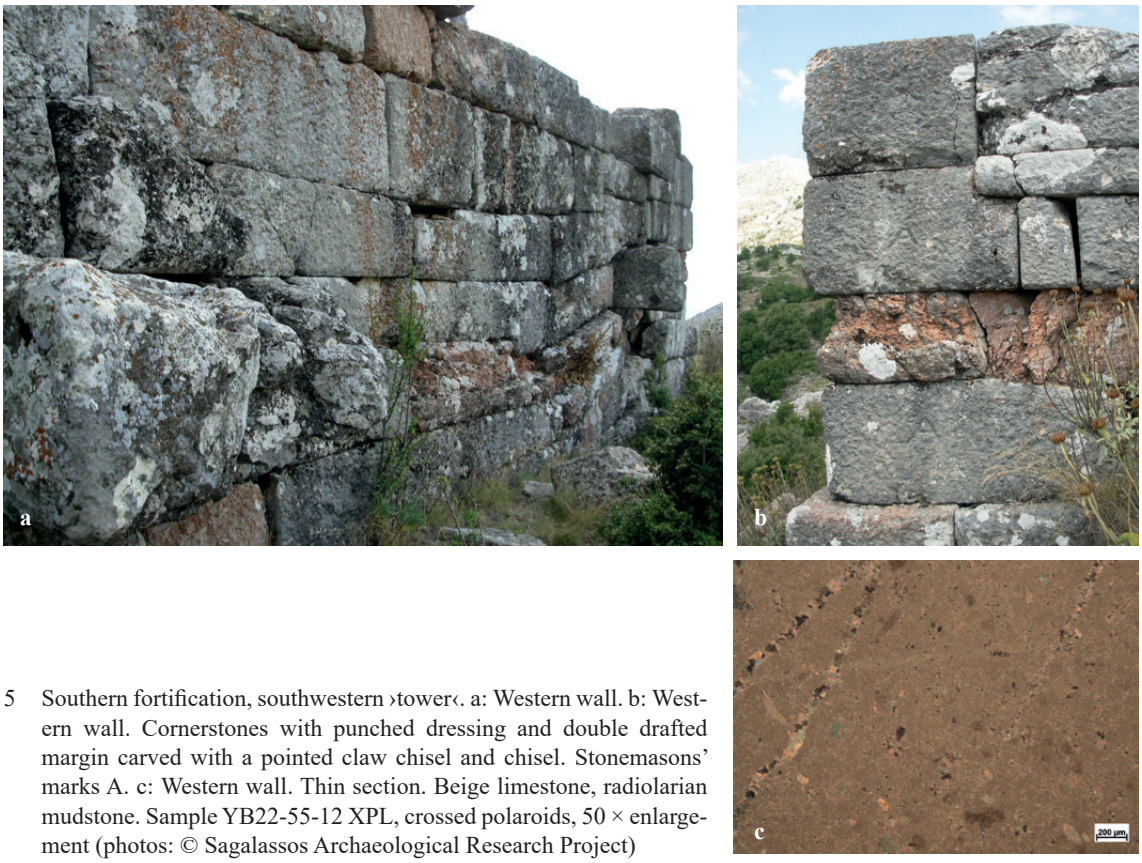
The Southern Fortification, the Southwestern ›Tower‹

The ruins of a rectangular ashlar building, west of the north-south oriented plateia, were described as the remains of a ›tower‹ of the southern fortification[26], primarily taking into account its strategic position on a steep slope, overlooking the southern necropolis. However, as this building has not been excavated yet, its possible function within the southern fortification must remain hypothetical. This ›tower‹ was dated during the late Hellenistic period[27]. In the absence of stratigraphical data, this chronology can only be verified based on a comparative analysis of the traces of the stone carving.

The western facing's ashlar masonries show recesses and sloping courses (fig. 5 a). The individual ashlars have a low rustication with a broached or a punched dressing and a double drafted margin. The internal drafted margin was carved with a pointed claw chisel, the external one with a chisel. In order to propose a preliminary chronology for this ›tower‹, these traces will now be compared with those of several other dated buildings at Sagalassos.

A double drafted margin was also found on the rusticated ashlars of the middle/late Hellenistic Agora Building (2nd cent. BC[28]), carved with a pointed claw chisel. A pointed claw chisel was also used for the single drafted margins of the equally rusticated ashlars of the southern wall of the late Hellenistic Terrace Building (late 2nd/early 1st cent. BC[29]), but inside the vaulted tunnel of this building, only chisel-drafted margins appear. Traces of both a pointed claw chisel and a chisel appear on the single drafted margins of the rusticated ashlars of the northern fortifications (late 2nd/early 1st cent. BC[30]). The single drafted margins of the rusticated ashlars of the late Hellenistic southern wall of the agora gymnasium (1st half of the 1st cent. BC[31]) were carved with a pointed claw chisel. Additionally, single and double drafted margins also appear on the rusticated ashlars in the vaulted corridor parallel with the *diazoma* of the theatre (end of the 2nd cent. AD[32]). The carving of the internal margin of the double drafted margins cannot be determined because of wear; the external one was carved with a chisel. Although these double drafted margins with a chisel-drafted external margin resemble those of the southwestern ›tower‹, a transfer of the theatre chronology to the ›tower‹ is not warranted because in the theatre corridor, ashlars with

22 Van Beeumen – Maréchal – Dar 2015.
23 Poblome 2016, 25.
24 Degryse et al. 2008b.
25 Doperé 2020.
26 Loots – Waelkens – Depuydt 2000, 605.
27 Loots – Waelkens – Depuydt 2000, 605.
28 Claeys – Karakurt – Lamberts 2015; Talloen – Poblome 2016, 118 f.; Claeys – Alper – Arnauts 2017.
29 Talloen – Poblome 2016, 119 f.
30 Van Beeumen – Maréchal – Dar 2015; Poblome 2016, 25.
31 Beaujean et al. 2018.
32 Vandeput 1997, 107–112. 215–220.



5 Southern fortification, southwestern ›tower‹. a: Western wall. b: Western wall. Cornerstones with punched dressing and double drafted margin carved with a pointed claw chisel and chisel. Stonemasons' marks A. c: Western wall. Thin section. Beige limestone, radiolarian mudstone. Sample YB22-55-12 XPL, crossed polaroids, 50 × enlargement (photos: © Sagalassos Archaeological Research Project)

double drafted margins appear mixed with ashlars with single drafted margins and they represent a smaller proportion (24 %). A reuse of at least some of the ashlars in the theatre corridor seems possible. The discovery in 2019 of a cornice with dentils and of a Doric capital incorporated in the same walls points in the same direction.

The double drafted margin of the rusticated ashlars of the ›tower‹ thus partly points to the middle/late Hellenistic Agora Building. Use of the chisel alongside the pointed claw chisel on single drafted margins was limited to ashlar masonries of the late Hellenistic period. The ashlar masonries of the ›tower‹ thus seem to be linked simultaneously to those of the middle/late Hellenistic Agora Building and to the other late Hellenistic constructions, so that a late Hellenistic date could be proposed in preliminary terms. Interestingly, the typology and the carving technique with the pointed chisel of the A in the stonemasons' marks on the corner ashlars of the ›tower‹ (fig. 5 b) are strikingly similar to the A in the three-letter mark of the equally late Hellenistic Terrace Building[33]. Additionally, the identification of the limestone of the ›tower‹ as radiolarian limestone from the Sarıkaya quarry (fig. 5 c), similar to the late Hellenistic northern fortifications[34], could be an important element supporting its function as part of the southern city fortification and its chronology during the late Hellenistic period. In this discussion, it is also important to mention that no construction dated to the 2nd century AD was built with radiolarian limestone from the Sarıkaya quarry[35].

33 Doperé – Beaujean (forthcoming).
34 Degryse et al. 2008b, 282 f.
35 Degryse et al. 2008b, 283–285; Doperé – Degryse – Poblome (forthcoming).

6 Bouleuterion. a: Western and southern seats (left). b: Northern wall with five doors between the bouleuterion (below right) and Basilica B (upper left) (photos: © Sagalassos Archaeological Research Project)

The Bouleuterion

The bouleuterion is located along the western side of the Upper Agora. It consists of a rectangular courtyard, surrounded by seats on three sides (west, south, east), and separated from a forecourt by a northern wall with five finely carved framed doors (fig. 6 a–b). The frames are only present on the southern facing of this wall, thus turned to the courtyard and the seats. It is difficult to reconcile this wall chronologically with this courtyard and the seats because three of the five doors are partially hidden by the seats.

The chronology of the construction of the bouleuterion and of the northern forecourt was determined based on the stratigraphy of the foundations of the pavement of the bouleuterion courtyard, of the top row of the western seats and the western wall, and of the southeastern corner of the forecourt[36]. The analysis of the stratigraphy in these different trenches came to a coherent proposed chronology during the early Roman Imperial period. The datable artefacts found in the different trenches defined a date range during the last quarter of the 1st century BC/1st century AD. This period is long enough to cope with the discrepancy between the northern wall with the five doors arranged in a *scaenae frons* configuration and the western seats partially hiding the two western doors. An early Roman Imperial chronology was also proposed for this wall's foundation, in the absence of datable artefacts, but because of the use of lime mortar, which was introduced in Anatolia after the middle of the 1st century BC[37]. The perfectly finished southern facing of the northern wall contrasting with the largely unfinished seats probably reflects two distinct construction phases, separated by a change of plan, and thus explaining the apparent spatial discrepancy between the two parts of the bouleuterion. In this context, it should be mentioned that the stones of the bouleuterion were quarried from the Sarıkaya quarry or from the Ağlasun Dağları Pass, except precisely those of the northern wall, which show a transitional limestone marble from an as yet unknown quarry.

All ashlars and door frames were carved with pointed claw chisels with eight or eleven teeth (fig. 7 a). The combined use of these tools was limited to the early Roman Imperial period[38]. Most of the seat blocks remained unfinished (fig. 7 b). The seating surfaces either show a punched or a broached dressing, carved with a pick or a pointed chisel. Of a total of 96 seats, 75 show a punched dressing (78 %), eight a broached dressing (8.3 %), and only 13 a finished carving with a pointed claw chisel (13.5 %). 17 of these seats even still show a rustication, some even very pronounced.

36 Talloen – Poblome 2016, 124–127.
37 Talloen – Poblome 2016, 126.
38 Doperé 2020.

7 Bouleuterion. a: Northern wall with five doors. Traces from a pointed claw chisel with eight teeth, and chisel-drafted margin, marked with a fine line. b: Western and southern seats (left). Unfinished top bed with rustication and punched dressing (photos: © Sagalassos Archaeological Research Project)

The Doric Temple

The Doric temple is situated on the highest built plateau of the monumental centre, together with the neighbouring propylon and the Northwest Heroon, above the northwestern corner of the Upper Agora (fig. 8 a). A deposit covering the limestone and ophiolithic bedrock and abutting the lower foundations of the southern wall of the temple and a walking level related to the levelling of the bedrock at the western side of the temple both contained ceramic sherds dated to the very beginning of the 1st century AD, which provides a terminus post quem for the first building activities at the Doric temple[39]. The first quarter of the 1st century AD is thus an acceptable estimation for the chronology of the construction of the Doric temple.

For the external facing surfaces, two different pointed claw chisels and a chisel were used (fig. 8 b). The coarse pointed claw chisel (eight teeth) was used for the central rectangular zone, the fine one (eleven teeth) for a large flat ›frame‹. This ›frame‹ is itself bordered by a small chisel-drafted margin. The combination of pointed claw chisel traces with eight and eleven teeth only occurred during the early Roman Imperial period[40]. The sequence as interpreted here, shows that the external facing of the Doric temple was carved with the intention of producing a perfect smoothly carved surface with tightly fitting joints. The selection of three successive tools for the carving of the central zone, the ›frame‹, and the chisel-drafted margin indicates the intention to obtain a high-quality rectangular facing surface.

DISCUSSION AND CONCLUSION

The Agora Building is the oldest construction in Sagalassos showing ashlar masonries. Nevertheless, this first ashlar building already shows an advanced degree of craftmanship, including aesthetic preoccupations and carvings avoiding placement damage. This care is limited to the exterior facings, while the interior masonries are stereotomically correct, but without any correspondence between the heights of the inner and outer courses. This shows that the parties responsible for the erection of this building had more in mind than simply a functional construction. This building was made to impress through its quality, at the same time expressing the importance of its function, of the civic community who ordered it and of the political body (?) or administrative service (?) housed inside. Although it is, at this stage of research, the only construction

39 Talloen 2019.
40 Doperé 2020.

8 Doric temple. a: From the southeast. b: Eastern wall, external facing. Traces from a pointed claw chisel with eight teeth on the central part, with eleven teeth on the large ›frame‹, and chisel-drafted margin (photos: © Sagalassos Archaeological Research Project)

demonstrating these qualities, we can conclude that the community taking these initiatives was organised and that its civic identity started to show its nature through the erection of (a) quality ashlar building(s). This marked the start of a new Sagalassos, including an urban plan, which ultimately led to a paved Upper Agora, with buildings and monuments expressing the power of the socio-political entities and the euergetism of the community's benefactors.

That such a building appeared at Sagalassos is probably not so surprising as it may seem, taking into account the multiple manifestations of similar architectural and ashlar-carving qualities in other Pisidian cities and elsewhere. Unfortunately, most of these sites have not been excavated, so that their so-called Hellenistic chronologies mostly rely on the interpretation of the carving of rusticated or pulvinated ashlars. Nevertheless, the archaeologically dated middle/late Hellenistic building at Sagalassos can only be understood in this more general context. Also, the Sarıkaya area must have been known, possibly first as a source of broken stones readily available as the result of the breaking and movement of the limestone rocks, and later as a proper quarry. Although adequate measurements on the oldest extraction traces in the quarry are not available, their regularity and carefully planned extraction seem to correspond with the equally superior care displayed by the Agora Building's ashlars, even if these received their final carvings at the building site and not in the quarry.

As the quality of the ashlars of the Agora Building seems to point to active political/administrative parties, the same logic could apply to finding the Sarıkaya radiolarian limestone to be incorporated in the northern and southern fortifications, in the bouleuterion and in the Doric temple. It is difficult to prove without written sources, but this could be an indication that this quarry had become a city quarry. However, a fortification was a huge building site consuming high volumes of stone. That quarries of the *necropoleis* were also involved should therefore not come as a surprise. The concomitant use of stones from more than one quarry was documented not only for the northern fortifications, but also for the bouleuterion. Nevertheless, the first choice for these city buildings seems to have been the Sarıkaya quarry. The first indication that stone quality may have played a role in this selection is that the very localised fissures in the western facing of the Doric temple were shown not to be due to frost damage, despite the very exposed positioning of the building, but to a local accidental fire[41]. Additionally, a detailed examination of all ashlar masonries erected with Sarıkaya radiolarian limestone shows a minimal number of fissures (not taking into account the ones to be attributed to earthquake damage), while multiple coarse and fine

[41] Degryse et al. 2008a, 219 f.

fissures are visible on the masonries of other contemporary buildings erected with ashlars from the *necropoleis* quarries or the Ağlasun Dağları Pass quarries (Terrace Building, Doric Fountain House, Northwest Heroon, honorific columns, bouleuterion [northern wall]). This can be linked to the high degree of fracturing of the limestone formations in these quarries[42]. Importation of marble from distant quarries for construction did not yet happen during middle/late Hellenistic (2nd cent. BC) and early Roman Imperial times[43], but building quality seems to have been considered important, as transport to bring blocks from Sarıkaya was effectively organised. Among all local limestone quarries, the Sarıkaya quarry was located at the longest walking distance (5.8 km with maximum altitude differences of approx. 120 m, Sagalassos being the highest point)[44]. From the 2nd century AD onwards, the quarrying activities at Sarıkaya seem to have stopped. This more or less coincided with the beginning of the importation of coloured construction marble[45]. The quality of a building was clearly now marked differently.

With regard to the stone-carving techniques in use during the early Roman Imperial period, one striking point arose from their analysis. The visible facings of the ashlars of the Doric temple, its propylon, the northern wall of the bouleuterion, and the Northwest Heroon were all carved with pointed claw chisels with eight and/or eleven teeth. These buildings were all situated above the northwestern corner of the Upper Agora, in a dominant position. It looks as if similar groups of stonemasons delivered ashlars to the sites of all these buildings. A possible argument against this hypothesis is that the fine carving of these buildings shows a different pattern, even though this is only visible under grazing light. It seems fitting that the Northwest Heroon was erected close to these major city buildings. A preliminary yet itself imposing suggestion is that the erection of the Northwest Heroon was possibly linked to the building sites around it, and that the aristocrat being honoured was a benefactor or a politically active player involved in or even responsible for this entire project.

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42 Doperé – Degryse – Poblome (forthcoming).
43 Waelkens 2021, 137 f.
44 Degryse et al. 2008b, 281.
45 Waelkens 2021, 138.

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J. Clayton Fant – Simon J. Barker

OPHITES, FROM THE EASTERN DESERT OF EGYPT TO ROME AND CAMPANIA

A STUDY OF A ›SMALL-QUARRY‹ STONE DEVELOPED IN THE AUGUSTAN PERIOD

Abstract
The study of stone quarries in Egypt's Eastern Desert over the past few decades has accrued a mass of documentary and archaeological evidence for Roman quarrying in the area. The earliest epigraphical evidence for Roman activity is found at Mons Ophiates, the quarry site in Wâdi Semna/Umm Wikala. Production at Ophiates and several smaller quarries seems to have begun under Augustus (prior to AD 14). Yet, the chronological profiles and distribution of the smaller quarries of the Eastern Desert and thus the earliest exploration of the area's lithic resources remain unclear. Here, the aim is to provide a more nuanced understanding of the interplay between Roman investment in the Eastern Desert and the earliest uses of these lithic resources by examining the evidence for the Metagabbro, Granito della sedia di San Lorenzo/San Pietro, from Wâdi Umm Wikala.

INTRODUCTION

We have been interested for some time in the Egyptian production, export, and use in Italy of four types of stone from Egypt's Eastern Desert from quarries which were physically quite small, at least in comparison to quarrying operations at Porphyrites, Mons Claudianus, and their satellites[1]. They are Eufotide (Metagabbro) from Wâdi Maghrabîya[2], the Roman Ophites (Metagabbro) from Wâdi Umm Wikala[3], Granito della colonna (pegmatitic diorite) from Wâdi Umm Shegilat[4], and Verde ranocchia or Serpentina Moschinata, the Roman batrachites (serpentinite), from Wâdi Umm Esh (fig. 1)[5]. Having attracted less attention from archaeologists and papyrologists, their chronological profiles are less clear and their ancient names, with the exception of Ophites[6] and probably the »frog-stone« variety of batrachites, which fits with Pliny's description of the serpentinite from Wâdi Umm Esh, remain unknown. Because of limitations of length, we focus here on just one, Ophites, with the others considered elsewhere[7], as well as with the intention of returning soon to

1 Klemm – Klemm 2008, 280–290; for Mons Claudianus, see Peacock – Maxfield 1997; Maxfield – Peacock 2001a; for Porphyrites, see Maxfield – Peacock 2001b.

2 Harrell – Brown – Lazzarini 1999.

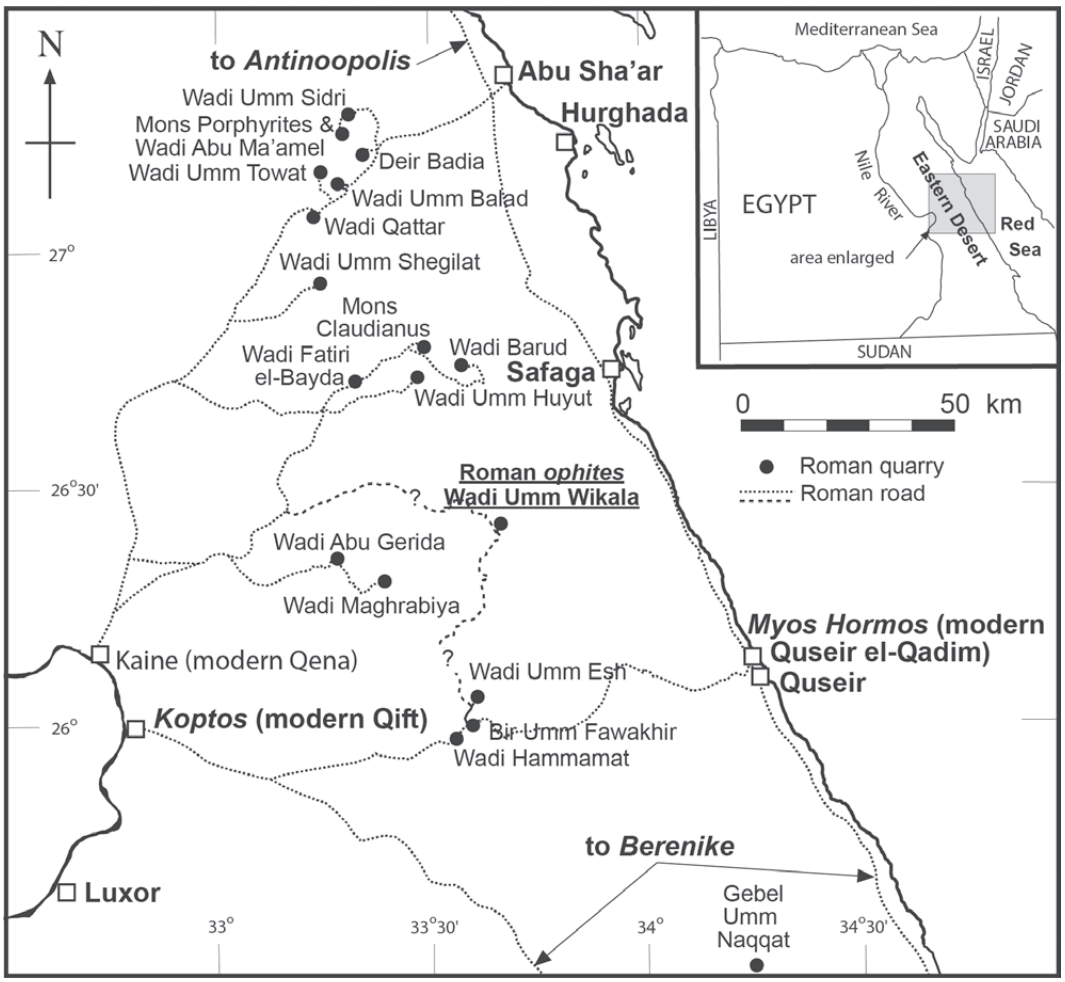
3 Sidebotham et al. 2001; Klemm – Klemm 2008, 291–294.

4 Sidebotham et al. 2001.

5 Klemm – Klemm 2008, 294 f. We have decided not to use the term ›granite‹, as none of the Eastern Desert stones are true granites in the geological sense (unlike the granite from Aswan). Only Granito della colonna, from Wâdi Umm Shegilat, a coarse pegmatitic diorite, is even geologically close to a granite. In contrast to marmor, Latin has no word for granite. We have opted, therefore, to use the collective tag ›Eastern Desert stones‹ or the geological description, the modern location name, or the traditional Italian name when discussing individual stones. We have also opted to use the ancient names of stones where known. A comprehensive interactive map can be found at <https://desertnetworks.huma-num.fr/interactive-map> (30.06.2023).

6 R. Gnoli (1988, 129–131) was the first to connect this stone with its ancient name. The name is also mentioned in the Wâdi Umm Wikala ›curator‹ inscription found in Wâdi Hammamat, see Sidebotham et al. 2001, 139.

7 For longer discussion of all four of the aforementioned quarrires, see Barker – Fant 2024.



1 Map of the Eastern Desert showing Roman stone quarries. The quarry considered here, Wâdi Umm Wikala, is underlined and in bold (courtesy of J. Harrell)

the stones from the larger quarring complexes at Porphyrites and Mons Claudianus. In this paper we aim to set the Egyptian evidence directly against evidence for the distribution and use in Campania of Ophites, with the hope of learning more about its chronology and contexts of use. We will bring in evidence from Rome and elsewhere selectively as relevant.

A number of major publications in archaeology[8], geology[9], and papyrology[10] furnish an opportunity for new syntheses, as called for by J. Gates-Forster in the »Oxford Handbook of Roman Egypt«[11]. Survey and excavation of ostrakon-rich middens at the smaller quarries are now picking up pace following exploration of the road forts along the Myos Hormos and Berenike roads[12]. It is to be hoped that similar work on the ›small‹ quarries in the near future[13] may pre-empt further vandalism and treasure hunting[14].

8 Peacock – Maxfield 1997; Maxfield – Peacock 2001a; Maxfield – Peacock 2001b; Sidebotham et al. 2001; Sidebotham – Gates-Foster 2019; Desert Networks.
9 Klemm – Klemm 2008; Harrell 2013; Harrell 2017.
10 Cuvigny 2021.
11 Gates-Forster 2013, 738.
12 Sidebotham 1991; Cuvigny 2003; Brun et al. 2018; Sidebotham – Gates-Foster 2019.
13 Sidebotham et al. 2001, 168, e.g., point to a large midden at the *hydreuma* in Wâdi Semna.
14 Vandalism was the initial stimulus for the Mons Claudianus project, see Peacock – Maxfield 1997, 12.

The general picture of decorative stones at Pompeii, from the earliest uses of white and/or coloured limestones in the 2nd century BC to the arrival of white and coloured marbles over the course of the 1st century BC, is now well known[15]. The use and distribution of specific marble types, however, has received less attention[16]. The cumulative effect is to foster the impression of more general distributions than previously documented. Our own fieldwork in the Vesuvian region has sought to refine this picture through detailed counts and identifications in a variety of contexts. For Campania we draw upon our bars project[17], our study of Villa A at Oplontis[18], our similar study (in progress) of the Stabian villas[19] and S. J. Barker's ongoing survey of marble use in all surviving houses of Pompeii and Herculaneum[20]. This comprehensive approach offers more precise information about the range of lithotypes present within the Vesuvian area and, in the case of stones from Egypt's Eastern Desert, important early documentation, as quarry evidence is often lacking.

Like many studies of Roman Italy, the focus on the Vesuvian area is largely one of convenience arising from the concentration of finds and their often superior preservation. However, this also has ramifications. First is obviously the chronological limit of the eruption of Mount Vesuvius in AD 79. Second is the fact that while Campania, as the playground for Rome's wealthiest (and home to profitable, producing villas)[21], is not necessarily representative of Italian cities in general, it is ideal for an inquiry into trade and distribution patterns of marble. Social competition and close ties to the elite in Rome, many of whom also owned Campanian villas, meant that trends rippled all the way down the social scale, which, combined with the unusual preservation (aided by Mount Vesuvius), make it a good index of stone circulation.

PRE-AUGUSTAN IMPORTS?

The basic question about the stones from Egypt's Eastern Desert is whether imports existed before the Roman annexation of Egypt in 30 BC. Since space does not allow a full examination here, we just touch on the chief points in anticipation of a fuller exposition elsewhere. However, even if Roman efforts to revive and expand mineral exploitation in the Eastern Desert, a low priority in the late Ptolemaic period, started a decade or two earlier than the epigraphical dates of AD 11 for Mons Ophiates[22], AD 14 for the metagreywacke (bekhen stone) quarries at Wâdi Hammamat[23], and AD 14 for Porphyrites[24], this is still not support for a pre-annexation date. Moreover, stones from Egypt's Eastern Desert are missing from Rome's elite houses on the Palatine Hill, many of which were built around the mid-1st century BC or renovated in subsequent decades. Their stone pavements show a general transition from using only local limestones to the addition of polychrome marbles – but not those of the Eastern Desert[25].

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15 Fant 2007; Barker – Fant 2018; Beck 2019, 110.

16 For alabaster, see Perna – Barker 2017; Barker – Perna 2018. D. M. Beck (2019, 111 n. 34) counts more than 20 instances of Marmor Numidicum in private houses of the 1st cent. BC in Pompeii.

17 Fant – Russell – Barker 2013.

18 Barker – Fant 2019a; Barker – Fant 2019b.

19 Barker – Fant – Ward 2015; Gardelli – Barker – Fant 2016; Barker – Fant 2018.

20 Barker 2022.

21 D'Arms 1970.

22 IPan 51; SEG 20, 167 no. 670.

23 IPan 43 = IKoKo 39.

24 AE 1995, 1615 (W. Van Rengen).

25 Floors of the Augustan period were generally produced in mixed materials, which remained typical up until the middle of the 1st cent. AD, see Guidobaldi 1985, 174; Olevano – Guidobaldi 1994, 163. This is exemplified in the »House of Augustus« (Carettoni 1963), now generally referred to as either the »House of Octavian« or »the interrupted house«, as the actual house of Augustus would likely have been built higher on the same site as part of the later temple project. The earlier house featured pavements with Marmor Carystium, Marmor Numidicum, Marmor Luculleum, and Marmor Phrygium alongside the more usual limestones such as Palombino. The floor and wall decoration, which can be dated to ca. 42–36 BC based on brick-stamp evidence, was stripped prior to its demolition

Of course, there had long been a flourishing trade between Alexandria and Italy[26] that became more prominent in the late 2nd century BC in Campania, most spectacularly in the Casa del Fauno (VI 12, 2)[27]. Most of the evidence comes from painted wall decoration, likely executed by travelling Alexandrian workshops[28], but pavements at the Villa of the Mysteries, now redated to the villa's pre-Roman phase[29], featured inserts of calcite alabaster (possibly of Egyptian origin)[30]. However, calcite alabaster came from quarries along the Nile, a very different situation for infrastructure and transport than the Eastern Desert. Moreover, the calcite-alabaster quarries seem to have been in regular operation for centuries.

Recent work on Alexandrian *sectilia pavimenta* offers another line of evidence. Paving elements from the excavations of the former British Consulate and Cricket Grounds, coming from wealthy houses of the 3rd to 1st centuries BC, show a rich scale of colours, leading A.-M. Guimier-Sorbets to remark, »it is obvious that the numerous possibilities of coloured stone in Egypt have been exploited for decorative uses.«[31] Photographs document some obvious imports, but no stones from the Eastern Desert are represented. One well-executed *sectilia emblemata* (from a reused context) includes coloured bands surrounding a central field, described as »dark green serpentine with light green spots«, but these are clearly the phenocrysts of *lapis lacedaemonius* (Green porphyry) from Sparta[32]. This *emblemata* seems to date from the last quarter of the 1st century BC to the period under discussion[33]. The conclusion must be that stones from the Eastern Desert were unknown or were not valued enough to be quarried, which amounts to the same thing.

Furthermore, P. Pensabene has noted that there is no proof of native hard stones, i.e. Aswan granite and granodiorite, being used for anything other than public monuments in Egypt[34]. In Lucan's somewhat overheated description, the Palace of Kleopatra VII was decorated with the utmost of luxuries and was paved with onyx (calcite alabaster), but no hard stones are mentioned apart from a purple one (*purpureusque lapis*), which, intriguingly, may be *lapis porphyrites*[35]. If there were no exports of Egyptian Eastern Desert stones from Upper Egypt to Italy before annexation, then we must ask when and in what form the early exploitation of Egypt's Eastern Desert stone resources occurred.

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for the construction of the Temple of Apollo and the terrace of the Portico of Danaids, see Gallocchio – Musco – Pensabene 2017; Pensabene – Gallocchio 2021, 19–44. 69–85.

26 Strab. 13, 7, 6–7; Fraser 1972, 154–157.

27 Daszewski 1985, 18–21 and earlier literature cited there.

28 Grandi – Guidobaldi 2008, 165 f.

29 Pisapia 2021, 427–440. These pavements are found in the three main porticoes (P1–P4), Room 62, Room 65, Exedra 1, and Tablinum 2. The pavements feature inserts of banded calcite alabaster, for which an Egyptian origin might possibly be suggested by the fact that they are weathered and very bleached.

30 The use of calcite alabaster in Pharaonic and Ptolemaic Egypt can be well documented with sources mainly from the Nile Valley, see Lucas – Harris 1962; Shaw 1986; Shaw 1987; Brown – Harrell 1995; Aston – Harrel – Shaw 2000; Lazzarini 2002, 223–289; Shaw 2010. However, their intensive exploitation began in the Roman period following the annexation of Egypt to Rome in 30 BC, see Barker – Perna 2018 for Second-Style uses of Egyptian calcite alabaster. For its use in the production of vase-shaped funerary urns starting in the Caesarean period (50–40 BC), see Perna 2014.

31 Guimier-Sorbets 2021,148 figs. 159–160.

32 Daszewski 1985, 173 cat. 48 pl. 24 b.

33 Daszewski 1985, 172 f. cat. 47.

34 Pensabene 2016, 37–40.

35 Lucan. 10, 114–117: *nec summis crustata domus sectisque nitebat armoribus, stabatque sibi non segnis achates purpureusque lapis, totaque effusus in aula calcabatur onyx*. See also Adriani 2000, 100. Earlier instances of calcite alabaster are mentioned in connection with royalty. E.g. Athenaeus' account of the Thalamegos describes the luxurious state barge commissioned by Ptolemy VI Philopator (reign 180–164 BC) as being lavishly decorated and laid with various precious and coloured stones, including calcite alabaster, see Athen. 5, 206c: »The Egyptians diversify their walls too with white and black courses of stones, and sometimes also with blocks of the stone known as alabastitis.«

METAGABBRO FROM MONS OPHIATES/WÂDI UMM WIKALA, GRANITO DELLA SEDIA DI SAN LORENZO/SAN PIETRO

An inscription from AD 11 documents a gathering of Roman functionaries at Mons Ophiates, the quarry site in Wâdi Wikala, a tributary of Wâdi Semna[36]. The namesake stone, a Metagabbro, was called Ophites, ›snakelike‹, from a perceived resemblance to a snake's skin. It comes in two varieties with smaller and lighter green speckles or larger and darker ones, both on a lighter ground. They are known in the Italian artisanal tradition from their (re)uses in ecclesiastical furniture as Granito della sedia di San Lorenzo and di San Pietro, respectively[37].

The inscription mentions a camp curator, also described as in charge of construction, and two architects, under the auspices of P. Iuventius Rufus. The text also notes a shrine of Pan dedicated by P. Iuventius Agathopous, freedman of P. Iuventius Rufus, legionary tribune, »prefect of Berenike and director general of the smaragdus mines, the topazos (mines), the pearl (fisheries), and all of the mines of Egypt.«[38] This is the earliest explicit attestation of Roman quarrying in the area[39]. The infrastructure at this site is impressive; it may have been the largest of the quarries in the area apart from Porphyrites, Mons Claudianus, and their satellite operations[40]. The survey authors cautiously estimate the workforce at 100–200 maximum[41]. Despite the early start of exploitation, these is no sign of an early 1st-century AD use of Ophites in Rome or Latium. The first case (unlikely to be the *absolute* earliest of course) is in the basketweave pavement of the Palatine nymphaeum of Nero's Domus Transitoria[42], ca. AD 60–64[43]. The brilliant white marble slabs are accented at the overlaps with inserts of San Lorenzo and San Pietro varieties of Ophites and of Eufotide.

In a passage from his »Pharsalia«, Lucan compares the belly of a serpent to »Theban Ophites«[44]. Since Lucan died in AD 65, this passage proves elite awareness of the stone and of its Egyptian origin. But we can be more emphatic: we know that Nero singled Lucan out for recall from his studies in Greece to join the circle of his friends (*amicus* was almost a formal rank) in the years during which the Domus Transitoria was constructed. We are told that Lucan dined with Nero and traded verses after dinner[45]. This hospitality certainly took place in the imperial dwellings on the Palatine, and it is not fanciful to imagine that Nero took his friends to see the nymphaeum under construction. When finished, it was spectacular, with 48 colonnettes of *lapis porphyrites* and *lapis Lacedaemonius* with gilded bronze bases[46]; Lucan perhaps also noticed the small squares of Ophites and made a note.

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36 For the site and comprehensive bibliography, see the »Umm Wikalah Desert Networks Project« (pers. comm. B. Redon, 17.11.2022).

37 For illustrated samples, see Mielsch 1985, 69 pl. 24 nos. 804–809; Gnoli 1988, 154–159 figs. 109–110 (should be labelled »sedia di San Pietro«); Borghini 1989, 211 fig. 80; Pensabene – Bruno 1998, 11 fig. 64; Price – Cooke 2012, Corsi Collection, nos. 820–821 (San Pietro only); MUSNAV, inv. 1751. 1866; Harrell 2017, no. 23 (varieties a–b).

38 Tregenza 1950; Tregenza 1951; SEG 20, 167 no. 670; IPan 51.

39 For other considerations that may bring work at various sites forward in time, see Fant 2022.

40 Sidebotham et al. 2001, 144–158.

41 Sidebotham et al. 2001, 169. The pottery and burial evidence suggest occupation of the site through the 2nd or early 3rd cent. AD, see Sidebotham et al. 2001, 159–167.

42 The pavement is located in »vano B«. The floor consists of a ›T-shaped‹ or basketweave motif, composed of rectangles of white marble (0.43 × 0.22 m) and squares of Eastern Desert stones (with sides 0.11 m). Stylistically, the pavement dates from the 2nd to the 3rd quarter of the 1st cent. AD, see Morricone Matini 1967, 64 fig. 24 pl. 29; Guidobaldi 1999, 643 pl. 248 b.

43 Construction of the Domus Transitoria likely began around AD 60, see De Vos 1995, 199–202. Both Tacitus (ann. 15, 39, 1) and Suetionius (Nero 31, 1) note the building's luxury in comparison to earlier buildings.

44 Lucan. 9, 712–714, *Thebanus ophites*; the *cenchris* was one of the snakes of the Libyan Desert which arose from drops of Medusa's blood; see also Plin. nat. 36, 55.

45 Tac. ann. 14, 16; Fantham 2011, 12–14, citing the edition of Vacca in Rostagni 1944, 146.

46 De Vos 1995, 200.

The appeal of this stone in imperial circles is further evident at an imperial villa on Lake Nemi in the Alban Hills[47]. The villa was lavishly decorated with *sectilia pavimenta*[48], and fragments from recent excavations include several stones from Egypt's Eastern Desert[49]. The fragments of Ophites (San Lorenzo and San Pietro varieties), Eufotide, and *lapis porphyrites* with round edges or irregular shapes must have come from walls or floors with rather complicated designs[50]. The closest comparanda to these pavements are in the nymphaeum of the Neronian Domus Transitoria in Rome and the late Fourth-Style (post-AD 62) floors of the Casa dei Cervi (IV 21) and Casa dell' Apollo Citaredo (V 11) in Herculaneum[51]. The use of these stones in the Nemi villa therefore belongs to the second half of the 1st century AD or perhaps slightly later[52]. On balance, this suggests that the Eastern Desert stones probably belong to the villa's third phase in the late Neronian-early Flavian period, between AD 60 and 80[53].

In Campania we find Ophites paired with Eufotide in elite contexts of the post-earthquake period (AD 62–79). In a floor of the Villa of the Papyri in Herculaneum, now relaid in Room 141 of the Naples Archaeological Museum[54], the two stones form the centrepiece of floor motifs. In the elaborate *sectilia* composition of Triclinium 5 of the Casa dei Cervi at Herculaneum, the rarer varieties are grouped together, while in the paving of the house's cryptoporticus, inserts of Ophites and other rarities call attention to the more important rooms[55].

At Pompeii, Ophites is found in both similar and less grand surroundings to those from Herculaneum. In Triclinium 17 of the Casa del Efebo (I 7, 11)[56], a single rectangle of the San Lorenzo variety of Ophites (fig. 2) stands out in the finished composition. In the vestibule of the Casa di Severus (VII 2, 29), the black-ground mosaic pavement with inserts of Marmor Chium in a grid

47 B. Poulsen (2020) suggests that the villa was the one owned by C. Julius Caesar and constructed in *nemore* or in *nemorensi*, that is in Diana's sacred wood (Cic. Att. 6, 1, 25; Suet. Iul. 46). Stamped tiles reused in the later phases of the villa and featuring the letters »ATI« flanked by a winged *caduceus* and a palm branch can be connected to M. Atius Balbus, praetor in 60 BC and married to Caesar's sister, Julia. Their daughter, Atia, of course married C. Octavius and was the mother of the Emperor Augustus. The villa or the land, therefore, probably remained under the ownership of the Julio-Claudian emperors – the villa is the only one with lake access, and its second phase corresponds to the period of the two floating palaces of Caius Caligula, which must have required a base on the shore of the lake. Moreover, the last major renovation of the villa was in the late Julio-Claudian period, which also fits with imperial focus shifting from Lake Nemi to Lake Albano when Domitian constructed his villa at Castel Gandolfo.

48 The *in situ* floors belong to the villa's peristyle and several of its adjoining rooms (P4. P7), its bath complex (rooms B2a, B5, and B9), and rooms S4 and S6 on the southern terrace, see Bülow Clausen – Moltesen 2020, 431 f. In addition, more than 100 fragments were found in Trench C1 in the northern corner of the *porticus triplex*. Trench EE in the southern part in front of the villa's terrace was the richest in terms of marble finds with over 6,600 pieces recovered, probably originally from the *parte nobile* of the villa, see Bülow Clausen – Moltesen 2020, 432.

49 Bülow Clausen – Moltesen 2020.

50 This includes 19 slabs of *lapis porphyrites* from Trench CI in the north, Trench EE in the south, and Trench EC on the southern terrace, see Bülow Clausen – Moltesen 2020, 451–453 cat. 214. 219. 223. 227–230. 232. 281. In addition, Trench EC included Ophites (Granito verde della sedie di San Lorenzo variety) (Bülow Clausen – Moltesen 2020, cat. 220. 222. 226. 233. 249) and a ›medallion‹ in Eufotide with all surfaces smoothed, perhaps for a special inlay in a floor or in a piece of furniture (Bülow Clausen – Moltesen 2020, 452 cat. 221).

51 Bülow Clausen – Moltesen 2020, 449, who also noted that the general assemblage of marbles (esp. *lapis Lacedaemonius* and *lapis porphyrites*) is characteristic of the Neronian and Domitianic floors on the Palatine in Rome.

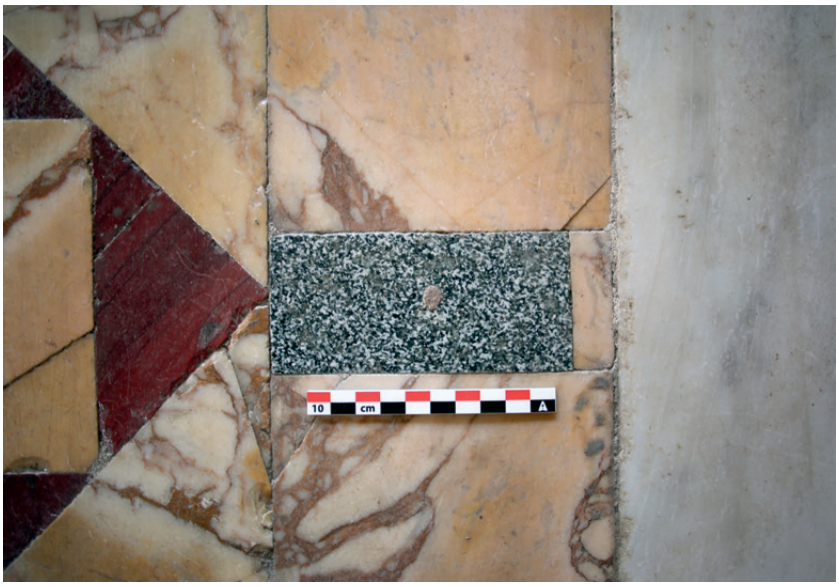
52 Considering the similarity of these fragments to the stones in the pavements discussed above, we would probably opt for a Neronian date, especially given the fact that some fragments have direct parallels to the pre-AD 64 nymphaeum of the Domus Transitoria, see e.g. Bülow Clausen – Moltesen 2020, cat. 217. 244. 262. Of course, a Flavian or later date is also possible.

53 Other fragments of Eastern Desert stones include *lapis porphyrites* fillets or strips (Bülow Clausen – Moltesen 2020, cat. 341. 394), a polygonal slab and a half lozenge in Eufotide, found during the cleaning of part of the terrace wall (Bülow Clausen – Moltesen 2020, 437 cat. 48), and a small fragment of a rectangular slab of Ophites (Granito verde della sedia di San Lorenzo variety) (Bülow Clausen – Moltesen 2020, 439 cat. 67).

54 Pisapia 2004; Miele – Esposito 2021.

55 Barker 2022, 119.

56 De Carolis – Esposito – Ferrara 2017.



2 Metagabbro (Ophites, San Lorenzo variety) tile in the *emblema* of the triclinium (17) of the Casa del Efebo (I 7, 11), Pompeii (photo: S. J. Barker, © Ministero della Cultura – Parco Archeologico di Pompei. All rights reserved)

included a small strip and triangle of Ophites (San Pietro variety) along with a small square of *lapis Lacedaemonius* and a triangle of *lapis porphyrites* (fig. 3)[57]. Proposed dates centre on the Claudian period (AD 41–54)[58]. Street-side bars at Pompeii and Herculaneum offer an additional context. Décor began to trend away from painted plaster to marble cladding roughly in the mid-Julio-Claudian period; in AD 79, about half of Pompeii's 200 bars had marble surfaces. A large proportion of the stone pieces are reused[59], most having no preserved edges. Egyptian lithotypes are rare in this context, but when available, they were prominently displayed. One bar (VI 10, 1) centred the composition of its façade on a large (47 × 30 cm), nearly square plaque of Ophites (San Lorenzo variety) (fig. 4), suggesting an imposing original setting. Smaller inserts of Ophites (San Pietro variety) were also found at a bar at Herculaneum (V 9–10). Our study identifies their primary sources as the off-cuts from regular renovation or pieces from the demolition of both public and private buildings, augmented (but not necessarily dominated) by clearing after the earthquake of AD 62[60]. This process probably reached back about one generation, suggesting that some amount of Ophites, some of it in large modules (to judge from the bar at VI 10, 1), was used at Pompeii by the beginning of Nero's reign in AD 54.

CONCLUSIONS

Despite the small presence of Ophites and the other stones from Egypt's small quarries in Italy – not surprising in light of the small footprint of the quarries – their use in Italy and the prestige

57 PPM VIII (1998) 241–263 s. v. VII 2, 29–30 (V. Samaolo) 245 fig. 3.

58 Noack – Lehmann-Hartleben 1936, 55–70. This date is also supported by Pernice 1938, 73. F. Kärfve (2022, 124) further notes that the Fourth-Style paintings (dated to ca. AD 65) in the atrium overlap the atrium-mosaic on its western side and likewise proposes a Claudian date (AD 41–54) in the transition period between the Third and Fourth styles. In contrast, M. E. Blake (1930, 65) proposed a later date for the fauces mosaic on account of the coarseness of the tesserae, the layout of the inserts in horizontal rows (which is typical of later pavements), and the inclusion of *lapis porphyrites*.

59 Fant – Russell – Barker 2013, 198 f.

60 Fant – Russell – Barker 2013, 200–202.

3 Metagabbro (Ophites, San Pietro variety) fragment (indicated by the red arrow) in the mosaic pavement of the fauces (vestibulum) of the Casa di Severus (VII 2, 29), Pompeii (photo: S. J. Barker, © Ministero della Cultura – Parco Archeologico di Pompei. All rights reserved)

4 Panel of Metagabbro (Ophites, San Lorenzo variety) used for the central element of the façade of the bar at VI 10, 1, Pompeii (photo: S. J. Barker, © Ministero della Cultura – Parco Archeologico di Pompei. All rights reserved)

which they were accorded *are* surprising. They precede the arrival of products from the larger quarries by decades, judging from their availability in Campania. Of the smaller quarries of Egypt's Eastern Desert, the pegmatitic diorite from Wâdi Umm Shegilat was perhaps the first to be exploited by the Romans, apparently in the first decade after annexation[61].

Pre-Neronian uses of these stones are generally incompletely understood. The *sectilia emblemata* of Caligula's Nemi ships with *lapis porphyrites* and what looks to be Eufotide[62] attest to some earlier uses at least in imperial contexts. Campania's marble-clad bars hint at a much wider, and earlier, distribution, and this is consistent with evidence for quarry infrastructure work in the last few years of Augustus' reign or earlier. However, the small quantities surviving from Neronian contexts suggest that their initial exploitation was on a small-scale, grounding a hypothesis that exploitation was ratcheting up under Nero with the introduction of *lapis porphyrites* and probably the stones from smaller Eastern Desert quarries for new imperial construction on the Palatine[63].

Stone from Mons Ophiates and the other small quarries therefore seems to have got a head start in Italy for several reasons beyond the fact that the large quarries, with the exception of Porphyrites, were opened after the Augustan era. Small quantities of smaller products required less transportation infrastructure. Baggage camels and even donkeys with panniers could travel across the terrain before the building of wide roads[64], and small wagons could use narrow roads. The small quarries also employed small labour forces (recall the estimated work force of 100+ at Mons Ophiates). In fact, given the clear official initiative seen at Mons Ophiates, it may be legitimate to consider it as a prototype for the later development of the large quarries. It seems likely that any early arrivals from the large quarries may have been reserved for use in the capital. The near-total absence of Mons Claudianus in private contexts in Campania is in contrast with the modestly-wide use of Ophites. Later pavements, e.g. in the triclinium of the Domus Flavia, seem to have used stones such as Granito bianco e nero/Marmor Tibereum from Wâdi Barud[65] rather than the smaller-quarry stones. The scale of imperial use clearly started to shift in favour of the larger quarries of the Eastern Desert.

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61 Fant 2022.

62 Ucelli 1950, 225 figs. 247. 251; Capelli 1981; Guidobaldi 2001, 65 n. 7; Ghini 2007, 5–30.

63 This has already been alluded to by F. Guidobaldi with what he terms »quadricromia neroniana«, the combination of Marmor Numidicum, Marmor Phrygium, *lapis porphyrites*, and *lapis Lacedaemonius*, see Guidobaldi 2003, 29–32.

64 Maniére – Crépy – Redon 2021, 21.

65 Morricone Matini 1967, 77–84 cat. 74–78 pl. 31; 121 fig. 1.

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Christopher J. Lyes

TOR CERVARA, AND THE TUFF QUARRIES OF THE LOWER ANIENE VALLEY, ROME

Abstract
Occupying over a thousand acres of the Roman Campagna, the tuff quarries of the Lower Aniene Valley represent one of the largest extant sources of evidence for the extraction of building stone in antiquity. Yet these enormous quarries, sites which are so obvious to anyone who passes by on the »autostrada«, are little studied when compared to the quarries of decorative stone from elsewhere in the Mediterranean. This failure deprives us of the opportunity to understand better not only a single large quarry, but a string of quarries spread out over an industrial landscape – a rare chance to study the inter-operation between multiple discrete and connected extractive zones. Through a multi-scalar analysis of the quarry landscape, this paper will explore this large zone and its associated archaeological evidence and will seek to question established beliefs with regard to the effectiveness of water and road transportation.

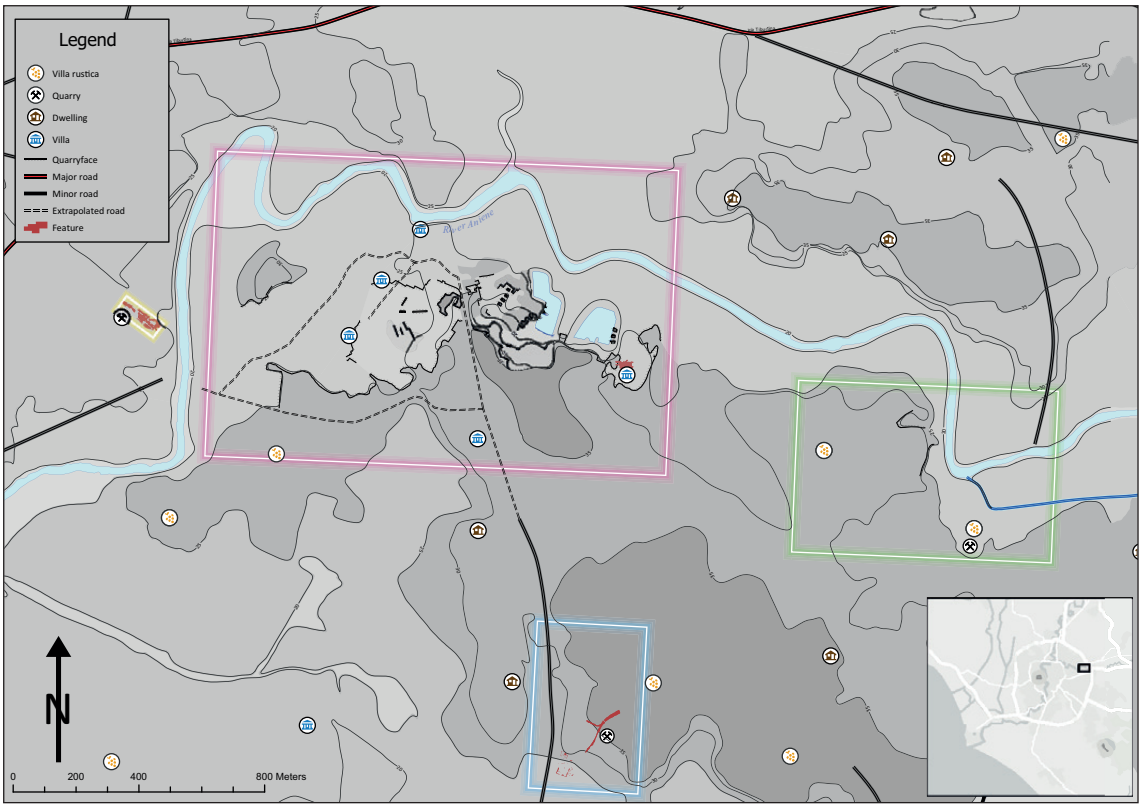
»It is a strange place. You are quite unconscious of any break in the wide grassy Campagna, till you suddenly find yourself on the edge of a precipice, with deep, narrow, miniature ravines yawning beneath you and winding in all directions till they emerge on a meadow near the Anio. And when you descend into these, openings in the rocks beneath lead into vast chambers opening one upon another, their roof supported by huge pillars of natural rock.«[1]

Scattered around the Roman countryside are littered the remains of an ancient industry. An industry that was once almost as significant to the ancient economy as agriculture. Today, these remains are abandoned, used as mushroom farms, fisheries, or dumping grounds for domestic refuse. Yet, these enormous quarries contain important evidence that can help bring new light to our understanding of the Roman economy. They can add insight to the interplay of local and global trade. They can illuminate aspects of human activity in urban, suburban, and rural spaces. And they can illustrate the symbolic and very real interaction between Rome and her neighbours. The Lower Aniene Valley possesses a wealth of archaeological evidence which can be used to explore the ancient tuff extraction industries. In this paper, we shall study in detail the archaeological evidence for that industry, focusing on a single case study – Augustus J. C. Hare's »strange place« – Tor Cervara.

9 km east of the centre of Rome, Tor Cervara is one of the most significant quarries in the Aniene Valley. However, it is also one of the most difficult to interpret, for the pattern of destruction that is so evident in other sites in the Roman Campagna is at its most extreme here. Surviving until the mid-20th century, a large number of caverns, similar to those nearby at Salone and La Rustica, once existed but were used as ammunition stores towards the end of World War II; rather than disposing of the ammunition, the fuses were ignited, destroying large amounts of evidence and leaving in its place the shattered remnants of *pilae*[2].

Today, what is left of the site is bifurcated by the Via di Tor Cervara; the route here, though, is a new one, and there is no direct evidence of the ancient road having proceeded directly northwards

1 Hare 1875, 161 f.
2 Quilici 1974, 63.



1 General plan of the Tor Cervara area: blue = Cervaletta, green = Le Piscine, pink = central area, yellow = Via Tiburtina No. 986 (map: C. J. Lyes)

to the Via Tiburtina[3]. Instead, the minor road from the south (and the Via Collatina) became a service road which descends into the quarry. As Antonio Nibby suggests, the crossing point over the Aniene is likely to have been further downstream, probably at the ford directly west of the quarry[4], rather than the modern bridge.

Geologically, the Tor Cervara quarries consist of an upper layer composed of extremely hard, primarily lithoid tuffs, which overlay a brown pozzolanic soil layer exposed at the quarry floor[5]. Moving towards the river, these geological formations transition to contemporary and recent alluvial deposits, encompassing materials such as gravel, sand, and clay, along with terraced accumulations and alluvial and colluvial coverings – representing the hillwash originating from the quarries (fig. 6).

Prior to the establishment of the quarries, the elevated terrain to the south of the quarries appears to have maintained a predominantly rural nature, featuring several *villae rusticae* and smaller residential structures, though tending to a more suburban nature to the southeast[6]. The archaeological findings indicate agricultural practices dating back to the mid-Republican era, and possibly into the Archaic period. These practices are marked by artificial terracing of the hillside, and the presence of drainage channels constructed using small fragments of tuff, accompanied sporadically by fragmented clay elements[7]. The agricultural lands were served by a network of roads, further evidence for which came to light in the form of a *diverticulum* found in 2006 on the

3 Donda 2000.
4 Nibby 1848, 457.
5 Donda 2000.
6 Mannino – Muscianese Claudiani – Perroni 2011.
7 Coletti 2005.

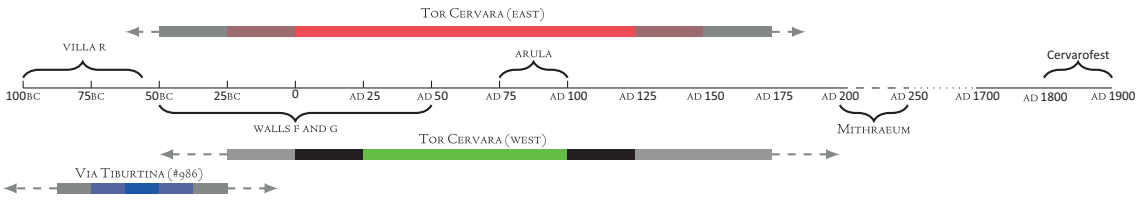
Cervaletta estate[8]. This dated to the mid-Republic (possibly as early as the 5th cent. BC), going out of use by the early Imperial period, at which point it was replaced with a necropolis, tied to an early Imperial hypogeum containing five marble sarcophagi, each housing an infant inhumation, seemingly all deposited in a single act[9]. To the south, an unidentified (though clearly domestic) Roman building, probably a small villa, though perhaps something grander given the evidence of the hypogeum, may have been the locus for this activity, though the interpretation of this area is still far from clear.

A fourth arm of the *diverticulum* terminated in a small mid-Republican quarry, with another working 160 m to the north exhibiting a short tunnel, 4 m long, interpreted by the excavator as a prospection trench[10]. This suggests some mid-Republican awareness of the economic potential of the underlying tuff and Pozzolan, though neither of these became major economic resources in this particular location. The superseding of the *diverticulum* by the burials gives the general sense that this area was abandoned as a productive zone, going out of use in the early Imperial period. What the evidence here suggests is that despite some attempts at exploiting the tuff, a significant change in the predominantly agricultural economic landscape occurred at the end of the late-Republican period, with the agricultural roads, and small quarries, going out of use to be replaced by the major quarry to the north, perhaps because of the proximity of the Aniene, but also the manner in which the tuff stratum presents itself, affording the opportunity to quarry through the use of galleries rather than using the open-cast extraction which the Cervaletta sites would have necessitated.

One mile northeast of the *diverticulum*, more evidence of putative quarrying activity lies at Le Piscine adjacent to the Aniene. Here, however, the work takes advantage of the contour of the hillside lying on the river-facing slope, being cut into the hillside and forming little more than a terracing of the slope. As the workings do not penetrate far into the pre-existing landscape, these were probably either prospection sites or, more likely, earlier quarries, perhaps mid-Republican, from which relatively small quantities of Tufo Lionato were extracted, probably for local use or at the nearby mid-Republican *villae rusticae*. To the south of the Le Piscine area, a third quarry is thought to have existed. 100 m south of the confluence of the Lungarina and the Aniene, Thomas Ashby noted tunnels[11], possibly a *cuniculus* or cistern connected to the *villa rustica*, whilst John H. Parker mentions quarries intersected by canals[12]. These seem to have formed an intricate hydraulic system which may be related to the water table problems also known at La Rustica[13], though no such arrangements are present in the main portion of the Tor Cervara site to which we shall shortly turn.

Firstly, however, we must take note of a relatively recent discovery which lies at the extreme west of Tor Cervara (fig. 1), though on the right bank of the Aniene, and which exhibits evidence of such interest that it should now be included in any discussion of quarry-working in this area. Excavations conducted in 2007 at a site known as Via Tiburtina No. 986[14], a former sports ground, brought to light a »cappellaccio« extraction site[15], revealing both the quarry floor and several phases of activity which appear to show a sudden cessation with blocks remaining partially worked and others only partially isolated. The excavation was, however, unable to reveal the entirety of the site, only defining the south, west, and east extents, so it is uncertain how far northwards it spread and the nature of quarrying there.

8 Scandaletti 2006.
9 Musco 2006.
10 Mannino – Muscianese Claudiani – Perroni 2011.
11 Ashby 1902, 141.
12 Parker 1876.
13 Quilici 1974, 90.
14 Actually on the Via Lanciano, rather than the Via Tiburtina.
15 Note that the excavators have here used the term »cappellaccio« as a general grouping term, it is not clear whether this is the same material quarried under the city.



2 Timeline of operations at Tor Cervara (graphics: C. J. Lyes)

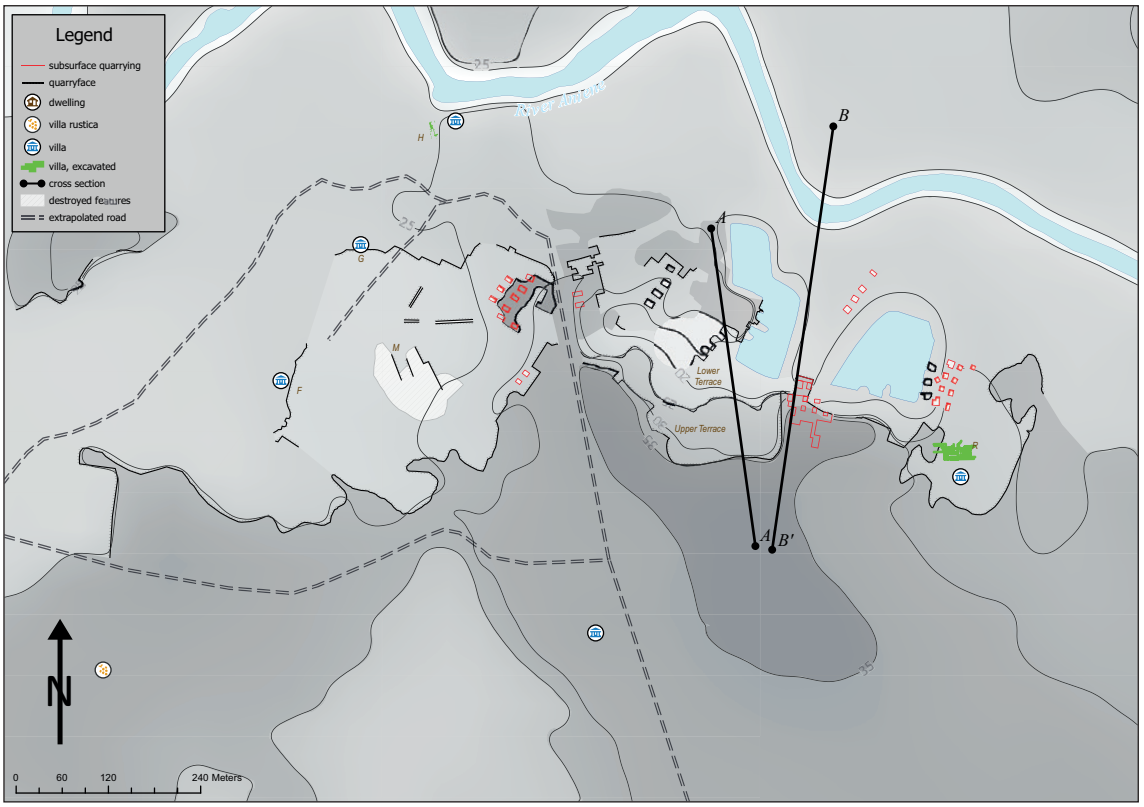
The site was located a short distance north of the point where a minor road from the ancient Via Tiburtina meets the river, the same point to which the service roads of the central Tor Cervara quarry orient themselves on the opposite side of the river. This suggests that a bridge or fording point may once have existed here. Occupying a little under 0.5 ha, this excavation offers a keyhole into what was clearly a much larger tuff quarry and production site, with an estimated 250 m³ of material having been removed from that part of the site so far revealed[16]. This quarry seemed to have been opened for, and specialised in, stone blocks of a standardised size, as a large number of rough-worked blocks measuring approx. 15 % more than 3 × 2 Roman feet (RF) lie scattered around, though some are in piles in specific parts of the site, suggesting that these were processing areas where the rough blocks were reduced down to size.

In terms of morphology, the Via Tiburtina site seems to be an example of a type of quarry not seen elsewhere in the Aniene Valley – the surface extraction site, where the material is removed directly from the rock-head with relatively little attempt to excavate downwards, rarely exceeding 1 m in depth. These kinds of quarries are relatively common in Greece, especially at the sites of early insular marble extraction, such as Melanes on Naxos, but are limited in central Italy. The evidence shows that at no point was the Via Tiburtina quarry made up of the sort of galleries seen elsewhere, for the uppermost layer of bedrock is still preserved in places, with ard-marks visibly representative of Late Iron Age to Archaic, pre-quarry agricultural activity that scored through the subsoil and into the rock-head.

Within the area revealed, it became evident to the excavators that activity developed in both a synchronous and diachronic manner. Here, the broader extraction strategy shows that a single layer of rock, roughly 2 RF high, was removed block by block. With one layer removed, work then began on the next layer, into which the channels from the upper layer would already have penetrated a little, providing a guide for the quarriers and leaving a checkerboard quarry canvas. The same approach of ›peeling back‹ one layer, then the next, was repeated elsewhere in the quarry, but stayed at a single level and did not penetrate down further.

Where the Via Tiburtina site is significant, however, lies not in the quarry morphology but in the quality of the archaeological work and the consequent freshness and fineness of the tool-marks, which are rarely preserved in the soft tuffs of the Aniene Valley. This provides an unparalleled opportunity to explore the methods of block extraction. The result is that a process analysis has been possible to better understand the sequence of tooling, such that it was possible to infer the order in which the quarry workers proceeded along the stone bench with the extraction pattern appearing to have exhibited a trend that could be defined as ›boustrophedonic‹, meaning that rows of blocks are alternately removed in opposite directions[17]. Given that the sectors are relatively small, it is reasonable to infer that this working pattern, which would require the shortest relocation of equipment from block to block, may also imply that a relatively small crew worked on each sector, perhaps just a single quarrier and their mate, working on the extraction of a single block at a time, as otherwise there would be a danger of crews working against each other, and

16 Boscarini 2007.
17 Boscarini 2007.



3 Archaeological map of Tor Cervara (for cross-sections A–A′ and B–B,′ see fig. 6) (map: C. J. Lyes)

the ›boustrophedonic‹ pattern would no longer be in evidence. We can then, perhaps, go so far as to suggest that each of these quarry sectors constituted a single *bracchium*, worked by a single small crew.

That the material worked in these *bracchia* was not fully processed is shown by a pile of blocks awaiting further work. Here 80 blocks in various states of finish are piled, along with chips of material that had been worked off them. This suggests that some of the reworking was done on-site in the *bracchium*, but we may also question why the pile was stacked on top of an existing working, thereby taking this area out of productive operation. It is possible that this reworking was a very rapid operation, in which case it did not matter that the area was temporarily unusable, though it may also be possible that the blocks were deemed unfit for use or not worth the additional efforts to process them further and that operations in this sector had ceased, perhaps due to cessation of customer demand. However, the pile of material does not have the appearance of an organised effort; instead, it is strewn across the quarry floor, suggesting a sudden abandonment, an appearance that is common across the site. The excavator has argued that the fact that the blocks were abandoned in such large numbers suggests that they were extracted for use in the *opus quadratum* technique, and that the cessation of quarry operations coincides with the reduction in the popularity of this technique in favour of *opus caementicium* towards the end of the 1st century BC[18].

The three sites surrounding Tor Cervara are important to consider as they contribute substantially to our understanding of tuff extraction in this immediate area. However, having developed an understanding of these quarries, we can now return to the main site, though the present condition of the quarries limits the amount of evidence available to us for study, given that so much of

18 Boscarini 2007.

the site was destroyed during the last days of World War II and later[19]. The area to the west of the Via di Tor Cervara is the most severely affected sector of the quarry, for what was once a broad area of gallery quarries, similar in scale to that seen at Salone, has now been entirely levelled beneath a large car park, with just five relict, half-buried, *pilae* remaining. Further west of this, the quarry face has been reworked in the 20th century, providing a clear contrast between the modern (rectilinear) workings and the ancient (curvilinear) quarry faces.

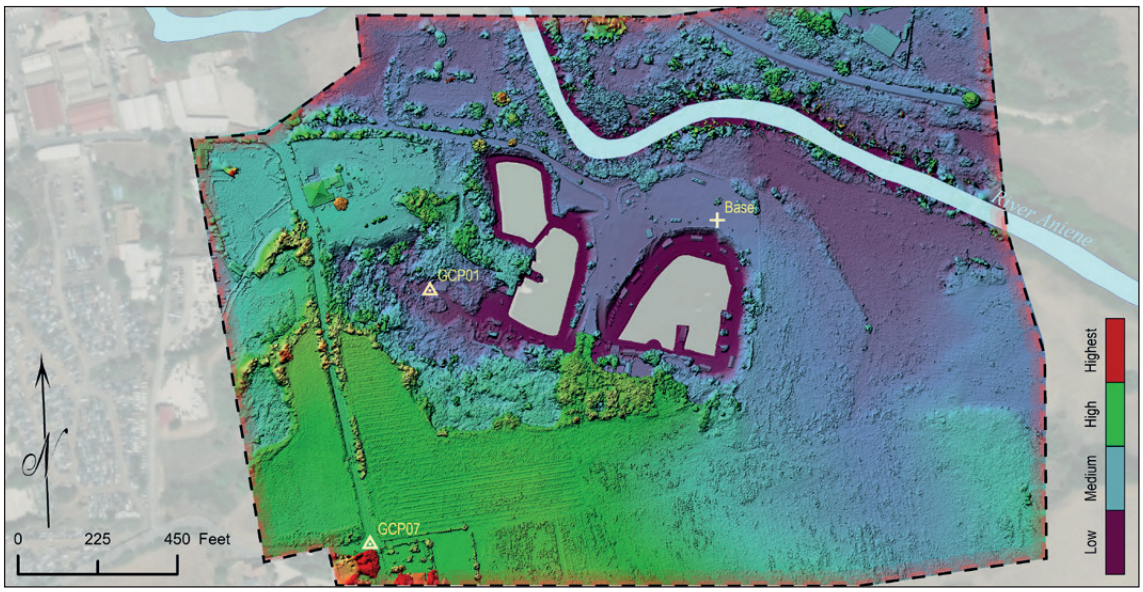
Despite the heavy destruction of the western part of the quarry, some evidence was extant prior to the clearances of the 1960s and was recorded by Lorenzo Quilici[20]. Most interesting were the remains of two structures of a residential character at the western edge (labelled F and G on fig. 3), which were placed out of use by the creation of the quarry. Though the precise stratigraphic relationship between these buildings and the quarry operations was not recorded, the structures do imply a terminus post quem for the commencement of quarrying on the central site. The walls, as uncovered, were substantial – 2 RF thick – and made in a well-constructed *opus reticulatum a parete piena* style which, in Rome, can be dated to between 55 BC and AD 50[21], coinciding well with a putative early Imperial date for the commencement of works. This impingement on domestic dwellings is also replicated in the eastern quarry where, following a series of excavations in 1938, a villa was unearthed which had been abandoned and undermined by the eastern quarry (R on fig. 3). Here, the construction was mainly *opus quadratum* in local tuff, a building style which is harder to date precisely, though in places, a form of *opus quasi-reticulatum* was deployed, which can be assigned to between 100 and 60 BC[22], and as we are looking for a terminus post quem rather than attempting to date the entire building, we can justifiably argue that the quarry did not reach this point prior to the late 1st century BC. This villa, however, is only known from the excavation photographs and has not been precisely located (its inclusion on fig. 3 being an approximation), but was a site of some size and pretension with fine floors of *opus tessellatum* and »cocciopesto«. The villa provides valuable evidence for the dating of the Cervara quarries. Based on the architectural style already discussed, and the technical characteristics of the villa, it is believed to have been built between the late 2nd and mid-1st century BC. Long walls in reticulate work found above the quarry debris, likely from the Augustan age, suggest the quarries were fully operational from the mid-1st century BC through the Augustan age, presenting the clearest evidence of local domestic dwellings being taken out of use by the quarry[23].

If, in the western part of the quarry, most of the evidence of quarrying has been obliterated, to the east of the Via di Tor Cervara, much remains, though evidencing considerable damage from the destructive activities of 1944 and the 1960s. As the first feature of the eastern sector, Lorenzo Quilici makes reference to »a large enclosed area between vertical walls«[24], though this has now been destroyed to make a flat platform for the »Ristorante da Peppe a Tor Cervara«. To the rear of the restaurant, however, two of the *pilae* that once supported the roof of the gallery are now visible in the open air, though heavily overgrown.

This area of the quarry was, until the mid-20th century, heavily covered with quarry spoil, forming a series of small hills (»montaroni«) similar to those that survive in the nearby travertine quarry »il Barco«, where two of these spoil heaps remain. The technique seems to have been that the galleries, once excavated and removed of their overburden, were then infilled by piling the waste chippings in between the *pilae* and then over them to form a small hill. This suggests that at least some of the refinement of stone blocks was done at the quarry rather than

19 Quilici 1974, 63.
20 Quilici 1974, 62 f.
21 Lugli 1957, 505 f.
22 Lugli 1957, 503–505.
23 Quilici 1974, 76 f.
24 Quilici 1974, 69.

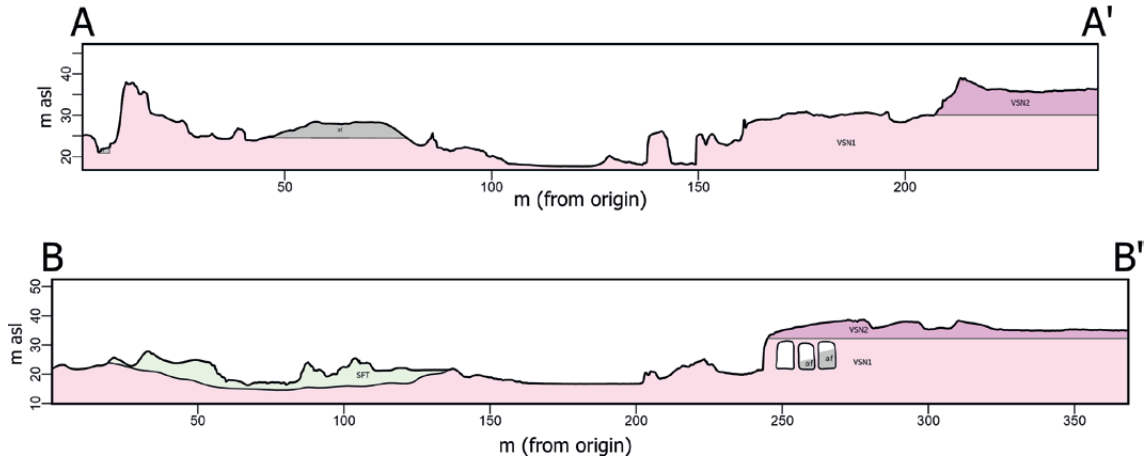
4 Tor Cervara (east), orthophoto, surveyed August 2021 (graphics: C. J. Lyes)



5 Tor Cervara (east), elevation, surveyed August 2021 (graphics: C. J. Lyes)

the construction site, which has the rather obvious benefit of reducing the weight of material that has to be exported.

East of this point, the Tor Cervara (east) quarry is characterised by a series of terraces, the upper terrace lying above much of the galleried areas (figs. 4–5, 7). This is the representation of a geological boundary where the upper »pozzolanelle« layer has been removed in order to provide access to the lower Tufo Lionato. This upper terrace is not uniform and is heavily overgrown, but we might expect it to evidence early attempts to extract the Tufo Lionato through the surface extraction method seen at the Via Tiburtina site. It may, therefore, be that the upper terrace represents the earliest form of quarrying on the site, though further work, including clearance of the site, would be needed to confirm this. The lower terraces have been flooded for a »laghi sportivi«, but photographic evidence from the 1960s suggests that considerable amounts of spoil



6 Sections A–A´ and B–B´ at Tor Cervara (east), see fig. 3 for locations): af = artificial fill (spoil), SFT = alluvium, VSN1 = Tufo Lionato, VSN2 = »pozzolanelle« (graphics: C. J. Lyes)

were present when these lakes were being excavated, indicating that the original quarry works penetrated deeper below the level of the terrace, by at least 2 m.

To the east of the lower terrace, a very large series of galleries remain, extending deep into the hillside and surviving to a height of 20 m (similar to the historic quarries at La Rustica[25]), though these are in large part filled with both spoil and quarry detritus, making access difficult (fig. 8). At least nine *pilae* are present, most presenting the inverted pyramid shape characteristic of hand-quarrying. These are all that is left of a much larger series of galleries that originally extended north and east of this point. In places, these galleries appear to have penetrated through to the upper terrace, though there is no indication that they were initiated from that point. Quilici reports that several rough-worked semi-isolated blocks were once visible in this area, mostly with cross-sectional dimensions of 2 × 2 and 2 × 1 RF and lengths of 4 and 5 RF[26].

Returning to the central part of the lower terrace, the surviving *pilae*, once covered with quarry spoil, retain a further element of interest, for approx. 2 m above the quarry floor on this roughly 20 m-high needle, a small niche, marked out in white plaster, was recorded by Elisa Lissi Caronna in 1965 as containing an *arula*. Just why this niche-*arula* is here, though, is rather complex to elucidate, as it exists in none of the contexts in which such objects usually appear – sanctuary, funerary, or domestic – nor is it in a rough-worked state to suggest that it was quarried on-site ready for onward consignment. These monuments are tied to their location and community as well as, we might assume, a centralised cult, thereby complicating our understanding of the distinction between private and public sacrifice[27]. This is, then, an object *in situ* in the place in which it was intended to be located. It was, for a time, religiously observed with a careful manipulation of the quarry works around it, but then covered with spoil, presumably sometime in the 2nd century AD, indicating that the quarry was still in use, having spoil management problems, so perhaps at its peak.

The altar in question does not depict any specific deity nor appear to bear any inscription, so attributing it thus is difficult, unless we consider it to be aniconic with respect to the *genius loci*. This is, however, not the usual form in which such concepts manifest, though we should also note a collection of several similarly sized small altars from the Roman quarry at Kreta in northern Bulgaria[28]. Those are all inscribed and dedicated to Mithras, or the deity which often accompanies

25 Lyes 2024.
26 Quilici 1974, 71.
27 Moser 2019, 55.
28 Velkov 1934, 83.

7 The upper terrace at Tor Cervara (east), photo 01635, November 2004 (photo: C. J. Lyes)

8 Lower terrace galleries, partially filled with spoil and detritus, photos 22608 and 22609, September 2021 (photos: C. J. Lyes)

him, Magna Mater, which may, as we shall shortly see, become apposite. Viewing this as the quarry's religious focus is an attractive thought and should not be dismissed until closer observation of both the altar and niche can be made, though the altar seems to be more funerary in nature, despite there being no evidence of any form of inhumation in this area. Noting the existence of later burials that we have already noted at Cervaletta, we might infer the altar to be commemorative in preserving, at least for a short time, the memory of a grave unearthed during the quarry works, but this too is challenging to accept, for there must have been many such incidents during a quarry's operation, yet nowhere else do we see such commemoration. Perhaps the more compelling possibility is that the altar commemorates someone who died here, a worker perhaps, though more likely someone of a higher status. Preserved for a period of time, until the worker passed from living memory, and then covered in line with quarry exigencies.

Religious observance does not, however, end with this small altar, for there is also evidence of Mithraism in the quarries, albeit after the final abandonment of the site as a productive entity. The attractiveness of caves and galleries to the adherents of Mithraic religions is well attested[29]; therefore the accidental discovery on 5th May 1964[30], of a Mithraic relief in the western part of the quarry ought not to be too surprising, though the means of discovery by the inspector, which

29 Vermaseren 1956; Bottez 2006; Alexandrescu – Topoleanu 2020.
30 Lissi Caronna 1965, 91.

involved her involuntary vertical acceleration downwards into the ›cave‹, might[31]. The Mithraeum (whose approximate location within what may have been a former gallery in the western quarry, is marked as M on fig. 3)[32] produced a high-quality tauroctony in Luna marble, attributable to the early 3rd century AD[33], which the post-war ordnance removals had severely damaged. The inspector – Lissi Caronna – was not, however, the first discoverer, and of the 57 fragments, part of Mithras's cloak, the chest, shoulders and head of the god, the bull's head, the head of Luna, and the face of Cautopates, were all missing, presumed to have been pulverised by explosions[34], but later found to have been stolen[35]. The head of Mithras seems to have passed through several hands before appearing, some years later, in the Badisches Landesmuseum (Karlsruhe). However, it was not until the efforts of Rolf A. Stucky that the reconstitution of the relief became possible[36], and the two pieces were reassembled via a permanent loan from Karlsruhe. This followed when in 2017, the head of the bull was discovered by the Carabinieri in the shop of an art dealer in Cagliari[37]. The almost complete relief, now valued at € 2,000,000, is on display in the Baths of Diocletian[38]. The scene of the tauroctony, as presented at Tor Cervara, is especially interesting for the over-articulation of the rock surrounding the central depiction, which may well be a specific reference to this location within the former quarry. Similarly unusual is the placement of the figures of the torchbearers Cautes and Cautopates in rock-cut niches on either side of the bull-slaying.

The quarries of Tor Cervara and its hinterland offer an exceptional means with which to explore the operations of tuff quarrying in the ancient world. The proximity of the river Aniene, of course, drove the quarries' development. However, in the limited amount of space available here, it has not been possible to cover that aspect in as much detail as would be wished. Indeed, a study of the Aniene as a linear feature is long overdue, for limitations encountered in trying to be more definitive about the manner in which stone was transported on the river have been undermined by the broader lack of knowledge of the archaeological history of the river itself. We still, for example, have no certainty about the positioning and nature of wharfing infrastructure, and very little awareness about the crossing points implied in so many places by the local road pattern.

Tor Cervara does, though, give us a clearer picture of the synchronic and diachronic landscape of this area of the *suburbium*. The manner in which the rural estates of villas and smaller dwellings were displaced in order to facilitate industrial operations provides one of the earliest illustrations of environmental despoliation resulting from primary resource extraction. At Cervaletta and Le Piscine, putative attempts at extraction of the Tufo Lionato material have been witnessed, and whilst dating of these is not yet possible, we might expect them to fall within the late Republic, a time when change was beginning to manifest in this part of the Roman countryside. Pulling together what limited dating evidence there is, events at Tor Cervara can be summarised in figure 2. The Via Tiburtina site is suggested to have been the earliest in operation. However, this has to be noted with some caution given that the dating is based on the phasing out of the use of *opus quadratum*, which is not an entirely convincing argument. The problem with this explanation is that the *caementicium*-based construction methods also require aggregate, or *cubuli*, for their walls, and one would have thought it not too challenging for a quarry such as that at Via Tiburtina, to pivot from making blocks of *opus quadratum* to making *cubuli* for *opus reticulatum*, or chips for aggregate. Even though the evidence seems to indicate that the manufacture of *cubuli* was done on the construction site itself rather than in the quarry,

31 Horst 2014.

32 The actual structure has never been found, though some architectonic elements were recovered, such as two white marble thresholds and a twisted, though not Solomonic, column.

33 Lissi Caronna 1965, 93.

34 Lissi Caronna 1965, 91.

35 Horst 2017.

36 Stucky 1987.

37 Horst – Pizziardi 2020, 139 f.

38 Horst 2017.

there would still need to be a supply of stone to service this, so the abandonment of that quarry may not be as simple as the excavator supposes.

Perhaps the most striking theme to emerge in the Aniene Valley is the dominance of the economic force of quarrying over that of the pre-existing agricultural landscape. The impact of the quarry industry on the domestic activity at sites such as Tor Cervara is evidenced through the destruction of several villas to make way for the quarries, most notably Villa R where the fabric of the building itself was undermined by galleries, and the spoil disposed of by covering the walls; a very clear and eloquent testimony to the economic dominance of the industry, and one which must lead us to question who might have had such power to be able to command the abandonment and destruction of so many dwellings? At Tor Cervara (west) we might suggest imperial takeover as a concept, but this does not seem likely given that Villa R on the other side of the quarry was undermined sometime in the mid-1st century BC. Similar evidence from nearby Salone, where the displacement of two earlier villas again suggests that landowners did not have any difficulty removing occupants, leads to the conclusion that they held some degree of sway over those who lived there. It is therefore tempting to see here the imprint of the growth of latifundia in the 1st century BC and the economic consolidation that ensued.

However, the greatest challenge posed by the evidence contained in the Aniene Valley is the role of the fluvial network. Evidence from other quarries, such as Acquoria, near Tibur, shows clearly that road transport was an option in certain, specific circumstances, but we must retain the prevailing opinion that the river was, at least for downstream transport, the dominant vector. This is, though, not without its issues – the narrowness of the Aniene must give cause for concern as to how efficient transport by this route was, and the problems of fluvial dynamics resulting from such a highly meandering river would have added to the difficulties faced in shipping goods downstream. The river Aniene, though, has not been studied as an archaeological artefact in its own right, and there are multiple locations which may be considered as having the potential to locate such infrastructure. The density of the local road network also has to be seen as a relevant and substantial economic investment. Whether as an ›overflow‹ option, as the route for return cargo, or the workers themselves, the existing stance of archaeologists that riverine transport is the supreme vector and must always be considered dominant does stand to be challenged, at least partially.

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EXPLOITATION OF THE GRANITE FROM THE LAVEZZI ISLANDS (SOUTHERN CORSICA) IN ROMAN TIMES

ARCHAEOLOGICAL AND GEOLOGICAL INVESTIGATION

Abstract
The main objective of the present study is to understand better the extraction and exploitation of granite from the Strait of Bonifacio (southern Corsica) during Roman times. The quarries of the Lavezzi archipelago, especially those of Cavallo and San Bainzu (and Lavezzu) were precisely dated but also thoroughly characterised in order to establish their relationship with monolithic granite columns, particularly prized in Roman imperial architecture. The historical and archaeological study is complemented by field observations and non-destructive analytical methodology. The innovative and non-destructive techniques combine field petrophysical (magnetic susceptibility, imaging and petrography) and geochemical analyses (pXRF). The success of our multidisciplinary approach will contribute to investigating the diffusion of granite-granodiorite extraction activity in southern Corsica during the Roman period and its impact on commercial exchanges in the Tyrrhenian Sea.

INTRODUCTION: RESEARCH CONTEXT AND HISTORY

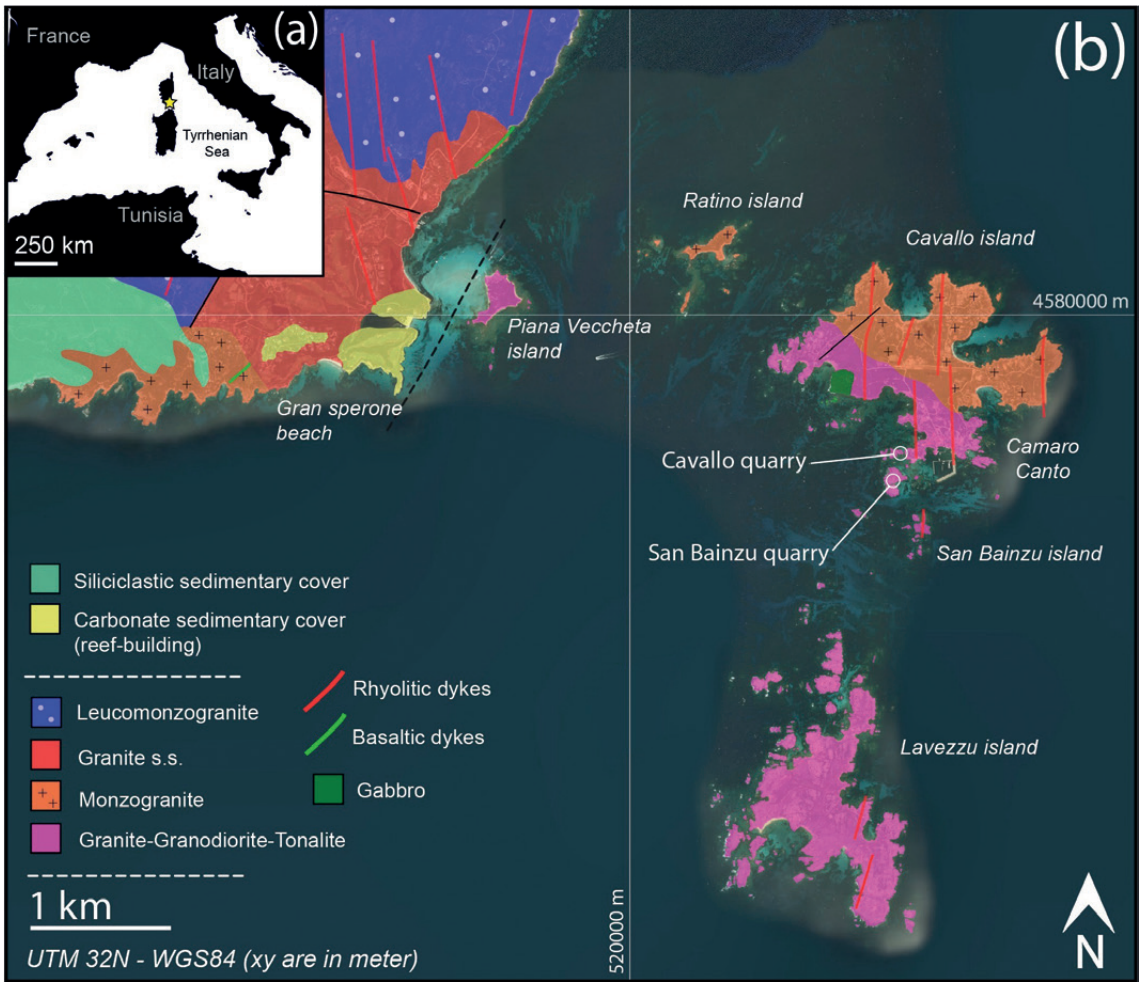
The quarries of the Lavezzi archipelago, especially those of Cavallo and San Bainzu located in the Strait of Bonifacio (southern Corsica; fig. 1) have been known since the beginning of the French period, at the end of the 18th century, through the accounts of geologist-travellers or writers. Prosper Mérimée described the quarry of San Bainzu in 1840 in his »Notes d'un voyage en Corse«: »It is supposed that the Romans, having recognized the excellent quality of this bench, had begun the exploration of it (…).«[1]

During the years 1954–1956, prospecting carried out by Paul Rossi and René Grosjean, in the company of Dorothy Carrington, »Lady Rose«, revealed the presence of two Roman bas-reliefs and a Roman ›agglomeration‹ in the southeast of the island[2]. These two reliefs represent Hercules and are to be understood as open-air sanctuaries associated with the quarries.

In 1970–1971, Jacques Biaggi, Paul Rossi and Geneviève Moracchini-Mazel completed a new archaeological survey[3]. For the first time, the authors related the Roman settlement of Cavallo with the exploitation of granite on the islet of San Bainzu.

In 1972, Paul Agostini distinguished two extraction techniques, one using iron wedges, which he placed between the Middle Ages and the 19th century, and another, using wooden wedges, in the Roman period. At the end of the 1972–1978 excavations, Agostini thought he could establish

1 Mérimée 1840, 84.
2 Grosjean, 1957, 77.
3 Biaggi – Rossi – Moracchini-Mazel 1970, 196–206; Biaggi – Rossi – Moracchini-Mazel 1971, 42–44.

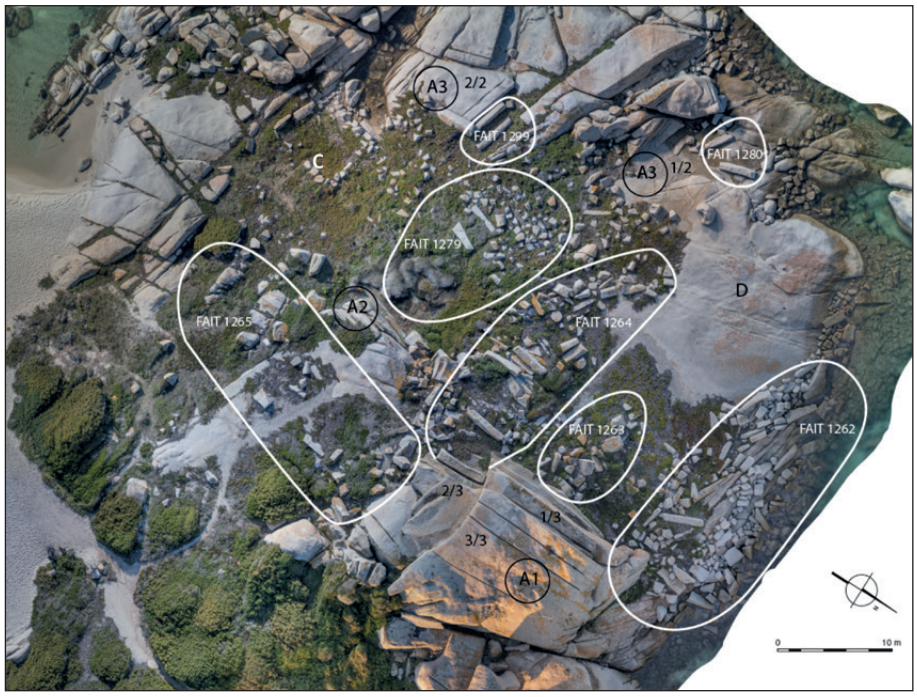


1 a: Location of the study area in Corsica. b: A revisited geological map (from the original Bureau de Recherches Géologiques et Minières [BRGM] geological map Orsini et al. 2011) of the Bouches de Bonifacio study area including Lavezzu, Cavallo and San Bainzu islands from the Lavezzi archipelago (graphics: N. Mattielli after Triantafyllou et al. 2021)

that the Roman settlement of Cavallo had no connection with the quarry, which he, like Jean Jehasse, placed in the late Roman period[4].

As part of the collective programme of research (PCR) on the archaeological occupation of the Strait of Bonifacio in Roman times, directed by Gaël Brkojewitsch and supported by the Direction Régionale des Affaires Culturelles (DRAC) and the Service Régional de l'Archéologie (SRA) of Corsica, the Université libre de Bruxelles (ULB) conducted excavation campaigns and geological studies in 2019–2020–2023[5]. The main scientific objective was to date the quarries and to understand better the extraction and exploitation of granite. The archaeological study was complemented by geochemical and petrological expertise, through which non-destructive, precise and reproducible techniques were developed for an in-depth characterisation of the quarries and establishment of their relationship with monolithic granite columns, particularly prized in Roman imperial architecture. The innovative and non-destructive methodology combines petrophysical (magnetic susceptibility, imaging and petrography) and geochemical measurements (portable X-ray fluorescence spectrometry). The success of our multidisciplinary approach will contribute

4 Agostini 1978, 31; Jehasse 1978, 461–469.
5 Clerbois et al. 2020a; Clerbois et al. (in print).



2 Orthophotography of the Cavallo quarry with associated archaeological structures (graphics: N. Bloch, N. Paridaens, H.-L. Guillaume)

to investigating the strategy and scale of extraction activity in southern Corsica during the Roman period and their impact on commercial exchanges in the Tyrrhenian Sea.

ARCHAEOLOGICAL SURVEY: TOPOGRAPHY, HISTORY AND EXTRACTION TECHNIQUES OF THE QUARRIES

The granodiorite of the Strait of Bonifacio was exploited in Roman times from the 1st to the 3rd century AD in the Lavezzi archipelago in southern Corsica (fig. 1). Many of these sites are quarry openings. Survey shows that the rock was not removed and that the blocks extracted were abandoned on-site. This observation shows that an intense prospecting occurred in the strait during Roman times, aimed at identifying the most promising or exploitable areas.

On Lavezzu Island, not far from Cala Giuncu, a stepped quarry is a good example of this prospecting process. All the extracted blocks lie around the quarry, which shows that the site was abandoned directly. The possible causes are multiple, but the presence of numerous mafic enclaves, combined with a more important fracturing of the granitic massifs at this place, could explain this abandonment.

Topography of the Cavallo and San Bainzu Quarries

On Cavallo (CAV), a large quarry face is located to the southwest of the island; on San Bainzu (SB), it is located on the top of the islet, along with a second one, next to the first one in a west-east alignment (figs. 2–3). The Romans adapted to the topography by erecting two ramps, C1 and C2, made of rock cuttings, to connect the upper part of the quarries to a dumping area; below the latter, underwater structures and archaeological material suggest that Area D may have served as a transshipment quay for boats. Connected to the latter, underwater structure E, made up of large quarry blocks, whose function is still unclear (dock, dike or pontoon [?]), connects San Bainzu to Cavallo.

On San Bainzu, traces of artisanal activities, including a forge workshop, were found during the excavations on the east side of the island. Dating analysis by ^{14}C of charcoal fragments, performed at the Institut Royal du Patrimoine Artistique (IRPA) and the Centre d'Innovation et de

Recherche pour l'Analyse et le Marquage (CIRAM, France), gave the chronological interval end 1st and 2nd centuries AD.

On Cavallo, a rectangular construction of 8 m long and 7 m wide, whose elevation still reaches 1.2 m in some places, is made up of large blocks (fig. 2: C). The structure could be interpreted as a quarry workshop, hosting a forge: a large amount of charcoal was found in its northwest corner. The ^{14}C analysis of charcoal reveals the same chronological interval.

In 2020–2021, two excavation campaigns collected archaeological material at the foot of the quarry faces of San Bainzu. Ceramological studies have revealed a chronology centred on the Flavian period, possibly extending to the first half of the 2nd century.

Reuse of the Quarries in the 19th Century

One may wonder whether the quarries were reused during the medieval period, particularly during the Pisan period. No field observations have validated this hypothesis. On the island of Elba, we have been able to document traces of medieval exploitation (poorly prepared wedge lines with large wedges), which is not found in the Lavezzi.

The first contemporary exploitation seems to have taken place in 1829. In the same year, an inscription engraved on a rock seems to testify to the appropriation of the granite exploitation on the island. Mérimée specifies that the activity of the quarries aimed at extracting blocks intended for the restoration of the mooring posts of the harbour of Bonifacio[6].

The quarrymen of the 19th century never opened an extraction point, they rather worked on the blocks accessible to or abandoned by the Romans, cutting them by direct fracture with metal wedges of smaller dimensions to those used by the Romans.

Techniques of Extraction, Extracted Volumes and Produced Objects

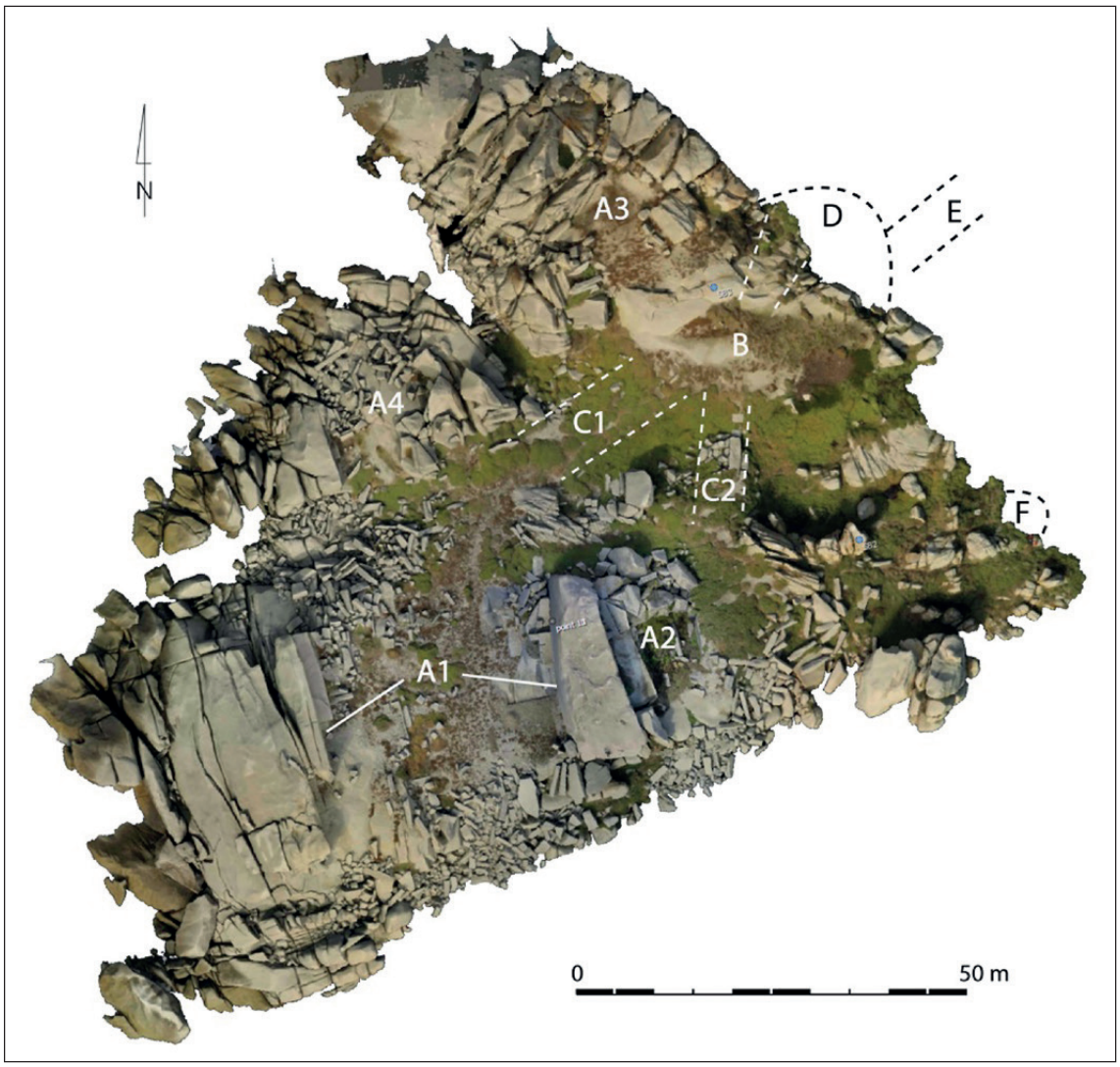
In the Lavezzi, the quarrymen did not use the classic technique of sockets, but rather long lines of wedges in the form of a V-shaped furrow dug with a pick in successive lines. At the bottom of the furrow there is a channel, into which the wedges are inserted at regular intervals. This process has the advantage of allowing a better control of the fracture lines and thus a better management of the working faces[7].

In Cavallo and San Bainzu, the quarrymen extracted parallelepiped blocks from which they made monolithic columns. The small columns are about 3.5 m long and 50 cm in diameter, the medium ones 5 m and 70–80 cm in diameter, and the large ones 9 m and 1 m in diameter. A column of this size, abandoned in the quarry, was used in 1932 for the war memorial of Bonifacio.

The extraction is probably less extensive than it appears. Within the A1 quarry of San Bainzu, the distance between the two working faces could suggest a massive extraction (fig. 3). However, the extraction zone should be seen as a series of large granodioritic rounded blocks (several tens of cubic metres) that formed the quarry, probably interspersed with fractures and unworkable chaotic zones. The excavation showed, for the western face, that the beginning of the quarry was located at 5.4 m from the working face that we can see today, which is about 10 m wide at this point. This volume represents probably between 10 and 15 columns of medium size, but hardly more. The dimensions of the columns correspond with Roman feet: the small ones are 10 feet, the medium ones 15 feet, and the large ones 30 feet, for an approximate 1 : 7 ratio of diameter to length.

In collaboration with the PANORAMA platform of the Université libre de Bruxelles, we tried to calculate the volumes extracted, according to the archaeological findings, and, therefore, estimate the number of blocks or columns produced at Cavallo and San Bainzu[8]. It is obviously

6 Clerbois et al. 2020b.
7 Clerbois 2023.
8 Clerbois 2023.



3 Orthophotography of the San Bainzu quarry with associated archaeological structures (graphics: N. Bloch, N. Paridaens, H.-L. Guillaume)

complicated to give an exact figure, because for some quarries, it is difficult to determine the type of columns produced, although it seems that it is mainly medium-sized columns that were sought. The figure is therefore a theoretical estimate. In total, according to our calculations, the quarrymen extracted about 250 medium-format columns, about 10 small-format columns and between 15 to 20 large columns.

PETROGRAPHIC, PORTABLE MAGNETIC SUSCEPTIBILIMETER AND PORTABLE X-RAY FLUORESCENCE SPECTROMETER RESULTS FROM CAVALLO-SAN BAINZU QUARRIES: IMPLICATIONS OF THE GRANODIORITE DIFFUSION WITHIN OR BEYOND CORSICA

Fieldwork and Analytical Methodologies

In addition to the historical and archaeological dimensions, the petrographic field observations aimed to determine the mineralogy, structure and texture of quarry rocks. The most representative rock surfaces were imaged using a digital field camera (Nikon D5300 DSLR). Triplicate photography per area was corrected for white balance, colour accuracy, and tonal response under

Figure 3. Semi-automatic rock image analysis

4 Photographs of the main lithologies encountered in the study area, and more particularly from quarries on the islands of San Bainzu (Gr. = granodiorite) and Cavallo South (Gr. = granodiorite), compared to Cavallo North monzogranite and granite from the beach of Grand Sperone (along the coast in the vicinity of the Roman villa of Piantarella and Bonifacio). Processing of the images by SPO software (Launeau – Bouchez – Benn 1990) for the quantification of the modal proportions of the rock and the analysis of the distribution of the size and orientation of the rock grains (graphics: N. Mattielli after Triantafyllou et al. 2021)

given lighting conditions. These images were then imported into the Fiji-ImageJ app compiled by the Weka trainable machine-learning (ML) algorithm in Fiji-ImageJ[9]. Mineral phase proportions were then provided by the ImageJ measurement tool, as well as grain size distribution and orientation using shape preferred orientation (SPO) software[10] (fig. 4).

Based on the most representative rock surfaces previously imaged, 10 × 10 cm square areas were selected, with a flat and the smoothest surface to perform the magnetic susceptibility analyses by a portable magnetic susceptibilimeter (pMS; determined using the MS3 portable instrument, linked to the MS2K field sensor – Bartington Ltd.) and whole rock chemical composition measurements by a portable X-ray fluorescence spectrometer (pXRF; Bruker Tracer IV). Great attention was paid to the number of measurements per analysis area and to the duration of each analysis. On the basis of numerous tests carried out on reference materials and granitoids of different natures, Antoine Triantafyllou and colleagues demonstrated that the dispersion of the pMS mean values is significantly reduced when the number of measurements increases up to 4 × 4 for coarse-grained granites, and 6 × 6 for fine-grained granitoids[11]. Thus, whereas 2–5 pMS measurements per rock/column were performed by Olwen Williams-Thorpe and Ian J. Rigby[12], we systematically carried out a calibration using 10 pMS measurements of the reference material (in the form of a disc provided by Bartington Ltd.) (measurement uncertainties during calibration < 1 %), then 16 successive analyses (10 s each) (spaced at ~2 cm each) of the analysis area, bracketed by two 10 s blank analyses (gun targeting air) for correction of instrumental drift.

For each sampling site, 16 pXRF measurements (75 s each), spaced evenly, were also conducted on the same 10 × 10 cm square area (previously used for photographs and pMS analyses). Ten analyses of the standard metal alloy (2250S) were performed prior to each on-site analysis to validate the reproducibility of field measurements and minimise the relative deviation of the measurements from the alloy reference values. Each set of 16 abundance data per chemical element was then averaged to provide a representative value for the rock under study. The number

9 Arganda-Carreras et al. 2017.
10 Launeau – Bouchez – Benn 1990. For more details, see Triantafyllou et al. 2021; Da Silva – Triantafyllou – Delmelle 2023.
11 Triantafyllou et al. 2021.
12 Williams-Thorpe – Rigby 2007.

of pXRF measurements per surface was also tested and contrasted. In addition, the calibration provided by Bruker (Bruker Soil) was compared to our own in-house calibration method that we developed using the CloudCal application and performed on pellets of twelve international SRM reference materials. This calibration exercise seemed fundamental to evaluate the effects of operational conditions (different instruments and weather conditions) and of the granulometry and freshness (flat or rough surface) of the rocks studied[13]. Our CloudCal calibration method appears much more robust and reliable and allows us to discriminate between chemical elements that present consistent data and those that should be rejected. Finally, the values obtained by pXRF were compared to data from inductively coupled plasma-mass spectrometry (ICP-MS; Agilent 7700 – for trace element concentrations) and inductively coupled plasma optical emission spectroscopy (ICP-OES; i-Cap – for major element contents) analyses carried out on samples from Corsican quarries after total acid dissolution. These last analyses aim to validate conclusions based on non-destructive field observations and measurements.

Portable Magnetic Susceptibilimeter and Portable X-Ray Fluorescence Spectrometer Results from Corsican Quarries and Columns: Valuable Insights into Granite Diffusion from/in Corsica during Roman Time

Based on field observations and revisits of the geological map of the Lavezzi archipelago (fig. 1), it is clear that quarrying targeted a particular lithology: a greyish granodiorite composed of centimetric grains of quartz (35–39 vol % in SB), plagioclase and K-feldspar (46 vol % in SB), and smaller grains of biotite and amphibole (hornblende) and oxides (15–19 vol % in SB) (fig. 4). The mineral proportions and melanocratic to leucocratic mineral proportion ratios (M/L), varying from 0.2 (SB) to 0.5 (CAV), are reported in Triantafyllou and colleagues[14]. Quarrymen sought this rock for its specific colour (alternating white and black minerals) and quality. It had to appear in imposing rounded masses, homogeneous (i.e. without enclaves, dykes, veins or a large number of diaclases) and fresh (i.e. unaltered). If the first phases of exploitation revealed one of these defects, the explored site was abandoned, as is the case for the Cala Giunco quarry on Lavezzu. Finally, the orientation of the major fracture planes (or base) was also important to facilitate the extraction from the massive rounded blocks.

Cavallo and San Bainzu quarries display similar magnetic signatures, with weighted averages of 5254 ± 69 μSI and 5749 ± 67 μSI (2σ), respectively. Contents in MgO, SiO_2, CaO and strontium (Sr) of San Bainzu (weighted averages of 1.8 ± 1.5 wt % standard deviation (SD), 53 ± 8 wt %, 2.9 ± 0.8 wt % and 279 ± 68 ppm, respectively) are not distinctive from the values obtained from Cavallo (1.8 ± 1.3 wt % (SD), 54 ± 11 wt %, 2.5 ± 0.8 wt % and 264 ± 91 ppm, respectively). However, K_2O and rubidium (Rb) contents are higher for San Bainzu (> 1.2 wt % K_2O and > 75 ppm Rb) than for southern Cavallo granodiorite. A similar trend is observed for iron (Fe) and titanium (Ti) abundances (> 2 wt % $(Fe_2O_3)_T$ and > 0.16 wt % TiO_2 for SB) relative to the Cavallo quarry.

The field observations and measurements demonstrated the homogeneous compositional and petrophysical properties required by the Romans for exploiting the San Bainzu and Cavallo quarries, which most likely constituted a single operating site. Based on this dataset, San Bainzu-Cavallo granodiorites were compared with columns from two prominent Corsican Roman sites.

Mariana was a notable city in the Roman province of Corsica, located on the territory of the present-day commune of Lucciana. The palaeo-Christian Mariana complex is composed of a cathedral and a baptistery and is probably one of the very first Christian cult buildings in Corsica. Cathedral columns (twelve objects, but only three reported: 7C–9C) as well as three shafts lying in the vicinity (nearby house of Marie-Eugénie Poli-Mordiconi) (one reported: 10C) were

[13] Triantafyllou et al. 2021.
[14] Triantafyllou et al. 2021.

Location	Aleria						Mariana	Cathedral		House*
Sample name	Column – 1C	Block – 2B	Column – 3C	Block – 4B	Block – 5B	Column – 6C	Column – 7C	Column – 8C	Column – 9C	Column –10C
Rock type	Pinkish granite	Grano-diorite	Micro-granite	Grano-diorite	Dolerite	Grano-diorite	Porphyritic monzo-granite	Porphyritic monzo-granite	Porphyritic monzo-granite	Porphyritic monzo-granite
pMS (SI)	0.003879	0.001722	0.031115	0.008565	0.000561	0.039980	0.000134	0.000139	0.000146	0.000120
	0.005203	0.001722	0.025667	0.004644	0.000500	0.031955	0.000143	0.000131	0.000136	0.000138
	0.003906	0.001578	0.025250	0.003328	0.000518	0.034816	0.000134	0.000122	0.000118	0.000126
	0.001533	0.001889	0.032991	0.010037	0.000535	0.036813	0.000130	0.000150	0.000137	0.000126
	0.002241	0.001504	0.028162	0.004027	0.000540	0.037667	0.000125	0.000137	0.000120	0.000145
	0.001807	0.001187	0.027507	0.005197	0.000552	0.041887	0.000139	0.000135	0.000131	0.000148
	0.002702	0.002001	0.025829	0.003504	0.000569	0.038542	0.000133	0.000127	0.000145	0.000116
	0.002210	0.002318	0.033953	0.007146	0.000569	0.034808	0.000125	0.000117	0.000135	0.000142
	0.001339	0.002314	0.028199	0.009600	0.000595	0.043335	0.000127	0.000130	0.000133	0.000129
	0.002673	0.001189	0.028303	0.005012	0.000543	0.035027	0.000128	0.000117	0.000138	0.000157
	0.004149	0.004088	0.029819	0.005360	0.000560	0.028995	0.000120	0.000125	0.000128	0.000165
	0.001881	0.002964	0.024650	0.003012	0.000499	0.039153	0.000121	0.000136	0.000139	0.000144
	0.002635	0.003361	0.025753	0.007504	0.000535	0.036613	0.000136	0.000141	0.000133	0.000167
	0.002484	0.003291	0.026639	0.007958	0.000551	0.038503	0.000131	0.000132	0.000133	0.000156
	0.001715	0.002850	0.025239	0.004828	0.000537	0.041936	0.000126	0.000120	0.000146	0.000157
	0.001800	0.001645	0.029417	0.005534	0.000518	0.041042	0.000118	0.000116	0.000137	0.000155
	0.003749	0.000756	0.024905	0.008486			0.000156	0.000108	0.000142	
	0.003592	0.001104	0.025121	0.008433			0.000140	0.000113	0.000148	
	0.002194	0.000729	0.025662	0.006029			0.000136	0.000099	0.000127	
	0.001146	0.000846	0.021447	0.004623			0.000136	0.000110	0.000124	
	0.004689	0.001395	0.021835	0.004167			0.000119	0.000126	0.000136	
	0.003052	0.001461	0.023592	0.008293			0.000137	0.000117	0.000141	
	0.002297	0.001543	0.027982	0.009350			0.000151	0.000113	0.000150	
	0.001177	0.001176	0.026114	0.007179			0.000119	0.000105	0.000142	
	0.002864	0.001175	0.021629	0.005746			0.000132	0.000098	0.000141	
	0.002593	0.001435	0.024559	0.004777			0.000149	0.000113	0.000151	
	0.002943	0.001101	0.026200	0.005978			0.000158	0.000114	0.000106	
	0.001269	0.001277	0.026503	0.005401			0.000126	0.000110	0.000139	
	0.001696	0.001627	0.022777	0.008679			0.000130	0.000109	0.000146	
	0.001573	0.002185	0.026202	0.004812			0.000138	0.000121	0.000137	
	0.002658	0.002396	0.027270	0.004197			0.000168	0.000118	0.000132	
	0.001955	0.003371	0.027324	0.005015			0.000161	0.000114	0.000137	

* House of M.-E. Poli-Mordiconi

Table 1 Magnetic susceptibility (pMS) of the columns and blocks from Aleria and Mariana cathedral, Centre de Conservation et d'Études (CCE) / Conservation and Study Centre of Aleria and archaeological site (measured with MS3 portable instrument linked to MS2K field sensor – Bartington Ltd.)

Location Sample name	MgO (wt%)	SiO_2 (wt%)	K_2O (wt%)	CaO (wt%)	TiO_2 (wt%)	Fe_2O_3 (wt%)	Rb (ppm)	Sr (ppm)	Cu (ppm)
Aleria									
	0.47	59.8	3.62	1.19	0.07	1.06	202		0
	0.54	53.3	1.48	3.16	0.28	2.94	189	736	3
	3.70	52.7	6.47	1.28	0.27	3.08	388	169	10
	1.31	63.4	1.46	0.62	0.65	5.20	195	125	4
	1.05	62.9	3.91	0.63	0.45	3.49	254	568	5
	0.89	66.3	2.26	0.80	0.23	2.16	210	71	
	1.33	56.6	15.56	1.95	0.44	0.94	1562	3748	
Column – 1C	0.85	50.8	4.35	2.07	0.08	1.22	282	291	0
Pinkish granite	0.81	55.4	14.10	3.22	0.08	0.62	1631	3446	
(CCE)	0.45	66.3	2.94	1.78	0.07	0.87	129	96	
	2.99	45.0	4.25	1.51	0.40	4.16	316	300	4
	2.17	54.3	5.06	1.89	0.12	1.48	287	135	
	0.54	57.9	1.45	1.33	0.26	2.49	114	202	4
	0.43	54.2	9.62	2.78	0.08	0.99	1093	2929	
	0.67	63.2	8.80	2.29	0.16	0.87	1064	3436	
	0.43	63.3	2.34	1.61	0.16	1.29	141	178	
	0.63	55.2	1.38	3.15	0.17	1.57	138	221	0
	5.81	30.8	0.41	4.64	0.18	4.11	207	635	17
	5.76	29.8	0.38	5.07	0.29	6.11	123	486	24
	5.54	42.7	0.77	6.06	0.32	5.61	244	455	14
	7.07	36.7	0.67	6.33	0.35	6.54	137	546	12
	4.19	41.9	0.95	7.51	0.21	3.79	217	475	9
	6.89	48.1	1.26	7.40	0.43	6.86	238	413	13
	2.79	39.4	0.66	7.24	0.35	5.73	100	551	20
Block – 2B	3.17	51.1	0.74	6.41	0.38	6.60	197	393	23
Granodiorite	4.52	45.6	0.62	6.31	0.54	5.85	75	331	26
(CCE)	2.33	46.3	0.65	6.04	0.13	2.19	246	428	7
	1.90	37.6	0.74	5.53	0.33	5.74	256	502	14
	3.49	45.3	0.91	6.80	0.30	5.31	80	395	8
	2.39	47.6	1.11	7.59	0.20	3.72	73	367	10
	2.60	41.6	0.68	5.81	0.21	4.23	158	390	18
	1.84	43.4	0.81	6.26	0.26	5.16	151	449	17
	7.04	44.1	0.68	7.11	0.29	5.22	168	516	9
	1.52	46.1	1.47	6.67	0.44	5.34	97	413	7
	1.04	62.3	7.07	4.43	0.28	2.91	1808		
	1.37	61.6	5.43	4.45	0.36	5.10	1598		
	2.47	55.1	7.44	5.24	0.61	6.20	1743		
	0.78	56.8	4.81	6.74	0.84	7.56	1236		
	1.71	64.1	6.01	5.10	0.51	5.64	1612	824	
	1.58	57.1	3.42	2.52	0.33	3.72	447	809	2
	1.68	50.5	2.10	2.75	0.21	2.98	422	874	4
Column – 3C	2.84	56.0	3.98	2.23	0.24	2.95	508	1299	7
Microgranite	0.87	59.6	2.55	2.09	0.15	1.73	327	802	2
(CCE)	4.47	50.0	4.52	1.46	0.18	1.82	412	1455	12
	2.79	54.7	3.11	2.72	0.25	3.34	440	1584	7
	0.63	59.3	2.90	2.43	0.24	3.29	419	679	6
	1.58	60.9	5.18	1.59	0.07	1.01	280	781	0
	0.73	58.3	3.78	2.36	0.16	1.79	374	900	4
	2.45	58.0	2.50	3.07	0.19	3.24	355	694	7
	1.94	54.8	3.85	1.70	0.15	1.17	451	1675	9
	2.82	58.6	3.33	2.27	0.19	2.35	426	774	5

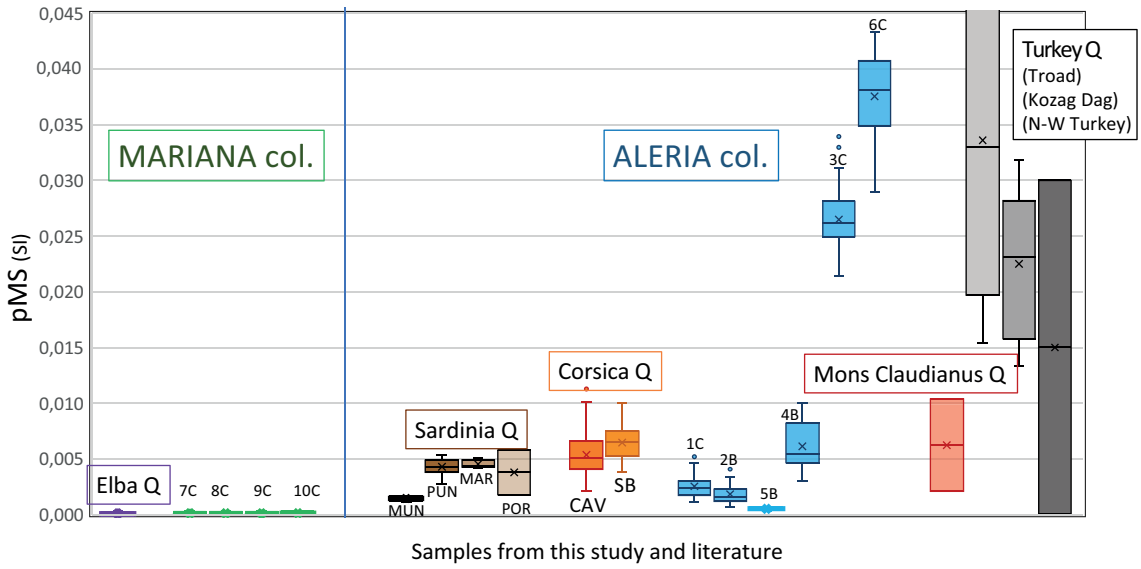
Table 2 Major and trace element compositions (pXRF) of the columns and blocks from Aleria and Mariana cathedral CCE and archaeological site

Block – 4B Granodiorite (archaeological site)	1.15	58.6	1.62	2.48	0.04	0.75	38	318	
	3.30	36.6	1.96	2.26	0.16	2.08	185	245	3
	3.92	53.2	1.61	1.93	0.81	6.59	149	194	7
	4.01	52.2	3.52	1.39	0.23	3.90	289	236	11
	2.02	50.6	2.64	1.81	0.13	1.52	126	241	3
	8.30	38.0	4.04	1.49	0.72	6.55	470	340	19
	2.93	45.9	2.39	3.65	0.52	6.17	280	285	10
	0.56	66.3	0.52	2.02	0.03	0.69	187	188	
	0.63	47.0	3.25	3.08	0.15	1.99	232	421	7
	2.41	39.8	3.32	3.80	0.21	4.35	308	384	4
	2.02	49.4	2.13	1.92	0.16	1.90	251	300	0
	0.62	63.8	0.39	1.24	0.07	0.93	47	100	
	1.77	50.5	2.75	2.04	0.16	1.95	98	271	1
	0.50	62.7	0.74	2.16	0.23	2.23	17	238	
	0.68	57.3	2.13	7.95	0.11	0.96	228	3922	
	0.43	50.1	3.03	1.95	0.03	0.79	253	322	
	2.87	50.2	1.18	2.97	0.35	3.11	203	381	0
Block – 5B Dolerite (archaeological site)	3.15	52.3	0.08	2.43	0.94	9.37	60	258	25
	1.80	51.9	0.17	2.16	0.32	6.00	128	208	13
	2.55	50.5	0.19	2.42	0.55	9.17	134	228	23
	0.45	57.9	0.07	1.29	0.37	6.76	27	88	12
	1.15	61.6	0.14	1.74	0.35	6.03	80	157	7
	1.06	50.5	0.13	2.79	0.66	9.32	28	191	19
	3.71	46.8	0.11	1.77	1.02	10.26	138	206	25
	0.53	59.5	0.07	2.16	0.40	5.68	16	162	7
	2.68	57.7	0.13	2.28	0.53	6.16	24	136	8
	2.69	58.2	0.15	1.32	0.67	8.13	67	176	25
Column – 6C Granodiorite (CCE)	1.99	52.4	4.39	2.14	0.07	1.50	384	1453	16
	3.36	50.1	5.52	1.89	0.13	2.50	592	1372	12
	2.15	43.5	3.33	3.14	0.11	3.04	466	1234	16
	1.98	48.9	4.69	2.49	0.16	3.29	414	1082	23
	2.54	55.0	5.36	2.02	0.08	2.26	358	1168	10
	0.77	41.7	1.02	4.29	0.08	2.59	276	1399	20
	4.29	47.5	1.49	3.92	0.05	1.89	255	1397	20
	3.07	52.7	3.19	4.70	0.50	3.97	299	1357	24
	3.65	51.5	4.40	4.82	0.58	3.75	348	1163	33
	4.22	44.2	4.63	7.23	0.10	2.06	384	1377	34
	3.93	48.8	3.88	5.84	0.12	2.55	364	1085	30
	7.01	46.5	4.13	2.41	0.19	5.12	365	1307	16
	3.36	49.4	5.04	2.21	0.14	2.88	393	1200	24
Mariana									
Column – 7C Porphyritic monzogranite (cathedral)	0.52	56.7	1.59	2.66	0.15	1.46	219	745	1
	4.11	58.9	3.32	2.02	0.17	1.64	353	294	
	4.25	52.0	5.90	0.54	0.37	3.36	621	280	11
	1.20	62.6	2.97	3.42	0.10	0.97	293	340	1
	4.09	44.5	5.15	1.61	0.50	4.45	544	366	15
	0.88	61.1	1.97	2.06	0.07	0.87	279	274	0
	2.42	52.1	2.73	1.79	0.52	3.78	317	285	11
	1.65	54.7	4.60	1.60	0.33	2.58	476	344	9
	0.76	55.3	2.19	3.20	0.45	3.92	454	369	13
	1.67	57.9	3.53	1.58	0.22	1.83	217	190	1
	0.64	59.8	3.06	1.38	0.30	2.24	365	312	3
	1.63	58.2	1.82	3.06	0.21	1.77	269	328	2
	1.30	60.7	3.62	0.78	0.35	2.93	396	128	6
	0.68	64.5	2.48	2.09	0.25	1.98	286	206	

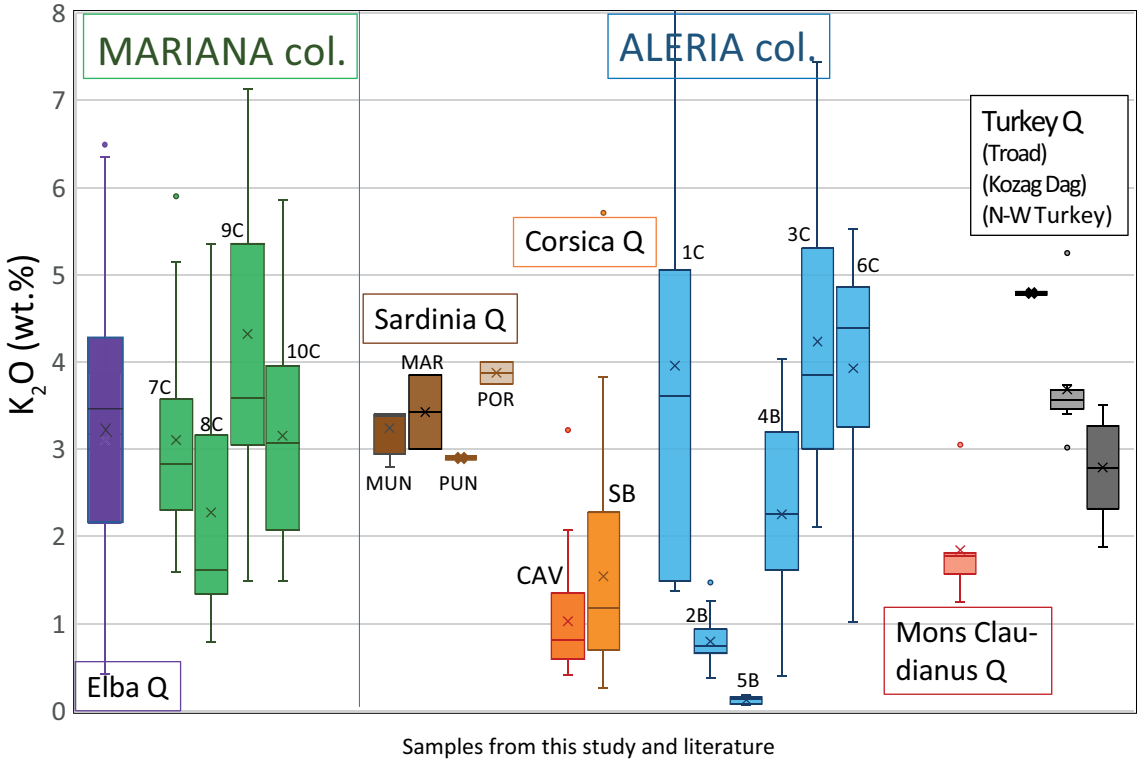
Table 2 continued

Column – 7C Porphyritic monzogranite (cathedral)	0.94	58.2	2.41	1.52	0.36	2.96	409	252	6
	0.59	59.0	2.60	2.36	0.11	1.15	333	402	3
	1.69	51.1	2.83	2.43	0.40	3.20	284	226	8
Column – 8C Porphyritic monzogranite (cathedral)	0.44	57.8	1.35	2.37	0.35	2.53	287	374	8
	0.47	62.3	1.08	3.01	0.17	1.40	129	270	
	0.53	55.1	3.63	3.28	0.10	1.20	222	405	0
	0.43	71.8	1.25	1.48	0.15	1.22	76	199	
	0.63	67.6	1.55	1.34	0.08	0.87	230	128	
	0.68	51.5	1.35	3.09	0.17	1.71	124	373	2
	0.48	64.4	1.56	1.38	0.23	1.53	163	248	
	0.70	66.2	1.31	1.73	0.36	2.38	59	189	
	0.82	56.2	2.14	3.12	0.17	1.48	129	388	0
	0.64	59.8	1.59	2.22	0.26	1.95	230	236	
	0.43	69.1	1.64	1.86	0.12	1.01	106	181	
	4.00	52.8	4.11	0.65	0.36	2.91	452	238	3
	1.41	60.8	2.38	1.74	0.52	3.74	167	208	4
	0.49	67.8	0.79	2.45	0.13	1.13	179	257	
	0.57	58.1	3.00	1.79	0.31	2.47	180	256	2
	0.85	67.9	2.67	1.08	0.23	1.86	167	144	
	3.63	53.4	4.16	2.10	0.53	3.75	239	287	0
	1.13	50.0	5.35	1.58	0.26	2.22	261	253	2
Column – 9C Porphyritic monzogranite (cathedral)	3.33	50.5	4.22	4.45	0.80	6.25	1617	3728	
	0.50	64.1	9.81	1.89	0.46	3.61	2207	2499	
	2.96	57.5	6.42	3.05	0.71	4.88	1661	3380	
	0.93	59.4	7.13	2.00	0.67	4.88	1854	2812	
	1.03	58.0	2.78	3.56	0.72	5.49	983	3216	
	2.19	56.0	3.58	1.86	0.39	3.35	287	814	9
	0.55	42.4	2.91	1.66	0.20	2.50	291	521	19
	1.86	53.1	7.12	3.80	0.88	3.95	1526	3753	
	2.38	55.0	3.48	1.80	0.28	2.24	183	334	1
	2.64	56.2	4.29	1.43	0.48	3.44	429	246	8
	0.49	62.2	1.49	1.55	0.19	1.75	209	112	1
	0.77	57.8	3.84	0.86	0.21	1.67	398	642	8
	1.03	53.5	3.81	1.81	0.42	3.39	201	170	3
	0.58	66.5	3.03	2.47	0.59	2.34	888	2680	
	1.87	51.6	3.26	1.70	0.68	5.13	464	293	13
	0.90	54.9	3.07	2.03	0.37	2.91	394	242	8
	1.87	47.7	3.20	2.91	0.23	1.94	361	416	9
Column – 10C Porphyritic monzogranite (House of M.-E. Poli-Mordiconi)	0.63	55.8	3.02	2.84	0.15	1.34	147	336	0
	0.43	57.2	1.49	1.26	0.06	0.81	150	200	4
	1.41	56.4	3.62	1.18	0.25	2.02	414	221	3
	1.69	48.3	3.07	2.38	0.42	3.72	474	354	10
	2.09	46.5	2.53	1.57	0.45	3.97	527	248	9
	0.83	59.4	4.20	1.37	0.25	1.93	376	226	3
	0.62	52.3	2.08	2.54	0.11	1.24	142	289	0
	0.56	62.0	3.81	0.84	0.39	3.11	417	249	2
	0.71	57.4	2.07	1.93	0.35	2.76	428	167	7
	0.65	65.0	2.10	1.86	0.34	2.66	183	162	11
	2.33	59.9	5.86	0.87	0.26	2.08	474	232	9
	1.40	63.5	3.46	1.66	0.25	2.32	231	240	15
	0.44	68.1	4.10	0.89	0.32	2.35	207	196	4
	0.72	61.5	2.06	1.94	0.16	1.33	245	210	2
	1.46	53.3	5.24	1.18	0.25	2.48	483	237	9
	0.43	59.0	1.59	2.55	0.28	2.14	148	188	8
	0.65	54.2	3.33	1.80	0.33	2.82	342	236	10

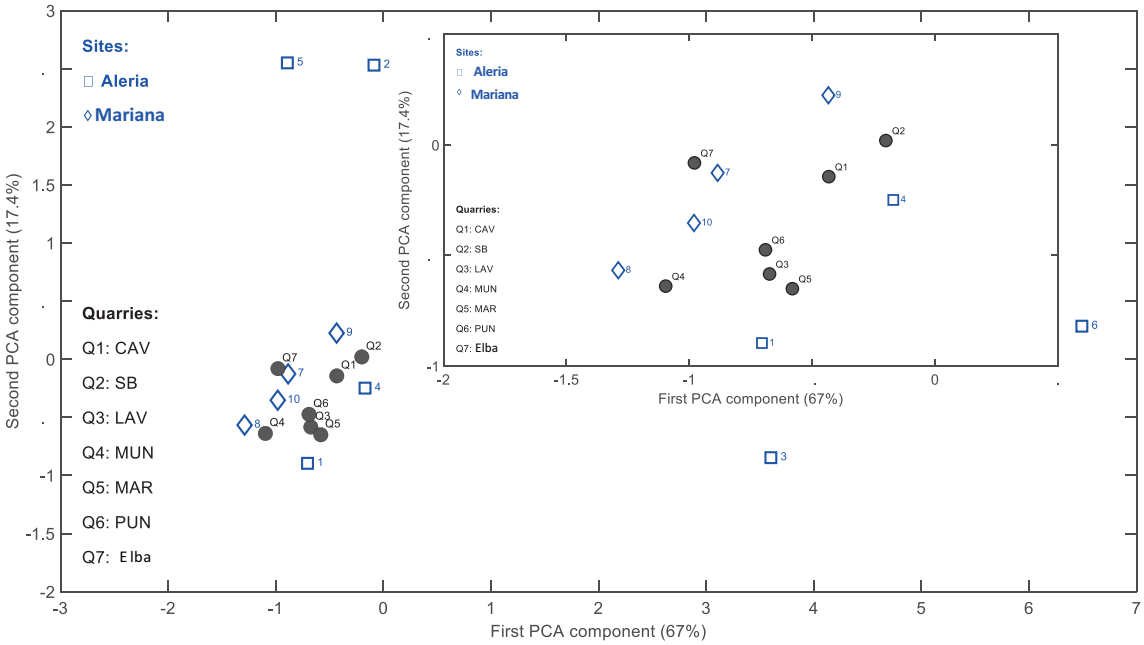
Table 2 continued



5 Results (in SI) from pMS analyses of columns (1C. 3C. 6C–10C) and blocks (2B. 4B. 5B) from Aleria (CEE and archaeological site) and Mariana (palaeo-Christian basilica), compared with our data obtained in Cavallo (CAV) and San Bainzu (SB) quarries (Q) (Triantafyllou et al. 2021) and Sardinia (MUN = Municca; MAR = Marmorata; PUN = Punta Falcone) and literature data for Sardinia (POR = Porto Rotondo), Elba and Turkish quarries (Galetti – Lazzarini – Maggetti 1992; Peacock et al. 1994; Brown – Harrell 1995; De Vecchi et al. 2000; Dini et al. 2002; Williams-Thorpe – Potts 2002; Williams-Thorpe – Rigby 2007; Williams-Thorpe 2008; Rochette et al. 2022) (graphics: N. Mattielli)



6 Results in K_2O (wt %) from pXRF analyses of columns (1C. 3C. 6C–10C) and blocks (2B. 4B. 5B) from Aleria (CCE and archaeological site) and Mariana (palaeo-Christian basilica), compared with our data from Cavallo (CAV) and San Bainzu (SB) quarries (Q) and literature data from Sardinia, Elba, Mons Claudianus and Turkish quarries (for references, see fig. 5) (graphics: N. Mattielli)



7 Principal component analysis applied to our pMS and pXRF data obtained on columns and blocks (numbered from 1–10 in accordance with tabs. 1–2 and figs. 5–6) from Aleria (CCE and archaeological site) and Mariana (palaeo-Christian basilica), compared to our data set from Cavallo (CAV-Q1), San Bainzu (SB-Q2) and Lavezzu (LAV-Q3) quarries (Triantafyllou et al. 2021) and literature data from Sardinia, Elba, Mons Claudianus and Turkish quarries (Q4–Q7) (for references, see fig. 5) (graphics: N. Mattielli)

analysed by 3D image, pMS (tab. 1) and pXRF (tab. 2), after careful petrographic observations. The porphyritic texture with K-feldspar megacrysts typical of monzogranite quarries of the Elba Island is observed in all the columns of Mariana. Consistently, their magnetic susceptibility values (105–167 µSI, with a weighted average of 132 ± 29 µSI [2σ]) are similar to the literature data reported for the Elba quarries (Monte Capanne) (100–220 µSI)[15] (fig. 5). Also, compositions in K_2O (0.8–9.8 wt %, weighted average of 3.02 wt %), CaO (0.5–3.6 wt %, weighted average of 2 wt %) or Sr and Rb of the columns measured by pXRF overlap the compositional fields of Elba quarries (K_2O: 4.32 wt %)[16], confirming their distinct signature from Corsica and their uniform origin from Elba (fig. 6). A visual representation of the data obtained using the two main axes of a principal component analysis (PCA) performed using µSI values and MgO, SiO_2, K_2O, CaO, TiO_2, Fe_2O_3, Rb, Sr and copper (Cu) abundance data further supports this hypothesis and displays the smallest Euclidean distance between the Elba data and those from Marianna's columns. The PCA was performed using Matlab; its first and second PCA components explain 67 % and 17.4 % of the variability, respectively (fig. 7).

Like Mariana, all three analytical techniques were applied to the study of columns and blocks from Aleria, colony, then capital of Roman Corsica. Among the seven objects preserved at the Aleria CCE (Centre de Conservation et d'Études / Conservation and Study Centre), one rectangular block (2B) and six column fragments were observed and analysed. Only one block (2B) shows a habitus potentially similar to the San Bainzu-Cavallo rocks; two objects (small columns) (including 1C) show a rather pinkish colour, corresponding to an alkaline granite, and four objects (including 3C and 6C) are melanocratic and show a finer-grained texture, differing from the granodiorite of interest. On the large excavation site open to the public, two blocks caught our attention. A granodiorite block (4B) and a dolerite block (5B) seem to have

15 Williams-Thorpe – Rigby 2007; Rochette et al. 2022.
16 Galetti – Lazzarini – Maggetti 1992; Peacock et al. 1994; Dini et al. 2002; Williams-Thorpe – Potts 2002.

been placed to serve as a wall base corner stone. The petrographic observations are confirmed by pMS (tab. 1) and pXRF data (tab. 2), highlighting only one block (2B) from the CCE with textures, mineralogy and some pXRF data (in particular K_2O – 0.74 wt % median value) close to those of San Bainzu-Cavallo, but the pMS (1600 μSI median value) (fig. 5) and other pXRF (in particular Sr – 449 ppm median value) data (fig. 6) are significantly distinct from those of San Bainzu-Cavallo. Petrophysical properties and geochemical compositions of the other CCE column shafts indicate a distinct origin from Corsica, potentially from Sardinia and/or Turkey (figs. 5–6). At the excavation site, the pMS (5468 μSI median value, for a range of 3504–10037 μSI) (tab. 1) and pXRF (K_2O varies from 0.52 to 4.04 wt %) (tab. 2) results of one of the two blocks (4B) suggest a local Corsican origin, in accordance with its granodioritic nature (figs. 5–6). The PCA results (fig. 7) confirm that only one block (4B), used as a building stone, at the Aleria site shows a relatively close similarity with the representative points of the San Bainzu and Cavallo quarries, which demonstrates the statistical occurrence of a cluster composed by the granodiorite block and the Corsican quarries. One cannot entirely refute an origin from San Bainzu-Cavallo, but we think rather a local Corsican origin for the building stones.

CONCLUSIONS

The present collaborative and detailed archaeological and geological investigations demonstrate the Roman exploitation from the 1st to the 3rd century AD of the granodiorite quarries from Cavallo and San Bainzu (Corsica), quarries where a particular technique to efficiently extract large blocks was developed for the production of large monolithic columns popularised in imperial buildings from the 1st century AD onwards. In agreement with ceramic dating, ^{14}C dating on charcoals confirmed the Roman operation period at the end of 1st and 2nd centuries AD for Cavallo and San Bainzu quarries.

At this stage of research, it is impossible to say whether the Lavezzi quarries were managed by the Roman administration of Corsica or Sardinia. In Sardinia, an inscription found in Aquae Hypsitanae (or Forum Trajani, now Fordongianus), dated AD 211 and dedicated by Servatus, procurator of mines and estates, honours the prefect of Sardinia, Q. Baebius Modestus. The title of *procurator metallorum* also designated the manager of the quarries, including the quarries of granite. If the quarries of Cavallo and San Bainzu depended on the Roman administration of Sardinia, it is possible that they were under imperial management at the beginning of the 3rd century.

Based on robust petrographic and analytical methodologies combining non-destructive pMS and pXRF measurements in the Cavallo-San Bainzu quarries and columns from Roman monuments and archaeological sites in Corsica, i.e. the palaeo-Christian basilica of Mariana and Aleria archaeological site/CCE, the absence of columns extracted from the Cavallo and San Bainzu quarries for local or regional production/construction is demonstrated. However, there is no evidence to refute the use of local rocks as building stones for constructions. Therefore, export of the columns extracted from the quarries of Cavallo and San Bainzu is suggested and would benefit from further investigation around the Tyrrhenian Sea.

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ALEXANDRIA TROAS

THE PORT AND THE ROLE OF THE CITY IN THE DISTRIBUTION OF GRANITE SHAFTS

Abstract
Granite from the Troad was widely circulated throughout the Mediterranean, and its distribution must have been of great economic benefit to those responsible for its production. This study proposes that Herodes Atticus and the local Quintilii family may have been involved in the control of these quarries. Furthermore, and based on the cataloguing of materials that were abandoned around the port piers, the organisation of the port is reconstructed. It is shown that this was a place used not only for the depot of architectural elements in Troad granite that were to be shipped and destined for the whole of the Mediterranean, but also a place of arrival for other marble materials that perhaps accompanied the Troadense in its exportation. It is also shown that the larger shafts were abandoned on the side of the harbour closest to the quarries, thus avoiding complicated movements inside the port, while the medium-sized shafts were mainly concentrated on the north pier of the outer basin.

INTRODUCTION

What characterises the granite quarries of the Troad is the great distribution of their products, equal perhaps only to the granite of Aswan and the Cipollino of Euboea, as it was an imitation of the grantie of Forum. It was precisely this need to propose a granite similar to the Egyptian one for columns that explains the fact that somewhat similar granite quarries were opened throughout the empire. Among these, the Troadense stands out for the scale of its production and the importance of the distribution of column shafts: other grey granite quarries, such as those in Misia, not far from Pergamon[1]; on the island of Elba; in Sardinia; and at Felsberg in Germany, never achieved a production of columns comparable to that of the Troad district. In the contributions already published by O. Williams-Thorpe[2] and by us in previous volumes of ASMOSIA[3], we have been able to enumerate more than 1,000 Troadense shafts scattered throughout the Roman Empire,

1 It was mainly used for private or city construction – the 32 columns made of this material in the forum of Sabratha are remembered here – but it was also commissioned by the emperor, as shown by its presence in the public architecture of Rome in the 2nd cent. AD, such as in the Villa Adriana and in the Severian phase of the Porticus Octaviae, see Pensabene 2013, 403.

2 Williams-Thorpe 2008. This author inventoried 1,176 granite shafts, among which he identified 324 as being of Troadense; he measured the diameter – taken at half the shaft height – of 202 of them.

3 Rodà – Pensabene – Domingo 2012; Pensabene – Rodà – Domingo 2015; Pensabene – Domingo – Rodà 2018; Gasparini et al. 2023.

1 Troad quarries, shafts *in situ* in the district of Yedi Taşlar (photo: J. Á. Domingo)

particularly in Italy, Greece, Tripolitania, Syria and Asia Minor, but there is no lack of granite columns from the Troad, some numerous, in Spain[4], Gaul[5], and Carthage, etc.

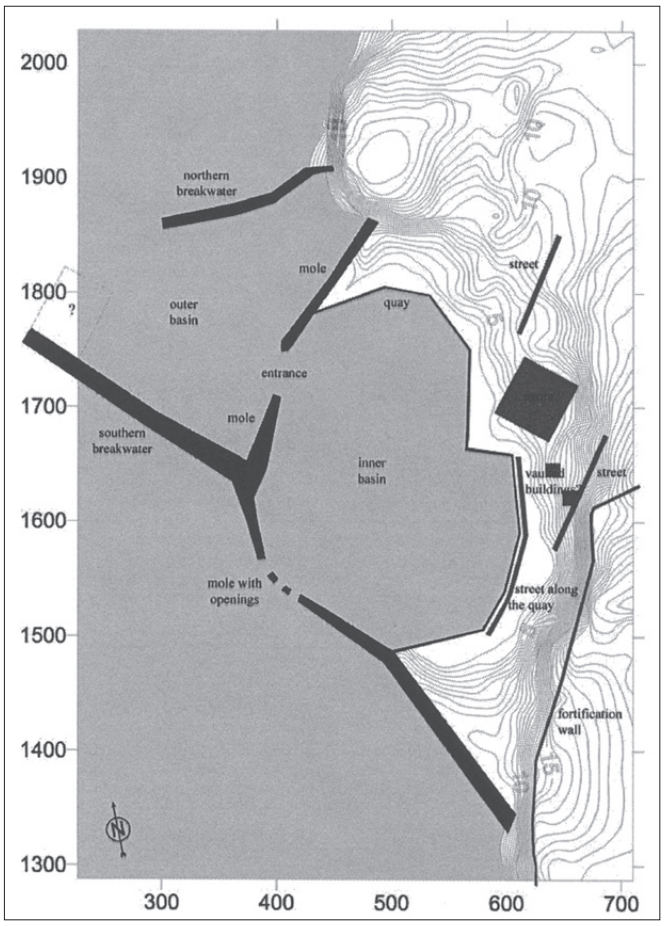
This important distribution of artefacts in Troadense implies that distribution must have been eased by the imperial administration, perhaps also through the availability of its transport networks. However, we are fairly certain that we are not dealing with an imperial-owned marble district, as there are no initials to justify such an assumption[6]; moreover, in Rome, Troadense is almost never used in public architecture commissioned by the emperor but only in private architecture. In the public areas of Italian cities and provincial towns, however, there is a more or less widespread use of this granite for columns, together with other architectural artefacts in white marble, very often imported from the quarries of Prokonnesos. Therefore, it remains much more likely that the quarries were privately owned or owned by the city of Alexandria Troas.

At this point we wondered whether there were any Alexandria-related persons of such wealth that could be justified by their control of the quarries and the distribution system. They must have been located in the city, where they are likely to have played important roles in public life.

4 Recently, the varieties of granites used in the 52 column shafts of Écija were identified, attributing 20 of them to Troadense (Turbay et al. 2019), a significantly higher number than documented in previous studies, corresponding to 11 specimens (Williams-Thorpe – Potts 2002, 182–184 tab. 3; Felipe 2008, 117–128). The 52 shafts are formed by 20 shafts in Troad granite; 13 shafts in Spanish Type II granite (quarries in Gerena); 6 shafts in Spanish Type III granite (quarries near Córdoba); 5 shafts in Forum granite; 4 shafts in Elba/Giglio granite; 3 shafts in Misian granite; and 2 shafts in an unidentified type of granite. Larger shafts correspond to Troadense while smaller ones mostly use local varieties, see Turbay et al. 2019. Shafts in Misian, Elba/Lilium, Troad and in different local varieties come from the portico of the city forum, see Felipe 2014, 101–104.

5 A recent study, which considered a total of 276 granite shaft fragments (belonging to at least 174 complete shafts) from 21 different localities in Gallia Narbonensis, showed that Turkish granites (Troadense and Misian) account for 75 % of the total, followed by Elba granite with 20.5 % of the total: 81 specimens correspond to Troad granite, 47 to Misian, 35 to Elba granite, 5 to Corsica granite, 3 to Aswan granite and 3 to Sardinia granite, see Rochette et al. 2022.

6 Ponti 1995, 291–293.



2 Reconstruction of the port of Alexandria Troas (from Feuser 2011, fig. 12)

In this regard, the local Quintilii family immediately became evident: of equestrian origin[7], they belonged to that wave of Italic immigration to Asia Minor of horsemen, *publicani* and *meratores*, who then settled in the cities of Asia Minor, forming the local aristocracy. It was from the families descended from these Italics that senators often emerged to add enrichment to the senate of Rome. The various Quintilii were already present in Alexandria in the Augustan age, when the Troad enjoyed a particular prominence due to the Trojan legends underlying the genesis of Rome and the *gens Iulia*. Their wealth continued to increase, but the sources do not give an accurate picture of the reasons for this, which was assumed to lie in landed property[8]. It is assumed that one of the causes was the ownership or contracting of the district of quarries that produced granite, which extended to the west of the city and was considerably large, as it consisted of several groups of quarries. The transport of their products must also have been facilitated by the distribution network for the products of their estates, and it can be imagined that the Quintilii possessed, or at least controlled, a discrete fleet of transport ships.

Nevertheless, if Quintilii surely were patrons of the city, however, we cannot overlook the presence and attendance of Alexandria Troas by Herodes Atticus, from AD 130s, when Herodes

7 Esch 2018.

8 Sex. Quin(c)tilius Valerius Maximus, the grandfather of the brothers Sex. Quintilius Condinaus and Sex. Quintilius Maximus, is honoured in an inscription from the beginning of the 2nd cent. AD as *patronus coloniae* (I.Troas 39), and was also promoted by Nerva to senator, after holding various municipal offices in Alexandria, such as that of *praefectus fabrum*, see Kuhn 2012, 426 f. On his position as *praefectus fabrum*, see Saddington 1985. His son was *legatus pro praetore provinciae Achaiae* during the reign of Trajan in AD 115, see Kuhn 2012, 429.

conducted several building projects in Alexandria Troas[9]. He became the patron of the city, as he financed many public artworks such as the aqueduct and baths and a nymphaeum[10]. We also think it is possible that he was involved in construction work on the port basin, adapting it to the need to load large granite monoliths onto ships. In this case we wonder if he also played a role in the monitoring of quarries, or part of them, and in the production of Troadense shafts, which are often found in cities such as Canosa, where he carried out his euergetic activities. In fact, it has been suggested that perhaps the Pentelic quarries – or a part of them – belonged to him, on the basis of an inscription found at the *marmorata* by L. Bruzza, which, however, presents a dubious interpretation: *Serbilio Pudente et Fufidio Pollione co(n)s(ulibus) caesura CLA Hier(odis? -acis?) Attici et Apolloni Lupi*…[11]. In any case, the entry could indicate the presence of freedmen specialised in extraction (*caesura*) and who had, before the inscription, been slaves of Herodes Atticus in those quarries that belonged to him or that he had rented[12].

If Herodes Atticus did have control of the Pentelic quarries, this may have been one of the main sources of his wealth[13]. It should be considered that Herodes acted on the emperor's assignment, so even on this type of subversive activity with extensive use of marbles, there always would have been some control by the central power[14].

What is certain is that it is impossible to understand the ease with which Troadense shafts were exported everywhere unless one assumes a strong link between the quarry owners and the imperial administration: link that could well have existed between figures such as the Quintilii and Herodes Atticus, associates, and in some cases personal friends, of emperors[15]. Client relations with the emperor explain the transportation, probably facilitated, to all parts of the empire of shafts in Troadense, and also explain the control over the quarries. They are mentioned together with those of Prokonnesos and Dokimeion in the famous imperial rescript of 414 BC, repeated in AD 416 in the Theodosian Code, where the contractors of the three marble districts are not exempted from the tax relief granted generically to the other districts[16]. It is the system of contracts to which the Troad granite quarries were subjected, at least in the late Imperial age, that allows us to assume that they had become imperial property in that period, perhaps following the condemnation of the Quintilii Varii and the confiscation of their assets by Commodus[17].

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9 Kuhn 2012, 423 f.: Herodes Atticus is also known for his building promotion activities through the use of white marble, especially Pentelic marble in Athens, and Proconnesian marble in Canosa di Puglia and various cities in Asia Minor, where he was governor of cities on the coast, including Alexandria.

10 Kuhn 2012, 423 f. with bibliography.

11 Bruzza 1870, no. 291; Dodge 1991, 34; Fant 1993, 167.

12 Pensabene 2013, 268. However, Pausanias' reference (Paus. 1, 19, 6) to Herodes' use of Pentelic marble for the stadium in Athens is not evidence of Herodes' direct ownership or control over the quarries, see Pensabene 2013, 268. It is true, as Pausanias recounts (Paus. 6, 21, 2), that Herodes made great use of Pentelic marble, as in a statue of Demeter and Kore dedicated by him; he also mentions the rebuilding of the stadium of Delphi, see Paus. 10, 22, 1. Philostratus (soph. 2, 550) also alludes to Herodes' numerous Pentelic constructions.

13 Ward-Perkins 1951, 92; Pensabene 1996/1997, 19–28. One might think that Herodes Atticus had other interests in different quarries, possibly through contracts. This could explain not only his frequent use of Cipollino in buildings commissioned by him – such as the exedra in Olympia or the triopion on the Appian Way in Rome, from which two Cipollino shafts now in Naples with his name inscribed in Greek (IG XIV 1390) come – but also the fact that his activity as *curator* and *euergetes* was always accompanied by the use of a great deal of marble, as can also be observed in Canosa, where he is mentioned by Philostratus (soph. 2, 551) as the renovator of the city.

14 Pensabene 2013, 269.

15 Kuhn 2012, 430–437. These are similar links to those that united Trajan with the owners of the figulines that produced the bricks for the large buildings in Rome and Ostia, such as Marcus Rutilius Lupus or some members of the imperial family itself, see Bianchi 2003, 329–352.

16 CTh XI 28, 9: […] *omnium generalium titulorum sub aequa lance tam curiis quam collatori privato et patrimoniali, divinae quin etiam domui omnique iuri munifico, nec non et cellariis, praeter trium metallorum debitoribus docimeni, proconensis et troadensis, concessimus reliqua*. See Barresi 2003, 99.

17 Cass. Dio. 72, 33, 1. The large villa that the Quintilii family had in Rome was confiscated and became one of the emperor's favourite places; see also Cass. Dio 73, 13, 14.

Transport was provided by the organisation of the port of Alexandria Troas. Pathways led to it, directly connecting the quarries with the column storage areas around the port basin[18]. In an attempt to understand the organisation of the port with its warehouses, we undertook the cataloguing of the shafts and other architectural elements still present at the port, trying to understand whether there was a logic in their distribution.

But a premise must be made. In fact, the shafts found around the Alexandria harbour basin are part of the puzzle of why many dozens of shafts were abandoned in the quarries[19]: for example, in the quarries near Yedi Taşlar, there are still 15 shafts between 37 and 39 feet high (fig. 1) and a further 15 shafts between 11 and 18 feet high, only a few of which display stone defects. This means that we cannot consider any of the others as not approved or as having been rejected due to the defective quality of the stone or workmanship, but rather as shafts left in the quarries for other reasons[20]. B. Russell does not consider the explanation of shafts with processing defects, or surplus shafts produced in anticipation of the order, or shafts left over from large orders to be sufficient. He rather[21] considers that it should also be assumed that the design of the buildings for which they were ordered had been abandoned in the meantime, or that customers preferred to order columns in more precious coloured marbles[22]. What is certain is that many shafts which had been transported to the port were abandoned close to it, as we will see in our catalogue: among them are some that are at least 38 feet or slightly higher (one is exactly 38.64 feet), i.e. corresponding to approx. 11.44 m[23]. It is the very high number of shafts found at the port that brings the above explanations into question, as anyone of them could be challenged. We also believe that the topic of shaft workshops and their relationship with the *conductores* of the various quarry sectors should be included in the discussion. In other words, it is possible that each producer group occupied an assigned sector of the port warehouses, perhaps organised in such a way as to satisfy the demand of specific clients, be they cities or private individuals[24].

P. Pensabene – I. Rodà de Llanza

THE PORT

The port[25] has been dated to the Augustan period and was presumably built over the old port of the Hellenistic period, which, however, has never been found. The abandonment took place at an unspecified time between the 5th and 7th centuries AD[26]. The port was composed of two lakes

18 By 1879, during his visit to Alexandria Troas, H. Schliemann had already noticed the same measurements between large shafts in the quarries and three specimens on the sand dunes in the port.

19 Ponti 1995; Böhlendorf-Arslan 2021.

20 On other quarrying sectors, see Lazzarini 1987; Yavuz 2014.

21 Russell 2013, 227.

22 E. V. Yavuz suggests that the shafts may have been abandoned at different stages of production, both in the quarries and in the port, due to an abrupt discontinuation of work in the quarries, perhaps due to silting problems in the port, the loss of influence of this port after the founding of Constantinople, or an earthquake, see Yavuz 2014, 509.

23 Ponti 1995, 312; Russell 2013, 225.

24 The miraculous rescue of a late antique cargo of Troadense shafts ordered by Bishop Silvanus in the port of Alexandria Troas, see Sokr. 7, 37, cited in Böhlendorf-Arslan 2021, 62 n. 35.

25 As is well known, the city of Alexandria is located in a strategic position, only 27 km from the entrance to the Dardanelles Strait, and its port was the only port in the area that allowed ships, even large ones, to await the arrival of favourable southerly winds that would allow them to continue their journey, see Feuser 2011, 259.

26 Feuser 2011, 257. 270 f. Some of the earliest studies, sometimes accompanied by more or less schematic plans, date back to the 17th–18th cent., such as the works of P. Della Valle from 1674 (Della Valle 1674) or L.-F. Cassas, made in 1786 by commission of M. Choiseul-Gouffier and published by this author in 1842 (Choiseul-Gouffier 1842, tab. 39; Feuser 2011, fig. 3), the latter depicting two lakes, one inner and one outer, the remains of ancient Roman piers, and some architectural fragments scattered in the area. Later, in 1814, M. L. J. J. Dubois made another drawing of the port, also commissioned by M. Choiseul-Gouffier and published by this author in 1842 (Choiseul-Gouffier 1842, tab. 44; Feuser 2011, fig. 4), in which only the inner lake, some architectural fragments and column shafts scattered in the area are depicted; two of them, south of the lake, are depicted perfectly parallel to each other

3 Area of the port of Alexandria Troas (photo: P. Pensabene)

4 North pier of the port, with embedded shafts used as a berth for ships (photo: E. Gasparini)

or basins (fig. 2), a larger internal one (fig. 3), with a surface area of 45,000 m², and a smaller external one of 24,000 m², open to the sea[27]. The inner one had two piers on the west side built of stone blocks and *opus caementicium*, the one to the north preserved for a length of 50 m and

(Choiseul-Gouffier 1842, tab. 44; Feuser 2011, fig. 4), an arrangement that must be the result of a deposition that was not accidental but intentional. Again in 1837, A. Prokesch von Osten published a new study, and more recently, S. Feuser made a new in-depth study, see Prokesch von Osten 1837; Feuser 2009; Feuser 2011.

27 Feuser 2011, 271.

a thickness of between 1 and 4 m, and the one to the south with a visible length of 25 m and a width of 8 m. In the north pier, a few sections of granite shafts protruding just 80 cm are preserved on the surface, which have been interpreted as moorings for ships[28] (fig. 4). To the south of the southern pier are the remains of stone block structures and *opus caementicium*, approx. 11 × 7 m, which do not have a connection between them (fig. 5), generating three openings that connected the inner basin directly with the sea, perhaps to prevent silting of the inner basin by maintaining a constant flow of water[29].

As for the outer basin, this was formed by two other, much larger piers: the one to the south with a preserved length of more than 100 m, which is partly under water today[30], and the one to the north, largely submerged. To the north and west of this last pier, more than 100 slabs and shafts of Troad granite were found under water, the latter with a height of approx. 3.8 m and a maximum diameter of 80 cm, perhaps deposited here to protect this point of the pier from the sea currents that, coming from the north, affected the structure of the port[31].

A further pier was most probably located on the eastern side of the large inland lake, where some stone block structures were found and *opus caementicium* 8 m long, with seven 40 cm-diameter column shafts embedded at the top, most of which protrude a mere 80 cm, and which could also have served as moorings for ships[32].

E. Gasparini

DISTRIBUTION OF ARCHITECTURAL ELEMENTS FOUND AROUND THE PORT

S. Feuser[33] refers to the presence in the harbour area of 78 shafts of different sizes, all in Troadense except for two specimens allegedly made of marble, most of them concentrated in the northern and eastern areas of the lake as currently preserved, which corresponds to the ancient inner basin[34]. In addition to these shafts, there are numerous specimens documented underwater on the north and west sides of the north outer pier.

The aim of this work is not to present the complete catalogue of all the preserved architectural fragments, as many of them are not easily accessible and some are totally or partially submerged in the sea, but to analyse and investigate, starting from the elements that are currently visible, the mechanisms that defined the organisation of the port's activity. For this reason, we present the catalogue of architectural elements ordered according to their position within the port (fig. 6; tab. 1).

From the materials identified, it is likely that this port was not only the main sorting place for Troad granite elements, shipped here and destined for the entire Mediterranean, but also an important arrival point for other marble materials that could be sold or shipped together with Troadense shafts to supply other markets. We were also able to observe how a large proportion of the shafts deposited near the port are at an unfinished stage of processing, as the final cleaning of the surfaces and often completion of the mouldings of the scapes are missing. This is indicative of

28 Feuser 2011, 261. 264 figs. 6 (H1–H2). 7. 11.

29 Feuser 2011, 263–265 figs. 6 (H6–H8). 12. 14–15.

30 Feuser 2011, 261 f. figs. 6 (north pier H10–H11. H17–H18; south pier H4–H5). 9–12.

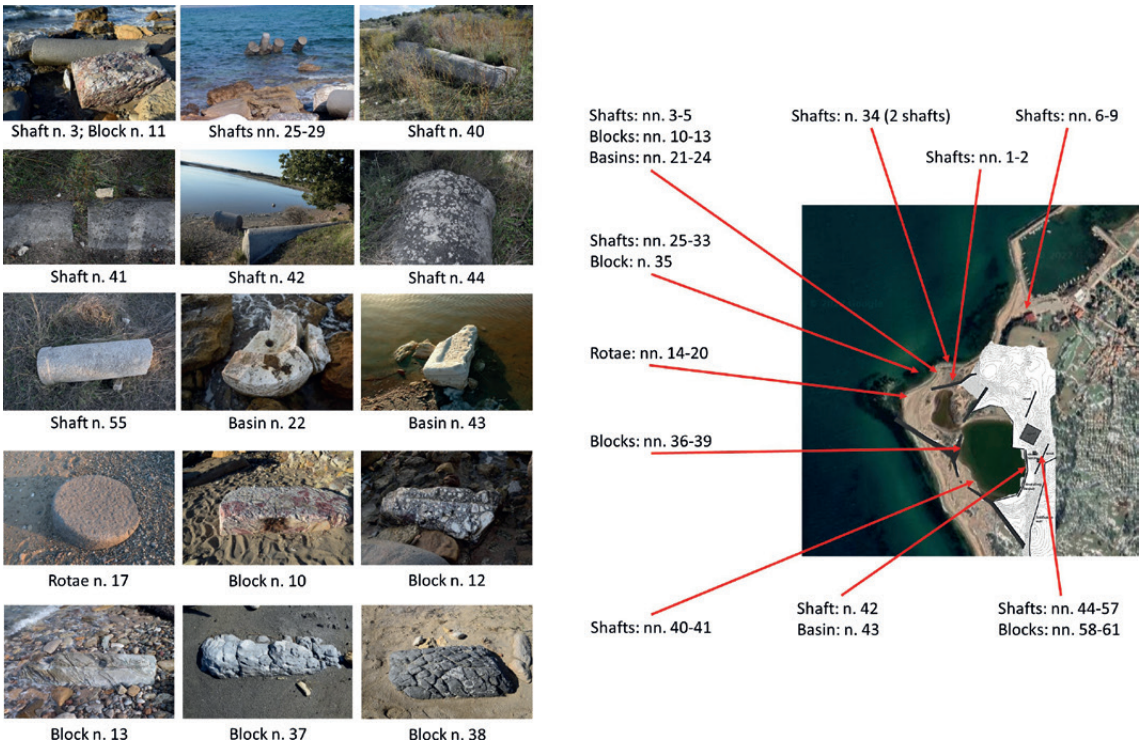
31 Feuser 2011, 261.

32 Feuser 2011, 265 figs. 6 (H9). 16–17.

33 Feuser 2009; Feuser 2011.

34 Out of these shafts, 53 specimens have a preserved height of up to 2.4 m and a diameter of about 40 cm, so they can be considered medium-sized; four shafts are said to be large, two of them on the western side of the lake with a height of 11.5 and 11.3 m and a diameter of 1.4 m, and two others placed perfectly parallel to each other on the southeastern side of the lake, with a height of 9.2 and 8.8 m and a diameter of 1.16 m, the latter shafts already represented in the plan by M. L. J. J. Dubois of 1814, published in 1842 by M. Choiseul-Gouffier (Choiseul-Gouffier 1842, tab. 44). S. Feuser mentions another seven shafts in the northeast and west area of the lake, on the beach, with a shaft height of 40 cm and a diameter of 62–92 cm, see Feuser 2011, 268 figs. 21–22.

5 Structures south of the southern pier (photo: E. Gasparini)



6 Distribution of architectural elements within the port (photos: P. Pensabene, E. Gasparini, J. Á. Domingo)

the fact that the material came directly from the quarries and was waiting to be shipped to other destinations, where finishing would be completed.

No.	Place of conservation	Element	Material	Dimensions	Observations
1	Outer basin, north pier	Shaft	Troad granite	Dm inf. 33–39 cm, Dm imoscape 38–44 cm, H scape 7–10 cm	The surface of the shaft is smooth and the moulding of the scape appears to be finished. It is a shaft embedded in the pier, perhaps used as a mooring for ships.
2	Outer basin, north pier	Shaft	Troad granite	Dm inf. 33–39 cm, Dm imoscape 38–44 cm, H scape 7–10 cm	It does not retain the scape. It is a shaft embedded in the pier, perhaps used as a mooring for ships.
3	Outer basin, north pier	Shaft	Troad granite	H max. 2.36 m, Dm on the side opposite the scape 58 cm	It is a shaft fragment deposited on the beach together with other architectural elements. It does not retain any of the scapes.
4	Outer basin, north pier	Shaft	Troad granite		A section of a shaft located in the sea.
5	Outer basin, north pier	Shaft	Troad granite		A section of a shaft located in the sea.
6	Outer basin, north pier	Shaft	Troad granite	H max. 1.6 m, Dm inf. 33 cm, Dm imoscape 39 cm, H imoscape 10 cm	It is fractured about halfway and retains only the imoscape. It is unfinished. It may have been left here in modern times.
7	Outer basin, north pier	Shaft	Troad granite	H max. 1.11 m, Dm on the fractured side 34 cm, H scape 8 cm	It is fractured and retains only one of the scapes, which is unfinished. It may have been left here in modern times.
8	Outer basin, north pier	Shaft	Troad granite	H max. 0.84 m, Dm inf. 38 cm, Dm imoscape 44 cm, H imoscape 7 cm, Dm on the fractured side 40 cm	It is fractured and retains only one of the scapes, which is unfinished. It may have been left here in modern times.
9	Outer basin, north pier	Shaft	Troad granite	H max. 44 cm, Dm inf. 39 cm, Dm imoscape 44 cm, H imoscape 10 cm	It is fractured and retains only the unfinished imoscape and a short section of the shaft. It may have been left here in modern times.
10	Outer basin, north pier	Marble block	Breccia corallina or Fior di pesco	L 1.55 m, W 0.63 m, T 39.5 cm	It is deposited on the beach. It has an incision at the top that divides the surface of the block in half.
11	Outer basin, north pier	Marble block	Breccia corallina or Fior di pesco	L max. 1.38 m, W 1.04 m, T max. 38 cm	It is deposited on the beach. It is very similar to the previous block.
12	Outer basin, north pier	Marble block	Pavonazzetto or Breccia di Sciro	L max. 1.03 m, W max. 56 cm, T visible (partially underground) 26 cm	It has a slope at the top that divides the surface in half. It is deposited on the beach. It could be a block with very similar measurements to the previous ones.
13	Outer basin, north pier	Marble block	Cipollino	L 1.82 m, W max. visible 49 cm, T max. visible 34 cm	It has a slope at the top that divides the surface in half, and a circular perforation in one side that crosses the block obliquely. It is deposited on the beach.
14	Outer basin, north pier	*rotae*	Troad granite	Dm 80–90 cm	It is deposited on the beach and probably cut out of a shaft.
15	Outer basin, north pier	*rotae*	Troad granite	Dm 80–90 cm	It is deposited on the beach and probably cut out of a shaft.
16	Outer basin, north pier	*rotae*	Troad granite	Dm 80–90 cm	It is deposited on the beach and probably cut out of a shaft.
17	Outer basin, north pier	*rotae*	Troad granite	Dm 80–90 cm	It is deposited on the beach and probably cut out of a shaft.
18	Outer basin, north pier	*rotae*	Troad granite	Dm 80–90 cm	It is deposited on the beach and probably cut out of a shaft.
19	Outer basin, north pier	*rotae*	Troad granite	Dm 80–90 cm	It is deposited on the beach and probably cut out of a shaft.
20	Outer basin, north pier	*rotae*	Troad granite	Dm 80–90 cm	It is deposited on the beach and probably cut out of a shaft.
21	Outer basin, north pier	Fragment of basin	White or only slightly veined Afyon marble	L max. 1.27 m, W max. 64 cm, border W 33 cm, Dm circle 72 cm, T max. 40 cm	No mouldings or other decoration can be observed. The surface is very worn. It is deposited on the beach.

Table 1 Catalogue of Troad granite and marble fragments arranged around the port

No.	Place of conservation	Element	Material	Dimensions	Observations
22	Outer basin, north pier	Fragment of basin	White or only slightly veined Afyon marble	L max. 1.4 m, W max. 99 cm, border W 37 cm, T max. 59 cm, Dm in the base 53 cm	It shows part of the bottom of the tank and the beginning of one of the side walls. At the bottom, in an off-centre position, it has a perfectly circular perforation, indicating reuse. The surface is very worn. It is deposited on the beach.
23	Outer basin, north pier	Fragment of basin	White or only slightly veined Afyon marble	L max. 64 cm	It is a small fragment deposited on the beach, about 10 m away from previous examples towards the modern port.
24	Outer basin, north pier	Fragment of basin	White or only slightly veined Afyon marble	L max. 70 cm, W max. 54 cm, T max. 23 cm	This is most probably the bottom of the tank, as a circular perforation similar to that documented in no. 22 is partially observed. It is deposited on the beach.
25	Outer basin, north pier, in the water	Fragment of shaft	Troad granite		
26	Outer basin, north pier, in the water	Fragment of shaft	Troad granite		
27	Outer basin, north pier, in the water	Fragment of shaft	Troad granite		
28	Outer basin, north pier, in the water	Fragment of shaft	Troad granite		
29	Outer basin, north pier, in the water	Fragment of shaft	Troad granite		
30	Outer basin, north pier, in the water	Fragment of shaft	Troad granite		
31	Outer basin, north pier, in the water	Fragment of shaft	Troad granite		
32	Outer basin, north pier, in the water	Fragment of shaft	Troad granite		
33	Outer basin, north pier, in the water	Fragment of shaft	Troad granite		
34	Outer basin, north pier, on the shore of the sea	Fragment of shaft	Troad granite		Two column shaft fragments.
35	Outer basin, north pier, in the water	Marble blocks	Marble		These are several blocks of marble that cannot be directly observed because they are in the water.
36	Inner basin, south pier	Marble block	Bigio di Lesbo marble		
37	Inner basin, south pier	Marble block	Bigio di Lesbo marble		
38	Inner basin, south pier	Marble block	Dokimeion marble		
39	Inner basin, south pier	Marble block	White marble		
40	Inner basin, south side	Fragment of shaft	Troad granite	First drum: H 4.3 m, Dm imoscape 90 cm / Second drum: H 3.8 m, Dm inf. 90 cm, H fascia scape 25 cm, H shaft ca. 8.1 m	It is fractured and divided into two parts.
41	Inner basin, south side	Fragment of shaft	Troad granite	H imoscape 22 cm, H fascia sommoscape 17 cm, H listel below 5 cm	It is partly buried. It has an interrupted trench roughly in the centre to divide it. The scape is formed with an upper band that is followed by a smaller one.
42	Inner basin, east pier	Fragment of shaft	Troad granite	Fragment with imoscape: L max. 1.69 m, H imoscape 32 cm, Dm imoscape 1.42 m, Dm inf. 1.31 m Central fragment: L max. 4.85 m, Dm west side 1.37 m / Fragment with sommoscape: L max. 4.88 m, H sommoscape 36 cm	It is presented in three fragments. The upper end consists of an upper band, which is followed by a lower one.

Table 1 continued

No.	Place of conservation	Element	Material	Dimensions	Observations
43	Inner basin, east pier	Fragment of basin	Afyon marble		Unlike the basins located in the northern pier of the outer basin, this one has a rectangular base and not a circular one.
44	Inner basin, road to the east	Fragment of shaft	Troad granite	H 11.6 cm, H fascia imoscape 28–30 cm	
45	Inner basin, road to the east	Fragment of shaft	Troad granite	Dm ca. 38–40 cm	It is placed in the bushes beside the road.
46	Inner basin, road to the east	Fragment of shaft	Troad granite	Dm ca. 38–40 cm	It is placed in the bushes beside the road.
47	Inner basin, road to the east	Fragment of shaft	Troad granite	Dm ca. 38–40 cm	It is placed in the bushes beside the road.
48	Inner basin, road to the east	Fragment of shaft	Troad granite	Dm ca. 38–40 cm	It is placed in the bushes beside the road.
49	Inner basin, road to the east	Fragment of shaft	Troad granite	Dm ca. 38–40 cm	It is placed in the bushes beside the road.
50	Inner basin, road to the east	Fragment of shaft	Troad granite	Dm ca. 38–40 cm	It is placed in the bushes beside the road.
51	Inner basin, road to the east	Fragment of shaft	Troad granite	Dm ca. 38–40 cm	It is placed in the bushes beside the road.
52	Inner basin, road to the east	Fragment of shaft	Troad granite	Dm ca. 38–40 cm	It is placed in the bushes beside the road.
53	Inner basin, road to the east	Fragment of shaft	Troad granite	Dm ca. 38–40 cm	It is placed in the bushes beside the road.
54	Inner basin, road to the east	Fragment of shaft	Troad granite	Dm ca. 38–40 cm	It is placed in the bushes beside the road.
55	Inner basin, road to the east	Fragment of shaft	Troad granite	Dm ca. 38–40 cm	It is placed in the bushes beside the road.
56	Inner basin, road to the east	Fragment of shaft	Troad granite	Dm ca. 38–40 cm	It is placed in the bushes beside the road.
57	Inner basin, road to the east	Fragment of shaft	Troad granite		
58	Inner basin, road to the east	Block	Troad granite		
59	Inner basin, road to the east	Block	Troad granite		
60	Inner basin, road to the east	Block	Troad granite		
61	Inner basin, road to the east	Block	Marble		

Table 1 continued

Outer Basin, North Pier (tab. 1, nos. 1–24)

Fragments of two shafts of similar size are found in this sector (nos. 1–2), with a lower diameter of 33–39 cm, an imoscape diameter of 38–44 cm, and a scape height of 7–10 cm. Only the shaft no. 3 appears to be slightly larger in size, with a diameter, measured about halfway up, of 58 cm. Other fragments, since they are in the sea (nos. 4–5), were not measured.

Most shafts have unfinished surfaces and scapes. An exception would be the specimen no. 1, with a smooth surface, but in this case, as is also the case with the specimen no. 2, these are shafts embedded in the pier, probably used as berths for ships. Other shafts (nos. 6–9) deposited on the beach north of this pier, at the beginning of the modern pier, may have been placed here in modern times.

Some marble blocks also originate from this area (nos. 10–13). They are of similar dimensions, with a length of 1.55–1.82 m, a width of 63–104 cm and a thickness of approx. 34–39.5 cm. They are in Breccia corallina or Fior di pesco, Pavonazzetto or Breccia di Sciro and Cipollino. And finally, there are also some *rotae*, 80–90 cm in diameter (nos. 14–20), and some fragments of white or only slightly veined Afyon marble basins deposited on the beach (nos. 21–24).

Outer Basin, North Pier, into the Water (tab. 1, nos. 25–35)

Some fragments of Troadense shafts originate from this area, many of them preserved in the sea and only partially visible, so their dimensions could not be measured. They correspond to medium-sized shafts and all retain at least one of the scapes protruding from the water.

These shafts can be joined by some marble blocks that we have not been able to catalogue, because they are partially or totally submerged in the sea (no. 35), in an area very close to the previously mentioned *rotae* warehouse.

Inner Basin, South Pier (tab. 1, nos. 36–39)

A number of marble blocks come from this area, two in Bigio from Lesbos (nos. 36–37), one in Afyon marble of Pavonazzetto quality (Dokimeion) (no. 38) and another in white marble, possibly Scythian (no. 39)

Inner Basin, South Side (tab. 1, nos. 40–41)

Two medium-sized Troadense shaft fragments come from this area (nos. 40–41). One of them (no. 41) has an interrupted trench in the centre, indicating the beginning of the division of the shaft into sections.

Inner Basin, East Pier (tab. 1, nos. 42–43)

From this area comes a large preserved Troadense shaft fractured into three parts (no. 42), with an overall height of about 11.5 m and a lower diameter of 1.31 m, and a fragment of a marble basin, probably from Afyon (no. 43).

Inner Basin, Road to the East (tab. 1, no. 44–61)

Several Troadense shafts preserved on the sides of a road that led to the city of Alexandria came from this area. This road[35] (fig. 7) has a width of 3.8 m and is visible for about 100 m. It has a crepidoma formed by 25 cm-wide granite blocks. The road seems to follow the perimeter of the basin.

The arrangement of the shafts in this place made S. Feuser think of the presence here of a column depot that would extend along the road[36]. One of the shafts is large, with a height of 11.6 m (no. 44), while another twelve shafts are in various stages of preservation, many fractured, and of similar size, with a diameter of about 38–40 cm.

Other architectural elements come from this area, such as several granite blocks (nos. 58–60) and one made of marble (no. 61).

J. Á. Domingo

CONCLUSIONS

The data obtained in our study reveal the importance that the port of Alexandria Troas played not only in the export of Troad granite shafts, but also in the arrival of other materials, as shown by the presence of parallelepiped blocks in different types of white and coloured marble documented mainly in the north pier of the outer basin and the south pier of the inner basin (in Breccia corallina or Fior di pesco, Pavonazzetto or Breccia di Sciro, Cipollino, Bigio di Lesbo), and the

[35] Feuser 2011, 265 (H14. H20).
[36] Feuser 2011, 265.

7 One of the roads that connected the port with the city of Alexandria Troas (photo: P. Pensabene)

fragments of Afyon marble basins with a circular base in the north pier of the outer basin, and a specimen with a rectangular base in the east pier of the inner basin.

In addition, it is interesting to note the total absence of Proconnesian material in the port area, perhaps a sign that the distribution of this material, extracted from quarries not necessarily under imperial ownership (there must have been sectors on the island leased to private individuals), took place through channels other than the Troad one. In fact, it is very likely that this marble was first transported to Nicomedia, from where it was then distributed throughout the Mediterranean[37] along with other marble varieties, as shown, for example, by the shipwreck of Punta Scifo, in Crotone, which transported Proconnesian and Pavonazzetto marble elements[38]. Architectural elements such as capitals in Proconnesian marble apparently come from a polygonal building near the forum[39]. However, the stone provenance is doubtful given the presence of similar marbles in quarries in Ephesos and elsewhere in Asia Minor. In any case, if this origin is correct, we would have a clue that Proconnesian was used in the city, even though its port was not a transit and sorting point for ships carrying cargoes of this marble.

As far as Troad granite is concerned, the most important extraction point was the Yedi Taşlar sector, located 8.8 km from the port and only 830 m from another mining sector, Kosali[40]. The material was transported to the city of Alexandria, from where it continued on its way to the port following the two documented roads paved in Troad granite (fig. 8) and heading towards the eastern side of the inner basin, the innermost area of the port and closest to the city.

Although S. Feuser suggests the presence not far from the port of a sorting area for materials, a depot that has not yet been identified[41], the distribution of architectural elements around the two basins of the port and on the sides of at least one of the two roads that led from Alexandria to the port, suggests the use of this space as the actual sorting area for materials. In this way, the

37 Ward-Perkins 1980, 329; Pensabene 2013, 315.
38 Pensabene 2010, 81.
39 Söldner 2018, 179.
40 Yavuz 2014, 504.
41 Feuser 2011, 269.

8 Road in the city of Alexandria Troas, leading to the port (photo: P. Pensabene)

architectural material would be arranged in the same places where the ships that were to transport it would dock.

Moreover, the port's main activity was the loading and transport of Troad granite shafts: this explains the difficulty in locating areas of the port designated for the unloading and loading of other goods. Architectural material is distributed around most of the piers. Nevertheless, it seems that most of the shafts were concentrated in the area of the north pier of the outer basin, where medium-sized specimens predominate; this is also where most of the marble blocks, *rotae* and Afyon basins came from. Furthermore, it is in this very area, to the north and west of the north pier, that S. Feuser mentions the presence of more than 100 architectural elements between slabs and granite shafts under the water (shafts with a height of approx. 3.8 m and a maximum diameter of 80 cm)[42].

It seems, however, that shafts with larger sizes were concentrated within the port basin, on the side closest to the city of Alexandria (nos. 40–42), which is explained by the difficulty in manoeuvring these heavy elements within the port. Near the road leading to the city, another important area of accumulation of medium and small shafts is documented (nos. 45–56), together with other architectural elements, essentially parallelepiped blocks of granite and marble.

But it is the distribution of Troad granite shafts throughout the Mediterranean that can help us better understand the importance of the port of Alexandria and the volume of material transported from here, with more than 1,000 shafts of different sizes catalogued so far. This commercial activity would have been one of the most important sources of capital income for the city since, as the Monumentum Ephesenum, Alexandria already enjoyed a tax privilege from the age of Augustus, which was the opportunity to benefit from customs taxes levied within its territory, the *portorium provinciae Asiae*, a tribute that without this privilege would have gone to the imperial treasury and would have been collected by the *publicani*[43].

As mentioned above, at the same time, the great families associated with this city in some way had to benefit economically. In this regard, we have mentioned the Quintilii as possible

42 Feuser 2011, 261.

43 Merola 2001, 114 f. 128; Barresi 2003, 119. 477; Feuser 2011, 257.

members of these aristocracies who played an important role in the city at the peak of the distribution of Troad granite. Their rivalry, well documented by the sources, with Herodes Atticus, who was also a city's patron, may have had among its causes the conflict that arose over the control and distribution of Troad granite, the importance of which had certainly not escaped the great and wealthy Athenian figure, whose construction companies often used Troad granite shafts.

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Simona Perna

PURPLE PORPHYRY AND OTHER HARD STONE VASES AND URNS FROM THE EARLY IMPERIAL PERIOD

TECHNOLOGY AND TRANSMATERIALITY

Abstract
The overall number of known early Imperial vases carved from purple porphyry and other harder stones, such as greywacke and granite, is rather meagre compared to that of contemporary calcite alabaster vases and urns (tureens), whose production peaked in the early 1st century AD. The present paper gathers the hitherto known examples of hard stone vases, particularly those carved from purple porphyry, which are normally assigned by scholars to late periods. This paper shows that most vases date to the Julio-Claudian and Flavian periods, also by comparing them with examples in calcite alabaster. Moreover, stylistic and technical comparisons between hard stone vases and contemporary ceramic, metal, and glass containers, suggests that artisans were transposing the most fashionable shapes into lithic materials regardless of their hardness. This was due to technological innovation, such as the lapidary lathe, cross-craft fertilisation and interaction among early Imperial arts and artisans.

INTRODUCTION

The overall number of known early Imperial vases carved from purple porphyry and other harder stones, such as greywacke and several varieties of granite, is rather meagre compared to that of contemporary calcite alabaster vases and urns (tureens), whose production peaked in the early 1st century AD[1]. It has proven very difficult for scholars dealing with these objects to quantify them due to their dispersion among international museums, auction houses, private collections, and cathedrals' »Schatzkammern«. The latter contain reworked vases, such as the series of the ›Cana miracle jars‹, revered as sacred relics in Christian churches. Modern replicas and, possibly, fakes further complicate any attempts at a quantitative and qualitative analysis. Nonetheless, a thorough sifting of all the available evidence from past archives and more recent discoveries, coupled with a survey in the flesh of the extant examples, offers a clearer picture of the production, distribution, and consumption of lithic vases in the Roman period. At the same time, a re-examination of the question helps dispute most of the previous scholarly assumptions regarding the uses and chronology of this class of material, particularly of purple porphyry vases.

The Roman production of architectural and statuary sculpture in Egyptian purple porphyry reached its peak between the 2nd and the 4th centuries AD; however, the use of this stone is attested as early as the Julio-Claudian period[2]. Porphyry artefacts from this epoch include vases of various shapes and sizes. Overarching narratives and misleading assumptions on the symbolism

1 Perna 2021a.

2 ›Discovered‹ at Mons Porphyrites (Gebel Dokhan) in the Egyptian Eastern Desert in AD 18 by a Roman legionary of Tiberius named Caius Cominius Leugas, porphyry is attested as early as the ages of Caligula, albeit on a very small scale, and of Nero, when it started to gain popularity for decorative uses in architecture. Leugas' discovery was the result of a long inspection campaign that had begun under Augustus, probably by orders of the emperor himself. Similarly, no evidence of deliberate extraction of porphyry in the Dynastic and Ptolemaic periods has been found.

of porphyry sculpture as exclusively expressing imperial power, coupled with the fact that many antiquarian finds cannot be dated due to the lack of contextual information and of a typological framework, have led scholars to assign such vases to late periods[3]. Nonetheless, recent archaeological evidence, combined with a closer analysis of the material, compels us to review such a chronology[4]. Moreover, it is generally understood that the consumption of purple porphyry artefacts, including vases, was limited to the imperial family, a hypothesis which, albeit exclusive, cannot be easily dismissed, given the high number of decontextualised objects.

The present paper gathers together the hitherto known examples of hard stone vases, particularly those carved from purple porphyry. While discussing some of their physical and technical features, its aim is to offer another contribution towards solving the chronology problem in light of recent evidence. I contend that many vases which are believed to be considerably later in date may instead be more confidently dated to the Julio-Claudian and Flavian periods by comparing them with examples in other materials, primarily calcite alabaster. Moreover, by discussing the most frequent shapes from a comparative perspective, I highlight their transmateriality, namely the transfer of shapes across multiple, seemingly different, materials, a phenomenon that so markedly characterises early Imperial artistic production[5]. As I argued elsewhere, the influx of imported lithic materials in the Augustan period constituted a factor that prompted the creation of containers in the new, exotic decorative stones by skilled craftspeople, whose products became sought-after by Roman customers. Stylistic and technical comparisons between hard stone vases and contemporary ceramic, metal, and glass containers suggests that artisans were transposing the most fashionable shapes into lithic materials regardless of their hardness. I argue that such a phenomenon was the result of technological innovation, cross-craft fertilisation and interaction among the artisans that participated in the creation of early Imperial artistic production.

PURPLE PORPHYRY VASES AND URNS: SHAPES, CHRONOLOGY AND TECHNOLOGY

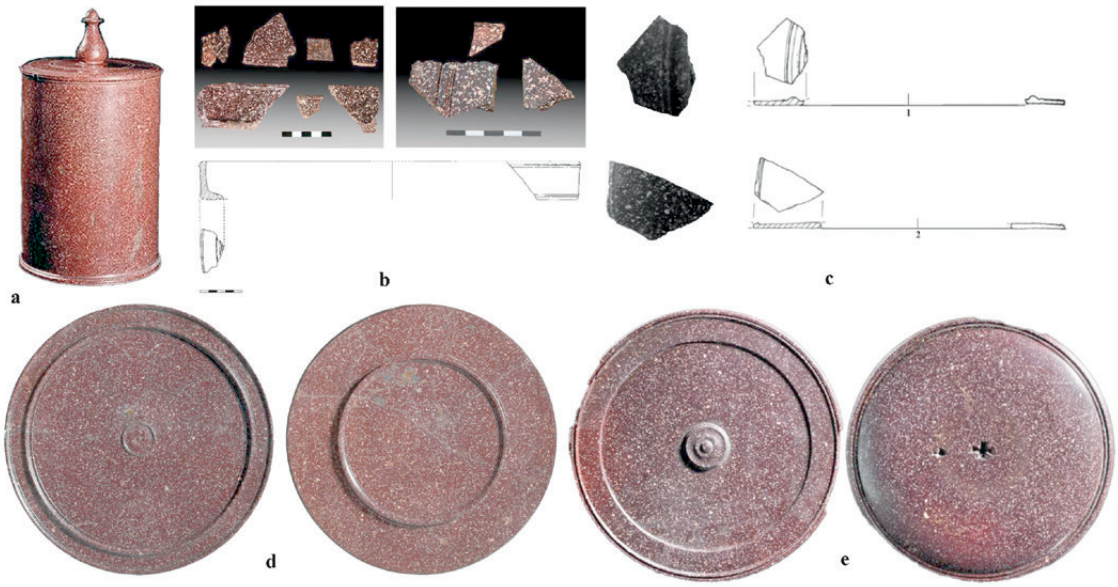
The known examples of purple porphyry vessels have come to us through two main sources: via the antiquities market or art collections and directly from excavations. Some 41 examples, whole or in fragments, can be said to be of early Imperial date or manufacture spanning from the 1st to the 2nd century AD (although some may be much later)[6]. Porphyry vases occur in miscellaneous shapes, which may be broadly divided into closed and open, with a predominance of large (5) and small (3) plates/trays and bowls of varying sizes (6). Among the closed shapes, large and medium size

3 Delbrueck 1932; Belli Pasqua 1989; Del Bufalo 2012. E.g., most statues and other artefacts, including vases, gathered by D. Del Bufalo (2012) are almost all dated to the 2nd–3rd cent. AD, although some works are visibly 1st cent. AD. On the other hand, sculpture and statuary datable to the beginning of the 1st cent. AD are indeed very rare.

4 As indeed already proposed by S. Perna, see Perna 2015a.

5 The concepts of ›intermateriality‹ or ›transmateriality‹, developed outside the field of classical art history and archaeology, have only recently been applied to both disciplines to address the interdependencies detectable at multiple material levels in Roman artistic production from the late Republic to the 1st cent. AD. These relatively novel approaches quite eloquently help make sense of the complex design networks within early Imperial Roman material culture production and move away from previous scholarly views based on reductive concepts, such as imitations, and on material hierarchies among craft productions. For the application of this concept in classical archaeology, see Flecker 2021.

6 Some 27 vases were first gathered by R. Delbrueck (1932). His catalogue included mortars and modern pieces, which he erroneously dated to the early Imperial period, such as a couple of fluted examples which are clearly Baroque (16th–17th cent.). D. Del Bufalo (2012), whose catalogue of porphyry works updates, reviews and integrates Delbrueck's, distinguishes between mortars and vases. The latter comprise a total of 156 examples (V1–V156), of which V1–V39 are ancient except for V8, V9b, V18, V25, V31 and V39 of dubious antiquity, while V9–V17, V30 and V34 are certainly late antique. Other scattered examples are catalogued by C. Gasparri (2013), F. Slavazzi (2007; 2010) and V. García-Entero and colleagues (2024). In this paper, I concentrate on the 1st-cent. AD vases, some of which have been traced through recent and past auction catalogues or surveyed in the flesh by myself. Nonetheless, my recollection is far from definitive, as more vases may be unpublished or uncatalogued.



1 a: Cista, Tommasso Collection London (from Del Bufalo 2012, 141 no. V28). b: Fragments of a plate from Cremona and drawing of its section (from Slavazzi 2007, 150 f. figs. 1–2). c: Fragments of the plates from Breno and drawings of their section (from Slavazzi 2010, 326 f.). d: Large plate, Berlin, Antikensammlung Staatliche Museen, inv. Sk 2008 (photo: <arachne.dainst.org/entity/1188374> [30.06.2023]). e: Large plate, current location unknown (from Pandolfini 2023, 108 f. no. 135)

amphoras (4) and ›canopic-like‹ vases (3) prevail[7]. An elegant, tall beaker from Begram (Afghanistan), a cista with pear-shaped finial of unknown provenance, probably used as a cinerary urn (fig. 1 a), and possibly an oinochoe or single-handled jug from Trier may be considered single examples. Two exquisitely carved situlas, one being almost double the size of the other, both resting on three little feet and with handle attachments in the shape of bearded masks (Silenus or Dionysus), feature among the best-preserved examples[8]. All the known shapes with their provenance (where known), current whereabouts, dimensions and proposed dating have been summed up in table 1. As the table shows, 25 vases bear an indication of their provenance but only 17 vases come from recorded archaeological contexts. While the number of excavated examples is certainly very low, the chronology supported by some of them, together with stylistic analysis, has proved decisive in pinning down the earliest phases of the production. This is the case with a large (45 cm in diameter) porphyry plate discovered in an Augustan domus excavated in Piazza Marconi in Cremona (Italy) in 2005 (fig. 1 b). The ten fragments were found in the layers of abandonment of the domus dated to AD 69, the year of the sack of the city by Vespasian's troops. The plate has been dated to the

7 Vases characterised by a simple profile which broadly resembles that of the Pharaonic canopic jars, that is without handles and foot and slightly tapering towards the base.

8 Angers, Musée des Beaux-Arts, Trésor de la Cathédrale Collection, H 47 × Dm max. 40 cm; New York, the Metropolitan Museum, H 30 × Dm 25 cm. The former is the situla which King René d'Anjou bought from the monastery of Saint Paul in Marseille in 1449 and donated to the cathedral of Angers because it was believed to be one of the Cana miracle jars, thus a sacred relic. The vase was filled up with wine and brought in procession once a year for the liturgy known as »fête de l'hydrie« in the Angers cathedral to commemorate the miracle of the wine. The situla, which is missing its lid, may have come from the Gallo-Roman cemetery of Marseille, where it had quite possibly been used as a cinerary urn, see Perna 2021a, 59. 70–72; the latter was acquired in 2014 by the Metropolitan Museum of Art in New York from the art market (ex-Lopez-Willshaw Collection purchased by Rainer Zietz Ltd., through Christie's, Paris). Its archaeological context of provenance is not known, but judging by its perfect state of preservation, it could come from a funerary context.

Shape	Condition	Provenance	Dimensions	Location	Chronology	Bibliography
Amphora	Whole	?	H 33 cm	Unknown (ex Gden-Smith collection, London, 1930s)	early/mid-1st cent. AD	<https://www.artnews.com/art-news/market/frieze-london-2019-sales-report-13318/> (30.06.2023)
Amphora	Whole	?	H 43.1 × W 27 cm	Paris, Louvre, ex St. Denys Treasure, inv. MR 422	1st cent. AD (?)	Delbrueck 1932, 203 fig. 107
Amphora with lid	Whole	?	H 38 cm	Private collection, ex Hewatt-Jaboor London	early/mid-1st cent. AD	Del Bufalo 2012, 142 no. V37
Amphora with lid	Whole	?	W 16.7 cm (max.)	Oxford, Ashmolean, inv. AN1879.366	2nd cent. AD (?), modern (?)	<https://collections.ashmolean.org/collection/search/per_page/25/offset/0/sort_by/relevance/object/79060> (30.06.2023)
Beaker-vase	Whole	Begram, Royal Palace Room 13	H 25.38 × W 11.08 × Th 0.3 cm	Kabul, Archaeological Museum, inv. MK 57-1-86 (04.1.65)	early/mid-1st cent. AD	Tissot 2006, 281 no. 705; 445; Hiebert – Cambon 2011, 201 no. 215
Bowl	6 Fragments	Carranque (Toledo), Palace	H 7.5 × W 21.6 cm	Toledo, Museo de Santa Cruz	1st cent. AD (?)	García-Entero – Aranda González – Perna 2024, fig. 5, vase no. 1
Bowl	1 Fragment	?	H 4 × L 10 cm	London, British Museum, 1814, 0704.1648	1st cent. AD (?)	<https://www.britishmuseum.org/collection/object/G_1814-0704-1648> (30.06.2023)
Bowl (with omphalos)	Whole	Begram, Royal Palace Room 13	H 4.5 × W 18.5 × Th 0.45 cm	Kabul, Archaeological Museum, inv. MK57-1-85 (04.1.67)	early/mid-1st cent. AD	Tissot 2006, 281 no. 706; 446; Hiebert – Cambon 2011, 201 no. 216
Bowl fluted	2+ Fragments	Egypt (?)	H 8.4 × W 19.4 cm	Brussels, Royal Museums, E4710	Roman (?)	Malgouyres 2003, 26
Bowl or dish (unfinished)	Whole	Nile Delta	W 13 cm	Cairo, Archaeological Museum, inv. 18758	early Imperial (?)	Delbrueck 1932, 195 fig. 97
Canopic	Whole	?	H 28.5 × W 15.3 cm (max.)	Paris, Louvre, inv. 1215	1st cent. AD (?)	Malgouyres 2003, 46 f. no. 4
Canopic	Whole	?	H 35 cm	Unknown (ex Landau collection)	1st–2nd cent. AD (?)	Del Bufalo 2012, 142 no. V35
Canopic	1 Fragment	?	H 17 × W 14 × Th 1 cm (W 30–40 cm max.)	Hildesheim, Cathedral	1st–2nd cent. AD (?)	Delbrueck 1932, 196 f. fig. 111
Cista with lid	Whole	?	H 33 × W 15 cm (max.)	London, Tommasso Brothers collection	early/mid-1st cent. AD	Del Bufalo 2012, 141 no. V28
Cup or deep bowl (?) with vegetal relief	2 Fragments	Carranque (Toledo), Palace	Th 0.5–0.8 cm	Toledo, Museo de Santa Cruz	late (?)	García-Entero – Aranda González – Perna 2024, fig. 6, vase no. 2
Cup or deep bowl (lid[?])	1 Fragment	Altbach, Temple Complex (Trier)	?	Lost	1st–2nd cent. AD (?)	Delbrueck 1932, 198 fig. 102 B
Dish (make-up)	Whole	Pompeii	H 1 × W 5.3 cm	Naples, Archaeological Museum, inv. 77273 (4636)	early/mid-1st cent. AD	Delbrueck 1932, 207 f. fig. 111
Finial	1 Fragment	?	?	Trier, Rheinisches Landesmuseum, inv. EV 1956,51	2nd cent. AD (?), late (?)	Unpublished
Goblet fluted	Whole	?	H 16 cm	Sotheby's	1st cent. AD (?)	Del Bufalo 2012, 142 no. V32
Jug (?) (spout with carved decoration)	1 Fragment	Carranque (Toledo), Palace	Th 1.6–3.6 cm	Toledo, Museo de Santa Cruz	late (?)	García-Entero – Aranda González – Perna 2024, fig. 7, vase no. 3

Table 1 Summary of all the porphyry vases, whole and fragments

Shape	Condition	Provenance	Dimensions	Location	Chronology	Bibliography
Large bowl (footed, double-handled)	Whole	?	H 28 × W 33 cm (max.)	Private collection, ex Christie's 2002–2004	1st cent. AD (?), modern (?)	Del Bufalo 2012, 142 no. V31
Large plate	1 Fragment	Breno, Temple of Minerva	5 × 3.7 × Th 0.3–4 cm (max. W +25 cm)	Breno (?)	early/mid-1st cent. AD	Slavazzi 2010, 326 f.
Large plate	1 Fragment	Breno, Temple of Minerva	3.5 × 2.8 × Th 0.1–4 cm (max. W +20 cm)	Breno (?)	early/mid-1st cent. AD	Slavazzi 2010, 326 f.
Large plate	Whole	?	W 35 cm	Pandolfini Auction House	2nd cent. AD (?), late (?)	Pandolfini 2023, 108 f. no. 135
Large plate	Whole	?	H 2.6 × W 44.3 × Th 1 cm	Berlin, Antikensammlung Staatliche Museen, inv. Sk 2008	1st cent. AD	Del Bufalo 2012, 140 no. V20
Large plate or deep dish	6 Fragments	Cremona, Domus Piazza Marconi	H 4.5 × W 45 × Th 0.4–0.85 cm	Cremona, Archaeological Museum	early/mid-1st cent. AD	Slavazzi 2007, 150 f. figs. 1–2
Oinochoe or pitcher (?) situla (?)	2 Fragments	Altbach, Temple Complex (Trier)	W ca. 20 cm (mouth)	Trier, Rheinisches Landesmuseum, inv. St118.94	mid-1st cent. AD (?)	Delbrueck 1932, 198 fig. 102 A–A'
Situla	Whole	Marseille, necropolis (?)	H 47 × W 40 cm (max.) (weight 62.5 kg)	Angers, Beaux Arts Museum, inv. MA 1 R 105.1	early/mid-1st cent. AD	Delbrueck 1932, 201 f. figs. 93, 105
Situla	Whole	?	H 25.5 × W 24.8 cm (max.)	New York, Metropolitan Museum, inv. 2014.215	early/mid-1st cent. AD	<https://www.metmuseum.org/art/collection/search/634951> (30.06.2023)
Small bottle	Whole	Vatican catacombs	H 5 cm	Vatican Museums Pio Cristiano	1st–2nd cent. AD (?)	Del Bufalo 2012, 137 no. V4
Small plate or shallow bowl	1 Fragment	Tiber	5.6 × 4.6 cm	Rome, Museo Nazionale Romano, Gorga collection, inv. 254724	early/mid-1st cent. AD	Gasparri 2013, 175 no. 1 fig. 1, 1 pl. 1, 1
Small plate or tray (with handles)	1 Fragment	Tiber	8 × 5 cm	Rome, Museo Nazionale Romano, Gorga collection, inv. 254725	early/mid-1st cent. AD	Gasparri 2013, 175 no. 2 fig. 1, 2 pl. 1, 2
Small plate or tray (?)	1 Fragment	Los Bañales (Zaragoza), Domus	3.5 × 2.5 (est. W 12 cm) × Th 0.3 cm	Los Bañales storerooms	1st cent. AD (?)	García-Entero – Aranda González – Perna 2024, fig. 2
Undefined base	2 Fragments	Carranque (Toledo), Palace	Th 0.8–1.9 cm	Carranque, Archaeological Park	1st–2nd cent. AD (?), late (?)	García-Entero – Aranda González – Perna 2024, 166–173
Undefined base	2 Fragments	Carranque (Toledo), Palace	Th 0.7–1.2 cm	Carranque, Archaeological Park	1st–2nd cent. AD (?), late (?)	García-Entero – Aranda González – Perna 2024, 166–173
Undefined base (closed shape)	1 Fragment	Tiber	H max. 2.9 × W 1.9 cm	Rome, Museo Nazionale Romano, Gorga collection, inv. 254726	early/mid-1st cent. AD	Gasparri 2013, 175 no. 3 fig. 1, 3 pl. 1, 3
Vase (?)	1 Fragment	Carranque (Toledo), Palace	Th 0.5–0.9 cm	Carranque, Archaeological Park	1st–2nd cent. AD (?), late (?)	García-Entero – Aranda González – Perna 2024, 166–173
Vase (?)	1 Fragment	Carranque (Toledo), Palace	Th 0.5–0.9 cm	Carranque, Archaeological Park	1st–2nd cent. AD (?), late (?)	García-Entero – Aranda González – Perna 2024, 166–173
Vase (?)	1 Fragment	Carranque (Toledo), Palace	Th 0.5–0.9 cm	Carranque, Archaeological Park	1st–2nd cent. AD (?), late (?)	García-Entero – Aranda González – Perna 2024, 166–173
Vase with one handle	Whole	?	H 28 cm	Florence, Opificio Pietre Dure	1st cent. AD (?)	Del Bufalo 2012, 141 no. V26

Table 1 continued

mid-1st century AD (Neronian)[9]. Another similar discovery was made in 2003 in the Sanctuary of Minerva in Breno (Brescia, Italy), where two small fragments pertaining to two large size plates or trays (more than 20–25 cm in diameter) were recovered in the Flavian period layers (fig. 1 c)[10]. The discovery of these plates in datable contexts allows us to push back to the Julio-Claudian period the earliest date of creation of other similar large trays, such as the one in Berlin (fig. 1 d)[11], for which much later chronologies have been proposed[12], and possibly the one put up for sale in March 2023 in Florence (fig. 1 e)[13], as well as smaller plates, like the ones in the Gorga Collection in the Museo Nazionale Romano (fig. 2 a)[14] and the one discovered in 2022 at the site of Los Bañales (Uncastillo, Zaragoza, ancient Tarraga/Tarraca) in Spain, which presents close stylistic affinities with the examples from the Tiber[15]. The chronological frame delineated by the Cremona and the Breno finds confirms, and is confirmed by, that provided by the small plate or dish reportedly found at Pompeii and its AD 79 terminus ante quem[16]. Partially datable is the context of provenance of the two porphyry vases from Begram (ancient Kâpicî, Afghanistan, capital of the Kushan Empire, AD 50–350). One is an elongated, bell-shaped beaker-vase resting on a very short disc base with very thin walls, elegant mouldings around the rim and two series of incised parallel lines decorating the outer surface (fig. 2 b); the other one is a shallow bowl with thin walls, moulded rim, and a raised boss (omphalos) within a raised ridge at its centre (fig. 2 c). These vases were found in 1937 at the Site II palace, in sealed Room 13 in the New Royal City, stacked together with a hoard of miscellaneous goods, some of them quite rare, in different media (wood, glass, ivory, bone, metal, plaster artefacts, including three calcite alabaster vases) produced in the Roman Empire, mostly in Roman Egypt[17]. The chronology proposed for the Roman artefacts within the Begram hoard has been fixed to between the late 1st century BC and late 1st/early 2nd century AD, based on their typological, stylistic, iconographic or technical features, although it is apparent that their date of production did not coincide with that of deposition and that most of the artefacts were already antiques when they were gathered and sealed

9 Slavazzi 2007, 149. F. Slavazzi (2007, 153) hypothesised that the plate was part of the treasure of the Domus Aurea seized by Otho and taken with him to Cremona as his booty.

10 Slavazzi 2010. For F. Slavazzi, the trays had been donated to the sanctuary as votives by members of the local elite or the imperial family itself.

11 The plate has a profiled navel in the centre and a wide, slightly raised moulded rim. On the underside, there is a profiled base ring.

12 These span from the 2nd-cent. AD date proposed by R. Delbrueck (1932, 195), who also reports the wrong diameter, and accepted by D. Del Bufalo (2012, 140 [V20]) to the 4th cent. AD according to H. Mielsch (2002, 373 no. 73), based on comparisons with the series of large late-Roman silver trays, such as the one from Mildenhall (England) now in the British Museum (Dm 60.5 cm, inv. 1946,1007.1). However, the stylistic features and the sizes of these plates are quite different from those of the porphyry counterparts.

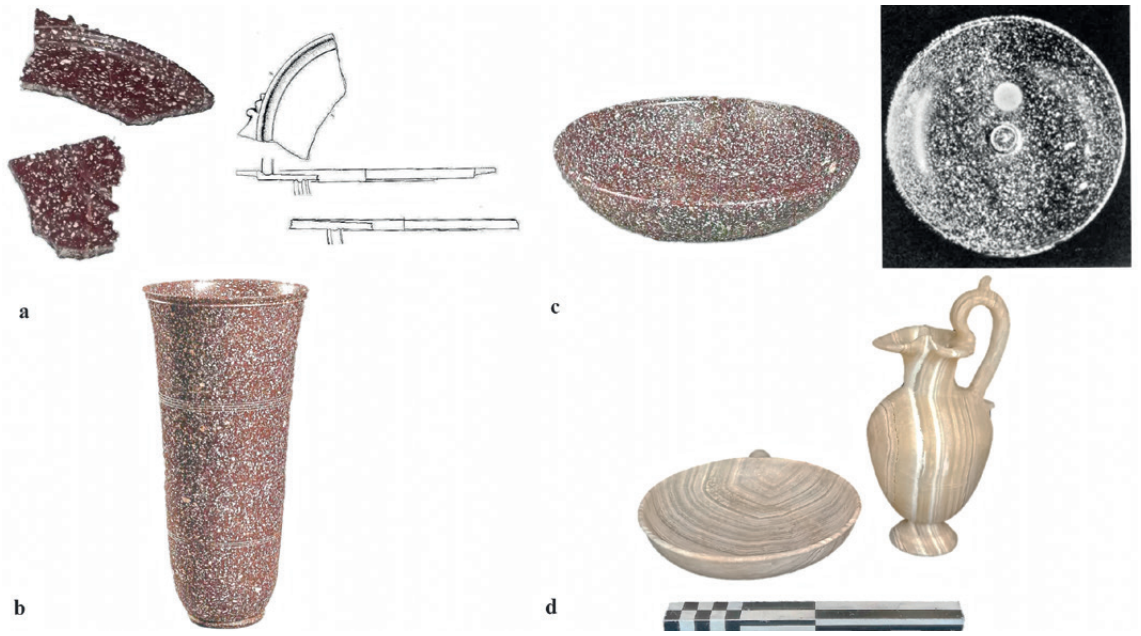
13 Pandolfini 2023, 108 f. no. 135, reported by F. Slavazzi (2007, 151 f.) as up for sale in Venice in 2004 at Semenzato Auction House. Smaller (Dm 34 cm) and qualitatively inferior, in the upper face it has a large external frame and a central, raised umbo that resembles the one carved on the Berlin plate, while the underside is smooth with a thin frame around the edge and a cross carved at its centre, which F. Slavazzi (2007, 152) quite rightly interprets as the slot for the insertion of a stand. The suggested dating for this plate oscillates between the 2nd and the 4th cent. AD, but an earlier date cannot be entirely ruled out.

14 These pieces had initially been dated by C. Gasparri (1999, 173 cat. 1–3) to the 2nd and 3rd cent. AD, a dating which he later reviewed to the early/mid-1st cent. AD, see Gasparri 2013, 174.

15 García-Entero – Aranda González – Perna 2024, 164–166 fig. 2. From the so-called domus of the peristyle, a rich residence is located in the northern sector of the site. The study of the stratigraphy of the context of discovery is still in progress, but preliminary observations seem to link it to the last level of occupation of the building, whose abandonment seems to have occurred at the end of the 2nd cent. or the beginning of the 3rd cent. AD.

16 With the caveat that nothing else is known about this object, whose only available image was published in black and white by R. Delbrueck, see Delbrueck 1932, fig. 111.

17 Hackin 1954; Tissot 2006; Hiebert – Cambon 2011. The hoard also included artefacts produced outside the Roman Empire, in China, India, and the Middle East, whose date of production was roughly contemporary to that of the Roman objects.



2 a: Fragments of a plate or tray with handle, plate or shallow bowl and undefined shape from the Tiber and profile drawings, Rome, Museo Nazionale Romano, Gorga Collection, inv. 254724–254726 (from Gasparri 2013, 175 no. 1 fig. 1, 1–3 pl. 1, 1–2). b: Tall beaker from Begram, Kabul, Archaeological Museum, inv. MK 57-1-86 (04.1.65) (from Hiebert – Cambon 2011, 201 no. 215). c: Bowl from Begram, Kabul, Archaeological Museum, inv. MK57-1-85 (04.1.67) (from Tissot 2006, 281 no. 706; 446; Hiebert – Cambon 2011, 201 no. 216). d: Set of jug and patera from Montpellier, Lyon, Musée des Beaux Arts, inv. H2021 (jug) and H2022 (patera) (photo: S. Perna, with permission of the museum)

inside the room in the 3rd century AD[18]. The chronology of production of the Begram stone vases may be pushed back to the early/mid-1st century AD based on similarities with objects whose technical and stylistic features fit comfortably within the repertoire of Roman artistic production of the late 1st century BC and the early 1st century AD. For example, the amphoriskos in calcite alabaster is very similar to an amphoriskos from Pompeii in the same material found in an early Augustan tomb[19], while the oinochoe and patera present very strong similarities with a trilobed juglet and a ram-headed patera in calcite alabaster found in a mid-1st-century AD (Flavian) tomb excavated at Montpellier (fig. 2 d)[20]. Further comparisons with other artefacts seem to support this chronology. For example, the rock crystal skyphos found in the Begram hoard shows very strong similarities with an example found in an Augustan tomb at Santa Maria Capua a Vetere (ancient Capua, Italy)[21]. In addition, the Begram calcite alabaster vessels show stylistic and technical similarities with some unfinished vases found among the production wasters of a Graeco-Roman workshop excavated at Memphis in 1900[22]. Finds included tubular cores and borers of various sizes, roughly pecked calcite

18 Mehendale 1996; see, more recently, Morris 2017 and Morris 2020, which include a summary of previous scholarly arguments on the nature (a merchant's stock or a private collection of artworks [?]) and dating of the hoard. L. Morris's study has reviewed the numismatic and architectural evidence from the site and proposed AD 260 as a terminus post quem for the deposition of the Begram hoard.

19 Pompeii, Casa di Bacco store rooms, no. 59863, H 28 × Dm max. 22 cm, (re)used as a cinerary urn in a tomb of the mid-late 1st cent. AD, in the Porta Nuceria Gate necropolis excavated in 1984.

20 Now at the Musée des Beaux Arts de Lyon, no. H2021 (jug) and no. H2022 (patera). They measure is H 22 × Dm 9.7 cm and H 4.4 × Dm 17.6 cm, respectively.

21 In Naples, in the Museo Archeologico Nazionale, no. 124701, ca. H 12 × Dm 15 cm, see Perna 2021a, 70.

22 Petrie 1909, 14 pl. 45; Petrie 1910, 44 f. pl. 39; Engelbach 1915, 33 f. pl. 60. The finds were scattered among several museums, but the larger set was donated to the University College Museum, now UCL Petrie Museum of Egyptology.

alabaster blocks and chips, unfinished containers (alabastra and other cosmetic bottles, bowls, plates, jugs, bowls, kohl pots) broken before and during drilling, all broadly dated by F. Petrie to between the late Hellenistic and the early Roman period. Two items in particular, a roughed-out oinochoe and an unfinished amphoriskos[23], present strong formal similarities not only with the Begram vases but also with the Montpellier ones, thus suggesting a common period of production in the early/mid-1st century AD. Therefore, not only is it possible that the Begram calcite alabaster vases and the finished and unfinished examples were contemporary, but also that they could have been produced at Egyptian manufacturing sites, such as Memphis, in the early 1st century AD[24]. Consequently, we may envisage a similar production scenario for the porphyry vases from Begram. Although no remains of porphyry vase workshops, in Egypt or in other parts of the Roman Empire, have yet been found, a shallow porphyry bowl with two handles, which was reportedly found in the Nile Delta area and is now in the Cairo Museum, may represent potential evidence of porphyry vase-making in Egypt in the early Imperial period (fig. 3 a)[25]. The bowl presents eight holes in its interior resulting from tubular drilling, a method developed and employed by Egyptian artisans for the preliminary hollowing of stone vases from Pharaonic to Roman times[26], while its handles and the overall external surface have only been roughed out. The object may be interpreted as a discarded or unfinished piece from a workshop, and although nothing else is known about its archaeological context, judging by its style and profile, it may be late Hellenistic, or more likely, Roman. Therefore, it cannot be excluded that the Begram porphyry vases were also produced in Egypt in the 1st century AD, a chronology that seems to be further confirmed by stylistic and technical comparisons. The beaker-vase presents a very similar profile to that of some of the glass beakers within the hoard that have been dated to the 1st century AD based on formal similarities with glass beakers and goblets from the same period (e.g. Ising forms 29 and 34), while the bowl with omphalos also has 1st-century parallels in glass (Ising forms 1 and 18–19), silver and bronze[27]. Moreover, although they do not have immediate stone parallels, both porphyry vases present incised concentric lines and mouldings shared by datable porphyry examples, something which seems to further confirm a (mid-)1st-century AD date for them. To a similar period, we may date the bowl reconstructed from some six (possibly ten more) fragments found scattered across the late Antique (Theodosian) palatial complex excavated at Carranque (Toledo, Spain)[28]. The bowl, which is the only vase whose profile could be reconstructed with certainty, has very thin walls (0.2–1 cm) and is very similar to the Begram example, albeit slightly deeper and wider, and may also be dated to the mid-1st century AD. Although the main phases of frequentation of the palace date to the 4th century AD, it is possible that this vase was already an antique when it ended up in the palace, something which cannot be confirmed or disproved given the current state of knowledge of the site, which is still under study[29]. This may also be the case with the three vase fragments listed by R. Delbrueck as coming from the Altbachtal temple district in the eastern part of the Roman city of Trier (ancient Augusta Treverorum)[30]. The largest one consists of a portion of a rim with part of the neck possibly pertaining to a (single-[?]) handled vase, a pitcher

23 UC69811 and UC69810, measure H 13.4 cm and H 11.3 cm, respectively.

24 Ancient stone vase manufacturing centres have rarely been found and it is very difficult to pin down potential production sites. Some workshops have been identified in Egypt, e.g. at Hierakonpolis (Quibell – Green 1902, 17 pl. 68) and Naukratis (Masson 2015).

25 Von Bissing 1907, 168 no. 18758; Delbrueck 1932, 195 fig. 97.

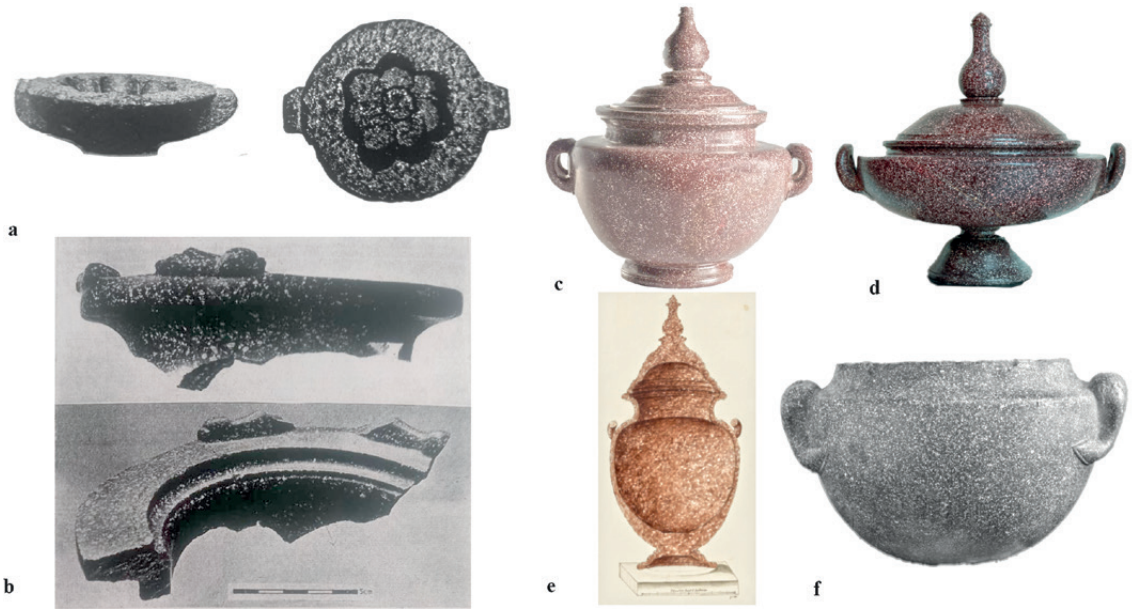
26 On this, see Perna 2015a; Perna 2021b.

27 Whitehouse 2001, 444 f.

28 García-Entero – Aranda González – Perna 2024, 166–175. The site has been excavated since 1988 in a series of consecutive campaigns (till 2003 and from 2009 to present) and has so far yielded 21 porphyry vase fragments and one large piece of a labrum. The finds are distributed between the Carranque Archaeological Park and the Museo de Santa Cruz of Toledo.

29 García-Entero – Aranda González – Perna 2024, 166–175. Other fragments of walls and bases pertain to at least two more distinct shapes, a cup or deep bowl and possibly a jug, but their surface decoration seems to suggest that these may be later.

30 Delbrueck 1932, 198 fig. 102 A. A'. B.



3 a: Unfinished bowl with tubular drill holes, Cairo, Archaeological Museum, inv. 18758 (from Delbrueck 1932, 195 fig. 97). b: Fragments from Trier, Trier, Rheinisches Landesmuseum, inv. St118.94 (from Delbrueck 1932, 198 fig. 102 A–B). c: Type-B tureen urn from la Tour de l'Horloge, Aix-en-Provence, inv. 862.3.3 (from Malgouyres 2003, 54–56 no. 9). d: Type-C tureen urn, Washington, Dumbarton Oaks Collection, inv. 41.5 (photo: <https://www.doaks.org/resources/online-exhibits/ancient-art-at-dumbarton-oaks/the-classical-world-at-dumbarton-oaks/urn> [30.06.2023]) . e: Type-A tureen urn from Civita Castellana, currently untraceable (from Del Bufalo 2012, 142 fig. V33b). f: Unfinished (?) porphyry tureen, stolen in 2005 from Hever Castle (Kent), Astor Collection (photo: <arachne.dainst.org/entity/1067512> [30.06.2023])

or oinochoe, or a bucket (situla [?]) with remnants of a plastic decoration, possibly dolphin or duck heads, marking the upper attachment of a vertical handle (fig. 3 b). The inside of the rim, just below the lip, presents a ›step‹ for the lid, meaning that the vase had a cover, something which jugs do not normally have. A similar rim decoration is found on three calcite alabaster oinochoes[31], which present animal protomes on one side of the rim where the handle attaches, and is usually found on metal counterparts. The similarity with the decoration of the three calcite alabaster jugs, whose dates oscillate between the late 1st century BC and the early/mid-1st century AD, seems to support a similar dating for the Trier porphyry fragment, though a mid-/late 1st-century AD date seems more plausible[32]. The phases of the Roman frequentation of the Altbachtal complex, which comprised over 70 temples and shrines to various deities, span from the Augustan age to the mid-4th century AD (mid-330s), but as in the case of the Carranque fragments, it is impossible to say which phase and context the vases belonged to due to the lack of secure stratigraphic data[33]. Delbrueck considered the other two fragments, one of which was a globular wall, part of the same vase, together with the rim fragment, but this is now impossible to ascertain because both fragments were lost in World War II[34]. A fourth fragment, which was not catalogued by Delbrueck, is the upper part of a lid's finial with acorn-shaped tip resting on a disc, stylistically resembling the upper part of pear-shaped finials

31 Perna 2021a.

32 R. Delbrueck (1932, 198) suggested a Hellenistic to early Imperial date. Even if a dating to the Hellenistic age of porphyry artefacts now seems unlikely, the scholar was probably right in considering it a work of the 1st cent. AD rather than a late one, given that in any case, the early Imperial artistic production is still largely indebted to that of the Hellenistic period.

33 Loeschcke 1928. The vases may have been recovered during S. Loeschcke's excavation campaign in the 1920s.

34 Korana Deppmeyer, pers. comm. (15.02.2021) inv. ST 12166. ST 12077.

found on the Julio-Claudian tureen funerary urns (see below). Its provenance is unknown, and, although the stone has the same hues as the rim fragment, it is difficult to tell whether they formed part of the same vase.

The early Imperial production of vases includes four examples of tureens, urns with a double-handled body, lid, finial and foot. Some 67 examples have hitherto been catalogued, the majority of which are carved from calcite alabaster (61)[35]. These urns came into use between the late Augustan period and the early 2nd century AD in elite Roman burials, in Rome, the Italian Peninsula, and some western provinces of the Roman Empire[36]. The use and production of the tureens likely peaked in the Julio-Claudian period in Rome and Italy, as the datable examples show; however, tureens found in provincial contexts suggest that their spread outside Italy peaked between the Flavian and Antonine periods[37]. The most securely dated is the type-B tureen found in 1776 in the Mausoleum of Tour de l'Horologe in Aix-en-Provence (France) and now in the Granet Museum (fig. 3 c)[38]. A silver coin of Trajan and a bronze coin of Lucius Verus found among its contents provide a terminus post quem for the burial[39]. The second is a type-C porphyry tureen now in the Dumbarton Oaks Collection in Washington (fig. 3 d)[40]. Its context of provenance is unknown, but it was quite possibly found in Rome because it had first been acquired by the Brummer Gallery in September 1927 from Attilio or Ugo Simonetti (inv. P4455), private Roman collectors[41]. Both the Aix-en-Provence and the Dumbarton tureens share similar profiles to the lid and finial, though the lid on the French example is incised with circular concentric grooves, while the body is footless. Moreover, the foot and the finial of the Dumbarton tureen were carved separately, on the lathe, and then joined to the urn. The third porphyry tureen is known from drawing no. 913 in Cassiano Del Pozzo's »Paper Museum« (1588–1657) (fig. 3 e)[42]. The drawing dates to 1682–1683[43] and shows a type-A tureen, measuring 63.5 cm in height and 30.5 cm in width. The overall profile of the body is similar to that of a basalt type-B tureen from a London burial dating to the Claudian period (AD 41)[44], while its lid and finial are similar to the ones on ›Livilla's‹ type-A tureen from the Ustrinum Augusti (Julio-Claudian)[45]. The Del Pozzo tureen may be the one reportedly found in Civita Castellana (Rome) in 1682[46]. The discovery reports emphasised its remarkable thinness and workmanship (»bellezza, simmetria, e sottigliezza«), details that would explain the drawing of its section (an unusual practice at the time)[47]. According to the records, the urn, which is now lost, contained ashes and was buried in a richly furnished underground burial chamber that was found intact. Also currently lost is the other porphyry tureen found in the 18th century in the Vigna

35 Perna 2014; Perna 2021a, 58. 70–73. The peculiarity of these urns is that the foot and the lid finial were carved separately on the lathe.

36 Perna 2019.

37 Perna 2019; Perna 2021b.

38 Inv. 862.3.3: H 37.5 × W 37 cm; see Perna 2014, no. 31. In type-B tureen urns, which have a deep hemispheric or slightly oval body, the width equals the height.

39 Perna 2019, 318–320. It also contained a gold ring with emerald and an engraved onyx gem.

40 Inv. 41.5: H 40 × W max. 45 cm with handles, see Perna 2014, no. 50. Type-C tureens are wider than they are high, with a shallow hemispheric body.

41 Perna 2014, no. 50.

42 In Windsor Royal Library. It was brought to my attention by Amanda Claridge in summer 2015 and is reproduced in Del Bufalo 2012, 137 no. V5b; 142 no. V33b.

43 Amanda Claridge, pers. comm. (26.07.2015).

44 Perna 2014, no. 27; Perna 2015b, 130 f.

45 Perna 2012, 789 fig. 1; Perna 2014, no. 1. Type-A tureens are higher than they are wide, with an elongated oval body.

46 Discovery reported in »Roma antica distinta per regioni, secondo l'esempio di Sesto Rufo, Vittore, e Nardini; ornata di rami delle più celebri fabbriche antiche diligentemente intagliate; coll'aggiunta dello stato di Roma nel secolo 12 e delle memorie di varie antichità trovate in diversi luoghi della città di Roma scritte da Ulisse Aldovrandi, Flaminio Vacca, Francesco de Ficoroni, Pietro Santi Bartoli, ed altri fino all'anno 1741«, Vol. I, 361.

47 The palm used is the »palmo romano d'architetto« measuring ca. 22.3 cm. The urn's wall thickness is ca. 1.1 cm.

Caracciolo (formerly Piccolomini) on the Via Tiburtina in Rome[48]. The urn, whose reported height in palms is 62 cm[49], was buried inside a travertine cist/well. It was believed by the excavators to be the urn of Pallas, Claudius' freedman, based on the location of his funerary monument on the Via Tiburtina given by Pliny the Younger[50], though no evidence was recovered in support of the identification. The urn was bought by Pope Clement XI for 3,000 escudos and was seen in the Albani Collection in Rome by Johann Joachim Winckelmann in 1763[51]. It was reportedly confiscated by the French in the late 1790s, later bought by Empress Josephine for her Malmaison Collection and finally acquired by the Marchioness of Dree. It was last seen at the auction sale of the Pourtales-Gorgier Collection in 1865 in Paris[52]. Possibly pertaining to a fifth porphyry tureen is the body of a vase that used to be in the Astor Collection in Hever Castle (Kent, United Kingdom)[53] and that was stolen from the property in 2005[54]. The piece may have possibly been acquired in Rome by William Astor during his time there as American ambassador (1882–1885). No detailed descriptions of this piece exist, except for one drawing and two photos. The vase had a hemispheric body, with a very high neck and two rather bulky lateral handles, and no foot and lid (fig. 3 f). The unusual profile of the rim/shoulder and the fact that the handles are solid and not carved in the round seem to suggest that it may have been an unfinished piece. Nonetheless, it is currently not possible to assess whether it was an original ancient unfinished tureen or a modern one.

The contexts of the porphyry tureens suggest that these urns were commissioned for the funeral of some very high-ranking individuals, as in the case of the porphyry tureen from the Tour de l'Horloge, a funerary monument built to commemorate a *laticlavius*, Sextius Iulius Verus, whose urn was sealed in its pedestal[55]. Nonetheless, the porphyry tureen from Aix-en-Provence is the only one in this stone that can be dated with more certainty. Its dating to the Antonine period, however, may not necessarily mean that porphyry tureens came into use later, rather it may be taken as one of the last attested uses of these urns. Two tureens, one in Aswan red granite and the other in olivine basalt, date to AD 37 and 41, respectively. At least two of the five porphyry tureens we have seen above, the Dal Pozzo and the Dumbarton ones, may be dated to the late Julio-Claudian/Flavian period based on stylistic comparisons with the other tureens. Such similarities allow us to push back the production, and thus the use, of porphyry tureens to roughly the same period, in line with the increased consumption of purple porphyry artefacts[56].

Overall, despite the complexities in the evidence (or lack thereof) relating to the chronology of production and use of the porphyry vases and urns analysed here, there are three aspects they all share: surface decoration, wall thinness and lathe marks. This is due to the formal, stylistic, and

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48 It contained ashes and a gold ring with engraved carnelian depicting a chimera, see de Ficoroni 1732, 53. 64. No image of this tureen exists; thus it is not possible to know its body profile.

49 In the 1700 reports, the tureen is described as »un sottil (thin) vaso di porfido, di meravigliosa struttura, alto circa 3 palmi, con i suoi manichi, il cui coverchio diviso in tre pezzi, o membri, veniva a comporre una curva sottocoppa col suo piede.«

50 Plin. epist. 7, 29: *Est Via Tiburtina intra primum lapidem (proxime adnotavi) monimentum Pallantis ita inscriptum: Huic senatus ob fidem pietatemque erga patronos ornamenta praetoria decreti et sestertium centies quinquagies, cuis honore contentus fuit*.

51 Delbrueck 1932, 209.

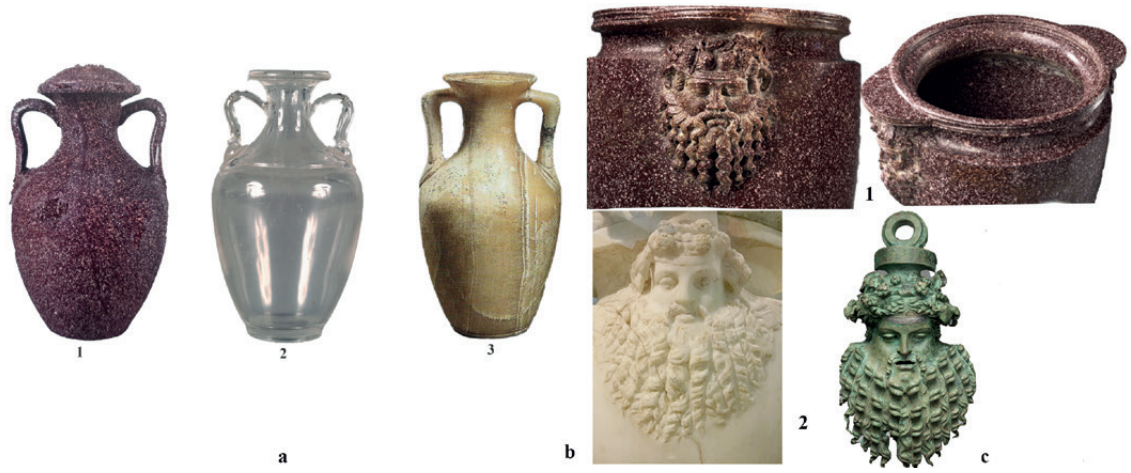
52 Catalogues des objects 6.02.1865, no. 1; Perna 2014, no. 11.

53 Astor 1969, 11 no. 93; Del Bufalo 2012, 140 no. V19.

54 <https://www.kentonline.co.uk/kent/news/early-roman-vase-stolen-from-cas-a19297/> (30.06.2023).

55 Perna 2019, 318 f. The choice of porphyry may have been due to the intention to celebrate the career of the young Verus, who died before fulfilling his position of *laticlavius*, seeing as this Latin word literally means tribune with the wide striped toga (of purple) and indicates the first step of the *cursus honorum* of young aristocratic men (20–25 years) who were to become senators.

56 Literary accounts on the funerary uses of porphyry by emperors are also misleading. After the isolated case of Nero, Septimius Severus, who died in AD 211, was said to have been buried in a porphyry urn, see Cass. Dio 77, 15, 4; however, accounts on the urn's material are discordant, as the Historia Augusta (Septimius Severus 24) and Herodian (3, 15, 7) report gold and alabaster, respectively.



4 a: Amphoras in three different materials. a1: Purple porphyry amphora, private collection, ex-Hewatt-Jaboor London (from Del Bufalo 2012, 142 no. V37). a2: Amphora of rock crystal from the tomb of a girl in the necropolis of Cádiz, H 12.7 × Dm 3.9 cm (mouth), Cadiz, Archaeological Museum (from Lopez de la Orden 2009, 120). a3: Calcite alabaster amphora from Begram, H 27.3 × Dm 13.5 cm, Kabul, National Museum of Afghanistan, inv. 04.1.77 (from Hiebert – Cambon 2011, 176 no. 174). b: Situlas in two different materials. b1: Porphyry situla and details of the bearded mask, New York, Metropolitan Museum, inv. 2014.215 (photo: <https://www.metmuseum.org/art/collection/search/634951> [30.06.2023]). b2: Pentelic marble situla, detail of the bearded mask, Ancona, Archaeological Museum, inv. A.62.I (photo: <https://it.wikipedia.org/wiki/Museo_archeologico_nazionale_delle_Marche#/media/File:Situla_funeraria_in_marmo,_ansa_con_testa_di_Dioniso_2_-_Museo_archeologico_nazionale_delle_Marche.jpg> [01.05.2025]). c: Bronze handle attachment in the form of a mask, possibly from a situla, New York, Metropolitan Museum, inv. 1972.118.98 (photo: <https://www.metmuseum.org/art/collection/search/255411> [30.06.2023])

technical links between early Imperial minor arts that can be found across a wide range of small and medium-sized vases carved from gemstones, semi-precious stones and other marbles. Such links are indicative of a common artistic and technical language that also strongly suggests a date in the mid-1st century AD for the vases without contextual information. Details, such as the wall thickness – between 4 mm and 1 cm – of most specimens, the harmony of the forms and the use of the lapidary lathe to achieve these, seem to characterise these ›early‹ vessels. The same can be said of shapes and decorative motifs. For example, the amphora and amphoriskos shape, which became quite fashionable in the Julio-Claudian period, is found in various sizes in different mediums, from rock crystal and cameo-glass to sardonyx, porphyry, and calcite alabaster. Examples of this form are represented by the cameo glass Portland Vase in the British Museum[57], the rock crystal example from the Julio-Claudian (Augustan [?]) tomb of a girl excavated in Cadiz[58], and two aforementioned examples in calcite alabaster from Begram and Pompeii (fig. 4 a, 1–2). One porphyry example of unknown provenance[59] presents such a shape in addition to sharing some decorative motifs, such as an elegantly moulded lid and leaf-shaped handle attachments, with other contemporary containers, such as the tureens (fig. 4 a, 3)[60]. It is therefore quite possible that this amphora was made within a similar time interval, perhaps between the Julio-Claudian period and the Flavian period. That the art of carving porphyry vases developed a little later than

57 No. 1945.0927.1, H 24.5 × Dm 17.7 cm.

58 From Calle Escalzo, Tomb 25, Cádiz, currently in the Museum of Cádiz, H 12.7 × Dm 3.9 cm (mouth).

59 Del Bufalo 2012, 143 no. V37, ex-Hewatt-Jaboor Collection, current location unknown.

60 The central part of the handles is also incised with a series of lines, a ribbed pattern, which is also found on the handles of the tureen urns for example. A (movable) finial, of the kind found on the tureen urn lids, may have been inserted into the lid, judging by the empty slot on its top. The fact that the amphora is lidded suggests that it might have been a funerary urn.

that of vessels in other stones is obviously due to the fact that the quarrying of this rock took off in the Tiberian period; however, it is very likely that the working techniques used for the other materials were soon adapted to this new rock by skilled (Egyptian-Alexandrian [?]) craftsmen, who soon began to reproduce and translate the most sought-after forms and motifs in multiple mediums. Such material interdependence or transmateriality resulted from the interaction among crafts and from the exchange of technical and technological innovations among artisans, which allowed shapes, motifs and techniques to cross material boundaries and to create new, desired forms of material culture. The phenomenon is admirably substantiated by the two aforementioned porphyry situlas and a Pentelic marble one, found in an Augustan tomb in Ancona, where it had been reused as a cinerary urn (fig. 4 b, 1–2)[61]. All three vases are connected stylistically by their bearded masks of Silenus/Dionysus and other shared details, such as the overall profile of the body, the handle attachments and the presence of feet, all elements which are commonly found in silver and bronze situlas following a late Hellenistic design (fig. 4 c)[62]. The Pentelic marble situla may be dated to the mid-to-end 1st century BC on stylistic grounds, thus it was made not long before its reuse as urn in the early 1st century AD. A similar dating (Julio-Claudian [?]) can be assumed for the porphyry situlas.

Whether all porphyry containers analysed above date to the early, mid-, or late 1st century AD is currently impossible to say with certainty; however, a date later than the late 2nd century AD seems quite unlikely. Of course, the production of porphyry vases did not cease after this period, but continued into late Antiquity, although in different forms. These later examples present evident technical and stylistic differences, such as considerably thicker walls and a tendency towards larger containers, such as craters and basins, which clearly mark the shift towards new tastes, trends and technologies[63].

OTHER HARD STONE VASES: DATASET AND CHARACTERISTICS

A total of 29 examples of vases, whole or in fragments, are carved from hard stones other than purple porphyry. These stones range from a variety of granites and Serpentino verde rana, all of uncertain geological identity and geographic provenance, but in all probability Egyptian, to basalt, possibly from the Egyptian quarries at Wâdi Hammamat, and Green porphyry – Porfido serpentino antico – from Greece[64]. Vases in these stones are even rarer than calcite alabaster and purple porphyry ones. All the examples discussed here are reported in table 2. The selection of shapes seems to be limited to bowls of various sizes (11), trays or dishes (3) and large amphoras (2); however, this could be due to a recovery bias and to the very fragmentary state of preservation of most pieces. Moreover, the ancient examples are often difficult to recognise because concealed by modern modifications and additions, such as frames and mounts. This is the case, for example, with two early-1st-century AD Green porphyry vases, a small bottle at the Victoria and Albert Museum in London[65] and a shallow bowl from the St. Denys treasury in the

[61] Perna 2021a, 67 f. Ancona, Archaeological Museum, inv. A.62.I, found in 1990 in Grave 62 at the cemetery of Via Matteotti, Ancona, ca. 42.5 × Dm 39 cm (mouth); masks H 19.5 cm. The lid is a plain, flat disc carved from a different variety of marble (Carrara [?]), which confirms that the vase had been reused as urn.

[62] On the iconography and religious symbolism of this type of Hellenistic-Roman situla, see Jenkins 1994, 279–284.

[63] E.g. mortars, which are also quite numerous, form a different category of recipients with a distinct utilitarian function deserving a separate study. For this reason, they have not been included in the present analysis.

[64] The stone discrimination is based purely on macroscopic observation or on the definition given in the reference literature, thus without geochemical analysis, so it is very difficult to be sure of the origin and type of the lithic varieties.

[65] The mount was made of silver between 1468 and 1491 for Margaret of York, Duchess of Burgundy, but the vase is quite possibly ancient, see <https://collections.vam.ac.uk/item/O111550/ewer-van-steynemoelen-seger/> (30.06.2023).

Shape	Condition	Material	Dimensions	Provenance	Location	Chronology	Total number	Bibliography
Amphora (large)	Whole	Aswan pink granite	?	Rome (?)	Brindisi, Cathedral Museum	early/mid-1st cent. AD	1	<http://db.histantartsi.eu/web/rest/Reperto Archeologico/332> (30.06.2023)
Amphora (large)	Whole	Aswan granodiorite (?)	H 68.5 × W 54 cm	Rome, Domus Transitoria	Private collection	early/mid-1st cent. AD	1	<https://www.sothebys.com/en/auctions/ecatalogue/2015/treasures-l15303/lot.16.html> (30.06.2023)
Bowl (closed) or cup	Fragment	Egyptian black granite (?)	H 6 × Dm 12 cm (max.)	Castlecary, Scotland	Edinburgh, National Museums Scotland, XFR190 (1)	early/mid-1st cent. AD	1	Hunter 2020, 248 f. no. FR 190.1
Bowl (deep)	Fragment	Serpentino verde rana	Dm 4 cm (foot max.)	Tiber	Rome, Museo Nazionale Romano, inv. 254736	early/mid-1st cent. AD	1	Gasparri 2013, 175 no. 12
Bowl (deep)	Whole	Egyptian granite (?)	H 5 × W 12.4 cm (max.)	?	New York, Metropolitan Museum, inv. 1995.83	early/mid-1st cent. AD	1	<https://www.metmuseum.org/art/collection/search/256212> (30.06.2023)
Bowl (deep) (convex foot)	Fragment	Serpentino verde rana	Dm 4.1 cm (foot max.)	Tiber	Rome, Museo Nazionale Romano, inv. 254735	early/mid-1st cent. AD	1	Gasparri 2013, 175 no. 11
Bowl (shallow)	Fragment	Granito verde a erbetta (?)	W 4.1 (max.) × D 3.6 cm (max.)	Tiber	Rome, Museo Nazionale Romano, inv. 254728	early/mid-1st cent. AD	1	Gasparri 2013, 175 no. 5
Bowl (shallow)	Whole	Granito del foro (?)	H 6.5 × Dm 28 cm	?	Private collection	early/mid-1st cent. AD	1	<https://kunsthandel-pamminger.de/produkt/schale-rom-1-3-jahrhundert-frankreich-19-jh/> (30.06.2023)
Bowl (shallow)	Whole	Green porphyry (Greece)	Total W 17 cm	?	Paris, Louvre, inv. MR 415	early 1st cent. AD	1	<https://collections.louvre.fr/en/ark:/53355/cl010096635> (30.06.2023)
Bowl (shallow) lidded (?)	Fragment	Egyptian black granite (?)	H 4.8 × W 5.8 cm (max.)	Castecary, Scotland	Edinburgh, National Museums Scotland, XFR 190.2	early/mid-1st cent. AD	1	Hunter 2020, 249 no. FR 190.2
Bowl handled	Fragment	Serpentino verde rana	4 × 2.2 cm (inv. 254729)	Tiber	Rome, Museo Nazionale Romano, inv. 254729	early/mid-1st cent. AD	1	Gasparri 2013, 176 no. 15
Cup or small bowl (hemispheric)	Fragment	Serpentino verde rana	H 1.4 × Dm 4.5 cm	Tiber	Rome, Museo Nazionale Romano, inv. 254739	early/mid-1st cent. AD	1	Gasparri 2013, 176 no. 16
Cup or small bowl spouted	Fragment	Serpentino verde rana	4 × 3.5 cm	Tiber	Rome, Museo Nazionale Romano, inv. 254737	early/mid-1st cent. AD	1	Gasparri 2013, 176 no. 14
Dish or large bowl	Fragment	Granito verde a erbetta (?)	W 11 (max.) × D 8.4 cm (max.)	Tiber	Rome, Museo Nazionale Romano, inv. 254727	early/mid-1st cent. AD	1	Gasparri 2013, 175 no. 4
Olpe (handled)	Fragment	Serpentino verde rana	H 2.8 (max.) × W 3.8 cm (max.)	Tiber	Rome, Museo Nazionale Romano, inv. 254738	early/mid-1st cent. AD	1	Gasparri 2013, 176 no. 13
Plate or tray (handled)	Whole	Greywacke	H 1.9 × Dm 24.1 × W 31.9 cm	?	New York, Metropolitan Museum, inv. 2014.248	early/mid-1st cent. AD	1	<https://www.metmuseum.org/art/collection/search/650960> (30.06.2023)
Plate or tray (rectangular)	Fragment	Serpentino verde rana	5.5 × 4 cm	Tiber	Rome, Museo Nazionale Romano, inv. 254734	early/mid-1st cent. AD		Gasparri 2013, 175 no. 9
Saucer	Fragment	Serpentino verde rana	Dm 4.2 cm	Tiber	Rome, Museo Nazionale Romano, inv. 254733	early/mid-1st cent. AD		Gasparri 2013, 176 no.10

Table 2 Summary of all the hard stone vases, whole and fragments

Shape	Condition	Material	Dimensions	Provenance	Location	Chronology	Total number	Bibliography
Small bottle	Whole	Green porphyry (Greece)	H (total) 15.2 × W 8.2 cm (bottle ca. 12.5 cm)	?	London, Victoria & Albert Museum,inv. 627-1868	early/mid-1st cent. AD	1	<https://collections.vam.ac.uk/item/O111550/ewer-van-steynemoel-en-seger/> (30.06.2023)
Undefined shape	Fragment	Serpentino verde rana	?	Tiber	Rome, Museo Nazionale Romano, inv. 254741	?	1	Gasparri 2013, 176 nos. 19–25
Undefined shape	Fragment	Serpentino verde rana	?	Tiber	Rome, Museo Nazionale Romano, inv. 254742	?	1	Gasparri 2013, 176 nos. 19–25
Undefined shape	Fragment	Serpentino verde rana	?	Tiber	Rome, Museo Nazionale Romano, inv. 254743	?	1	Gasparri 2013, 176 nos. 19–25
Undefined shape	Fragment	Serpentino verde rana	?	Tiber	Rome, Museo Nazionale Romano, inv. 254744	?	1	Gasparri 2013, 176 nos. 19–25
Undefined shape	Fragment	Serpentino verde rana	?	Tiber	Rome, Museo Nazionale Romano, inv. 254745	?	1	Gasparri 2013, 176 nos. 19–25
Undefined shape	Fragment	Serpentino verde rana	?	Tiber	Rome, Museo Nazionale Romano, inv. 254746	?	1	Gasparri 2013, 176 nos. 19–25
Undefined shape	Fragment	Serpentino verde rana	?	Tiber	Rome, Museo Nazionale Romano, inv. 254747	?	1	Gasparri 2013, 176 nos. 19–25
Wall (closed shape)	Fragment	Serpentino verde rana	5.5 × 6 cm	Tiber	Rome, Museo Nazionale Romano, inv. 254740	early/mid-1st cent. AD	1	Gasparri 2013, 176 no. 17
Wall (closed shape)	Fragment	Serpentino verde rana	5.5 × 5 cm	Tiber	Rome, Museo Nazionale Romano, inv. 254730	early/mid-1st cent. AD	1	Gasparri 2013, 176 no. 18

Table 2 continued

Louvre[66], both of which are ›harnessed‹ in mounts that have modified their original appearance into a ewer and a patena respectively, and a grey granite shallow bowl to which a pair of handles and a foot have been added (fig. 5 a)[67].

Out of the 29 examples inventoried here, only 21 come with an indication of the archaeological context of provenance, albeit very broad. This is the case for the 19 fragments of various vase shapes recovered from the Tiber and now in the Museo Nazionale Romano, for which only a stylistic analysis can provide a chronological indication of their production[68]. The stone employed in most cases is green with yellowish striations, known in the Italian literature as Serpentino verde rana[69]. Two fragments are carved from a variety of green granite, described as »a erbetta«, which is more likely to be a type of granodiorite from Egypt[70]. Most of these fragments, which pertain to

66 The bowl rests on a low ring disc. The mount was added between AD 850 and 900, while the little gold fishes were added in antiquity, see <https://collections.louvre.fr/en/ark:/53355/cl010096635> (30.06.2023).

67 The added elements are made of gilded bronze. The vase has recently come up for sale on the web, see <https://kunsthandel-pamminger.de/produkt/schale-rom-1-3-jahrhundert-frankreich-19-jh/> (30.06.2023).

68 See Gasparri 2013, 173–176 nos. 4–25.

69 A rock whose name derives from its resemblance to the skin of a frog, possibly the *lapis ophites* described by Pliny, see Plin. nat. 36, 7. It was quarried both in the Egyptian Eastern Desert and in the Italian Piedmont region, see Gnoli 1988, 134; Harrell 2012. Its use for vases is recorded since Predynastic times in Egypt, see Harrell 2012.

70 Inv. 254727, W max. 11 × D max. 8.4 cm and inv. 254728, W max. 4.1 × D max. 3.6 cm. Possibly the speckled white, medium-green and dark-green, uniform fine- to mainly medium-grained Gabbro from Wâdi Umm Wikala (sample no. 23a <http://www.eeescience.utoledo.edu/Faculty/Harrell/Egypt/Quarries/Hardst_Quar.html> [18.07.2022]), not to be confused with the grass-green granite quarried in the Ruwer Valley near Trier, which was not commonly used in Rome and in the Mediterranean Basin, see Ruppienė – Gluhak 2018.

5 a: Green porphyry bowl modified into a patena, Paris, Louvre, inv. MR 415 (photo: <https://collections.louvre.fr/en/ark:/53355/cl010096635> [30.06.2023]) and grey granite bowl with gilded bronze mount, private collection (photo: <https://kunsthandel-pamminger.de/produkt/schale-rom-1-3-jahrhundert-frankreich-19-jh/> [30.06.2023]). b: Fragments of green granite bowls from the Tiber and profile drawing, Rome, Museo Nazionale Romano, inv. 254727–254728 (from Gasparri 2013, 176 fig. 1, 4–5; 177 fig. I, 3–4). c: Fragments of various vases in Serpentino verde rana, Rome, Museo Nazionale Romano, inv. 254729–254740 (from Gasparri 2013, 176 fig. 1, 9–18; 177 fig. I, 5–8). d: Egyptian black granite (?) vase fragments from the Roman fort of Castlecary (Antonine Wall, Scotland), Edinburgh, inv. NMS XFR190 1–2 (from Hunter 2020, 243 fig. 16, 8). e: Reconstructed vase profiles of fragments inv. NMS XFR190 1–2 (from Hunter 2020, 244 fig. 16, 9)

both open and closed shapes, like spouted containers, cups, small bowls and plates (saucers), are datable to the Julio-Claudian period (early Augustan – mid-1st cent. AD)[71]. One of the fragments is a large piece of a large shallow bowl (lidded serving dish [?]) with flat ring foot edged by grooves and double concentric grooves on the walls (fig. 5 b–c). The hem is also grooved, perhaps to support a lid. The other fragment may pertain to a shallow bowl with double concentric grooves on the inside and one groove on the bottom surface. These features are connected stylistically to the ones noted on the porphyry trays and bowls discussed above, and thus further support the early/mid-1st-century dating proposed for these two examples.

Two vase fragments were reportedly found in the area (praetorium [?]) of the Roman wall fort at Castlecary (Antonine Wall, Scotland) in 1841 and are now in the National Museum of Scotland (Edinburgh) (fig. 5 d–e)[72]. One fragment is the rim and wall of a deep closed cup with faceted walls. The exterior surface is very polished and shiny with lathe marks on both the exterior and the interior walls, which are remarkably thin[73]. The other fragment is part of the curved wall with flat rim of a large open bowl, possibly a dish with cover[74]. The identification

71 Inv. 254729–254740. C. Gasparri (2013, 176 nos. 13. 17–18) posited a late dating for three of these fragments in Serpentino verde rana, but this seems to conflict with the supposed early dates of the other fragments of vases in the same material.

72 The finds were collected from the debris of the railway construction work, which cut through several forts along the Antonine Wall, and were donated to the museum in 1850 by Daniel Wilson. They were all given the same inv. 190, see Hunter 2020, 244 f. on these finds.

73 Dm max. 12 cm (14 % survives), H 6 cm, W 4.2 cm, Th wall between 3.9 and 6 mm, Th rim 3.9 mm, Wt 28 gr, see Hunter 2020, 248 f. no. FR 190.1

74 W max. 5.8 × H 4.8 cm, estimated total Dm 30 cm, of which 5 % survives; Th wall 6.5–5.4–5.1 mm, rim 8.5 mm, Wt 41 gr. Described as a lidded pyxis, see Hunter 2020, 249 no. FR 190.2.

of the stone as Egyptian basalt from El Haddadin (Cairo) is probably incorrect, as it is more likely to be Aswan black granodiorite[75]. Both fragments must have pertained to two fine pieces of tableware (use-wear has been noticed on their surface), judging by their elegant shapes with thin walls and finishing, obtained by lathe turning, and the rarity of the stone, whose glossy surface recalls that of the sought-after Corinthian bronze ware[76], though no immediate stone parallels of these two vases exists. The decoration of one of the two fragments, which consists of a pattern of ovals, may be compared to the series of faceted glass cups and beakers, whose peak of production has been dated to the early/mid-1st century AD[77]. The other fragment lacks decoration, but the technical similarities – lathe marks and surface finishing – and of course the choice of the same material as the faceted vase, suggests a similar dating. Therefore, a dating within the 1st century AD for both vases seems very plausible, but in the absence of more secure contextual and stratigraphic data, it is very difficult to confirm or disprove it. In any case, these rare pieces must have belonged to one of the high-ranking officials living in the fort between the late 1st century and the mid-2nd century AD. The discovery of two large fragments and the foot of a calcite alabaster tureen urn, presumably from one of the graves pertaining to the nearby fort of Camelon, north of the wall, seems to confirm the presence of high-ranking military personnel with a taste for exotic stone vases[78].

Among the complete vases are two large granite amphoras. One is the (Aswan [?]) pink granite amphora in the museum of the cathedral of Brindisi (Apulia, Italy)[79] and it has an elongated ovoid body tapering towards the bottom; a bell-shaped foot, which is worked separately; a high cylindrical neck with everted, moulded rim; and two pairs of loop handles, one of which is broken, with leaf-shaped attachments (fig. 6 a). The vase featured as early as 1470 among the sacred artefacts of the cathedral of Brindisi, as it was considered one of the Cana wedding jars, but its place of origin (possibly Rome [?]) is unknown. The other amphora is carved from coarse Awan granodiorite of dark-grey to nearly black colour with white, light-grey, pale-green and pink phenocrysts (fig. 6 b). It is very large (H 68.5 × W 54 cm) and has an ovoid-shaped body with rounded shoulder and pedestal foot, very short cylindrical neck with flaring rim, and two pairs of loop handles with ivy leaf-shaped attachments. It bore a lid which is now missing[80]. The vase, which was part of the collection of antiquities at Castle Howard (Yorkshire, United Kingdom), was reportedly found in Rome in 1721, in the nymphaeum, known as the so-called Baths of Livia, of Nero's Domus Transitoria (destroyed by the fire in AD 64)[81]. The amphora must have been part of the nymphaeum's decoration, together with the polychrome marble wall and floor revetment, porphyry columns and white marble statues[82]. Both amphoras present very strong stylistic similarities with the tureen urns, particularly with the aforementioned Aswan red granite urn of Napes, *liberta* of Antonia Minor (ca. AD 37) from the Esquiline Hill in Rome and the olivine basalt urn from London which contained a coin of Claudius (AD 41). These sim-

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75 Black ground mass with occasional, large feldspar crystals (›phenocrysts‹), bluish and white dots and sporadic creamy veins on the exterior, beige in section. For James Harrell (pers. comm. 19.07.2022), it is very likely to be Aswan granodiorite variety 1 (cf. samples Aswan no. 6: black granodiorite, variety 1 – sample 1 [from outcrop on Gebel Togok] and Aswan no. 6: black granodiorite, variety 1 – sample 2 [from outcrop on Gebel Togok], see <http://www.eeescience.utoledo.edu/faculty/harrell/egypt/quarries/Stones_List.html> [18.07.2022]).

76 Plin. nat. 34, 15; 35, 182. The Romans seem to have favoured bronzes darkened by adding a patina made of bitumen.

77 Oliver 1984, 35–58, particularly cat. 3. 14. See also Hunter 2020, 245 f., for more comparative material.

78 National Museum of Scotland, inv. F219. The Camelon fort phases of occupation span from the Flavian (ca. AD 79–86) to the Antonine period (ca. AD 140–158), see Hunter 2020, 237–243.

79 <http://db.histantartsi.eu/web/rest/Reperto Archeologico/332> (30.06.2023).

80 First purchased by William Ponsonby through his agent in Rome, Thomas Jenkins. The vase went up for sale at Sotheby's in 2015, see <https://www.sothebys.com/en/auctions/ecatalogue/2015/treasures-l15303/lot.16.html> (30.06.2023).

81 Suet. Nero 31, 1.

82 Borghini – D'Alessio – Scoccianti 2019.

6 a: Aswan pink granite amphora ›Cana‹ vases, Brindisi, Cathedral Museum (photo: <http://db.histantartsi.eu/web/rest/Reperto Archeologico/332> [30.06.2023]). b: Aswan granodiorite (?) large amphora from the Domus Transitoria, private collection (photo: <https://www.sothebys.com/en/auctions/ecatalogue/2015/treasures-l15303/lot.16.html> [30.06.2023]). c: Map of the geographic distribution of the findspots (graphics: S. Perna)

ilarities allow us to propose a dating to the Julio-Claudian period, a chronology which is also confirmed by the AD 64 date of the fire which destroyed the Domus Transitoria. The other two whole vases are a granite bowl and a greywacke handled plate, both of unknown provenance and in the Metropolitan Museum of Art in New York. The former has a very elegant inversed bell-shaped body with flaring rim resting on a low ring foot and very thin walls (fig. 7 a)[83]. It is carved from a fine-grained variety of beigey-pink granite with some darker zones and frequent clusters of black dots, possibly Egyptian, but it is impossible to tell with certainty. The plate is flat with a narrow rim and two solid handles projecting from both sides of the rim (fig. 7 c)[84]. A low raised boss with a raised central dot within an outer raised circle decorates the centre

83 Inv. 1995.83, see <https://www.metmuseum.org/art/collection/search/256212> (30.06.2023).

84 Inv. 2014.248, in European private collections before 1972; bought by Ariel Herrmann from Münzen und Medaillen, Basel, Switzerland, in 1972, see <https://www.metmuseum.org/art/collection/search/650960> (30.06.2023).

7 a: Pink-beige granite (Aswan [?]) deep bowl, New York, Metropolitan Museum, inv. 1995.83 (photo: <https://www.metmuseum.org/art/collection/search/256212> [30.06.2023]). b: Bronze cup, H 11.4 cm, 1st century BC, private collection (photo: <https://www.christies.com/lot/a-roman-bronze-cup-circa-1st-century-6136457/?intObjectID=6136457&lid=1> [30.06.2023]). c: Greywacke plate with handles, New York, Metropolitan Museum, inv. 2014.248 (photo: <https://www.metmuseum.org/art/collection/search/650960> [30.06.2023]). d: Greywacke plate with handles, bottom surface, New York, Metropolitan Museum, inv. 2014.248 (photo: <https://www.metmuseum.org/art/collection/search/650960> [30.06.2023]). e: Roman silver bowl, end 1st century BC – early 1st century AD, H 5 × W 27.5 cm, Phoenix art Lot. 15860 (photo: <https://phoenixancientart.com/work-of-art/roman-silver-bowl-with-richly-ornamented-handles/> [30.06.2023]). f: Roman steatite dish, ca. 1st century BC – 1st century AD, H 8.7 × W 1.3 cm, New York, Metropolitan Museum, inv. 74.51.5027 (photo: <https://www.metmuseum.org/art/collection/search/243907> [30.06.2023])

of the plate in its upper surface, which is very smooth and matt. The handles are simplified volutes with animal heads in profile with ears, eyes and beaks. On the underside, the base is a ring encircling two concentric raised circles of varying diameters with a small, raised disc at their centre, which have been created on a lapidary lathe. The stone may be described as fine-grained, green to greyish-green greywacke from Wâdi Hammamat in Egypt[85]. Both vases may be stylistically dated to the early to mid-1st century AD, though an earlier dating cannot be excluded. Their shapes find exact parallels in a wide range of contemporary receptacles in different mediums produced between the end of the 1st century BC and the early 1st century AD. For example, the profile of the plate with large handles finds parallels in other mediums (fig. 7 d–f)[86], while the choice of the stone seems to be a deliberate allusion to the patinated surface of contemporary fine bronze ware (fig. 7 b). It seems clear that these vases represent eloquent examples of the material transfer or transmateriality within early Imperial artistic production and of the material interplay which clearly appealed to Roman customers' tastes, and which resulted from ingenious craftsmanship and technological crossover.

85 See <http://www.eeescience.utoledo.edu/faculty/harrell/egypt/quarries/wh-ss-4.jpg> (30.06.2023). Greywacke became a very popular stone starting from the Augustan period especially for its association with Pharaonic and Ptolemaic Egypt, see Belli Pasqua 1995 for the repertoire of early Imperial greywacke sculpture.

86 Cf. MET 17.194.867 East Gaulish terra sigillata plate; silver bowl 1st cent. BC – 1st cent. AD. Phoenix art; Christies 2014, CKS015610115000 (a Roman silver pyxis and two dishes, ca. 1st cent. AD); MET, steatite dish 74.51.5027, see <https://www.metmuseum.org/art/collection/search/243907> (30.06.2023).

CONCLUDING REMARKS

The gathering and scrutiny of several examples of purple porphyry and other hard stone vases has allowed us to gain some interesting insight into the production of these objects, while expanding the corpus of examples known from both archaeological contexts and the art market. Firstly, the archaeological evidence combined with the analysis of the stylistic and technical features of the vases clearly points to the Julio-Claudian and Flavian periods as the floruit of this artistic production. This suggests a similar dating for the majority, if not all, of the purple porphyry vases analysed here. In any event, I hope I have demonstrated that the 2nd- and 3rd-century AD dates proposed for them by previous studies are surely too late.

The combined total of 70 extant examples of purple porphyry and other hard stone vases, many of which survive in fragments, shows that this was a limited production. Of these, purple porphyry vases total 41, while 29 are carved from other hard stones, with various granites of possible Egyptian origin and a green stone known as Serpentino verde rana prevailing (fig. 8 a). In any case, hard decorative stone vases are quantitatively inferior to those in calcite alabaster, which remains the favourite medium of this production, whether due to customers' taste, artisans' choice, or both. Nonetheless, such selection of stones for recipients reflects and is in line with the general patterns of marble trade and consumption for decorative and architectural uses in Rome and in the Vesuvian area in the early/mid-1st century AD (Julio-Claudian/early Flavian period). Such trends include the use of some very rare varieties of green and grey granites (or granodiorites) which feature, albeit in small quantities and sizes, in the floors of the Vesuvian area[87]. Conversely, greywacke, which was a very popular stone and one of the earliest to gain popularity in Rome, particularly for statuary due to its iconographic association with Egypt and its colour, recalling that of patinated bronze, is represented by only one vase. The production and consumption of purple porphyry vases, on the other hand, seems to counterbalance the scarcity of documented statuary in this material in the early/mid-1st century AD, although its use in the form of tiles and medium-sized columns is documented in Rome (e.g. Caligula's barges, Domus Transitoria). At the same time, porphyry tiles, some of which were already in secondary use, as well as painted wall panels, already appear in the houses and bars of the Vesuvian area, at Pompeii and Herculaneum, confirming that porphyry was more widespread earlier than might be expected[88]. In any event, the evidence provided by the vases seems to dispute most of the previous assumptions about the uses and chronology of purple porphyry in the Roman period.

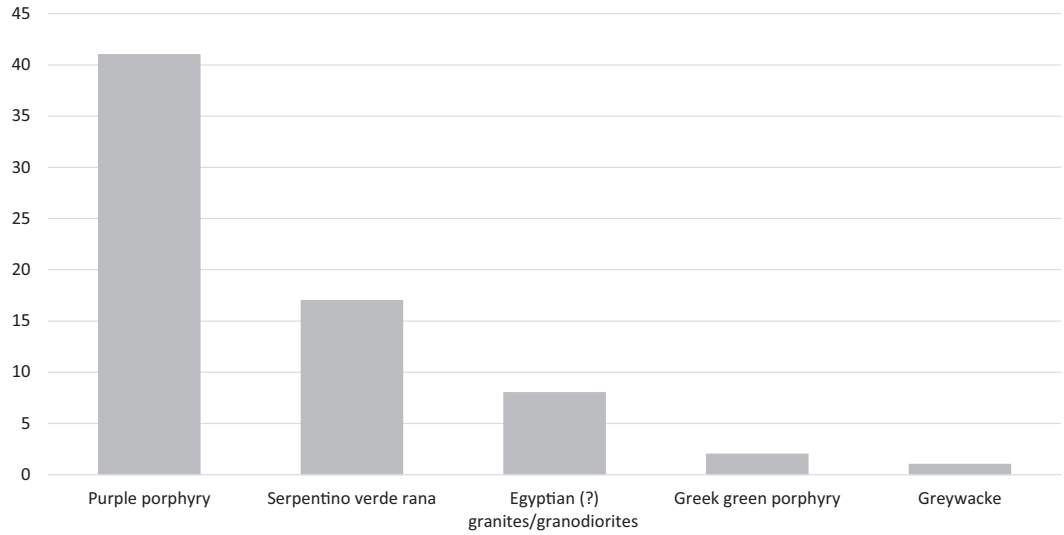
That there was a correlation or an interplay between the colour of the stone and the shape of the vases is further confirmed by the choice of dark coloured stones, like greywacke and black granites, which could have been playful yet explicit allusions to patinated Corinthian bronze ware. Similarly, it may be posited that the red colour of purple porphyry was first and foremost semiotic for the wine and the god that symbolized it, and therefore apt to represent both Dionysus and his ritual sphere. The dark red/burgundy tones of purple porphyry may initially have been associated with the precious drink, as suggested by the choice of this stone for the carving of containers related to wine consumption, such as situlas. Whether these vases ever had a practical function and contained real wine, or just a ceremonial one, as exhibits, only an in-depth analysis of their surface can confirm.

As for the shapes, plates, bowls and amphoras of varying sizes predominate in both purple porphyry and granite (fig. 8 b–c). From a comparative perspective, it is interesting to see how materials, shapes, and techniques cross and intersect at multiple levels. Stylistic and technical similarities among the stone vases and those in other materials speak eloquently in favour of an intense interaction between artisans engaging with different forms of crafts, from metalworking

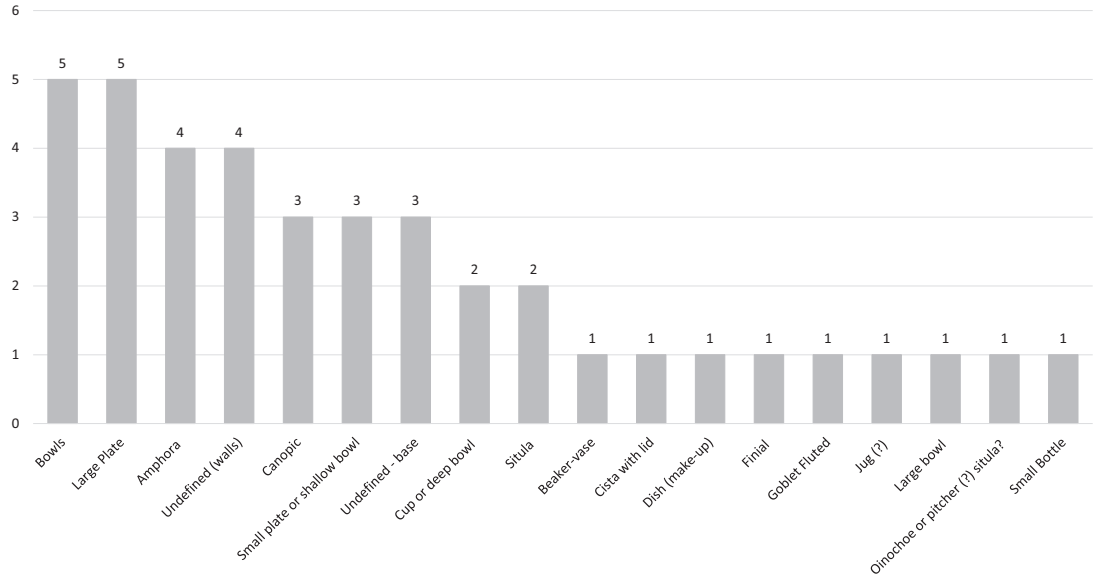
87 On this, see Barker – Fant, in this volume.

88 Fant – Russell – Barker 2013; Barker – Taelman 2021.

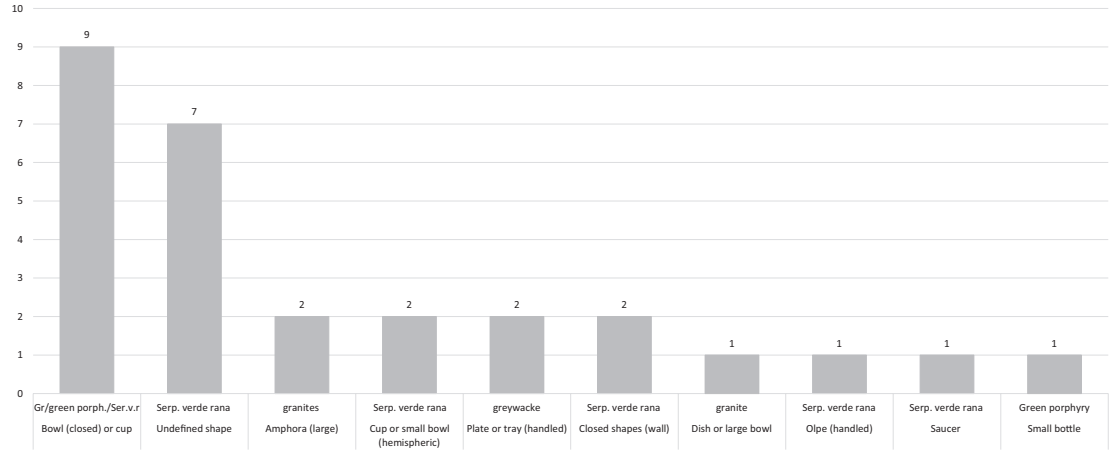
a



b



c



8 a: Graph showing all stone types used for the production of the vases analysed here. b: Graph showing total quantity of shape by stone type (excl. purple porphyry). c: Graph showing the total breakdown of purple porphyry vases by shape (graphics: S. Perna)

and glass-blowing to pottery making, or at least, of a sustained dialogue between early Imperial crafts. The enhanced technology in stone working must have facilitated such material cross-overs, and the lapidary lathe featured among the tools that made this possible. The fact that lathe marks have been retrieved on 90 % of the analysed samples confirms that this tool would be powerful enough to be used across a broad range of stones, regardless of their hardness[89]. At the same time, given the many technical similarities, it may be posited that the production of stone vessels was indeed in the hands of one and the same workshop or very few connected workshops producing these objects. Whether these artisans or workshops were in Egypt, in Rome, or both, it is not possible to say; however, there is some evidence, though very fragmented and limited to the production of small and medium calcite alabaster vases, of workshops being active in Egypt (e.g. Memphis) between the late Hellenistic period and the 1st century BC. It also possible, as I argued elsewhere, that artisans/workshops migrated from Egypt to Rome during the 1st century AD when demand for these objects, particularly for cinerary urns, became regular.

Based on the very scanty information of their find-spots, the geographic distribution of these vases shows a variegated consumption pattern, which spans from Castlecary in Britain to Begram in Afghanistan through to Carranque and Los Bañales in Spain and Trier in Germany. As in the case of the tureen urns, several examples come from Italy (Cremona, Breno, Rome, Pompeii) (fig. 6 c). Similarly, the few recorded find-spots span from religious contexts, as exemplified by the porphyry vases retrieved at the sanctuary at Breno and the sanctuary complex in the Altbach Valley (Trier), to domestic contexts, such as the Carranque ›palatial‹ complex, the domus at Cremona, Los Bañales, the Domus Transitoria in Rome and perhaps the Castlecary fort, and of course funerary monuments and tombs such as those in Aix-en-Provence and Rome. We obviously ignore the circumstances of acquisition of these vases, but possible ways may include direct purchase and commissioning and/or being given as gifts via gift exchange. In some cases, the date of production may not necessarily coincide with that of deposition or use, as earlier objects are found in later contexts, as seen in the case of the Carranque fragments or the Begram vases, because deemed valuable collectibles and/or heirlooms for special uses, such as votive dedications in temples, display items during special occasions and as ash containers in tombs. These reasons are not mutually exclusive and should all be considered equally possible in the absence of more granular contextual and epigraphic data. Notwithstanding complexities in the evidence, it seems more than plausible that most of these vases, including the porphyry ones, could be commissioned or purchased by private individuals. Indeed, apart from the emperor, it seems clear that only extremely wealthy personages, including those of a high senatorial rank, had the means to afford precious purple porphyry and other imported stone urns and sets of vases[90]. Their paucity and cost must have made these even more desirable and exclusive artefacts to be displayed during important events and ceremonies or dedicated in temples and sanctuaries by a restricted, wealthy clientele, which included, but was not limited to, the emperor.

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[89] Although no physical evidence of this tool exists, the marks retrieved on a very broad range of objects made of different materials and produced between the end of the 1st cent. BC and the 1st cent. AD testify to the ample applications of this tool and the high level of sophistication it had reached by the Roman period. Marble vases were worked on the lathe in Greece as early as the 5th cent. BC. On this, see Perna 2022.

[90] See also Ambrogi 2005, 151–153, esp. 152.

Actions-IF-2019 (Grant Agreement: 895286); part of this work was also carried out within the framework of the projects »El Mensaje del mármol. Prestigio, simbolismo y materiales locales en las provincias occidentales del imperio romano entre época antigua y alto-medieval a través del caso de Hispania y Aquitania« (PI: Anna Gutiérrez Garcia-Moreno, ICAC), funded by Agencia Estatal de Investigación, Proyectos I+D Generación del Conocimiento (PGC2018-099851-A-I00) and »Cosas de mármol. Creación, usos y reciclaje de las producciones marmóreas en Hispania« (MarmoRED2) (Coord. D. Gorostidi Pi ICAC) (RED2022-134955-T) as well as »Mobiliario, menaje y vajilla marmórea en la Hispania romana (siglos I a.C. a V d.C.)« (MarFur) (PIs: V. Garcia-Entero and I. Mañas Romero – UNED) (PID2023-150060NB-I00).

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Scott Pike – Kenneth Sheedy – Elena Familetto

A FIRST REPORT OF THE WHITE MARBLE FROM THE SANGRI VALLEY IN SOUTHERN NAXOS

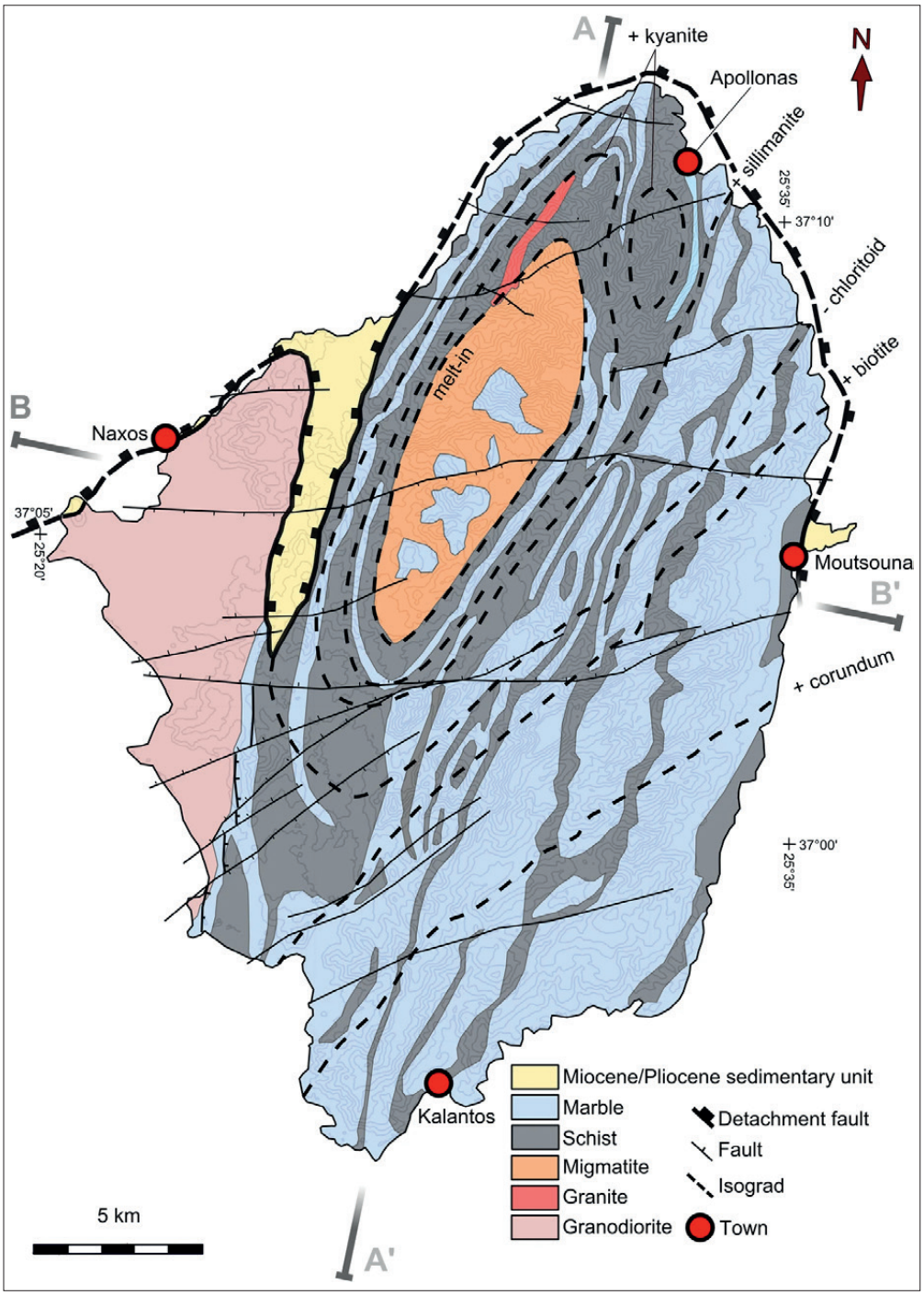
Abstract
Geochemical and stable isotope analysis of several Bronze Age and Archaic marble artefacts from Cycladic sites including Bronze Age figurines and Archaic kouroi suggest that the source marble comes from resources in the southern region of Naxos. However, no known ancient marble resources have been identified south of the known ancient quarries at Melanes and Apollonas which lie in the middle and north of the island, respectively. This paper is a first report of newly identified white marble outcrops in southern Naxos. The marble is situated atop relatively low-lying hilltops in the Sangri Valley. The stable isotope ratios of carbon and oxygen of these marbles suggest that these outcrops may have been the source of the aforementioned artefacts. Work is ongoing to map and further refine the geochemical fingerprint these resources.

INTRODUCTION

History of the exploitation of marbles on Naxos dates back at least to the Bronze Age when the marble was used in the making of many iconic Cycladic figurines[1]. The marble was among the first to be used in the entire Greek world and played a key role in the development of stone-working techniques and the evolution of Greek sculpture[2]. Naxian marble was used throughout the Archaic, but went out of favour in the Classical era. Examples of Archaic use of Naxian marble outside the Cyclades include a statue of a kore[3] recovered from the Athenian acropolis and the Sphinx of Naxos excavated at Delphi. The known ancient quarries on Naxos are near Melanes in the central part of the island and Apollonas on the north coast, where larger-than-life unfinished kouroi statues remain *in situ* at both sites (figs. 1–2).

Stable isotope analysis of many of the Neolithic marble artefacts recovered from recent archaeological excavations by C. Renfrew and M. Boyd on Keros and Dhaskalio[4] as well as published studies of other Neolithic material including the Keros Hoard[5] identify many of the Cycladic artefacts as having originated from southern Naxos. The attribution is based on similar textural features and carbon and oxygen stable isotope values identified in N. Herz's Aegean marble database[6]. However, the precise locations where Herz gathered his reference sample collection are not known. To date, no known ancient white marble quarries have been identified in the southern part of the island, leading to speculation that the Cycladic artefacts identified as being from southern Naxos were perhaps carved from well-rounded beach cobbles collected along the shore. K. Sheedy and S. Pike present stable isotope data that suggest that fragments attributed to the colossal marble statue of Apollo dedicated to the god by the Naxians in his sanctuary on Delos ca. 600 BC do not come from the well-known Archaic quarries of Melanes

1 Getz-Gentle et al. 2003; Tambakopoulos – Maniatis 2017.
2 Attanasio – Brille – Ogle 2006.
3 Acropolis Museum 619, <https://www.theacropolismuseum.gr/en/statue-kore-3> (30.06.2023).
4 Renfrew – Boyd – Margaritis 2018.
5 Maniatis et al. 2009.
6 Herz 1987.



1 Simplified geologic map of Naxos. The red stars indicate the location of known ancient marble quarries of Melanes and Apollonas (graphics: S. Pike after Kruckenberg et al. 2010 and Cao et al. 2013)

and Apollonas but rather from a white marble resource originating in southern Naxos[7]. This being the case, there must be at least one white marble source on southern Naxos that has so-far escaped detection. This paper is a first report of a recently discovered white marble sources in the southern region of Naxos.

7 Sheedy – Pike (forthcoming).

2 The unfinished Kouros of Faranghi near Melanes, Naxos. Note that vegetation hinders the ability to observe quarry field attributes from the ground (photo: S. Pike)

GEOLOGY OF NAXOS

Naxos is the largest of the islands in the Cycladic archipelago with an area of approx. 430 km². It is considered a metamorphic core complex[8] originating from post-orogenic extension which resulted in an elongated a-type dome structure[9]. On Naxos, a variety of rock types can be observed with abundant marbles alternating between low-grade metamorphic schists and higher-grade metamorphic gneisses in the magmatic central part of the island. The marbles form bodies of a few metres to several hundred metres thickness and are of various colours, with greyish and dark rock colours dominating in the southeast, while white marbles are more characteristic towards the central high-temperature section and to the north[10].

ARCHAEOLOGICAL MARBLES

Archaeological interest in Naxian white marble has focused on the known quarries at Melanes and Apollonas. Stable isotope and geochemical databases of these two quarries have been published by N. Herz[11], L. Moens, P. de Paepe and M. Waelkens[12], C. Gorgoni and colleagues[13] and D. Attanasio, M. Brille and N. Ogle[14]. To date, the physical extent of both quarry regions has not yet been fully mapped, although the authors and the Ephoreia of the Cyclades are coordinating an aerial and pedestrian survey in the near future to better assess the extent of the quarries.

8 E.g. Lister et al. 1984.
9 Jolivet et al. 2004.
10 Ebert et al. 2010.
11 Herz 1987.
12 Moens – de Paepe – Waelkens 1992.
13 Gorgoni et al. 2002.
14 Attanasio –Brille – Ogle 2006.

3 Map of Naxos. The purple region shows the extent of the geological survey. The three orange polygons mark the boundaries of the three white marble hilltops identified in the survey (graphics: S. Pike generated on Google Earth Pro)

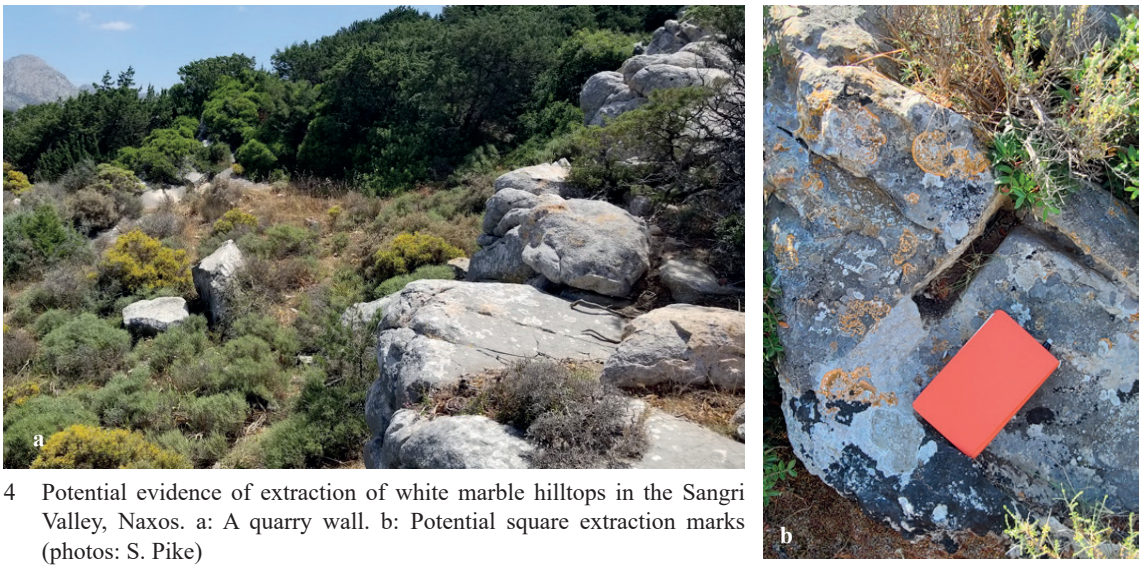
SOUTHERN NAXIAN MARBLE

The difficult question of geochemically sourcing white marble artefacts to quarries that have yet to be recognised led to a preliminary and small-scale geologic pedestrian survey of southern Naxos in the summer of 2019 with the aim of identifying potential white marble sources in the region. The survey found and identified several white marble outcrops in the Sangri Valley (fig. 3). The marble outcrops sit atop weathered schistic hills and were likely overlooked on previous field survey campaigns, as geologic maps do not identify the hills as being capped by carbonate material. Similar to the Cycladic figurines and the Naxian Colossus on Delos, the marbles have a range of grain sizes from medium to coarse, are white to blueish-white and have natural jointing wide enough to permit large block extraction. Our survey revealed at least one abandoned quarry pit within the white marble outcrops and subsequent shallow extraction indentations similar to those visible at Melanes and Apollonas (fig. 4).

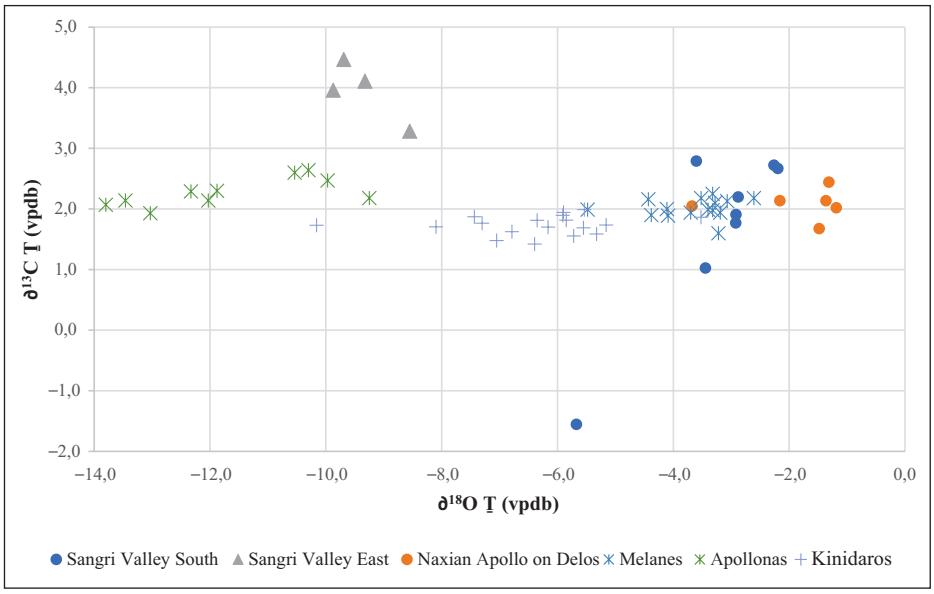
STABLE ISOTOPE DATABASE OF SANGRI VALLEY WHITE MARBLES

A reference collection of twelve samples was collected from the marble outcrops (fig. 3). The samples were collected directly from the bedrock and did not mar any potential ancient quarries. As mentioned above, the samples are white, with a maximum grain size greater than 5 mm. Aliquots from the reference collection were analysed by continuous flow mass spectroscopy at the Stable Isotope Laboratory, Department of Geology, University of Alabama using the protocols established by C. Spötl and T. W. Vennemann[15] and P. Debajyoti and G. Skrzypek[16]. Table 1 presents the stable isotope ratio data relative to the pee dee belemnite standard. Figure 5 graphically

[15] Spötl – Vennemann 2003.
[16] Debajyoti – Skrzypek 2007.



4 Potential evidence of extraction of white marble hilltops in the Sangri Valley, Naxos. a: A quarry wall. b: Potential square extraction marks (photos: S. Pike)



5 $\delta^{18}O$ and $\delta^{13}C$ of Sangri Valley Marble, Naxian Colossus on Delos and Naxos Marble Database (graphics: S. Pike)

Sample no.	$\delta^{18}O$ (‰ VPDB)	$\delta^{13}C$ (‰ VPDB)
Sangri Valley 19.010	–3.6	2.8
Sangri Valley 19.011	–5.7	–1.6
Sangri Valley 19.012	–2.3	2.7
Sangri Valley 19.013	–2.2	2.7
Sangri Valley 19.016	–2.9	2.2
Sangri Valley 19.017	–2.9	1.9
Sangri Valley 19.018	–3.4	1.0
Sangri Valley 19.019	–2.9	1.8
Sangri Valley 19.021	–9.7	4.5
Sangri Valley 19.022	–9.3	4.1
Sangri Valley 19.023	–9.9	4.0
Sangri Valley 19.024	–8.6	3.3

Table 1 Stable isotope ratios of Sangri Valley white marble samples

displays the Sangri Valley data as well as the stable isotope database of Melanes and Apollonas published by D. Attanasio, M. Brille and N. Ogle[17] and the isotope values for the Naxian Colossus on Delos.

As displayed, the oxygen stable isotope values of south Sangri Valley white marbles overlap with and are slightly more positive than those values from the Melanes quarries. The medium to coarse grain sizes of the Sangri Valley marble are also similar to those marbles from Melanes. Interestingly, there appears to be a wider distribution of carbon ratio values for the Sangri Valley samples, but whether this is statistically significant will require a larger reference sample collection to determine.

It is highly likely that the white marble outcrops in the Sangri Valley are the source for many of the well-known Cycladic figurine sculptures. The region shares a similar isotopic profile and the marbles have similar texture and colour. As for the stable isotopes of the fragments attributed to the Naxian Colossus on Delos, it appears that the attributed conjoined fragments are, in fact, from different marble blocks with at least one of the marbles likely being from the Sangri Valley[18]. However, to fully understand the extent and volume of white marble that was extracted in the Sangri Valley, a thorough and proper archaeological survey of the Sangri Valley must be carried out.

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ANCIENT QUARRIES OF THE DODECANESE (AEGEAN SEA, GREECE) AND THE USE OF THE EXTRACTED STONES

RECENT EXPLORATION AND RESULTS

Abstract
The intense research programme on Kos and its neighbouring islands conducted during the past two decades by a scientific team from Athens University in order to locate possible stone sources which provided the necessary material used in the Hellenistic sanctuary of Halasarna brought to light important evidence about the stone-quarrying activity in the Dodecanese during antiquity. The information gathered was included in the writer's thesis »Koan Stones and Koan Stone-Carving Activity«, submitted to Athens University in 2011, under the supervision of Georgia Kokkorou-Alevras. Our recent archaeological research in the Dodecanese added important information to the catalogue of the Dodecanesian quarries. In this paper, there will be a short presentation of the recently discovered quarries of poros at Philerimos and of marble at Lardos on Rhodes; of poros at the Asklepieion on Kos; of volcanic rocks at Argos on Nisyros, Pacheia and Pergoussa; and of grey hard limestone at Levitha, as well as of the connection of the extracted stone with known archaeological findings, based on the recent archaeometric research, visual observation and literary sources.

INTRODUCTION

Our past research on the ancient quarries of Kos and the use of their rocks added important knowledge on the quarries of the Dodecanesian Islands and the extensive use of their products, beginning with the possible stone sources of the building material of the Hellenistic sanctuary of ancient Halasarna (Kardamaina) and the stone artefacts that came to light. Later, in the »Corpus of Ancient Quarries«, published in 2012 under the direction of Georgia Kokkorou-Alevras[1], 159 ancient quarries of the Dodecanese were recorded. The recent autopsies by the responsible Ephorates of Antiquities at some newly discovered quarries shed light on the stone extraction and exploitation during antiquity at major ancient sites of principal islands such as Rhodes and Kos, but also on the smaller islands of the Dodecanese like Nisyros, Pacheia, Pergoussa and Levitha (fig. 1).

POROS QUARRY AT PHILERIMOS ON RHODES

Rhodes, the largest island of the Dodecanese, is not volcanic. The island is dominated by Mt. Atavyros. Sedimentary rocks, like limestone, were extensively quarried throughout the whole island in antiquity[2]. Based on the register of the Rhodian quarries in the »Corpus of Ancient Quarries« 130 quarries were once located on the island[3].

Generally on Rhodes, two types of limestone could be extracted: the grey limestone of Lardos[4] and Kymisala[5], which was preferable for architecture, sculpture, and funerary monuments

1 Kokkorou-Alevras et al. 2012.
2 Poupaki 2024a, 277–280.
3 Kokkorou-Alevras et al. 2012, nos. 91–220.
4 Kokkorou-Alevras et al. 2012, nos. 102–105.
5 Kokkorou-Alevras et al. 2012, no. 101.

1 Map of the Dodecanesian Islands mentioned in the text (graphics: E. Poupaki)

(stelae, altars, etc.), and a kind of soft limestone or sandstone, which was often covered with stucco or mortar, and which was the commonest rock used as building stone in public and private buildings. As a matter of fact, panchina/panicia (formed by broken shells) and poros (formed without shelly fossils) limestone are the typical rocks of the island[6]. The quarry at Philerimos, where the acropolis of Ialysos lies, was opened on a hill, the upper part of which is dated to the Late Triassic and is formed by limestone with intercalations of chert, while panchina and poros also occur here[7].

The quarry was first located in 2018 during investigation of the archaeological site of Philerimos, the ancient acropolis of Ialysos, in order to determine the provenance of the building material of the Athena Polias and Zeus Polieus Temple at the invitation of Monica Livadiotti and Giorgio Rocco of Bari Polytechnic School. The rocky outcrop where the quarry was opened mainly consists of poros limestone, and it was levelled in order both to erect the temple and to exploit its rock as a building material for the construction, as a circular cutting may indicate. The levelled rocky surfaces are still visible beneath the krepis of the temple, whereas the deepest areas of extraction lie behind its western wall. Stepped and vertical extraction can be distinguished on a photograph from 1923 from the archives of the Italian Archaeological Expedition[8], where the deep quarry trench is depicted. This is not the limit of the excavation trench, but it is the quarried rock underneath the temple krepis where the Archaic votive deposit[9] had been found.

The quarry was extended to the north of the temple, whose western façade lines up with the quarry front. Quarrying also continued to the southwest of the temple and east of the Byzantine

6 Rice 1995, 401 n. 36; Higgins – Higgins 1996, 154 f.
7 Higgins – Higgins 1996, 155.
8 Livadiotti – Rocco 1996, 46 fig. 107; Rocco 2018, 24 fig. 25 b; Poupaki 2024b. Unfortunately, there are no published reports about this excavation, except from some sketches, see Benzi 1984, 94 fig. 1.
9 Martelli 1988; D'Acunto 2014.

2 Quarry at Philerimos, archaeological site, acropolis of Ialysos, Rhodes. Imprints of detached blocks east of the Byzantine underground chapel of Agios Georgios Chostos (photo: E. Poupaki)

underground chapel of Agios Georgios Chostos, where more quarrying traces can be detected, such as imprints of detached blocks, a carved plinth surrounded by the extraction channels (fig. 2) and a semicircular cutting. The surface in front of the chapel was also levelled as a result of the extraction. Scattered blocks and chipped stones built into a retaining wall are still visible. For the quarrying, a light quarry pick was probably used, marks from which can also be observed on the plinths of the western façade of the temple. The deepest quarry trench was behind the western temple wall, almost at its mid-length, and seven steps of 5 m in total height have been distinguished, which implies efforts by the temple constructors to avoid the surface quarrying of low-quality rock because of the erosion. That is, the stepped extraction of the material is due to the effort to exploit the best-quality rock, avoiding the superficial low-quality material.

Despite sufficient excavation evidence about the existence of an Archaic sanctuary on the site[10], the dating of the quarry cannot be considered of that period, but rather of Hellenistic date, the construction period of the preserved temple.

MARBLE QUARRY AT LARDOS ON RHODES

The grey marble quarried in Lardos (ancient Lartos) on Rhodes, the so-called Lartian stone, belongs geologically to Upper Jurassic and Lower Oligocene Kattavia flysch[11]. Marble had also been quarried at various sites between Lardos and Lindos, where there are crystalline limestones to marbles which belong to the Lindos unit and are partly of Cenomanian age[12]. Lardos's quarries have been investigated and studied by many scholars in the past[13], while the characterisation of their grey marble has recently been published[14]. A ›Lartian stone‹ quarry is situated at Lothiarika near Lardos, close to Artemis Cave, at a short distance from the coast[15]. It had been widely used

10 Maiuri 1928, 77 f.; Livadiotti – Rocco 1999, 109 f.; Livadiotti 2007, 723.
11 Mutti – Orombelli – Pozzi 1970.
12 Papanikolaou 2021, 153–155.
13 The full bibliography about the quarries is cited in Gavalas 2015, 118–121.
14 Papavassiliou et al. 2020.
15 The quarry is mentioned by Sørensen – Pentz 1992, 84 f.; Trantalidou – Valvis 2017, 949–951. We visited the quarry in 2019 during an autopsy with Foteini Zervaki, archaeologist of the Ephorate of Antiquities of Dodecanese, and Giorgos Valvis, archaeologist of the Ephorate of Palaeoanthropology and Speleology.

3 Quarry at Lardos, Lothiarika, Rhodes. Blocks with identical parallel quarry-pick striations, typical of the ancient extraction (photo: E. Poupaki)

4 Quarry at Lardos, Lothiarika, Rhodes. Circular lime-kiln (photo: E. Poupaki)

5 Quarry at Lardos, Lothiarika, Rhodes. Series of carved lines (hastes) and inscribed modern names on the chamber walls of the Artemis Cave (photo: E. Poupaki)

in modern times, based on the preserved tool-marks, as well as the preserved iron wedges. However, some extracted blocks preserve the identical parallel quarry-pick striations typical of ancient extraction (fig. 3). The site is full of chipped stones and blocks of various sizes, which have been used for the construction of four circular lime-kilns (fig. 4), where lime was produced using the remnants from marble extraction. These lime-kilns are probably contemporary, because they belong to the type of running or draw kilns, which are dated in the industrial period[16]. It is worth noting that the occurrence of lime-kilns on Rhodes Island is rather rare or totally unknown[17], which is why the Lardos lime-kilns are so important.

The nearby cave opens at the lowest part of the quarried rocky hill, which also preserves quarrying traces[18] and was probably enclosed by a low wall built with rubble masonry. It is named after the inscription Αρτέμιδι Σωτείραι[19] and the relief of Artemis (?), both carved on its entrance walls. The depicted goddess – totally unrecognisable nowadays – is holding torches and she is accompanied by a dog, which is why she was identified as Hekate by Friedrich Hiller von Gaertringen, who had also noted another inscription (Ροδίας)[20], as well as series of carved

16 Mastora 2019, 34–38.

17 There is no mention of lime-kilns in the doctoral dissertation of Evangellia Mastora, see Mastora 2019. Perhaps, the absence of lime-kilns on Rhodes Island can be explained by the lack of marble or suitable limestones for burning.

18 Trantalidou – Valvis 2017, 950 fig. 36.

19 Hiller von Gaertringen 1892; Sørensen – Pentz 1992, 84. See also Van Gelder 1900, 311.

20 IG XII 1, 915.

lines (hastes)[21] on the entrance and chamber walls of the cave (fig. 5), probably numbers of the extracted blocks from the above quarry. The deity Artemis Soteira was often worshipped in caves[22] (e.g. Drakaina Cave at Cephalonia[23], at Syracuse[24], etc.). The property of the goddess relevant to ancient quarries is associated with the treatment of human pain and the relief of the suffering labourers, many of whom died because of the hard work. On the other hand, Hekate – in her chthonic hypostasis – was also worshiped in caves[25], »the entrances to the nether world«, which is why she as was considered as the protector deity of the workmen with underground occupations (miners, quarrymen, etc.)[26].

POROS QUARRY AT THE ASKLEPIEION ON KOS

Kos belongs to the active volcanic arc of the Aegean Sea, and the western part of the island is volcanic. Not only the volcanic outcrops of the island (rhyolite and ignimbrite), but also various rock formations of Mt. Dikaios (marble, travertinoid limestones, and monzonite), which dominate the northeastern part of the island, were extensively exploited during antiquity and wrought important change in the everyday life of ancient Koans[27]. At the foot of Mt. Dikaios, the bedrock is formed by Neogene sediments like limestones[28]. »Antimacheia basin is formed by neotectonic structures, which are extended between the Kefalos Peninsula and the western slopes of Dikaios Mountain«, while the Asklepieion belongs to the »post-alpine structure, which is characterized by thick Miocene sedimentation«[29].

The quarry investigated is found in the ›holy wood‹ of Asklepios, in the vicinity of the Hellenistic temple[30], beyond the higher terrace of the Asklepieion. It was first located in 2014 at the suggestion of Wolfgang Ehrhardt of Cologne University. It is a quarry of a porous brownish or greenish marly limestone and consists of a rocky outcrop which had been levelled by the quarrying. On the preserved rocky surfaces there are several imprints of cut rectangular and cylindrical blocks surrounded by trenches (extraction channels), a few centimetres wide, formed by the digging of the quarry pick. The nature of the rock precluded preservation of the tool-marks on the quarry fronts, except for the parallel striations of the light quarry pick (fig. 6). The various extracted blocks are scattered all over the area, whereas a considerable part of the quarry remains unexplored beneath the vegetation of the site.

The rock extracted was probably used for the nearby Hellenistic temple, as well as for the foundation of Temple B in the middle terrace of the Asklepieion[31]. Therefore, it seems plausible that the quarrying activity is dated in the Hellenistic and early Roman period.

Both the quarries of the Asklepieion on Kos and of Philerimos on Rhodes are typical Classical and Hellenistic quarries of soft rocks, like various others in Rhodes, Piraeus, Corinth, Laconia,

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21 Trantalidou – Valvis 2017, 951 pl. 1. A series of carved lines on the quarrying surfaces is a common feature from the Archaic until the Roman period, see Kokkorou-Alevras et al. 2012, nos. 238. 474. 955. 1001.

22 In Classical antiquity, before their marriage, the young women visited a cave sanctuary of Artemis and offered her a sacrifice, see Håland 2018, 128.

23 Karadima 2021.

24 Sfameni Gasparro 1973, 123.

25 Håland 2017, 128 n. 436. Hekate was worshipped in Zerynthos Cave on Samothrace, see Lehmann 1975, 60.

26 According to certain scholars, Hekate's qualities were inherited by Saint Barbara in the Christian cult, who protects quarrymen, miners and labourers in mine shafts or tunnels and whose traditional pastry in Thrace is called »Hekatean Dinners« (Ἑκαταία Δείπνα), which recalls the bloodless offerings to Hekate at the beginning of the winter, see Papathanassi-Mousiopoulou 1979, 85. It is striking that in front of the entrance of the salt mine at Hallstatt (Austria), a statuette of St. Barbara, as the protector of the salt-miners, has been erected.

27 Poupaki 2011a, 38–44.

28 Higgins – Higgins 1996, 160 f.

29 Zananiri – Memou – Lachanas 2006, 411.

30 Morricone 1950, 327.

31 Observation of the geologist Kostas Mavrogonatos.

6 Quarry at the Asklepieion, ›holy wood‹, Kos. Quarry front with the parallel striations from the light quarry pick (photo: E. Poupaki)

and Crete[32]. In these quarries we find traces of the light quarry pick, the ›typis‹, whose flattened edge was used for the digging of the extraction channels, whereas the absence of wedge-holes can be explained by the soft nature of the stone, which allowed the block to be detached simply by striking the digging tool alone.

QUARRIES OF VOLCANIC ROCKS AT ARGOS ON NISYROS

Nisyros Island was formed by the volcanic activity of the Late Pleistocene. It is famous for the wide caldera of its volcano, which is a stratovolcano, characterised by a caldera and post-caldera domes. The recent eruptions in the 19th century caused phreato-magmatic explosions towards the bottom and in the walls of the caldera and partly formed the geological substructure of the island[33] (andesites, rhyolites, rhyo-dacitic lavas, etc.). Its underground quarries at Argos and Avlaki were explored and mentioned by many scholars in the past[34], while the »Hellenic Authority

32 Rhodian quarries (e.g. Kallithea, Archangelos, Lindos, etc.) and the quarries of Piraeus, Corinth (Kleonai and Examilia), Laconia (Viglafia), Kythera (Avlemonas and Feloti) and Crete (Falasarna, Stavros Akrotiriou and Almyrida Apokorona) also exhibit the same features, see Kokkorou-Alevras et al. 2012, nos. 150. 92–94. 105–112. 760–939. 634. 627–629. 689. 238. 240. 420. 417–418. 402.

33 Papanikolaou 2021, 325.

34 For a short discussion about the history of the research, see Poupaki (in print).

7 Underground quarry at Argos, Nisyros. The stoa with the walls consisted of black lava rubble blocks (photo: E. Poupaki)

of Geological and Mineral Surveys«[35] explored an underground quarry at Argos, which produced ›millstone lava‹, a special rock for the carving of mills[36].

The Nisyrian mills were renowned in antiquity, judging from the epigrams of the »Anthologia Graeca«[37] and the citation from Strabo[38]. That is why our research has focused on the provenance of the material of hand mills from ancient Halasarna (modern Kardamaina) on Kos since the early 1990s. Several geochemical analyses on volcanic rocks of Kos and Nisyros, as well as on samples of mills from Halasarna have been undertaken. At first, instrumental neutron activation analysis (INAA) was applied, but the results were insufficient[39]. Therefore, some years later, different archaeometric methods were tried; inductively coupled plasma-mass spectroscopy (ICP-MS), X-ray diffraction (XRD) and scanning electron microscopy (SEM)[40] finally proved that the Classical and Hellenistic Olynthian querns (hopper-rubbers)[41] were carved in the volcanic rock of Argos, and the early-Byzantine rotary querns in the volcanic rock of Peleketa and Kastelli quarries from the Kefalos Peninsula on Kos[42]. This evidence triggered an intense exploration of the area of Argos in order to locate the exact quarrying sites.

After a thorough investigation by a team from Athens University between the Karaviotis and Trapezina volcanic domes[43], an ancient open-air quarry was found in Argos. The quarried rock was black aphanitic lava and its petrography and geochemistry have been studied thoroughly[44]. Fragments and chips of the quarried volcanic stone, extracted blocks, half-finished and finished ›Olynthian‹ mills are abundant there, while wedge-holes (probably for wooden wedges), a square cutting (maybe for the insertion of a wooden pole and the retention of carried stone-products with ropes) were observed. The existence of pressing beds carved in the same stone from the site proves the variety of agricultural or household implements produced.

35 Former Institute of Geological and Mineralogical Research (IGME).

36 Vougioukalakis – Theodosiou 2012, 29 map p. 28 (Γ).

37 They are dated in the Late Hellenistic period; one epigram (Anth. Gr. 9, 418) mentions Νισυρίων κοῖλα βάρη μυλάκων (»heavy concave millstones of Nisyrians«) and another one (Anth. Gr. 9, 21) by an anonymous author βάρος πέτρης Νισυρίτιδος (»the weight of Nisyrian rock«), see Paton 1915.

38 Strab. 10, 488–489.

39 V. Kylikoglou in: Poupaki 2011a, 113–119.

40 Katerinopoulos et al. 2016; Katerinopoulos – Mavrogonatos – Poupaki 2017.

41 Poupaki 2011b, nos. 31–35; Poupaki 2017, 82; Poupaki 2020, 92 f.

42 Katerinopoulos et al. 2016, 270. 272.

43 Since 1995, several surveys have been conducted on the island by the writer, to localise extraction sites of volcanic rocks suitable for mills. In 2013, a research team, which consisted of Athanassios Katerinopoulos, now professor emerita of petrology at the Geological Department of Athens University; Konstantinos Mavrogonatos, now assistant professor at the Department of Earth Sciences at Pisa University; and the writer, as a scientific collaborator of the excavation at Kardamaina, explored the eastern and southern part of Nisyros.

44 Katerinopoulos et al. 2016; Katerinopoulos – Mavrogonatos – Poupaki 2017.

Some years later, during an autopsy by the Ephorate of Palaeoanthropology and Speleology[45], an underground quarry of basalt-andesitic lava[46] was found close to Rallis's deserted sulphur factory on the road to Agia Eirene. That is probably the underground quarry mentioned by Richard M. Dawkins and Alan J. B. Wace[47]. The opening of that stoa can be noticed in the lowest part of a retaining wall. The underground gallery is carved in soft pyroclastic rock. The depth of the highest part of its ceiling is approx. 1 m below the ground level, while its dimensions are as follows: width 1 m; height 2 m (fig. 7). The ceiling is semicircular or pointed, and the walls of the gallery consist of black lava rubble blocks and assure the safety of the structure and that the ceiling will not collapse. The track of the gallery is not straight; it leads to a square room, where rubble material from the extraction seals the tunnel. Niches were opened in the walls, probably in order to widen the passage in case two workers, moving in opposite directions, came across each other. The same niches were detected at the Avlaki underground gallery.

The underground quarry at Avlaki has also been well documented by many scholars. Ludwig Ross, who had visited it, was the first, but later others followed[48]. However, it was impossible to relocate it, because nowadays its entrance is sealed by the rubble from the collapsed buildings at the harbour of Avlaki, behind which it was opened.

Argos was a significant ancient polis of Nisyros, where the ancient sanctuary of Poseidon Argeios is considered to be located[49]. Its acropolis was at Palisia[50]. More subterranean quarries are found in the proximity of Argos. Not far from them, the remains of a defensive net of towers at Diavatis, Lefkos and Kateros (site Pyrgoi) can be found[51], and this was expanded on the neighbouring islets, Pergoussa[52] and Pacheia[53], and belonged to the defensive programme of the Hekatomnids in the late 4th century, given that Nisyros was part of the Mausolus' state together with Rhodes and Kos. Drakospilo (»Dragon Cave«) at Lefkos Cape was erected above a cave, which could provide lodgings for the guardians of the tower[54]. It remains unclear whether these were also the supervisors of the nearby quarries, given that close surveillance of the quarrying areas was required for smooth operation of the quarrying activities and secure shipping of the quarried products.

The Nisyrian millstone industry, dated from the Late Classical period onwards and based on the exploitation of local volcanic lava, guaranteed the stable production of household implements of everyday use and high commercial value (mills, the beds of oil presses, big mortars, etc.)[55].

QUARRIES OF VOLCANIC ROCK ON PERGOUSSA ISLET

Pergoussa, Pacheia, Agios Antonios, Stroggyli and Gyali are small volcanic islets close to Nisyros, which were created after the volcanic explosions of the wider area of Nisyros, at the eastern

45 For the information cited here, I would like to thank Georgios Valvis, with whom we visited the quarry in 2018, as a research team of the Ephorate of Palaeoanthropology and Speleology.

46 The petrography and the geochemical study of the samples were conducted by Konstantinos Mavrogonatos and they are going to be published shortly.

47 Dawkins – Wace 1905, 170.

48 Ross 1843, I 69. 79; see also Bean – Cook 1957, 119; Runnels 1981, 92 f.; Giannidi 1987, 122. George E. Bean and John M. Cook were also aware of »a millstone quarry on the beach below Nikia«, which probably refers to Avlaki quarry, see Bean – Cook 1957, 119; Angelina Dworakowska mentioned it in her monograph »Ancient quarries of Greece«, see Dworakowska 1975, 65. 155.

49 Filimonos 1993, 141.

50 Ross 1843, II 79; Giannidi 1987, 121; Koumentos 1994, 46. Ancient architectural parts are visible in the masonry of the chapel of Timios Stavros, see Lazaridis 1953, 240; Tsirpanlis 1990, 22–30.

51 Papachristodoulou 1993, 41 n. 14; Filimonos-Tsopotou 2013, 154 f.

52 Filimonos-Tsopotou 2013, 155 f.

53 The tower is unpublished, and we visited it in July 2020, during our survey of the islet with Georgios Valvis.

54 The information about Drakospilo and the published photos are owed to the former guardian of antiquities at Nisyros, Georgios Sakellaridis, to whom I am really indebted.

55 Poupaki (in print).

8 Pergoussa Island. Outcrop of andesite, vertically carved, with three succeeding extraction levels close to the ancient tower (photo: E. Poupaki)

end of the volcanic arc. Pergoussa and Pacheia, west of Nisyros, belong to the Nisyros Group[56] and they consist of volcanites[57], which were exploited in antiquity. In particular, »Pergoussa forms a volcanic cone with a small crater of a few hundred metres diameter«[58]. At Pergoussa[59], Ludwig Ross had already discovered two Hellenistic isodomic towers in 1841. During an autopsy in 2020, the ancient quarry of reddish andesite[60] for the erection of two towers was found. It is located on a low hill between the two towers, where the imprints of the extracted blocks surrounded by extraction channels are still preserved. There is another outcrop of andesite, though, which had been vertically carved with three succeeding extraction levels still visible; each of them corresponds to the extraction of a series of plinths (fig. 8). In the southern part of the islet, two rocky hills formed by andesitic lavas were also lowered by quarrying, whereas bare outcrops were probably formed by the modern extraction.

56 Papanikolaou 2021, 324 f.
57 <https://nisyros.igme.gr/index.php/geology/> (15.07.2013).
58 Nomikou et al. 2021, 10.
59 Plin. nat. 5, 127.
60 The identification of the rock is due to Konstantinos Mavrogonatos.

9 Pacheia Island. Vertically quarried rocks with an extraction channel close to the ancient tower (photo: E. Poupaki)

QUARRY OF VOLCANIC ROCK ON PACHEIA ISLET

Pacheia Islet, 4 km west of Nisyros, is hardly accessible because of its sheer cliff coasts, the result of its geological formation; it represents a volcanic dome with steep flanks and pumice deposits on its top[61]. During the recent autopsy to the north of the Hellenistic tower and its adjacent buildings, several outcrops of andesite[62] were found. The volcanic stone had been extracted superficially for the erection of the nearby buildings. Detached blocks with parallel striations from a quarry-pick, wedge-holes, extraction channels, and vertically cut rocks were noticed (fig. 9). The abundance of the fragments and quarry chips all over the islet as far as the shore enabled the erection of the nearby buildings, without quarrying, and the probable transfer of the stone material in boats to neighbouring areas. According to one hypothesis, which needs further investigation, the volcanic rock of Pacheia and Pergoussa was also used for the carving of mills[63].

QUARRIES OF MARBLE ON LEVITHA ISLET

Levitha[64] is on the marine route between Amorgos and Leros. The island belongs to the Amorgos unit on the southeastern edge of the Cycladic metamorphics[65]. Its quarry of grey coarse-grained

61 Nomikou et al. 2021, 10.
62 See previous note.
63 <https://www.geodifhs.com/kappaomegaiotaalpha/pyrgousa> (7.06.2023).
64 Strab. 10, 5, 12; Ov. ars 2, 79–82; Ov. met. 8, 220–222.
65 Papanikolaou 2021, 162.

10 Levitha Island. General view of the quarry (photo: E. Poupaki)

marble, known ever since 1688[66], was in use until 1950. The quarried marble was in use in antiquity, as demonstrated by the fact that there are blocks for the Hellenistic fortification at Kastro in the modern quarry. Unfortunately, modern extraction left no ancient traces, but only huge piles of quarrying chips and fragments. Modern quarrying fronts are quite high and several tens of metres long (fig. 10). Scattered ancient quarrying traces can also be seen on the rocky fortified hill of Kastro, where the ancient acropolis of the island lay.

Levitha marble must have been used in the early Byzantine period for the carving of architectural parts, which were transferred to nearby islands, such as Leros and Nisyros[67].

EPILOGUE

Closing our short presentation about these quarries, there is no doubt about the superior skill of the Dodecanesian quarrymen and carvers, who managed to exploit much of the available rock on their islands. The ascertained imports of raw materials from the Carian territory on Kos, after the island's synoecism (377 BC)[68], may insinuate the possible moving of craftsmen from nearby Caria to the Dodecanesian Islands, who transferred their knowledge and skills to Dodecanesian inhabitants. The evidence from Kos demonstrates the strengthened ties with Caria during the first half of the 4th century BC, in the age of the Hecatomnids. Even if it is daring to suggest similar Carian implication in the establishment of specific stone industries in other subjugated

66 Dapper 1688.
67 Katsioti – Papavasileiou 2002, 137 f.
68 La Buff 2016, 53 n. 151; Poupaki 2021, 149 f.

cities without sufficient evidence, it may nevertheless be argued that the Dodecanesians borrowed technical skill and the necessary know-how for digging up their open-air or subterranean quarries from their neighbours, the Carians[69].

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[69] Carpenter – Boyd 1977.

[70] Kokkorou-Alevras et al. 2012.

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QUARRY INSCRIPTIONS, MARKS AND EPIGRAPHIC SIGNS FROM THE ROMAN FORUM, THE PALATINE HILL AND THE TEMPLE OF PEACE IN ROME

Abstract
New quarry inscriptions, marks and epigraphic signs were identified in the central areas of ancient Rome, providing new data on marble supply for the monumentalisation of this sector of the city. These testimonies are engraved on unworked marble and architectural elements in white and coloured marbles. There is one case in which the stone is Lapis Tiburtinus. For many of these artefacts the place of discovery is unknown and the current location does not help to identify the original monument to which they belonged. The inscriptions are short, often incomplete, with a marble trade control form. There is a prevalence of numerical indications, single letters or signatures composed of a few letters. The clearly recognisable names are the consul Augurino, to be identified with the magistrate of AD 132 already known from numerous other inscriptions, and the servant Hilaro, mentioned for the first time among the personnel active in the Pavonazzetto quarries.

The central archaeological area of Rome has always been of great interest in relation to the trade of ancient marble given its ancient historical, political and religious functions and the involvement of important patrons, especially imperial ones. Over the centuries, historical events have greatly altered this reality, with acts of plundering and unearthing, accumulated fills, dispersion of the material and its fragmentation to be reused or intended for lime-kilns. However, it is still possible to explore the methods of supply, distribution and circulation of ancient marble.

This contribution is dedicated to a series of quarry inscriptions, marks and epigraphic signs, often unclear but occasionally identified, in the areas of the Roman Forum, the Palatine Hill and the Templum Pacis. These are mostly unpublished testimonies, engraved on unworked marble, architectural elements and slabs. The materials used are mainly white marbles, whereas coloured marble is rarely found. Travertine was uncovered in just one case[1]. For many of these artefacts the place of discovery is unknown[2], and given their movement over time, the current location does not help to identify the original monument to which they belonged. Despite these hindrances, the inscriptions provide new data on marble supply for the monumentalisation of the central area of ancient Rome, scene of the imperial propaganda par excellence.

CATALOGUE OF ARTEFACTS

The catalogue includes 22 artefacts. Most are in white marbles, with 13 specimens in Luna marble (nos. 1–13) and two in white fine-grained marble (nos. 14–15). It also comprises other specimens in coloured marbles with samples in the Bigio of Lesbos (no. 16), in Bigio from Teos (no. 17), in

1 With the exception of one marble artefact from Teos, for which archaeometric analyses have been performed, the identification of stone quality is based on autoptic analysis, which is often hindered by the presence of encrustations and black patinas on the surfaces of the artefacts.

2 Most of the materials were found during intensive excavations conducted between the 2nd half of the 19th cent. and the 1st decades of the 20th cent., when the remains of the main monuments of this city sector were brought to light. The documentation produced in those years does not always allow us to trace information back to individual finds.

1 Roman Forum. Parallelepiped blocks in Luna marble (cat. 1–3) (photos: S. Violante)

African (no. 18) and Pavonazzetto marble (no. 19) and in pink granite (no. 20). There is one case in which the stone is an unspecifiable coloured marble (no. 21). The catalogue ends with an artefact in Lapis Tiburtinus (no. 22). Each card lists the identification of the object, the type of stone, the current location, the dimensions, a brief description of the artefact and an analysis of the inscription.

Luna Marble

1. Squared Block in Luna Marble (fig. 1)

Roman Forum, Basilica Julia. 174 × 60 × 56 cm. H of letters 19/21 cm.

Parallelepiped block, fractured at one end. The surfaces are partly rough-hewn, partly worked with a toothed and a flat chisel. On the upper surface, which is roughly hewn and bears wide recesses of irregular shapes, part of an inscription engraved at the fractured end remains. It reads:

DASXX

The exceptionally large size of the letters and the inaccurate italic ductus are distinctive. At the moment, the meaning of the letters preceding the numeral is unclear[3].

[3] A similar sequence of letters occurs in two more detailed inscriptions engraved on quarry blocks of African marble, where the Dasumius Rusticus consulate of the Hadrianic era is explicitly indicated, see Baccini Leotardi 1989, 8–10 nos. 5–6 tabs. 10. 12 fig. 3.

2. Squared Block in Luna Marble (fig. 1)

Roman Forum, Basilica Julia. 188.5 × 55 × 52.5 cm. H of letters 3.5–6.5 cm.

Parallelepiped block, nearly complete, with the surfaces partly hewn and partly finished with a toothed chisel.

On one of the surfaces characterised by two deep quadrangular recesses, the following inscription, engraved close to a margin, stands out:

B XVI

The size of the B is especially small compared to the numeral that follows[4].

It is not clear whether the five parallel strokes, which can be seen in another part of the same side of the block and orthogonal to the aforementioned inscription, are to be understood as a further indication.

3. Architectural Element (Probably) in Luna Marble (fig. 1)

Roman Forum, atrium of Santa Maria Antiqua. H 43.5 cm, L 166 cm, T 59.4 cm. H of letters 3.5 cm.

Parallelepiped architectural element, fractured at one end. The current upper surface is divided lengthways into three parts, of which the central one is roughly hewn. One of the sides is worked with a toothed chisel and is topped by a thin frame of smooth mouldings; it formed the main side of the original element. The opposite side has been reworked as a threshold, creating a long groove and a recess for the hinge. There are also two additional quadrangular recesses, one of which was made by partially damaging the following engraved inscription:

ARD

The inscription does not compare to any other currently in our possession[5].

4. Rough Block in Luna Marble (fig. 2)

Roman Forum, from the marble stack of the area behind the Curia Iulia, at the limit of Caesar's Forum. 37 × 33 × max. 15 cm. H of letters 9.5/10.5 cm.

Small rough-hewn parallelepiped block, fractured on two sides. The following inscription is engraved on one of the worked surfaces:

AGR *hedera distinguens* A

The inscription can be compared to the initial part of two lengthier epigraphic texts found on two rough blocks recovered from the Tiber in 1772[6]. These blocks are made of fine white marble, that could be identified as Parian or Luna marble[7]. In the latter case, it would be the same stone as the block in question. According to L. Bruzza, the first three letters could refer to the name of

4 The letter could also refer to *bracchium*, cf. Pensabene 2015, 463. 518.

5 Similar abbreviations with a different letter sequence occur for instance on a block of Cipollino marble on which the abbreviation RDA can be seen (Bruzza 1870, no. 1) and on a column drum in Luna marble found in the marble load of the wreck of Séte, where ADR can be read (Pensabene 2015, 485).

6 Poch 1773; Bruzza 1870, 163. 193 nos. 282–283; Dubois 1908, 114 nos. 273–274; Hirt 2010, 444 nos. 1267–1268. The following inscriptions are reported by A. M. Hirt (2010): no. 1267 = AGR AUG Do(mitiani) XX | III A NV ΛAC; no. 1268 = AGR AUG Do(mitiani) DESA | NN XXXV ΛAC.

7 L. Bruzza (1870, 163) refers to Parian or Luna marble, while C. Dubois (1908, 114), citing Bruzza, seems to favour Luna marble. A. M. Hirt (2010, 444) seems to hesitate between Parian marble or another white marble, possibly from Greece.

2 Roman Forum. Rough or squared blocks in Luna marble (cat. 4–6) (photos: S. Violante)

a servant of an Augustus (of an emperor), perhaps an Agrius or Agraulus. Based on this example, in the present text we propose supplementing the final A, followed by a block break, with AUG.

It should be noted that the letters AGR or ACR were also found on some fragments of columns made of alabaster unearthed in Ostia and Rome. They were either engraved on the stone or imprinted on built-in lead stamps on the shafts[8]. The presence of *hedera distinguens* used as separation, uncommon on quarry inscriptions, can also be found on a block of a smooth Ionic cornice in Luna marble of the Basilica Ulpia at Trajan's Forum[9]. The attribution of the inscription to the world of quarries and the marble trade remains hypothetical.

5. Rough Block in Luna Marble (fig. 2)

Roman Forum, portico in front of the Basilica Aemilia. H 23 cm, L (total) 60 cm, D 58 cm. H of letter 22 cm.

Parallelepiped block, damaged on the upper side and on one side. One side is not visible, as it is leaning against a marble pedestal. The remaining surfaces are rough-hewn. On one of these, the following large letter can be seen:

X

The block is found employed in a late or post Roman structure.

8 Baccini Leotardi 1979, 27. 40 nos. 89–90; Pensabene 1994, 113–115 n. 48; 200 n. 10.

9 Milella 2002, 549 n. 322; Pensabene 2015, 505. It is assumed that the inscription was originally engraved on the quarry face.

6. Architectural Element in Luna Marble (fig. 2)

Roman Forum, near the Temple of Romulus[10]. 76 × 49 × 42 cm. H of letters 6/7 cm.

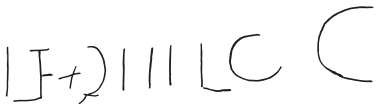
Parallelepiped block presumably intentionally fractured on one side, given two aligned partially preserved recesses, probably wedge holes. The surfaces are mainly worked with a toothed chisel. On one of the sides, characterised by a slightly lowered hewn strip and containing various quadrangular recesses, some of which are deep and large, the following numerical sequence can be seen:

XIIII

7. Podium Cornice in Luna Marble (fig. 3)

Roman Forum, Temple of Castor and Pollux[11]. Inv. 23348. 214 × 150 × 64 cm. H of letters ca. 3.5/4 cm.

Cornice pertaining to the crownwork of the temple podium, with smooth mouldings at the front, unpolished laying surfaces and sides, and damaged rear. On the upper surface, there are several incisions and small cavities, often difficult to read and which are yet to be understood[12]. Among these is an inscription, currently completely illegible due to the worn state of the letters. Based on a photo dating back to 1983[13], they seem to spell out:



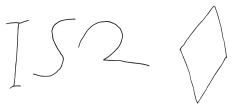
It is unclear whether, other than the nexus between the letters T and F[14], there was an additional letter in ligature to which the lower horizontal stroke immediately preceding the T might belong. The numeral followed by Loc(o) could suggest that the text is attributable to the quarry organisation. On the same side of the block, other engraved signs of unclear meaning can be seen, including what appears to be a pair of rectangles[15].

8. Modillion Cornice in Luna or Pentelic Marble (fig. 3)

Roman Forum, Basilica Julia. Inv. 409184. H 29 cm, L (max.) 60 cm, T 59.5 cm. H of letters 10 cm; H of rhombus 13.5 cm.

Small modillion cornice, fractured on one side. The surfaces are so worn that the sequence of mouldings and decorative motifs are unrecognisable.

On the preserved side with the unfinished surface, the following epigraphic signs remain:



[10] Another quarry inscription (PE R XR) was found in this same area. In this regard, see Pensabene 2015, 494 with previous bibliography.

[11] Another quarry inscription with numerals (IIIDCCCCLXII), engraved on the rear of a base, is reported by P. Pensabene (2014, 46) near the Temple of Castor and Pollux.

[12] The podium cornice was published by S. Sande as part of the results of a systematic study conducted on the Temple of Castor and Pollux, see Sande 2009, 121 f. tab. 3, 5.

[13] The image was kindly provided by Siri Sande and Manula Michelloni of The Norwegian Institute in Rome.

[14] Cf. Pensabene 2015, 498. 517. More commonly attested is the ligature between E and T on some inscriptions on artefacts in Pavonazzetto and other stone types, see Bruzza 1870, nos. 257. 279. 297; Bruno 2010, nos. 8. 76–77. In this case, the lack of the lower stroke of the E seems to hint at an F.

[15] The drawing recalls the drawing reported by L. Bruzza on a boulder of Cipollino marble, see Bruzza 1870, no. 46.

cat. 7

cat. 8

cat. 9

3 Roman Forum. Cornices in Luna marble (cat. 7–9) (photos: S. Violante)

4 Roman Forum. Pulvino (cat. 10) and composite column bases in Luna marble (cat. 11–13) and white fine-grained marble (cat. 14–15) (photos cat. 10. 14: Parco archeologico del Colosseo; photos cat. 11–13. 15: S. Violante)

9. Corner Cornice in Luna Marble (fig. 3)

Roman Forum, Basilica Julia. Inv. 408969. H 70 cm, dimensions 102 × 116 cm. H of letter 7 cm.

Smooth moulded cornice made on two adjoining orthogonal sides. On the smooth lower surface, where there are three small quadrangular recesses, the following engraved letter can be seen:

A

10. Pulvino in Luna Marble (fig. 4)

Roman Forum, Basilica Julia. Inv. 408962. H 15 cm, dimensions 63 × 55 cm. H of letters 7 cm.

Quadrangular slab with oblique cut sides, which confers the artefact the appearance of a Pulvino. The surfaces are worked with a toothed chisel. On the upper surface, in addition to the remains of a recess, there are two letters engraved with some distance between them:

X D

11. Composite Column Base in Luna Marble (fig. 4)

Roman Forum, atrium of Santa Maria Antiqua. H 37.5 cm, plinth sides (max.) 50 cm. H of letter 4.5 cm.

Fragment of a composite base with plinth, two *tori* separated by a *scotia* framed by *listellos* embellished by an astragal. On one side of the plinth, in no particular central position, we can distinguish:

C

12. Composite Column Base in Luna Marble (fig. 4)

Roman Forum, Basilica Julia. H 43 cm, Dm ca. 64 cm. H of letters 2.5 cm.

Composite base with plinth, lower *torus*, double *scotia* separated by a *listello* surmounted by two astragals and an upper *torus*. The base is worked together with the lower scape of the shaft, on which the following numeral is engraved:

VIII

13. Composite Column Base in Luna Marble (fig. 4)

Roman Forum, Basilica Julia. H 34 cm, Dm 76 cm. H of letters 3.5/4 cm.

Composite base similar to the previous one, but without the lower scape of the shaft. It is probably composed of three fragments currently juxtaposed. On the upper side of a fragment, on which we can see a quadrangular cavity with a groove in which to pour the lead, the following numeral is engraved:

XXIIII

It is unclear whether any marks on one of the other fragments relate to a further inscription.

White Marble

14. Composite Column Base in White Fine-grained Marble (fig. 4)

Roman Forum, Basilica Julia. Inv. 408932. H 31 cm, Dm 88 cm. H of letters ca. 2.5 cm.

Composite base similar to the previous one, but with double *scotia* separated by a *listello* surmounted by one astragal. On the concave surface of the lower *scotia*, the following numeral is engraved:

XIII

15. Composite Column Base in White Fine-grained Marble (fig. 4)

Roman Forum, Basilica Julia. H 29 cm, Dm 66/67 cm. H of letters 3.5 cm.

Composite base similar to cat. 13. On one side of the plinth, the following is engraved:

HPω

It is probably the abbreviated signature of a Greek stonemason or the names of the head craftsman[16].

Bigio from Lesbos

16. Fluted Shaft in Bigio Marble, Presumably from Lesbos (fig. 5)

Roman Forum, Portico Dii Consentes. H (max.) 218 cm, Dm of echinus ca. 50.5 cm. H of letters 2.5 cm.

The largest part of a fluted shaft including the upper scape is preserved. On the upper side, finished with a toothed chisel and provided with a cavity with a groove into which to pour the lead, the following inscription is engraved:

[16] See Bianchi – Bruno – Pike 2015, where the signatures are interpreted as the names of the head craftsman of a workshop rather than as the signature of a stonemason.

cat. 16

cat. 17

5 Roman Forum. Fluted shaft in Bigio from Lesbos (cat. 16); Palatine Hill. Rough column in Bigio marble from Teos (cat. 17) (photos: S. Violante)

DIOG (or C)

The inscription, presumably an abbreviated name, is engraved accurately and harmoniously. As affixing quarry inscriptions on the Bigio artefacts of Lesbos is not attested[17], it seems more likely to be related to the finishing of the shaft.

17 Pensabene 1998, 177; Pensabene 2014, 43.

The findings in the area of further rudented column shafts, in the same stone and of similar dimensions, makes it possible to attribute the shaft in question to the rudented type. The use of Bigio marble in Rome from the late 1st century AD onward provides a terminus post quem for dating the inscription.

Bigio from Teos

17. Rough Column in Bigio Marble from Teos[18] (fig. 5)

Palatine Hill, »Horti Farnesiani«, Domus Tiberiana area. H (max.) 33 cm, Dm (max.) 60 cm. H of letters 5 cm.

Rough column shaft, partially preserved, with scape separated from the shaft through two parallel incisions that define a strip[19]. An orthogonal plane is attached to the curvilinear surface, and was made at the same time as the shaft, given the similar workmanship of the surface.

On the preserved laying surface, the following part of an inscription remains:

R S ERNLIII
[…]R SER(vi) N(umero) LIII

The first preserved letter, preceded by a fracture, is probably related to the servus's name[20]. We note the orderly progress of the inscription and the regular engraving of the letters. The inscription is included in those already attested on the Palatine Hill[21].

African Marble

18. Stepped Parallelepiped Block of African Marble (fig. 6)

Roman Forum, area between the Temple of Castor and Pollux and the Imperial Palace. L 142 cm, W 104 cm, T 50 cm. H of letters 8/9 cm.

Rough parallelepiped block, medium-sized. The surfaces are rough-hewn. Save the rear side and a side with a vertical cut, the remaining sides are worked in steps of different sizes and heights[22].

On the rear side[23] is an inscription that is difficult to distinguish due to the advanced deterioration of the letters[24]. At the moment, we can see:

N LXVI

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18 The identification of the marble, which had been speculated throughout visual analysis, was confirmed by archaeometric analyses carried out by Domenico Poggi.

19 H (bottom part) 15 cm; H (strip) 4.5 cm. For the type of artefact, see e.g. Pensabene 1994, 53 nos. 1–2 figs. 57–58; 133 no. 85 fig. 179.

20 One could also think of the expression Caesar(is) serv(i). However, in this case, the abbreviation of Caesar would be anomalous compared to ascertained cases, where the epigraphic forms CAES or CAE tend to occur.

21 See e.g. the inscription on a Tuscan capital in Luna marble at the Hippodrome mentioning the consul Tertullus and that on a frame of the Flavian era in Luna marble from the Domus Transitoria, on which the epigraphic text refers to Tiberius Claudius, see Pensabene 2015, 495. 504.

22 Starting from the front side, two sets of steps can be distinguished. The one on the right has a first L-shaped angular step (H 20 cm, sides 55.5 × 13.5 × 28.5 cm), a second rectangular step (H 12 cm, sides 35 × 31.5 cm), and a third step (H 19 cm) that reaches the upper floor. The second series on the left consists of a sequence of rectangular steps, of which the first is of reduced dimensions (H 27.5 cm, sides 45 × 8.5 cm), the second is wider (H 10 cm, sides 45 × 39.5 cm) and a third (H 12 cm) rises to the upper floor.

23 This refers to the side currently facing the structures of the Imperial Palace, nearly leaning against them, which hinders the reading of the text.

24 Currently, the block is covered with black crusts due to outdoor exposure, which strongly obstructs the reading of the marks.

cat. 18

6 Roman Forum. Stepped parallelepiped block of African marble (cat. 18) (photos: S. Violante)

It is not entirely clear whether the N has a curved sign with a bump facing inwards at the top of the second upright ( )[25]. This element has already been attested in other inscriptions, both identically[26] and with a reverse protrusion, facing the exterior of the letter[27]. The meaning of this sign, followed by a numeral, is not entirely clear.

The present inscription has already been described by P. Pensabene, who reports the following transcription: »NLXVI« – »N«[28]. This last letter has not been traced at the moment, perhaps due to the current state of the artefact, which is covered with black crusts.

Pavonazzetto

19. Framing Element in Pavonazzetto (fig. 7)

Temple of Peace[29]. H 8 cm, L 98.5 cm, T 11 cm. H of letters 4/6 cm.

Framing element with smooth mouldings, composed of two matching fragments and preserved in its complete length. The short sides are finished with a flat chisel, while the laying surface is roughly smoothed. On the hewn rear side, the following inscription can be read:

[…]ROB HILARO SER(vo) LOCO

There are evident traces of rubrication. The R placed at the beginning of the text was certainly preceded by at least one other letter, of which only a short straight stroke relevant to the lower end is preserved, slightly oblique and rubricated[30]. This letter was truncated upon the realisation of the framing, since the mark is seen close to one of the sides that was made then. This initial gap could be supplemented with a P by restoring the form *probante* + name and social status expressed in the ablative. It is a form used in other quarries to indicate the quality inspection probably carried out on the blocks[31]. The name of Hilaro recalls the *libertus* of the same name active in the quarries of Luni, but in this case we are dealing with a different character, given the different area and time he belonged to[32]. The frame was attributed to the restoration of the building in the Severian era[33].

The mention of *locus* in the ablative, documented in the quarries of Dokimeion from around AD 140 onwards[34], circumscribes the dating of the epigraph between the age of Antoninus Pius and the Severan age.

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25 Such an incision seems to be visible in particular lighting conditions, but it could also be the effect of the working marks on the surface and of the poor state of conservation.

26 The sign occurs e.g. on some blocks found in the Fiumicino canal in African marble, Pavonazzetto or in marble of uncertain type, see Baccini Leotardi 1989, nos. 8. 14. 16. 42–43. 130. See also the cases reported by P. Pensabene on marble blocks from Teos, see Pensabene – Lazzarini 1998, 148–150 nos. 2. 9. 20. 33. For another specimen, see Mari 2015, 222.

27 See e.g. a block of onyx and one of Cipollino marble found in Ostia, Baccini Leotardi 1979, 27 f. n. 92 tab. 3, 5; 19 no. 47 tab. 12, 2.

28 Pensabene 1998, tab. 19 fig. 1.

29 Another quarry inscription with a numeral (LI) was found in this same area, engraved on a base in Luna marble, see Pensabene 2013, 38 fig. 21.

30 The preserved trait enables us to exclude the possibility of a curvilinear letter.

31 Cf. e.g. some inscriptions on artefacts in Cipollino marble and Imezio marble (Bruzza 1870, nos. 1. 4–5. 292), where, however, the activity of a freedman rather than of a servant, is referred to. As regards the *probator*, see Bruzza 1870, 127 f.; Dubois 1908, XXXII–XXXIII. The author recalls that in the case of Pavonazzetto quarries, other abbreviations seem to refer to an inspection activity, such as *repr(obatum)* and *r(ecognitum)* or *r(ecensitum)*, the latter shortened to both R and R, see Dubois 1908, 85.

32 Pensabene 2013, 19; Pensabene 2015, 455. See also Mari 2015, 222.

33 For the restoration works carried out on this monument in Severian times, see Fogagnolo – Rossi 2010.

34 Pensabene 2011, 96 f.

7 Templum Pacis. Framing element in Pavonazzetto (cat. 19) (photos: S. Violante)

Pink Granite

20. Smooth Column Drum in Pink Granite (fig. 8)

Roman Forum, near the so-called Temple of Jupiter Stator. H 46.5 cm, Dm 78.5 cm. H of letters 8.5 cm.

Large column drum with finished surfaces. On the surface of the shaft are two opposing quadrangular recesses and the following engraved inscription in a vertical trend:

LOCCLXX\ (part of a V [?])

The inscription adds to those already known from the Roman Forum on artefacts in Egyptian granite[35].

Coloured Marble

21. Marble Paving Slab Veneer (fig. 8)

Roman Forum, Basilica Aemilia. Found in bibliographic and archival sources.

Marble paving slab veneer of the central nave floor of the Basilica Aemilia, dislocated in 1946 during the excavations conducted by P. Romanelli and G. Carettoni in the west sector of the channel of the Cloaca Maxima that crosses the area below the Augustan building[36]. On the coarse rear, the following inscription is reported, mentioned by Carettoni and transcribed in the archives[37]:

AVCURINCOS
Augurin(o) Co(n)s(ule)

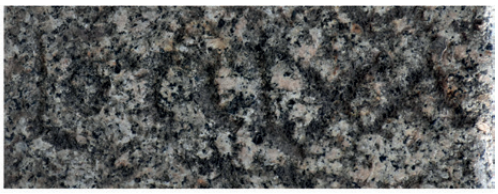
The magistrate referred to could be C. Serius Augurinus, who was consul in AD 132 with C. Trebius Sergianus or the consul of the same name who held office with M. Ceionius Silvanus

35 Two inscriptions engraved on the upper side of two column shafts, found near the Temple of Saturn in the Roman Forum refer to grey granite from Mons Claudianus, see Pensabene 1984, nos. 73. 107–108. 136. About other inscriptions, see Bruzza 1870, nos. 199. 331. See also Bruzza 1870, nos. 200. 332–337 (grey granite); Ward-Perkins 1976 (Aswan granite).

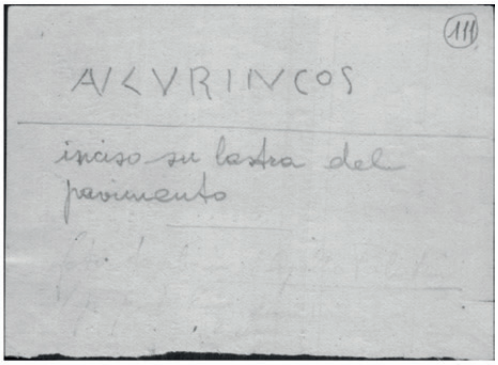
36 Carettoni 1948, 115 n. 2: »Dopo averne eseguito il rilievo, è stato tolto tutto il pavimento marmoreo dell'aula centrale ad ovest della cloaca massima (CL). Le lastre per la maggior parte ridotte in minuti frantumi sono state numerate e ricomposte; consolidate con cemento, esse hanno ripreso il loro posto dopo la copertura degli avanzi sottostanti. Sul rovescio grezzo di una lastra è incisa l'iscrizione: AUGURINCOS; trattasi di C. Serius Augurinus, console nel 132 oppure dell'omonimo console del 156? (Cfr. Prosop. Imp. Rom., s.v.). Ringrazio il dott. L. Cozza che me l'ha segnalata.«

37 Historical Archive of Palazzo Altemps, Fondo Boni, Sheet 111.

cat. 20



cat. 20



cat. 21

cat. 22

8 Roman Forum. Smooth column drum in pink granite (cat. 20); marble paving slab veneer (cat. 21); smooth frame in Lapis Tiburtinus (cat. 22) (photos: S. Violante)

in AD 156. The engraving on a coarse surface, the abbreviated form, the rendering of the letters with the ligature between A and V and the lack of spacing between the name and the role seem to relate to a series of inscriptions attested on quarry blocks of Rome and Ostia in African marble, Pavonazzetto, Cipollino and Giallo antico[38]. The consular date to which these inscriptions are traced back, and which is widely agreed[39], is that of the magistrate of AD 132. The inscriptions were probably affixed at the time of the arrival of the artefacts in the warehouses of Porto[40].

As regards the marble used for the construction of the slab in question, which is not indicated in the documentation, it should be noted that the flooring of the central nave of the Basilica Aemilia was made of African marble, Cipollino, Giallo antico, Pavonazzetto and Portasanta marble.

38 See blocks from Ostia, Bruzza 1870, nos. 4. 6–7. 257. 266. 298; Baccini Leotardi 1979, nos. 6. 8–9 (African marble). 38 (Pavonazzetto). 43 (Cipollino marble). 76–78 (Giallo antico); Baccini Leotardi 1989, no. 50 (Cipollino marble); Pensabene 1994, nos. 31–32 (Cipollino marble).

39 See e.g. Baccini Leotardi 1979, 12 n. 1.

40 Pensabene 1994, 86 f.

The slab, currently unidentifiable, is probably amongst those rearranged in the floor once the excavations were completed, as indicated by Carettoni[41]. The inscription attests to a restoration of the Augustan floor of the Basilica Aemilia carried out during or post Augurinus' consulate.

Lapis Tiburtinus

22. Smooth Frame in Lapis Tiburtinus (fig. 8)

Roman Forum, the Comitium area, at the foot of the modern retaining wall of the terrace. H 29.5 cm, L 70 cm, W 74 cm; H of the letters ca. 6.5 cm.

Smooth moulded frame with laying surfaces, sides and rear hewed out. On the rear, the following upside-down letters can be seen:

LGSC

The epigraphic text shows a slightly italic ductus and was no longer visible once the frame had been put in place. At present, inscriptions of this type engraved on Lapis Tiburtinus, where painted inscriptions are usually attested[42], are rare. Another case is the epigraph engraved on one side of a block brought to light in the Baths of Trajan[43].

CONCLUSIONS

Of the 22 artefacts examined, 20 have been identified as coming from the Roman Forum[44], while the remaining individual specimens can be traced to the Palatine Hill and the Temple of Peace, respectively. There are few attestations in Bigio and coloured marbles, while among the white marbles, evidence in Luna marble prevails, concentrated in the area of the Roman Forum, where the use of this stone quality appears to be dominant in architecture.

When it comes to working the stone, only two specimens are rough artefacts, one of which – the medium-sized stepped block in African marble – appears to be unused (cat. 18). The reasons are still unclear, and given the lack of data on the finding, specifying when the artefact arrived in the area, or establishing its use, whether for an imperial building or for post-antique constructions, is unfeasible. Even the partially preserved hewn shaft on the Palatine Hill does not seem to show traces of use (cat. 17).

Compared to these coarse marbles, some artefacts appear better worked in the form of squared blocks, but with rough (cat. 4–5) or unfinished surfaces (cat. 1–2). Most of the pieces, on the other hand, have reached the final stage of processing, morphing into well-defined architectural shapes. These consist of bases (cat. 11–15), shafts (cat. 16. 20), Pulvino (cat. 10), frames (cat. 7–9. 22), framing elements (cat. 19) and architectural blocks (cat. 3. 6); in only one case was mention made of a marble paving slab veneer (cat. 21)[45]. It is certain that many of these artefacts were put to use, and in rarer cases, a second use, as reuse can also be assumed. The original context is ascertained

41 Carettoni 1948, 115 n. 2.

42 See e.g. the inscriptions painted in red that trace back to the Colosseum and that are to be correlated to quarry activities or to construction site activities, Conti – Orlandi 2013.

43 The artefact is similar in shape to the blocks used for the column bases of the portico of the baths. The epigraphic text with irregular ductus consists of a few capital letters. DO, and perhaps another O, can be read. In this regard, see Volpe 2010, 90 fig. 14.

44 In addition to the inscriptions presented here and those mentioned previously, mention should also be made of the inscriptions engraved on a rough piece in Luna marble from the Temple of Concordia (Pensabene 2015, 495 with previous bibliography) and on the back of some Proconnesian frames of the pronaos of the Temple of Antoninus and Faustina (Pensabene 2014, 46).

45 Similar inscriptions attested on the back of cladding slabs are documented in Leptis Magna, see Bruno 2010, 91.

for only a few specimens, such as the crownwork of the podium of the Temple of Castor and Pollux and the marble floor slab from the Basilica Aemilia.

The most abundant nucleus of evidence is located in the area of the Basilica Julia, with testimonies ranging from unfinished square blocks to frames and bases. For many of these materials, it remains difficult to establish how and when they arrived in the area, as well as their relevance to the monument[46].

As for the epigraphic texts, they are mostly engraved on a hewn or secondary surface, which is usually no longer visible once the artefact is put in place. The exceptions are two composite bases with a numeral engraved on one of the mouldings, proof that the epigraphic signs were affixed after the pieces had been worked[47].

Generally, there is a prevalence of numerical indications, single letters or signatures composed of a few letters. The only clearly recognisable names are the consul Augurino, to be identified with the magistrate of AD 132 already known from numerous other inscriptions, and the servant Hilaro, mentioned for the first time among the personnel active in the Pavonazzetto quarries with the probable role of *probator*, according to an epigraphic form not attested before in Dokimeion.

Finally, the epigraphic signs identified on the frame in Lapis Tiburtinus enrich the repertoire of the rare inscriptions engraved on this type of stone.

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[46] As is well known, the Basilica Julia, begun by Caesar and completed by Augustus, was restored several times: first in Augustan times, then by Diocletian after the fire of Carinus and finally in the 4th cent. It was partially included in the construction of the Church of Santa Maria in Cannapara, which came to occupy an area of the building in the 8th cent. The area was also affected by several lime-kilns (Sala 2008). Finally, we know little about any moving of materials on the excavations carried out since the 2nd half of the 19th cent.

[47] Cf. Mari 2015, 217 no. 2 fig. 4.

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Manuela Wurch-Koželj – Tony Koželj

THE EXTRACTION TECHNIQUES OF SCULPTURES

THASOS (GREECE)

Abstract
Observation of traces of marble extraction in ancient quarries revealed many cuttings which testify to different techniques of extraction during antiquity. Eleven of them were innovative and correspond to identified periods of exploitation. Other techniques, such as the extraction of monolithic column shafts and of cylinders, whether for millstones or column drums, and the extraction for sculptures, were ›permanent‹, commonly used throughout antiquity. Occasionally sculptures were carved from a previously extracted parallelepiped block, but most of them were cut out directly from the bedrock. Global shapes were formed throughout the process of extraction. Remains of these extractions, ›negatives‹, reveal that some rough shapes were worked out laying on their back, face up, while others were set on their side, facing the front. Nonetheless, it seems that the position of the model could be the distinguishing characteristic. The position laying on its back might be the oldest one and surely was employed for the kouroi extraction, while the other, side-set, position seems to have been more appropriate for the quarryman-sculptor who afterwards improved this second method.

INTRODUCTION

To date, in Thasos we have identified just one initially shaped sculpture in the process of quarrying, still attached to the bedrock; but some rough-hewn carvings were found in the quarries. They allow us to identify an aspect of the production relating to exploitation in the quarries, which is the existence of cutting-carving workshops within the exploitation site, and also to understand the process of this specialised production, what can be called the steps of the operational chain (»chaine opératoire«)[1].

A sculpture was not carved out from a parallelepiped block which was previously extracted[2], but, like the column-drum, it was carved out directly from the bedrock. Its overall shape was given as the extraction progressed. Two methods have been noticed in relation to the extraction of sculptures: the extraction-carving of the rough shape lying on its back with its face to the sky, and the rough shape which is lying on its side, looking ahead towards the sculptor[3].

THE EXTRACTION TECHNIQUE OF THE SCULPTURE LYING ON ITS BACK

The References

Colossal sculpture extraction is immediately linked with the abandoned sculpture at the quarry above the village of Apollonia in Naxos. This colossal sculpture – L (max.) 10.9 m, W (max.) 2,5 m, T 2.4 m – is still lying on its back, quarrying in progress[4], at the quarry front (fig. 1 a).

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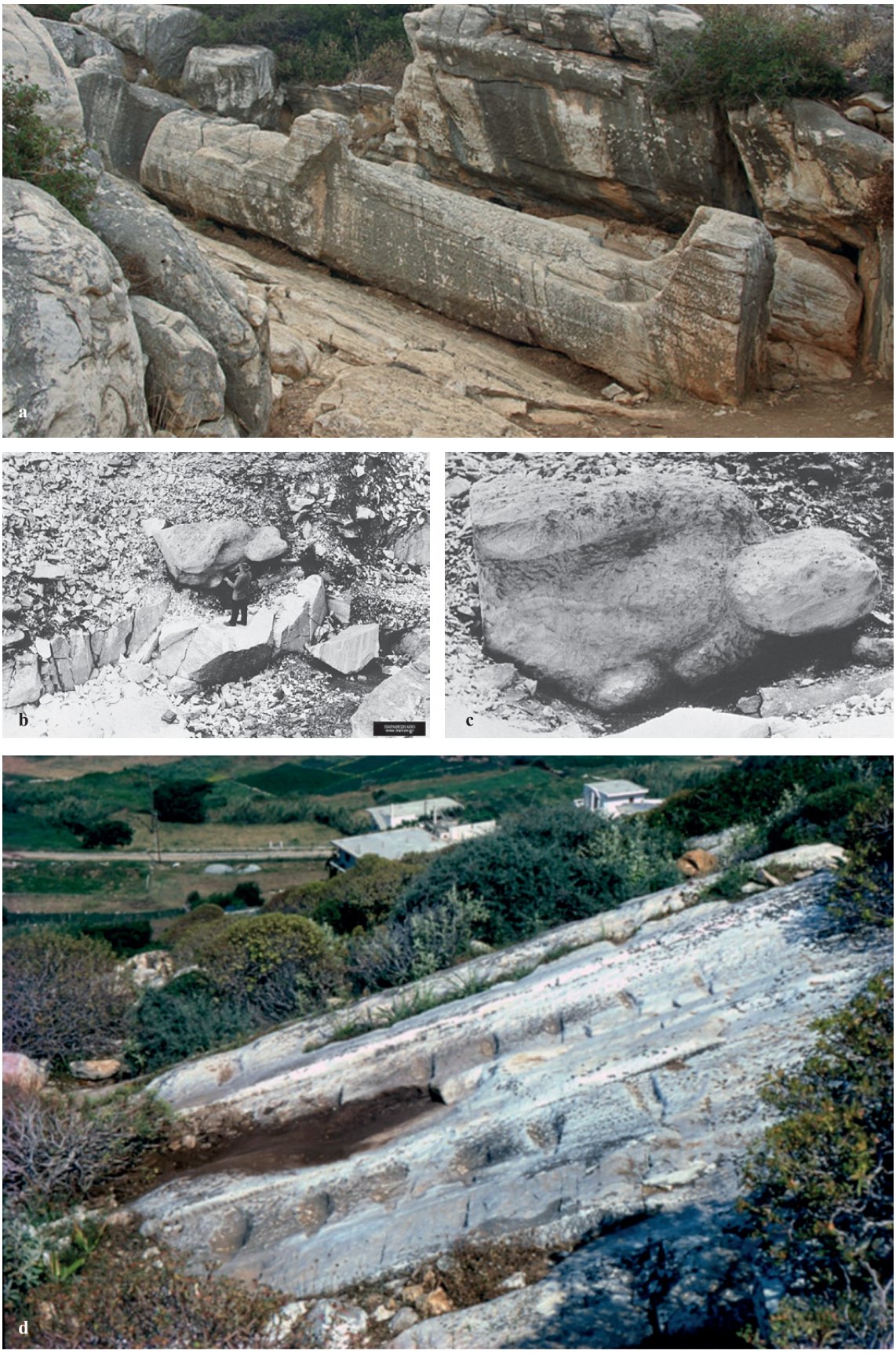
1 Wurch-Koželj 2017; Wurch-Koželj 2018; Koželj – Wurch-Koželj 2023.

2 Exceptions may have existed. Taking into account the carving-out techniques and the unusable mass of marble turned into debris, the process is difficult to consider.

3 Wurch-Koželj 2018, 54.

4 Already detached for some archaeologists.



1 a: Naxos. Colossal sculpture still on its bedrock (photo: T. Koželj). b: Mount Penteli. View from above of the colossal sculpture (photo: R. Carpenter). c: Mount Penteli. Upper part of the colossal sculpture (photo: R. Carpenter). d: Naxos. Negatives of three huge volumes (photo: T. Koželj)

The general shape of the sculpture and the first features of the model have been roughly hewn. The work progressed from the top to the sides using trenches, which were cut (in proportion to the thickness of the ordered statue) so that a quarryman or a stone-cutter could carve on the sides.

What type of statue was to come out of this rough-hewn volume? For some archaeologists, it is a kouros, for others, an Apollo.

The volume has to be detached from the bedrock from its rear face (the back side of the statue), using special wedges to create the split-plane (»plan de scission«).

What is the reason for abandoning it? When was it left? Before it had been detached from its bedrock? When digging the wedge-holes? When hitting the wedges to create the split-plane? Or was the work of the quarrymen and the stonecutters done and it was ready to leave the quarry? When did the crack which is observable today appear? Did it appear in ancient times or is it the result of bad weather conditions?

We notice that the colossal volume was carved from a good-quality vein which is not the case for the surrounding marble.

Another abandoned colossal sculpture[5] was identified on Mount Penteli (fig. 1 b–c). The upper part of the sculpture was left unfinished and rough-hewn. The lower part has yet to be found. The sculpture was detached from its bedrock (from the reverse side). No details were given concerning the tool-traces, or the location of its extraction. One hypothesis is that this unfinished sculpture broke during transport.

Abandoned kouroi already extracted, or other ones, unfinished, still lying in the quarries, near their extraction sites in Naxos[6] – Melanes, Flairio[7] –, as well as on Penteli[8] for example, show that they were extracted from an elongated and isolated quarry front, which is called a ›finger quarry‹[9]. Their morphologies are the result of the volume available[10] in the original mass of each ›finger quarry‹. That explains the wide shoulders and the close-set feet (and also the narrow base). The progressive cutting (cutting, rough-hewing) was executed from the top towards the side, defining the outline of the kouros lying on its back.

In Naxos, we can still find remains of extraction with deep wedges in the bedrock[11] (fig. 1 d), attesting to this special technique and allowing us to identify three ›negatives‹ of volumes separated from unexploitable marble.

The Technique of Extraction

The choice of the quarry front is very delicate: it must be suitable for extracting large or colossal sculptures. The option of the ›finger quarry‹ is restrictive and constraining in volume, but not in work, because you still need to remove the excess material to accurately bring its volume closer to the ordered shape (fig. 2).

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5 Carpenter 1968, 279 f. pl. 98.

6 On unfinished kouroi, see Waelkens – De Paepe – Moens 1988, 109 fig. 21. On a half-finished kouros at Flairio (Naxos), quite complete in height, see Koželj 1988, 13 pl. 1 fig. 3, 1. 2 (fragmentary, broken at the knee level). On another kouros at Naxos (L 5.55 m; Th 1.43 m, legs and feet missing), see Koželj 1988, 15 pl. 2 fig. 3, 4.

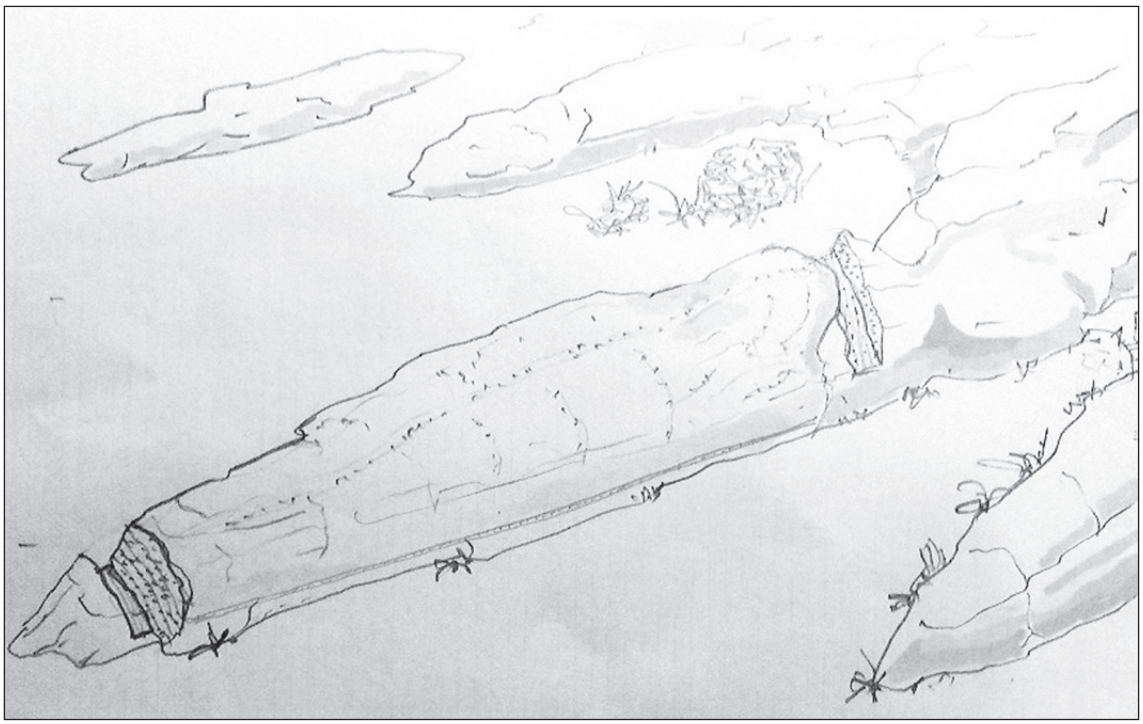
7 At Flairio (Naxos), the unfinished kouros is lying close to its bedrock (which is a ›finger quarry‹).

8 A Kouros from the Dionysio quarries in the Pentelic region, see Koželj 1988, 13 pl. 1 fig. 3, 2. 4.

9 On an abandoned kouros at Flairio (Naxos) and its environment, see Wurch-Koželj 2017, fig. 309.

10 Throughout the rock surface and the ›protective envelope‹ which corresponds to the excess of marble deliberately left for protection (»gras à laisser«) are very close.

11 Wurch-Koželj 2018, 51: encoignure: wedge-socket dug into the bottom of a carved cavity shaped like a sand-heap (truncated rectangular prism), dated Archaic period; 51: emboîture: wedge-socket, socket-shape and dating are correlated. Wurch-Koželj 2017, 93 figs. 194. 195, méga-emboiture: very wide and long wedge-socket approaching half a meter in length. See also Wurch-Koželj – Koželj 2024, 479.



2 Drawing of the rough shape of a kouros in a ›finger quarry‹ (graphics: T. Koželj)

We suggest the following succession of stages:

- Choosing the ›finger quarry‹ in which the ordered volume fits
- The volume is roughly cut from the top to the sides
- Depending on the thickness needed for the sculpture, the stone-cutter carved the wedge-holes with a long chisel point at the bottom, which will be the reverse of the sculpture
- Special long wedges, put in the holes, hit together, created the plan of splitting (»plan de scission«) to detach the volume from the bedrock
- The bedrock remains with the negative of the extracted volume and the traces of the half wedge-holes
- The following step is probably performed by more qualified stone-workers, maybe by master stonemasons or sculptors, and consisted of rough-hewing the volume in order to approach the ordered shape, while maintaining the protective envelope needed for transport. At this stage, the quality of the marble (without faults) was confirmed. This work was also done to make it lighter so that it could be more easily transported from the quarry to its destination.

The Thasian Examples

In Thasos, even fragmentary products of ›gigantism‹ have not been identified so far.

First Shaped Volume: Could it be a Kouros?

On 30th July 2019, during an expert inspection requested by the Ephorate of Kavala[12], we identified near the location Treis Gremmoi, a rough volume, resembling a first draft of a sculpture that

[12] We thank Stavroula Dadaki, director of the Ephorate of Antiquities of Kavala, and Konstantina Panousi, archaeologist at the Ephorate of Antiquities of Kavala and person responsible for the island of Thasos, for allowing us to

3 Thasos. a: Rough-cut volume. b: Rough-cut volume and its platform. c: Lateral view of rough-cut volume (photos: M. Wurch-Koželj)

may be a kouros (or a kore). It was abandoned during its extraction, probably due to the crack on its right side.

The rock face shows numerous crevices and the quality of the marble is far from being homogeneous. However, among all these rock masses, one resembles a ›finger quarry‹, where a rough volume and a flattened platform on one side have been preserved (fig. 3 a–c). On the boundary between the rough volume and the platform, deep cavities, one next to the other, have been dug using a long chisel point. This kind of cavity is related to large wedge-holes, the »encoignures«[13], that were used in the extraction technique of the Archaic period. Here, the extraction process has stopped, probably at the moment that the crack on the right side of the rough volume appeared. The changes to the surface prevent us identifying other tool-marks.

publish this find and also the pictures taken at the Archaeological Museum of Thasos.

13 Wurch-Koželj 2018, 51 f. fig. 2.

4 Thasos, Ram-carrying kouros. a–b: Detail of the epidermis of the right hand. c: Rough area surrounded by a line. Rough-hewn surface. d: Engraved Π. e: Location of the engraved Π. f–h: Traces of a long chisel point (photos: M. Wurch-Koželj)

The Unfinished Ram-carrying Kouros

We did observe work traces – done at the quarry – on the colossal unfinished kouros[14], which is exhibited at the Archaeological Museum of Thasos (inv. Λ1). Its trapezoidal shape (flared from

[14] Ram-carrying kouros (»kouros criophore«), Archaeological Museum in Thasos, inv. Λ1. The five pieces of the kouros, discovered by Edmond Pottier and Charles Picard in 1911, were extracted from the east terrace wall of the acropolis and transported to the museum in 1914. These pieces were used as construction (building) material. The Sanctuary of Apollon Pythios was built on the acropolis, and it is accepted that the kouros was erected there, and that it had been left and discarded after it fell down. It probably broke following a handling incident, and not due to the micro-cracks. The broken pieces, after having been built into the wall, suffered damage from the erosion, so that the micro-cracks became true cracks over the course of time. Surely the Gattilusi's cistern, built on the raised terrace, almost above the pieces, has contributed to their degradation, see Pottier 1920, 218–223; Picard 1921, 86–173; Koželj 1988, 13 pl. 1 fig. 3, 2. 2; 57 fig. 13; Grandjean – Salviat 2000, 111 fig. 65; 245 fig. 171 a–c; Koželj – Wurch-Koželj 1993, 119 fig. 28 A (transport of one of the pieces from the acropolis to the courtyard of the St. Nicolas Church).

bottom to top), with a narrow base plinth and large shoulders, indicates that it was extracted from a ›finger quarry‹[15].

A detail should be noted: the texture of the top of the right hand[16]. This surface could be the result of erosion due to the long period during which it was in the city walls, under the cistern, but it also seems to correspond to the original epidermis of the marble vein (fig. 4 a–c). If the latter is true, it would indicate that the epidermis of the original vein and the final shape of the hand were so close that the excess of marble left to be removed would be very tiny. A shallow engraved Π (fig. 4 d–e) can also be observed on its right shoulder (scapula), which implies that the kouros had been checked ready to leave the quarry area: its characteristics had been verified, according to the ordered sculpture.

Marks from four types of chisel point have been identified (also confirmed by Danièle Braunstein[17]), and indicate the phases of work[18]. Those from the rough-hewing, visible on the lower part of the kouros, its feet (fig. 4 f–h) and legs, were done with a ›long chisel point‹ by stone-cutters, at the preparation area of the quarry. The kouros was roughly shaped, keeping a thin »envelope de protection«[19] (an extra thickness of marble to protect the surface in the event of mishandling during transport), and it was verified with an incised Π, so that it could leave the quarry. It arrived undamaged at its destination, since the work on the shape of the hair and the ram was in progress, carved and hewn with a fine chisel point by master stonemasons or sculptors.

The dating of this unfinished kouros is given by Bernard Holtzmann based on the stylistic aspects: »The hair in large pearls is still that one of the 7th century […] the headband tied around the head […] as in the Attic kouroi of the beginning of the 6th century.« The given dating is »600 BC«[20].

Other fragmentary kouroi were discovered during excavations in Thasos[21], but their surfaces were ›finished‹ and finely carved. No traces of quarrying or rough-hewing at the quarry are distinguishable; the dexterity and finesse of the work done by the master sculptors made the remains of those traces disappear.

In view of the lack of remains and references to unfinished kouroi or quarries, to say that the ›finger quarries‹ were exploited only from the end of the 7th to the beginning of the 6th century BC remains a judicious hypothesis.

THE EXTRACTION TECHNIQUE OF THE SIDE-LYING SCULPTURE

The Reference

In May 2011, studying the quarries at Byllis (Albania)[22], we identified a rough volume of a sculpture[23] (fig. 5 a–b), lying on its right side, still attached to the limestone quarry front (south quarry). It measures 3.65 m. The roundness of the head, the volumes of the left arm, the body and the legs

15 This shape makes sense if it reflects a constraint linked to the initial volume of marble available.

16 The hand must have been very close to the surface of the available marble volume.

17 Braunstein 2018. We agree with the statements of Braunstein, except for the extraction of the kouros.

18 Work from the rough-hewing done by a stone-cutter at the quarry to the finely sculpted hairdo created by a master stonemason/sculptor. The progression of the work was from top to bottom.

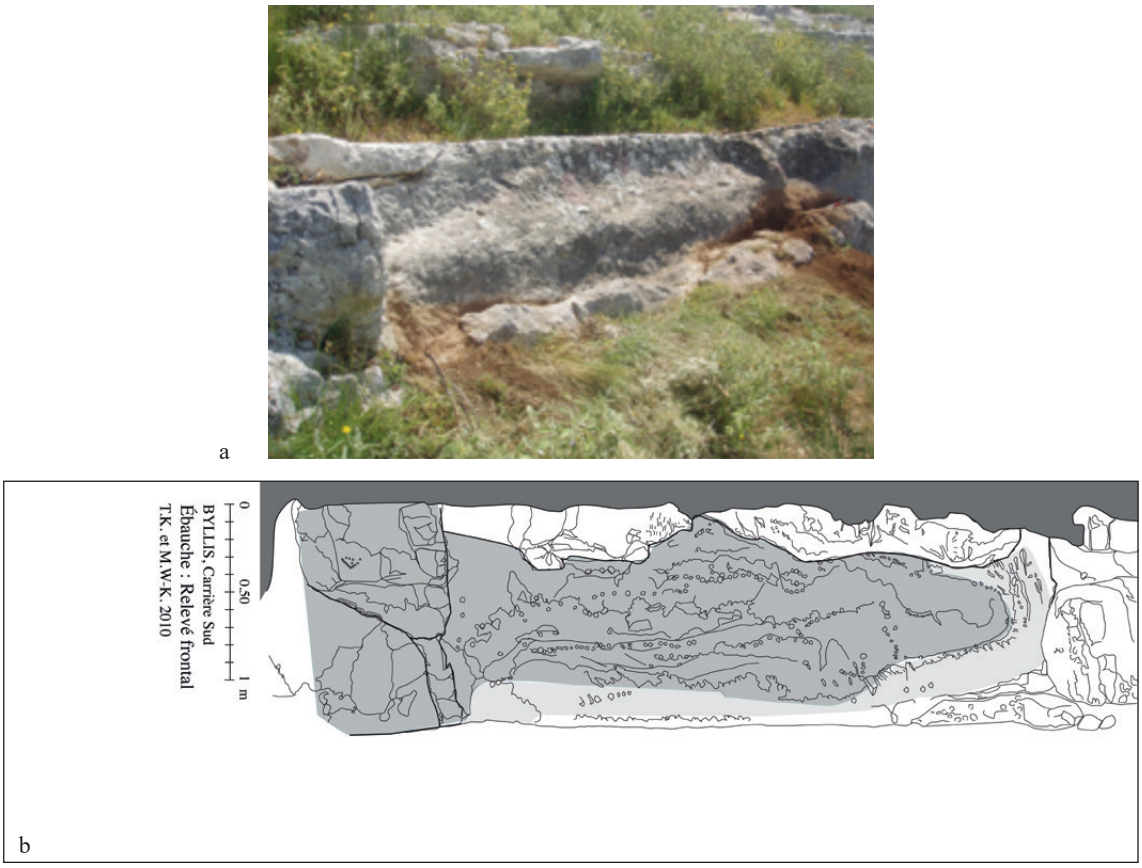
19 Wurch-Koželj – Koželj 1992, 504 f.

20 Translation of the citation: »La chevelure en grosses perles est encore celle du VIIe s. […] le bandeau noué autour de la tête […], comme chez les couroi (kouros ou couros, kouroi ou couroi) attiques du début du VIe s.«, see Holtzmann 1978, 294 f. fig. 181 a–c.

21 Kouros discovered at Aliki by Theodore Bent in 1887. The kouros is exhibited at the Archaeological Museum in Istanbul, see Koželj 1988, 13 pl. 1 fig. 3, 1, 1. On another fragmentary kouros, see Grandjean – Salviat 2000, 164.

22 Koželj – Wurch-Koželj 2018. The limestone quarries were exploited from the Hellenistic era to the early Christian period, providing building blocks and statuary pieces. The arrangement of the quarry fronts – in steps – indicates the extraction of large format products.

23 Koželj – Wurch-Koželj 2013, 738 f. fig. 13.



5 Byllis. a: View of the rough volume of a sculpture (photo: M. Wurch-Koželj). b: Frontal plan of the rough volume in its quarry front (graphics: T. Koželj, M. Wurch-Koželj)

stand out, and so does the base, which is 0.60 m high. The dimensions of the quarry front are 4.4 m long and 1.35 m high, and give an indicative width of the sculpture.

The abandonment during extraction is certainly due to the crack which crosses the rock obliquely and separates the lower part (base and feet) from the upper part (head, body and legs). The stone-cutter did not have time to cut the deep canal, one hewed side of which would create the back of the sculpture.

The Thasian Example E1

When we identified the rough volume at Byllis, we immediately thought of the rough volume E1 from the quarry Vathy II in Thasos[24]. Although the one at Byllis is attached to the main rock and the other one at Vathy II is detached, they present a similar shape (fig. 6 a).

The rough volume at Vathy II (Museum inv. Λ4068) has small holes, which have to be considered as ›reference points‹ (»points de report«) used to carve a copy[25] of a statue model (fig. 6 b–c).

[24] In the summer of 1981, Tony Koželj discovered the rough volume at the quarry Vathy II. Because of his efforts and with the help of Konstantinos Filipidis, who provided a truck and workers to help Tony to transport it, the rough volume was brought to the Archaeological Museum of Thasos (inv. Λ4068) where it is exhibited in the garden.

[25] When Amanda Claridge was in Thasos in 2007, she agreed with this interpretation of holes for copying purposes, see Moureaud 2018.

6 Thasos E1. a: The rough volume from Vathy II. b: The location of some of the reference points on the front face. c: The location of some of the reference points on the back side (graphics: T. Koželj)

At this stage of the carving, according to the number of these holes[26], it is impossible to say if the rough volume would be transformed into an ›approximate‹ copy of the model (copy with the main reference points), or if it would be transformed into an ›exact copy‹ with other reported points added in detail in a following stage. This indicates that the rough volume was hewn by a master stonemason or sculptor, and no longer by a quarryman. It also confirms the existence of a cutting or carving workshop in this quarry.

In both cases, no accurate date can be given. The quarry at Byllis was exploited for many centuries, until the early Christian period; but at Vathy II, no extraction in the quarry can be dated after the 3rd century AD. Are the similarities between the rough volume of a sculpture at Byllis and the rough volume E1 at Vathy a coincidence or are they contemporary?

THE THASIAN ›UNFINISHED‹ SCULPTURES STILL WAITING IN THE QUARRIES

The Rough Volume E2

In the quarry Saliara 2, the rough volume[27] E2 of 2.4 m length is still lying on its side to be hewn (fig. 7 a). It seems as if the volume had just been transported from the quarry front to this area (there is no quarry front nearby where such a volume could be extracted). It could be that the reason for its abandonment is related to the break in the knees.

26 Eleven reference holes or reference marks are certain. Other traces result from the use of the chisel point.
27 Identified in 1980 by Tony Koželj.

The Unfinished Sculptures

The Rough Volume E3

In the same area, about 7 m from the rough volume E2, there is an unfinished sculpture, already identified as a sitting person[28], but it could also be a Herakles with a club (»massue«) (fig. 7 b–e). Different traces of work with a chisel point are visible.

The Sculpture E4

In the quarry Saliara 3, there is the rough sculpture E4 in two pieces[29]. The upper part has been transported to the Archaeological Museum (inv. Λ3450). The height of the head and the torso is 1.01 m and the width at the shoulders is 0.70 m (fig. 7 f). The lower part stayed at the quarry. The height of the legs and the base is 1 m (fig. 7 g). The preliminary flaking was uniformly done, from head to feet and base[30]. The use of the chisel point is recognisable (fig. 7 h). This hewing is the work of a master stonemason or a sculptor. It is possible that the sculpture broke into two pieces as a result of a clumsy gesture. An important detail has to be mentioned: the remains of a vertical iron tenon still exist in the break in the torso (fig. 7 i), which indicates that the sculpture had broken and been repaired[31] at the quarry and left the quarry, despite being damaged.

No answer can be given as to whether the rough draft was ready to leave the workshop at the quarry to be moved to a sculpture workshop or to go directly to its intended destination (and to be finished on the spot).

The Unknown Sculptures

It is with great caution that we noted the information given by a modern quarry worker, who reported seeing a sculpture of a woman at Vathy I[32].

ANIMAL ARTEFACT

The Dolphin

At the top of the west quarry front B11 at Aliki[33], we identified a carved dolphin[34]. Its anatomic shape and the details, like its rostrum, the bulging of its head, were carved. The process of extraction is clear, from top to bottom, as it is still attached by its pectoral and caudal fins to the bedrock, but the lower part of its belly is free (fig. 8). No traces of the dorsal fin can be recognised[35]. Could the lack of it be the reason for the abandonment of the artefact? Or has it disappeared over time?

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28 Koželj – Muller – Sodini 1981, 963 fig. 71.

29 The rough-out was identified by Tony Koželj in 1978.

30 The face has acquired its first features (but not the hair), the position of its shoulders indicates the posture, the left arm is broken below its elbow, the right one is missing. The legs were still united, the right one in the front position shows the weight was on the left foot, of which only the knee and the thigh are preserved.

31 There are still repaired shafts with iron clams in the quarry in Euboea, see Koželj 1988, 3–79 pl. 27 figs. 22–26.

32 His anonymity will be preserved. He had the extreme kindness to show us the location where he had seen it before it was buried under the rubble during the construction of the road. It was at the same time that the relief of Herakles was destroyed by the effects of dynamite and that other remains (that we had identified) were damaged or also buried under tons of debris.

33 Aliki is the current name since Alexander Conze (1860, 30 f.). The real name of the place was »Alki« (»la force«), the fortress, as mentioned by Georges Perrot in 1856 (see Perrot 1864, 17 pl. 1; 84; 86 pl. 3; 87; 89–93), a name which is probably the consequence of the specific ecosystem during the palaeo-Christian period, see Wurch-Koželj 2017, 394.

34 The Dolphin was identified in 2010 by Manuela Wurch-Koželj. For its location, on the top of the quarry front B11, see Sodini – Koželj – Lambraki 1980, 85 f. fig. 6.

35 The dorsal fin is not protuberant and is almost non-existent in some artefacts.

7 a: Thasos E2. Detail of the first rough-hewn shape of the rough volume (photo: M. Wurch-Koželj). b: Thasos E3. Rough volume considered as a ›sitting person‹ (photo: T. Koželj after Koželj – Muller – Sodini 1981, 963 fig. 71). c: Thasos E3. View 1. d: Thasos E3. View 2. e: Thasos E3. Drawing proposal to recognize a Herakles with his club (drawing: T. Koželj). f: Thasos E4. The torso (Saliara 3) g: Thasos E4. The lower part. h: Thasos E4. Restitution of both parts (from Koželj 1988, 35 pl. 12 fig. 3, 18). i: Thasos E4. The broken surface with the iron tenon. j: Thasos E4. Detail of the iron tenon (photos: c–j: T. Koželj)

Located on the high point of the quarry front B11 (which is calcitic marble), it has undoubtedly fallen foul of bad weather and its epidermis is damaged.

To date, it is the only find of an attached animal artefact known in Aliki. It seems that the extraction of blocks from area B11 stopped when its quarry front got close to the dolphin, thus the progress of the extraction of platform C[36] worked around the dolphin, as it had to be preserved. If the latter is true, it indicates that the dolphin was not just an unfinished – unextracted – sculpture (abandoned for any unknown reason) but that it was considered as a symbol by the quarrymen[37] in the early Christian period. No tool-marks are recognisable that could help us to date the carving[38].

In conclusion, apart from the dolphin, these unfinished sculptures were identified in the same geographic area, three of them in Saliara and one (probably two) in Vathy. In this area, the marble is dolomitic and its colour is pure white with medium crystal grains, very hard and difficult to carve out. Only experienced stone-cutters and sculptors are able to work this type of marble.

It seems that these unfinished sculptures were in carving workshops. Each one turns out to be in a different phase of cutting:

- the first state is represented by E2, which is removed from the quarry face
- the preparation of a ›copy‹ of a model is defined by E1 with the reference marks
- an intermediate shape is revealed by E3
- an advanced shape is characterised by E4

The work phases of the three unfinished sculptures correspond to carving by experienced sculptors. As a result of that, we propose not only the presence of sculptors in the quarries but also the existence of sculptors' workshops in the quarry exploitation site, where the stone-cutter prepared the blocks for transportation and checked the quality of the artefact (product ordered), while reducing its weight.

The other question to answer is if these unfinished sculptures are from the same period.

The last period of exploitation of the area of Saliara-Vathy is the 2nd to 3rd centuries AD, according to many extraction traces, some special products, like the apse-sarcophagus in Vathy III[39], and the more recent inscriptions and graffiti. But the area had been exploited since the Archaic period, as the inscriptions at Saliara 1 (Ηρακλ and Ηρακλεως εισιας) and the graffito at Saliara 3 (Πα) demonstrate, as well as many traces of extraction on the abandoned quarry fronts.

In other areas with permanent quarrying, for example in Fanari[40], whose quarry fronts do not preserve the same traces of extraction, we noticed that some fronts were abandoned in favour of other ones, so that different areas of extraction correspond to different periods of exploitation.

In Saliara, the quality of the marble seems to be more homogenous and the extractions have advanced further and further. The ramps and the location of the hoisting machines seem to have been permanent; the same could be the case for the areas where the blocks were prepared, and probably for the sculptors' workshops as well. It is tempting to associate E3 with the Ηρακλ inscription, but there is no concrete evidence. Many representations of Herakles were carved until late Roman times. On the other hand, if the rough-hewn block E2 is an abandoned remnant of an ancient extraction, why did it remain unused rather than being recovered in the subsequent exploitations? The most probable answer is that these unfinished sculptures are contemporary with the last period of exploitation of the quarry[41], dated to the Roman period.

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36 Sodini – Koželj – Lambraki 1980, 106–108 fig. 53.

37 Like the three reliefs of Herakles found in the eco-system of Saliara, see Koželj – Muller – Sodini 1981, 961–963; Koželj 1982, 68–70.

38 The dolphin artefact could be contemporary with the exploitation of quarry A13, or even B11. The quarry area A13 was partly destroyed by the B11 and the C extractions, see Sodini – Koželj – Lambraki 1980, 95 (A13). 106 (B11). 108 (C).

39 Koželj – Wurch-Koželj 1995.

40 Phanari or Fanari, see Koželj – Wurch-Koželj 2009.

41 Wurch-Koželj 2017, 378–382 fig. 741. Saliara-Vathy quarries were »permanent exploitations« from the Archaic

8 Thasos. The dolphin at Aliki (from Wurch-Koželj 2017, 276 fig. 592)

The exploitation of the area Saliara-Vathy was abruptly abandoned. There are no extraction traces from the early Christian period. The area was no longer exploited until modern times.

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time to the Roman period. The remains of this last eco-system are proof of the rationalisation of the entire »chaine opératoire« from the extraction to the transportation, as well as the logistical organisation: villages, sanctuaries, guard towers, […] all characteristics converge for an imperial property.

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STONE PROPERTIES, WEATHERING EFFECTS AND RESTORATION

Montserrat Claveria

MARBLE AND PATINA ANALYSIS FOR INTERPRETING SCULPTURES FROM ANTIQUARIAN COLLECTIONS

A SET FROM THE MUSEU D'ARQUEOLOGIA DE CATALUNYA (BARCELONA) AND THE MUSEO NACIONAL DEL PRADO (MADRID)

Abstract
The article presents the results obtained through the investigation of 39 marble sculptures in classical style from antiquarian collections, whose ancient or modern chronology could not be easily determined. This group of sculptures corresponds to a representative selection of 150 sculptural works of this type studied in successive state research projects carried out between 2011 and 2022, and represents a significant group to demonstrate the important contribution of multimethod analyses of stone materials and those applied to the patinas deposited on the marble surfaces of these doubtful antiquarian sculptures to elucidate their age. The analyses by optical microscopy, cathodoluminescence (CL) and stable isotopes of carbon (C) and oxygen (O) of these works have ratified those of other sets of Roman marble sculptures carried out previously, which indicated a preference for the use of marble from Greece and Asia Minor in the 2nd and 3rd centuries AD, while the use of Luni-Carrara marble is common for the production of modern classical-style sculptures. Regarding the analysis of the patinas, our research team is finding them to be of great interest for obtaining data on the environments in which these sculptures have been preserved throughout their history.

OBJECTIVES

Most classic-style sculptures from antiquarian collections give us no information about their original archaeological context, ostensibly making the interpretation of the substantial properties of these works difficult, including their accurate dating using stratigraphic criteria and an understanding of the function(s) they performed throughout their history. Furthermore, among these pieces, as is well known, are Greek and Roman pieces and other sculptures from the modern period, including Renaissance and Baroque productions, and works from the 18th to the 20th centuries sculpted in styles and using techniques that were very close to those used to produce classical sculptures, the aim being to emulate these ancient works or to produce forgeries.

Between 2011 and 2016, the Universitat Autònoma de Barcelona's Grup d'investigació en Escultura d'Estil Clàssic (GREEC) carried out two research projects funded by the Spanish Ministry of Science, Innovation and Universities, in which we examined 150 chronologically ambiguous pieces of this type to determine if their age is ancient or modern. These projects were HAR2009-10798 »Ancient or Modern. Framing Classical Sculpture in its Corresponding Period«, and HAR2012-35861 »The Male Sculptural Portrait in Antiquarian Collections. Function, Chronology and Modes of Restoration«. Recently, we reviewed the analyses of eleven of these sculptures to verify the results of the two projects, which were obtained using optical microscopy examination only[1], whereas we had broadened the analysis by using cathodoluminescence and isotopes.

This article focuses on a representative set of these works, with the aim of publishing the results relating to this research and highlighting the contributions of the analysis of marble and patinas as

[1] Rodà et al. 2010; Rodà et al. 2015.

1 Modern male portrait from the Museu d'Arqueologia de Catalunya. MAC-19030 (photo: courtesy of the museum)

complementary techniques in the archaeological and artistic study of this type of sculpture[2]. The set was made up of 39 pieces from well-known antiquarian collections currently housed in the Museu d'Arqueologia de Catalunya at its headquarters in Barcelona and in the Museo Nacional del Prado in Madrid, most of which are portraits (33), plus five ideal statues and a sarcophagus.

METHODOLOGY

The methodology was based on the existing bibliographic and archival documentation of these sculptures and their technical, stylistic, iconographic and epigraphic study, if an inscription was present. The stone material of the pieces was analysed using optical microscopy (OM), visual examination, spectrophotometry to quantify shades of grey, cathodoluminescence (CL) and stable carbon (C) and oxygen (O) isotopes. These analyses were carried out at the Unitat d'Estudis Arqueomètrics of the Institut Català d'Arqueologia Clàssica (ICAC), which has an extensive archive of reference samples of ancient sculptures and whose researchers we thank for their analyses of the pieces presented here[3].

2 Part of this study has been carried out within the framework of the research project PID2022-137896OB-100 »Antiquae Feminae« funded by MICIU/AEI /10.13039/501100011033 and for FEDER, UE.

3 I would like to express my gratitude to Marie-Claire Savin, Laura Galán and Andrea Collado for the marble analyses of the pieces and specially to María Pilar Lapuente Mercadal for her invaluable help in interpreting the results obtained.

We also carried out interventions typical of conservation/restoration, such as organoleptic examination of the sculptures and analysis of the patinas that remain on the marble surfaces, applying the Wolbers cleaning method, which meant we could buffer the solutions to ensure a constant pH so that there were no variations when we cleaned the pieces, thereby enabling us to obtain more data. We worked together with the manager, restorer and archaeologist of the Restoration Unit of the Museu d'Arqueologia de Catalunya Isabel Moreno Martínez, who is a member of our research team and whom we thank for her unconditional availability. The combination of the results of these analyses, carried out from different study approaches, provided complementary data that better substantiated the chronological interpretation of the investigated pieces[4].

STUDY CASES

A total of 79 % of the sculptures in this group were carved from a single block of marble, including the ideal head preserved in the Museu d'Arqueologia de Catalunya under inventory number MAC-19030 (cat. 6; fig. 1)[5]. Even though at first glance we judged this head to be modern, we considered it would be interesting to carry out a stone analysis of it to see the intrinsic characteristics of the works produced in modern workshops for the antiquarian market[6]. The stylistic and iconographic study of this work allowed us to verify that its creator used a mixture of characteristics of models created in the Late Classical period, and that it represents a Herakles, or another mythical young man based on the various types established in the 4th century BC such as the Lansdowne Herakles and the Herakles Genzano. Its stone marble was shown to have come from the Luni-Carrara quarries, which we now know were used for carving both ancient and modern works. The lack of patinas anywhere on its surface indicated that it was not deposited in an archaeological context, which aligns with the properties of its style, its bulkiness and the lack of detail in its volumes, bringing it closer to classical-style carved sculptures from the 17th century onwards.

Similar conclusions were drawn for the five busts traditionally attributed to the collection of the Marquises of Barberà (cat. 10–14) and preserved in the warehouses of the Museu d'Arqueologia de Catalunya (hereinafter MAC) in Barcelona[7], where they probably arrived in the 19th century with the sculptural collections housed in Barcelona's Reial Acadèmia de Bones Lletres[8]. Cleaning using deionised water dressings and cellulose pulp showed that the patinas covering them were just layers of dust, and that there were no other pathologies and/or traces of oxalates indicating that they may have been buried in an archaeological context[9]. The stylistic and iconographic study of these busts led us to conclude that they were sculpted at the end of the 16th century in a workshop in northern Italy[10]. Like the previous piece, analysis of the marble they were carved from revealed all of them to be made from Luni-Carrara marble[11].

A head of Marcus Aurelius (cat. 29)[12], two female busts (cat. 36. 38)[13] and a smaller-format copy of the sarcophagus of Adonis exhumed from Rome's Via Latina in the mid-19th century (cat. 39)[14] are examples of other modern works carved in Luni-Carrara marble with, aside from dust

4 Claveria – Moreno 2018, 217–222.
5 Claveria 2013b, 119–122 pls. 3–4.
6 Rodà et al. 2010, 8 f.
7 MAC-7579. MAC-7577. MAC-7580. MAC-7581. MAC-7575.
8 Claveria 2010, 355–358; Koppel 2013, 305 f.
9 Claveria et al. 2015, 15–25; Moreno Martínez 2017.
10 Koppel 2013; Claveria et al. 2015, 25–43.
11 Rodà et al. 2010, 30 f. 37–44.
12 MAC-7572; Claveria – Moreno 2018, 227–229 pl. 5.
13 The first without inventory number and the second with MAC-7595; Rodà et al. 2010, 35 f. 45 f.
14 MAC-9524; Domínguez 2008; Trunk 2008, 210–213; Rodà et al. 2010, 47 f.; Moreno Martinez 2025, 320–322.

2 Modern medallion from the Museo Nacional del Prado. E-306 (photo: M. Claveria)

deposits, clean surfaces. To these five works can be added two more from the Mateu collection in Castell de Peralada (Girona) and currently preserved in the MAC. One of them is a male head (cat. 32)[15] with the general traits of portraits from the Antonine and Severe periods, and the other (cat. 31)[16] is a faithful reproduction of a private female portrait from the middle of the 3rd century AD. However, the lack of patinas on their surfaces and the presence of unusual stylistic features for antiquity[17] reveal that they were manufactured in modern times, an assumption that is supported by the origin of their material being the Luni-Carrara quarries and by the highly veined appearance of the female portrait, which is comparable with other busts made for the modern antiques market, and whose surfaces are covered with ageing patinas to imitate the antique appearance of Classical sculptures.

The surfaces of four medallions with portraits of famous people from the Museo Nacional del Prado (hereinafter MNPrado) (cat. 22–25)[18] had a similar appearance to the busts analysed previously, their iconographic examination confirming their modern chronology, belonging to a specific genre created in the 15th century to decorate façades and prominent entrances to northern Italian palaces and some buildings used for funerary purposes or for worship[19]. Three of them

15 MAC-19.059; Claveria 2013a, 289–293 pls. 5–8.
16 MAC-19.029; Rodà et al. 2010, 22 f.; Claveria 2013a, 285–288 pls. 1–4.
17 Such as the roundness of the contours of the face and the exaggerated width of the forehead.
18 E-204. E-252. E-306. E-310.
19 Claveria 2017a, esp. 271–275. 277 f. pls. 3. 5. 9–12.

3 Ancient female portrait from the Museu d'Arqueologia de Catalunya. MAC-15090 (photo: M. Claveria)

were made of Luni-Carrara marble[20] and the fourth from Proconnesian marble (cat. 24; fig. 2)[21], indicating that looted Roman sculptural or building material was probably used to make them, since the marble quarries of the Eastern Mediterranean were in territory controlled by the Ottoman Turks at that time, making it difficult to import material extracted from them[22].

The patinas of the female head MAC-15090 (cat. 35; fig. 3)[23], however, did reveal the presence of oxalates on its surface, oxalic acid salts characteristic of soils from archaeological contexts. The style of the head and the hairstyle confirm its ancient chronology from the mid-1st century AD, its material from Naxos adding weight to the evidence of antiquity provided by the previously obtained data. Similar cases in this regard were the reused male bust from Bárcino dated to the first half of the 2nd century BC[24], a late-Republican portrait broken in half[25], and a statue of Harpocrates with his head and limbs missing[26]. The rough workmanship of the first (cat. 34)[27] is in keeping with the bulkiness and lack of detail of the sculptural production of the Bárcino

20 E-204. E-252. E-310; Rodà 2015, 19–25. 30–32; Claveria 2017a, 280.
21 E-306; Rodà et al. 2015, 26–29; Claveria 2017a, 280.
22 Maischberger 1997, 39. 61. 67. 86.
23 Trillmich 1993, 63 pl. 25.
24 MAC-1346.
25 MAC-44056.
26 MAC-19041.
27 Moreno Vide 2018, 283 f. pl. 6.

4 Ancient female head from the Museu d'Arqueologia de Catalunya. MAC-19.604 (photo: courtesy of the museum)

workshops, an assumption that was confirmed on analysing the material from which it is made, proving to have come from the local stoneware quarries of Mt. Montjuïc[28]. The style and iconography of the second (cat. 27) indicate that is was produced at the end of the 1st century BC, the appearance and homogeneity of the patinas covering the entire piece attesting to the breakage already having occurred in antiquity, prior to it being deposited in an archaeological context[29]. Its material from the Luni-Carrara quarries is entirely in keeping with the type of marble materials used in Rome and the western provincial area in this Early Imperial period for portrait carving[30]. With the naked eye, we identified the same material used for the torso of Harpocrates (cat. 8), a small-format statue made between the end of the 1st century and the middle of the 2nd century AD and intended for ornamentation in a private home[31].

The study of a bearded male head (cat. 7)[32] and an oversized female head (cat. 9; fig. 4)[33] revealed traces of pigments from the layer of colour used for its finishing[34], an important clue as to the antiquity of the two pieces since, as is known, classical-style sculptures in the modern age were made from white marble without polychromy because it was believed that the Greek-Roman originals were not painted but were left to show the diaphanous surface of their marble materials. The stylistic and iconographic parallels led us to believe the male bust to be part of a herm from the Antonine period, imitating the model of a divine image from the first half of the 5th century BC[35], while the closest parallels for the female head are the images of goddesses and princesses of late Ptolemaic Hellenism[36]. We currently do not have sufficiently contrasted results on the materials used to carve the two pieces, which in the case of the male head pointed to Paros marble, while CL applied to a sample of the female head indicated Pentelic marble. Nonetheless, what is certain is that the oriental origin revealed by these analyses reinforces the antiquity of the two heads. Another female head from the MAC (cat. 37)[37] is of a style and displays a hairstyle typical of the first half of the 1st century AD. Its deficient state of conservation and the colour of the patinas on its surfaces align with those verified in other pieces from archaeological contexts, such as the previously mentioned head MAC 44056 (cat. 27), and *de visu* its material is fully consistent with that of the Luni-Carrara quarries, a material frequently used for portrait carving in this Early Imperial period. Taken as a whole, these data indicate that the piece was created in antiquity, although our

28 Rodà et al. 2010, 16 f.
29 Claveria – Moreno 2018, 222–224 pls. 2–3.
30 Rodà et al. 2010, 4 f.
31 Claveria 2013b, 125–127 pls. 7–8.
32 MAC-15098.
33 MAC-19604.
34 Claveria 2013b, 123. 130.
35 Claveria 2013b, 122–125 pls. 5–6.
36 Claveria 2013b, 127–130 pls. 9–10.
37 MAC-15089; Sáez 2013, 106.

observations on the patinas and the marble should be corroborated using multimethod analysis[38].

Regarding the bust of Nero (MAC-7571, cat. 28; fig. 5), it could not be demonstrated with any certainty whether it is ancient or modern since its style and iconography are perfectly comparable to ancient works, but some details of the hairstyle do not fit with them. Analysis of the patinas proved to be inconclusive as to whether it had been buried in ancient times[39]. Furthermore, the 2010 analysis of the marble by OM showing that it originated in Luni-Carrara[40] shed no light on the matter either. However, subsequent analysis of some of its patinas, similar in appearance to oxalates, turned out to be colonies of fungi from its conservation in the open air[41], and recent reanalysis of the marble using the multimethod approach determined a material that is unreferenced for ancient sculptures in the ICAC Archaeometric Studies Unit. Therefore, the results of the analysis of the patinas and those of the marble provide key data against the antiquity of this head[42].

5 Modern head of Nero from the Museu d'Arqueologia de Catalunya. MAC-7571 (photo: I. Moreno Martínez)

The almost true-to-life-size herma also preserved in the MAC (cat. 30)[43] was a similar case in point. Its stylistic-iconographic study revealed that it is a modern copy from the classicist period of a private portrait from the first decades of the 2nd century. Microscopic analysis of its patinas confirmed this conclusion, determining that there were no traces of oxalates but rather that it was covered with a biogenic layer formed in an open-air context causing its corrosion[44], while its Luni-Carrara material[45] and the letters A.P., which identify it as Antoninus Pius, corroborate the modernity of the piece[46].

Three unknown male portraits and another of Augustus complete the series of sculptures discussed so far, carved from a single block of marble. All of them belong to the MAC and have in common the difficulty of assigning them to ancient or modern times. The first three[47] show the char-

38 The study and analysis of this female portrait are research tasks to be carried out under the previously mentioned current project »Antiquae Feminae« funded by the Spanish Ministry of Science, Innovation and Universities.
39 Claveria – Moreno 2018, 224–227 pl. 4.
40 Rodà et al. 2010, 28 f.
41 Vendrell – Giraldez 2017, 4–10; Claveria – Moreno 2018, 225.
42 I thank María Pilar Lapuente Mercadal for her invaluable help and comments on the interpretation of this head material.
43 MAC-7574.
44 Claveria – Moreno 2018, 229–231 pls. 6–7.
45 Rodà et al. 2010, 20 f.
46 Claveria – Moreno 2018, 231.
47 MAC-7582 (cat. 1). MAC-7585 (cat. 2). MAC-7586 (cat. 4).

acteristics typical of private Roman busts with features of the Republican realist tradition, while also including details of the ideal abstraction introduced during the reign of Augustus because he wanted to recover the classical Greek style, making them artistically consistent with the private effigies produced in the last decades of the 1st century BC[48]. Two of them are made from Luni-Carrara marble (cat. 1. 4)[49], the most used material for carving portraits at the time, and the third is from Paros 2 (cat. 2)[50], a marble which, as we have seen, was much more used in ancient times, while in the area of modern Europe it was only accessible if the materials used for works or blocks preserved from antiquity were reused. However, some authors are hesitant to put an ancient age to either this portrait or to the one corresponding to MAC-7582 (cat. 1)[51]. The ancient chronology of the portrait of Augustus (cat. 3)[52] is likewise unconfirmed, despite it being carved from Paros 2 marble, indicating its antiquity[53], and the fact that the head seems to be a replica of the Augustus Prima Porta type and is very consistent with ancient portraits of the Julio-Claudian period. Having said that, certain details in some locks of his hair cannot be found in any other Roman portraits of this emperor[54], which is why some authors believe this bust to be modern[55]. We have not yet been able to study these four pieces in terms of their patinas, and the thick layer of dust that covers the surface of most of them is an obstacle to obtaining more information in this regard simply from careful visual observation. We trust that future analyses of these busts from this perspective of conservation/restoration will produce useful results in terms of determining their age.

The remaining 21 % of the sculptures in the group we wanted to study are assemblies of different pieces made in modern times to obtain sculptures for antiquarian collections. Two types of assemblages can be observed in the nine busts that make up this group. The first type are heads made from a single block attached to busts carved in modern times. Five of the nine busts are of this type, of which four have ancient heads carved with oriental marble. These data ratified the results of the stylistic and iconographic analysis and the result obtained from their patinas, which likewise indicated their Greek-Roman origin. Regarding the marble used, a portrait of Lucius Vero (MAC-7578, cat. 16) turned out to come from Lefkes (Paros 2)[56]. The sample taken from another portrait attributed to Zeno but actually representing Miltiades (MNPrado E-14, cat. 19)[57] was not representative, although *de visu* it looks like Afyon marble[58]. One portrait of Miltiades (MNPrado E-23, cat. 20; fig. 6) is made from Pentelic marble[59], and another attributed to Lysias (MNPrado E-25, cat. 21) is made from Lychnites marble[60]. Only in the case of a bust of Pseudo-Vitelio (MAC-7576, cat. 15) did both the head and the bust turn out to be modern, probably made at the end of the 16th century in a workshop in northern Italy[61], and both from Luni-Carrara marble[62]. Of the rest of the busts, only the one of the aforementioned Lucius Vero (cat. 16) was analysed, also

48 Claveria 2010, 358–361 pl. 1 (MAC-7586, cat. 4); 361–364 pl. 2 (MAC-7582, cat. 1); 364–366 pl. 3 (MAC-7585, cat. 2).

49 Rodà et al. 2010, 18 f. (MAC-7582, cat. 1); material confirmed by the analyses carried out using CL and isotopes in 2022. See also Rodà et al. 2010, 3 (MAC-7586, cat. 4).

50 Rodà et al. 2010, 10 f. (MAC-7585, cat. 2); material confirmed by the analyses carried out using CL and isotopes in 2022.

51 Claveria 2010, 361 n. 38; 364 n. 50.

52 MAC-7584.

53 Rodà et al. 2010, 26 f.; material confirmed by the analyses carried out using CL and isotopes in 2022.

54 Boschung 1993, 75. 144 f. pl. 121; Claveria 2010, 366–368 pl. 4.

55 Claveria 2010, 366.

56 Regarding the material and the interpretation of this piece, see Rodà et al. 2010, 34; Koppel 2013, 310–312 pls. 6–7; Claveria et al. 2015, 19 f. 25. 28 f. pl. 9; Moreno Martínez 2017, 212 f. pl. 3.

57 Cacciotti 2017, 93 f. pl. 3.

58 Rodà et al. 2015, 7–10.

59 Rodà et al. 2015, 11–14; Cacciotti 2017, 106–108 pl. 12.

60 Rodà et al. 2015, 15–18; Cacciotti 2017, 96. 101 pl. 6 f–g.

61 Koppel 2013, 312–314 pls. 8–9; Claveria et al. 2015, 19. 23. 25. 31–33 pls. 11–12; Moreno Martínez 2017, 212.

62 Rodà et al. 2010, 53–57.

6 Modern bust of Lucius Verus from the Museu d'Arqueologia de Catalunya. MAC-7578 (photo: M. Claveria)

turning out to come from the Luni-Carrara quarries[63]. All five of these busts, including those in the form of a herm (cat. 19–20), the one with a bare chest (cat. 21) and those dressed in a tunic and paludamentum (cat. 15–16) were made in the modern period to be adapted to the galleries of the illustrious of the collections to which they belonged[64].

The second type of assemblage consists of heads or busts made of fragments of different marble remains of ancient statues, completed with new marble to produce antiquarian works. The joints between the different parts are often hidden with layers of intentional ageing, thereby achieving smoother and more uniform surfaces. The head of an athlete in the polycletic style preserved in the MAC (cat. 5; fig. 7)[65] is a good example of this type, dependent on the model of the Doryphorus, Herakles or the Boboli-type Hermes of Polykleitos. Analysis of the patinas and the stylistic study enabled us to discern the core part of this piece[66], which was carved in Pentelic marble, as the analysis of its material showed[67]. These data reaffirm the antiquity of the piece and its possible origin in Greece or Rome, while the rest of the head is made up of modern additions of Carrara marble to complete its ancient core.

63 Rodà et al. 2010, 32 f.
64 Koppel 2013, 318 f.; Claveria et al. 2015, 41–43; Cacciotti 2017; Moreno Martínez 2017, 214 f.
65 MAC-19057.
66 Claveria 2013b, 116–119 pls. 1–2.
67 Rodà et al. 2010, 14 f.; the analyses carried out using CL and isotopes in 2022 rejected the 2010 result (polarised light microscopy), according to which it was Luni-Carrara, and confirmed that it is Pentelic marble.

7 Ancient male head in polykletic style from the Museu d'Arqueologia de Catalunya. MAC-19057 (photo: courtesy of the museum)

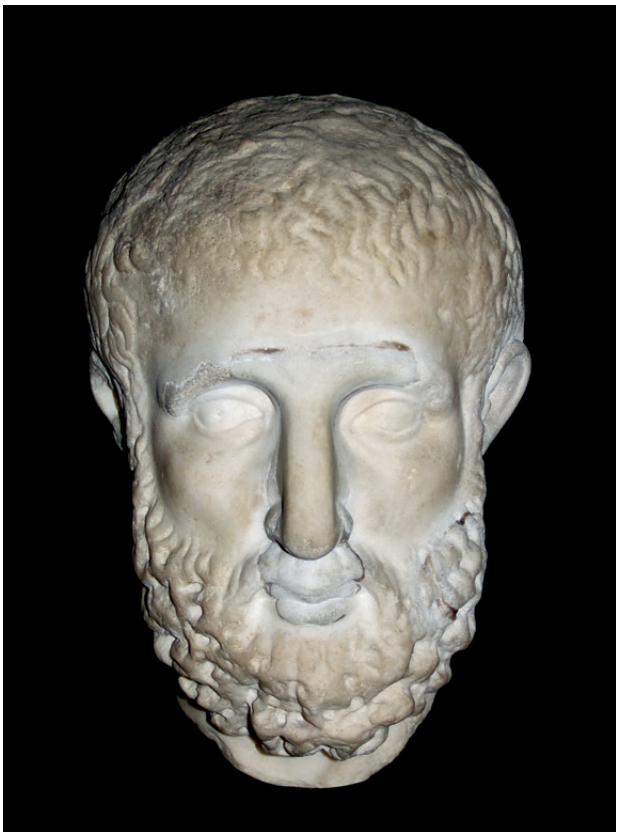
Another similar example is the bust of Caracalla housed in the MNPrado (cat. 26)[68]. The core of the head and that of the bust can be considered ancient due to their style, and are easily distinguishable from the modern additions by the yellow and pink patinas that can be seen on their surfaces[69]. The core of the head turned out to be made of Göktepe marble[70]. The type and chronology of the head ratify the antiquity of this fragment, which corresponds to an »Alleinherrscher«-type image of Caracalla from around AD 212. The head and the centre of the bust have been completed with modern-style fragments carved in Carrara marble[71].

Two more heads complete the group illustrative of this type of assemblage. Both belonged to the collection displayed by Cardinal Antoni Despuig in Raixa (Palma de Mallorca) and acquired after its dispersal by Ròmul Bosch i Catarineu, finally joining the MAC collection in the 1930s, where they are still kept[72]. One of them is a reproduction of an effigy of Caracalla (cat. 17)[73] in his first type of portrait as sole sovereign in a state of severe deterioration, which a conservation/restoration study determined to be consistent with having been exposed to fire. The missing parts of this head were reintegrated at an undetermined time using mortars and pestles to improve its appearance[74]. The high degree of granular decohesion and dehydration of the marble has so far prevented us from reliably determining the origin of its stone material[75]. The second portrait depicts a philosopher (cat. 18; fig. 8)[76], or possibly a cultured citizen, who cannot be identified due to the parts of the brow, nose and mouth added with a different marble in modern times. However, its sculptural typology entirely coincides with the heads of Hellenistic philosophers and orators, and its style is characteristic of the beards of the last Antonines and the first Severus, verifying that it was carved in Roman times[77]. Its material, from Paros 1, confirms that it was produced in antiquity[78].

68 E-379.
69 Claveria 2019, 234–238 pls. 1–7.
70 Rodà et al. 2015, 33–35.
71 Claveria 2019, 234–238 pls. 1–7.
72 Claveria 2013a, 292 f.
73 MAC-7583.
74 Claveria 2013a, 293–296 pls. 13–16. 296–302.
75 Claveria et al. 2015, 45–57 pls. 19–24; Moreno Martínez 2017, 216–219 pls. 8–12; Claveria 2019, 234. See also Rodà et al. 2010, 51 f., where it was reported to be carved in Luni marble (polarised light microscopy), although recent analyses from 2022 (CL and isotopes) have not provided satisfactory results.
76 MAC-7573.
77 Claveria 2013a, 293–296 pls. 9–12; Claveria et al. 2015, 57–61 pl. 25; Moreno Martínez 2017, 215 f. pls. 6–7.
78 Rodà et al. 2010, 24 f., where it was identified as Parian marble (polarised light microscopy), and recent analyses from 2022 (CL and isotopes) have ratified that the material of this head is from Paros 1.

CONCLUSIONS

Analysis of this set of 39 sculptures meant that we could verify that 49 % of them are modern and 41 % are from antiquity, while the age of the remaining 10 % of the pieces could not be determined because we were unable to examine them from the point of view of the patinas preserved on their surfaces. Regarding the materials used, 56.4 % of them were carved from Luni-Carrara marble and 33.3 % from Greek and Asia Minor marbles, among which are Paros 1 and Paros 2, Pentelic, Göktepe, Prokonnesos, Naxos and probably Afyon. Local marble from the quarries in Montjuïc in Barcelona was used for 2.6 % of the pieces, and the type of marble of 7.7 % of them could not be determined due to their poor condition (cat. 17) or a lack of reference samples in the available databases (cat. 28), the latter case leading us to deduce the modernity of the marble used to sculpt the head of Nero (fig. 5).



8 Ancient head of philosopher from the Museu d'Arqueologia de Catalunya. MAC-7573 (photo: courtesy of the museum)

All the modern pieces are made from Luni-Carrara marble, except for one medallion (cat. 24; fig. 2), which is made from Proconnesian marble. This medallion belongs to a sculptural genre created between the end of the 15th century and the beginning of the 16th century to decorate the façades of churches and palaces in northern Italy with architectural motifs in the so-called Antico style, which imitated ancient coins and gems. This piece testifies that it was probably made with reused materials from antiquity, since the Eastern Mediterranean was in the hands of the Turks at the time, making the extraction of these marbles from Greece and Asia Minor difficult. Carrara marble was notably not only the marble used most frequently in modern times to make sculptural works »a l'antica«, but also the most used to recompose deteriorated ancient sculptures that were recovered for sale in the antiques market. In this regard, our analyses verified that all the works made by assembling multiple fragments of different marbles align with the reuse of remains of ancient sculptures to create works for antiquarian collections.

The ancient sculptures are mostly made from oriental marbles: three from Pentelic (cat. 5. 9. 20), four from Paros 2 (cat. 2. 3. 7. 16), two from Paros 1 (cat. 18. 21), one from Göktepe (cat. 26), another from Naxos (cat. 35; fig. 3) and another probably from Afyon (cat. 19). Only four ancient sculptures (cat. 4. 8. 27. 37) turned out to be from the Luni-Carrara quarries, all of them belonging to early periods from the end of the Republic to the first half of the 2nd century, indicating the preference in the 2nd and 3rd centuries AD for Greek and Asia Minor marbles[79].

Multimethod analyses of marble and patinas are crucial in the equivocal field of study of sculptures belonging to antiquarian collections. We calculated that the study of the set of works

[79] This is in agreement with the results obtained with a set of marble sarcophagi from the Museo Nazionale Romano in Rome, see Van Keuren et al. 2011, 167.

Cat.	Museum Inv.	Sample	Object	VE	OM	CL	CO-Isotopes	Material	Ancient or Modern
1	MAC-7482	BCN-0540	Male portrait	x	x	x	x	Luni-Carrara	A (?)
2	MAC-7585	BCN-0536	Male portrait	x	x	x	x	Paros 2	A (?)
3	MAC-7584	BCN-0544	Augustus' portrait	x	x	x	x	Paros 2	A (?)
4	MAC-7586	BCN-0556	Male portrait	x				Carrara	A
5	MAC-19.057	BCN-0538	Polycletian ideal head	x	x	x	x	Pentelic	A (core)
6	MAC-19.030	BCN-0535	Ideal male head	x	x	x	x	Luni-Carrara	M
7	MAC-15.098		Ideal male head	x				Paros (?)	A
8	MAC-19.041		Harpocrates torso	x				Luni-Carrara	A
9	MAC-19.604	BCN-1487	Ideal female head	x	x	x	x	Pentelic (?)	A
10	MAC-7579	BCN-0552	Hadrian bust	x	x			Luni-Carrara	M
11	MAC-7577	BCN-0550	Domitian bust	x	x			Luni-Carrara	M
12	MAC-7580	BCN-0551	Antoninus Pius bust	x	x			Luni-Carrara	M
13	MAC-7581	BCN-0546	Otho bust	x	x			Luni-Carrara	M
14	MAC-7575	BCN-0553	Unknown emperor bust	x	x			Luni-Carrara	M
15	MAC-7576	BCN-0560 BCN-0559	Pseudo-Vitellius head Pseudo-Vitellius bust	x	x			Luni-Carrara Luni-Carrara	M M
16	MAC-7578	BCN-0548 BCN-0548-R BCN-0547	Lucius Verus head Lucius Verus head Pseudo-Vitellius bust	x x x	x x x	x	x	Unrepresentative Paros 2 Lefkes Luni-Carrara	 A M
17	MAC-7583	BCN-0558	Caracalla's portrait	x	x	x	x	Unrepresentative	A
18	MAC-7573	BCN-0543	Philosopher's head	x	x	x	x	Paros 1	A
19	MPrado E-14	MDR-1087	Zeno's head on a modern herma bust	x	x	x	x	Afyon (?)	A
20	MPrado E-23	MDR-1088	Miltiades' head on a modern herma bust	x	x	x	x	Pentelic	A
21	MPrado E-25	MDR-1089	Lysias' head on a modern herma bust	x	x	x	x	Paros 1	A
22	MPrado E-204	MDR-1090	Marble medallion	x	x	x	x	Luni-Carrara	M
23	MPrado E-252	MDR-1091	Marble medallion	x	x	x	x	Luni-Carrara	M
24	MPrado E-306	MDR-1092	Marble medallion	x	x	x	x	Prokonnesos	M
25	MPrado E-310	MDR-1093	Marble medallion	x	x	x	x	Luni-Carrara	M
26	MPrado E-379	MDR-1094	Caracalla's bust	x	x	x	x	Göktepe (?) (core head)	A
27	MAC-44.056	BCN-0532	Male portrait broken	x	x			Luni-Carrara	A
28	MAC-7571	BCN-0545	Nero's head	x	x	x	x	(?)	M
29	MAC-7572	BCN-0537	Male head	x	x	x	x	Luni-Carrara	M
30	MAC-7574	BCN-0541	Male portrait herma	x	x			Luni-Carrara	M
31	MAC-19.029	BCN-0542	Female portrait head	x	x			Luni-Carrara	M
32	MAC-19.029		Male portrait head	x				Carrara	M
33	MAC-9581	BCN-0534	Female portrait head	x	x			Luni-Carrara	A
34	MAC-9584	BCN-0539	Male portrait bust	x	x			Montjuïc stone-ware	A
35	MAC-15.090	BCN-0557	Female portrait head	x	x	x	x	Naxos	A
36	MAC	BCN-0554	Female bust	x	x			Luni-Carrara	(?)
37	MAC-15.089		Female portrait head	x				Carrara	A
38	MAC-7595	BCN-0549	Female bust	x	x			Luni-Carrara	M
39	MAC-9524	BCN-555	Sarcophagus	x	x			Luni-Carrara	M

Table 1 List of sculptures analysed, methodologies used and determination of their material, and ancient or modern origin. Abbreviations: MAC = Museu d'Arqueologia de Catalunya; MPrado = Museo Nacional del Prado; VE = visual examination; OM = optical microscopy; CL = cathodoluminescence

presented here contributes 59 % to verifying the results obtained using other archaeological-artistic approaches, lending a certain solidity to the conclusions reached. A total of 31 % of the results were decisive in determining the antiquity or modernity of the pieces, and in 10 % of the cases they may be determinate in future studies. Analysis of the patinas also provided new data to advance the knowledge of the contexts of conservation and use of these works, and in the ways to proceed in terms of reusing ancient marbles to produce modern sculptures.

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THE PORPHYRY OBELISK

A ROMAN MONUMENT OF CONSTANTINOPLE

Abstract
In Late Antiquity, Roman stonemasons carved a monolith out of the hardest, rarest and most precious of stones the empire could access – the Porphyry Obelisk erected in Constantinople in the Theodosian period. While the fragmentary remains of the obelisk remain in Istanbul, the monument has largely eluded comment; unearthed in the 19th century, its provenance was unknown. Only in the 20th and 21st centuries have other parts been rediscovered and the obelisk's inscribed pedestal identified and connected with a record of the inscriptions in the »Greek Anthology«. Its likely position in the cityscape at the Capitolium has been established and mentions of it in other Byzantine texts recognised. Like the column monuments of Constantinople and Rome, obelisks were erected in both Roman capitals for emperors who wanted to demonstrate their *virtus*. Like all-purple clothing, porphyry monuments were the preserve of emperors, yet the dedicatory inscription on the Porphyry Obelisk mentions a eunuch foreigner beneath the name Theodosius, and obelisks are Egyptian forms. It calls Constantinople »Rome« and describes its surroundings as a ›museum‹, probably the Byzantine university. The Porphyry Obelisk joined the spolia Tetrarchic statues now in Venice standing in an area known as the Philadelphion – on the major fork of the Mese thoroughfare and a *scena* for imperial self-fashioning. Here the Capitolium stood in for the Capitoline hill itself, where the rites of triumph were concluded. The Porphyry Obelisk, an imperial object with a non-imperial inscription, concentrates cultural associations of place, colour, *Romanitas*, and *imperium* in a single landmark.

The Porphyry Obelisk was probably the single largest monolith ever to be carved from porphyry. In the late 320s, the Emperor Constantine the Great had constructed the Column of Constantine in the forum of his newly eponymous city's urban plan. This monument – which survives *in situ* in substantial form – is the largest monument constructed of porphyry. The second largest porphyry monument ever made also stood in a focal area of the Constantinian city, but unlike the Column of Constantine – which is of colossal column drums – the Porphyry Obelisk was a porphyry monolith of nearly 12 m, the largest ever known. It was also the only known obelisk in porphyry, which is the most expensive type of stone listed in the Diocletianic price edicts. Porphyry is the hardest stone known to the ancient world, extracted under the most difficult conditions in a remote area of the Eastern Desert of Egypt.

As well as the practical difficulties involved, the symbolic value of porphyry was extremely high given the value placed upon the colour purple during antiquity, which was enhanced by the unique quality of purple dye for colourfastness – the dye derived from murex sea-snails was the only dye known to the ancients which did not fade or wash out over time and which was itself extremely labour intensive and costly to produce. Similarly, the extreme hardness and durability of porphyry means that it can take and retain a high polish which would have endured weathering and discolouration far better than comparable monuments of limestone, marble, or even bronze. As such, a porphyry monolith was among the most impressive and desirable types of monuments that an imperial patron could hope to commission. With this in mind, I now turn to the Porphyry Obelisk itself, on which I hope to summarise the developing literature and to note where scholarship has erred concerning this unique monument.

The largest surviving fragment of the obelisk is now in the garden of the Istanbul Archaeological Museum, where it has been for the past century (inv. 3195; fig. 1 a–b). The fragment has not

1 a–b Middle fragment of the Porphyry Obelisk inv. 3195 in the garden of the Istanbul Archaeological Museum (December 2019) (photos: G. Pinkerton)

always been recognised as an obelisk; its landmark presence in the skyline of Constantinople is becoming known belatedly.

In the 19th century, the director of the Constantinople Imperial Museum, Philipp Anton Dethier, thought that this fragment was one of the objects mentioned by the Greek historian Eusebius as having been set up in the Mausoleum of Constantine[1]. Dethier identified the obelisk as one of the twelve stelae (θήκας) representing the Twelve Apostles referred to in Eusebius' »Life of Constantine«[2].

In the middle of the 20th century Philip Grierson dismissed this idea: he thought Eusebius' description obscure and cryptic, pointing out that other witnesses do not corroborate his testimony: »Its description in the *Vita Constantini*, however, must be written off as fable. The twelve ›coffins as it might be sacred pillars‹ (θήκας ὡσανεὶ στήλας ἱερας) which flanked the sarcophagus of Constantine correspond to nothing about which we hear from subsequent writers, and it is difficult even to envisage what such a phrase, which sounds like a stage direction for Mozart's *Magic Flute*, can mean.«[3]

1 Dethier 1881, 18.
2 Eus. vita Const. 4, 60, 3 *apud* Winkelmann 1975, 144 f.
3 Grierson 1962, 5.

a b c

2 a–c Holes for metal staples at the broken lower edge of the Porphyry Obelisk's middle fragment (December 2019) (photos: G. Pinkerton)

Some years later, the Egyptologist Erik Iversen wrote of the Porphyry Obelisk: »No published record informs us as to the exact finding-place of the obelisk; but the authorities of the Archaeological Museum assure me that it came from the cache in the second court of the Seraglio.«[4]

Fifty years later, I too received the same assurances. This cache to which Iversen referred is a buried collection of ancient objects discovered in the 1856–1857 excavations in the second courtyard of the Topkapı Sarayi, revealing four imperial porphyry sarcophagi. The same place yielded two sarcophagus lids when excavated again in the second decade of the 20th century, and it is probable that the obelisk fragment came from the same place, though it seems no surviving document confirms this[5].

In the second decade of this century, the art historian Dario Del Bufalo published his monograph on porphyry. The Porphyry Obelisk hardly gets a mention – not even a whole page[6]. The only literature cited is the 1932 monograph by the classical archaeologist Richard Delbrueck. The entry in that work is itself only a single page: here he dismisses the idea that this obelisk is the one once purchased by a wealthy Venetian, Antonio Priuli, who intended to transport it to Venice but did not succeed, as recounted by the 16th-century author Pierre Gilles. Delbrueck points out that Gilles calls this obelisk »Theban stone«, which is his usual term for Aswan granite: Lapis Syenites[7].

Iversen concurred with this, adding that the obelisk dimensions recorded by Gilles are very different from those of the surviving fragment[8]. Iversen notes that several distinct obelisks are recorded in Constantinople, including the one monolith remaining *in situ*: the ancient Egyptian granite obelisk in the Hippodrome[9]. The characteristics of none of these match the Porphyry Obelisk fragment in the Archaeological Museum.

Iversen reasoned that the Porphyry Obelisk must have been brought to Constantinople before the burial of Marcian in 457, because Marcian was the last emperor known to have been buried in a purple porphyry sarcophagus (reports of later emperors' burials in such sarcophagi are not reliable)[10]. After having been found – probably in the Topkapı – the obelisk fragment moved to Hagia Irene in 1846. It was in the original museum collection established there by Fethi Pasha, Ottoman general of artillery. It came to its current site in the Istanbul Archaeological Museum in 1916[11].

4 Iversen 1972, 41.
5 Dumont 1868, 237–239.
6 Del Bufalo 2018, 198 fig. C114.
7 Delbrueck 1932, 145 f. fig. 60.
8 Iversen 1972, 48 f.
9 Iversen 1972, 9–50.
10 Grierson 1962, 45 f.
11 Iversen 1972, 41.

Where it was before that was long a mystery. Following Dethier and Delbrueck, Iversen reckoned it may have been near the Church of the Holy Apostles[12]. Both the obelisk and the imperial porphyry sarcophagi which were once inside the church broke and underwent repairs using lead and metal staples (fig. 2 a–c). Iversen tried to explain the silence of Byzantine sources on the obelisk's construction by attributing it to the Emperor Julian, whose achievements Christian sources preferred to ignore: »If as a mere guess, and irrespective of any connection with the sarcophagi, we assume that the obelisk had in fact been raised by Julian, the silence of contemporary sources respecting it would find a natural explanation in the reluctance of Christian authors to defile their mouths with the name of the Apostate.«[13]

Traces of similar repairs exist on the lower edge of the obelisk fragment in the gardens of the museum. It seems to have been Iversen, in his work on obelisks, who was first to point out the uniqueness of this Porphyry Obelisk, and he notes that there is no record of it having been erected anywhere else (in Egypt or in Rome) and there is little chance that it came to Constantinople before the imperial court settled there. Iversen therefore established a window for the obelisk's quarrying between the foundation of Constantinople in the reign of Constantine and the reign of Marcian.

Iversen thought the quarrying ceased in the mid-5th century and was connected with the religious schism with Egypt brought about by the Council of Chalcedon, following the hypothesis of Alexander Vasiliev[14], writing that »[i]t is therefore no coincidence that the last Byzantine Emperor to be buried in a sarcophagus of porphyry was the Emperor of the Council, Marcian (450–457). The years 330 and 457 represent, therefore, the absolute dates post et ante for the arrival of the obelisk in Constantinople«[15].

More recently, Del Bufalo proposed an earlier date for the closure of Mons Porphyrites. Del Bufalo's thesis is that religious reforms under Constantine had put an end to large-scale quarrying and that Mons Porphyrites had been exploited by the Ptolemies, from whose tombs in Alexandria the late Roman emperors had extracted porphyry sarcophagi for reuse in Constantinople[16]. This is not a convincing theory for several reasons, and it cannot explain the origins of the obelisk.

In spite of more recent work, Del Bufalo follows Delbrueck's thesis of Ptolemaic exploitation of Mons Porphyrites, relying on a handful of porphyry sculptures in Pharaonic style, a literary description of Cleopatra's dining room, a Hellenistic inscription on a porphyry tablet now in the Louvre and a lost Coptic manuscript mentioning porphyry monuments to the Ptolemaic kings around the tomb of Alexander the Great[17].

However, all pre-Roman porphyry sculpture and decoration is small-scale, not necessarily quarried but carved from individual loose rocks[18]. There are only insecure dates for these sculptures; and there are many Roman examples of ›Egyptian objets d'art‹. Cleopatra's dining room is known only from Lucan's »Pharsalia«[19], which is not a contemporary work and not intended literally. The porphyry Hellenistic inscription is a Renaissance fake, recognised in the 2000s. The inscription is genuine, but poorly copied from a marble original[20]. The lost Coptic manuscript of which Giuseppe Botti published a French translation in 1897 is a confused reference to »Pompey's Pillar« – atop which was a porphyry statue of Diocletian. As Del Bufalo himself admits, this confusion was pointed out by Hermann Thiersch in 1910[21]. Neither has Botti's supposition that the text was a fragment of the work of Chaeremon of Alexandria been sustained; in

12 Dethier 1881, 12. 18; Delbrueck 1932, 146; Iversen 1972, 41–43.
13 Iversen 1972, 44 n. 5.
14 Vasiliev 1948, 25 f.
15 Iversen 1972, 40 f.
16 Del Bufalo 2018, 14–19. 73–82.
17 Del Bufalo 2018, 14–19.
18 Maxfield – Peacock 2007, 5 f.
19 Lucan. 10, 111–116.
20 Cuvigny – Vagenheim 2005.
21 Botti 1897, 43; Thiersch 1910, 78 f.; Del Bufalo 2018, 17.

the 1932 edition of Chaeremon's remaining fragments, the French text was published only as a *fragmentum dubium* and it was left out of the 1983 edition altogether as having »no relation whatsoever« and »nothing to do with our author«[22]. Given the mention of the Diocletianic »Pompey's Pillar«, this purported witness of Ptolemaic porphyry sarcophagi around the tomb of Alexander – relied on by Delbrueck and Del Bufalo – is too late to be reliable for the Hellenistic period; the Late Antique author may even have had in mind the Column and Mausoleum of Constantine as the contemporary model of a superlative dynastic tomb and imperial monument. Botti himself stated that the exploitation of Mons Porphyrites's quarries started in the 1st century AD, judging there to be no evidence of major porphyry works from Pharaonic or Ptolemaic times[23]. In short, evidence is lacking that porphyry quarrying on the scale of sarcophagi, column shafts and the Porphyry Obelisk was ever undertaken before the Roman Imperial period.

Del Bufalo's ideas would mean the Porphyry Obelisk is contemporary with, or older than, the foundation of Constantinople. The closure of Mons Porphyrites would have happened at the start of Constantine's reign in the east. The Porphyry Obelisk would have to have existed before that time. Del Bufalo's erroneous thesis would open the possibility that the Porphyry Obelisk is of earlier Roman, Hellenistic, or even Pharaonic manufacture – it would be Constantinian-era spolia, not a monument of Late Antiquity in its own right, but Del Bufalo himself states the monument is of »Constantinian« date[24].

The archaeological excavations and surveys undertaken in the 1990s suggest Mons Porphyrites continued to function until at least the first quarter of the 5th century[25]. Del Bufalo's thesis about the early 4th-century closure of the quarries and the Alexandrian origin of the sarcophagi in Constantinople is therefore without foundation.

According to the excavators, there is no evidence the quarries worked before the Roman period. All pre-Roman porphyry objects are small and could have come from stray boulders of porphyry washed down the »wadi« or found on the surface. No evidence is known of a Ptolemaic quarry at Mons Porphyrites[26]. Iversen's date range (330–457) for the Porphyry Obelisk's production in Late Antiquity is therefore plausible. Returning to the obelisk, Iversen wrote: »It is therefore one of the numerous enigmas of the obelisk tradition that, in spite of the impressive dimensions which must have made it a conspicuous landmark in the city, it is not mentioned in any topographical or descriptive work until the middle of the 19th century, when a fragment of its shaft was discovered somewhere in the city, probably in the grounds of the Seraglio.«[27] »[…] the effort to trace the obelisk through the first 1400 years of its existence is like pursuing a phantom, for as a tangible archaeological object it does not appear until about 1846, when a badly damaged portion of its shaft was among the monuments which the military founder of Turkish archaeology, the artillery general Fethi Pasha, brought together in the Church of St. Irene.«[28]

The embryo of the museum collection, including the obelisk fragment and other stone and porphyry monumental items including imperial sarcophagi, was positioned in front of Hagia Irene[29]. Iversen wrote: »We have seen that it has generally been taken for granted that no records of the monument existed until the middle of the last century, when the monument itself cropped up, as it were, from nowhere. It is therefore surprising to find in a by no means unknown or obscure, and, in retrospect at any rate, fairly obvious sixteenth century source, what appears to be tangible pictorial evidence of both fragments.«[30]

22 Schwyzer 1932, 56; van der Horst 1987, XIV n. 24.
23 Botti 1897, 86–88.
24 Del Bufalo 2018, 198.
25 Maxfield – Peacock 2007, 414. 426.
26 Maxfield – Peacock 2007, 5 f.
27 Iversen 1972, 39.
28 Iversen 1972, 41.
29 Ebersolt 1921, 5 pl. 25.
30 Iversen 1972, 49.

By this, Iversen means the works of a fellow Dane: the artist Melchior Lorck, who was in Constantinople between 1555 and 1559. In his engravings of Constantinopolitan scenes now in the National Gallery of Denmark, Lorck includes details such as an obelisk fragment which bears the date of the artwork (inv. KKSsgb11623). Iversen identified that this fragment, broken at both ends, has a characteristic pattern of damage which bears comparison with the real fragment of the Porphyry Obelisk in the Istanbul Archaeological Museum. There is the same pattern of damage, with a large chip missing on either side.

Broken obelisks were a common feature of Lorck's depictions of Constantinople and its people. Lorck also adds pyramids – commonly conflated with obelisks in his day – and he also depicts an obelisk with hieroglyphs (inv. KKSgb8219) and the Obelisk of Theodosius in the Hippodrome, which he twice depicts without its hieroglyphs (inv. KKSgb8188; inv. KKSgb6142). Iversen identified the depiction of the obelisk fragment in a horseman's portrait (inv. KKSsgb11623) as representing the Porphyry Obelisk's middle section; he reasoned that »[w]hen seen by Lorck, the apex was therefore already broken off« and »[w]e must either imagine that the obelisk is purely imaginary and that Lorck in order to fill in the empty space between the head of the horse and the ground invented a broken obelisk or assume that it is copied from an object seen by the artist«. Another equestrian portrait (inv. KKSgb11624) also has an obelisk fragment as decoration. In that image the apex of the Porphyry Obelisk is distinguishable together with hieroglyphs added by Lorck's imagination, just as he had also removed hieroglyphs from the Obelisk of Theodosius.

Iversen's most crucial contribution concerns the Revan Kiosk at the Topkapı Sarayi. He identified the missing apex of the obelisk reused as spolia by the Ottomans (figs. 3–4). Iversen used the principles of obelisk construction to determine mathematically the size of the original monolithic obelisk, using the dimensions of the apex fragment in the Revan Kiosk wall and the surviving middle fragment in the Archaeological Museum. He calculated that it was just under 12 m tall[31].

At the beginning of the present century, Denis Feissel identified that this obelisk was in fact – contrary to what Iversen had written thirty years earlier – mentioned in three major Byzantine texts: the »Patria Constantinopoleos«, the »Chronicon Paschale« and the »Parastaseis syntomoi chronikai«. Feissel identified the monument as Theodosian, and not Constantinian in date[32]. It is now understood that the Porphyry Obelisk, because its inscription mentions the name Theodosius, must have been set up at the Capitolium in the time of Theodosius I, because it is to be identified with »Christ's emblem on the Capitol« mentioned in the Egyptian »Chronicon Paschale« for the year 407: »In this year there was great rain with thunder and lightning and earthquake [...] Christ's emblem on the Capitol fell down, and many ships foundered [...].«[33]

Further literary references to the Porphyry Obelisk all attribute its construction to Constantine the Great and connect it with the saint-emperor's famous visions and dreams. As Averil Cameron and Judith Herrin write, Constantine was »known as a great builder, and the temptation to credit him with otherwise unattributed building was irresistible«[34]. According to the medieval texts, the gilt bronze *crux gemmata* is set on top of the monolith to commemorate a vision. As Feissel noted, the »Parastaseis syntomoi chronikai« say: »In the region of the so-called gate of the Philadelphion, Constantine had a dream. There first of all he saw the sign (typos) of the cross, and he set it up, as he saw it, in the same length and breadth, on a four-sided porphyry column. He gilded it and fixed a sign (semeion) of a sponge at the feet (sic) of the cross.« »He honoured himself and his mother Helena and his sons, setting up ›statues‹ of them on thrones beside the four-sided column.«[35]

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31 Iversen 1972, 46–49 pl. 1.
32 Feissel 2003, 500.
33 Chr. pasch. 296 *apud* Dindorf 1832, I 570; Whitby – Whitby 1989, 60 f.
34 Cameron – Herrin 1984, 192.
35 Parastaseis syntomoi chronikai 58. 70 *apud* Cameron – Herrin 1984, 134 f. 150–153.

3 Porphyry spolia in the walls and arcades of the Revan Kiosk in the Topkapı Sarayi (May 2022) (photo: G. Pinkerton)

4 Apex fragment of the Porphyry Obelisk in the western wall of the Revan Kiosk in the Topkapı Sarayi (May 2022) (photo: G. Pinkerton)

Feissel points out that this »four-sided porphyry column« can only be the Porphyry Obelisk[36].

The Middle Byzantine »Life of Saint Constantine« edited by Michelangelo Guidi in 1907 also states that it was Constantine who set up a stylite cross on a column at the Capitolium (established in the Constantinian period and alternatively known as the Philadelphion), one of three such crosses in Constantinople attributed to the city-founder by the anonymous hagiographer: »[…] he made three crosses out of pure bronze, after the pattern of the three visions, and gave them the following altogether sacred names: Jesus, Christus, Conquer! […]. The cross called Christus, holy and to be revered by all, he fixed on top of a pillar of Roman marble in the Philadelphium, and it still stands today in the same place.«[37]

The »Roman marble« alluded to is purple porphyry; »Roman marble« was a Greek synonym for porphyry in the Middle Ages. The cross's name in this text recalls the »emblem of Christ« phrasing from the »Chronicon Paschale«. Luke Lavan has suggested that the Porphyry Obelisk originally had a *XP* on it which fell down in 407, and only later bore a cross[38].

36 Feissel 2003, 506.
37 Life of Saint Constantine 33 *apud* Guidi 1907, 650; Lieu – Montserrat 1996, 138 f.
38 Lavan 2021, 494.

Another reference to the Porphyry Obelisk identified by Feissel is the »Patria of Constantinople«, which similarly associates the cross at the apex with Constantine: »On the cross of the Philadelphion – Saint Constantine set up the cross, gilded with precious stones and glass, and in accordance with the cruciform figure he had seen in the sky, on a column in the Philadelphion. And he made statues of his sons next to that porphyry column, showing them seated on a throne. He made relief pictures of his deeds on that column, and Latin inscriptions which indicate the final days. It stands opposite his two sons who are seated on a throne, and the others who embrace each other.«[39]

As Feissel recognised, the »Patria of Constantinople« mentions both the Porphyry Obelisk and the embracing statues that gave the place its name – the place of brotherly love – and which in all probability were the porphyry statues which since the mid-20th century have been recognised as stylite statues from the Tetrarchic period taken as spolia after the Fourth Crusade from Constantinople, where they were already second-hand[40].

Near the Laleli Mosque, the archaeologist Alfons Maria Schneider discovered in 1930 and published in 1940 an inscribed marble pedestal (Hagia Sophia Museum, inv. 145; fig. 5). He found it close to the site of the Capitolium-Philadelphion of Constantinople[41]. This inscribed pedestal was identified by Feissel as the monumental base of the Porphyry Obelisk. As the »Patria of Constantinople« says, it had a Latin inscription (as well as Greek ones), though the inscriptions said to be »on that column« are in fact on the base; inscriptions on porphyry itself are very rare. Schneider found it near the location of the Capitolium, where the Mese bifurcated. Standing on this pedestal, the Porphyry Obelisk's height would have been over 14 m[42].

As Feissel realised, the complete text of the otherwise illegible fragmentary Greek inscription is in fact preserved in the »Greek Anthology«. The scribe has labelled it as being »On the Porphyry Column in the Philadelphion« – in truth, on its marble base. In English translation it reads: »Muselius is a well-wisher of the Emperor. Public works proclaim it; the force of facts is strong. He presented Constantinople with a museum and with a splendid painting of the sovereign inside, an honour to poets, an ornament of the city, the hope of youth, the instrument of virtue, the wealth of good men.« »These works did Muselius cheerfully dedicate to words, in pure belief that God is the Word. He built parts of the museum himself, and other parts which were in danger of falling he saved and set them up firmly.«[43]

Muselius was grand chamberlain (*praepositus sacri cubiculi*) in the early reign of Theodosius II, meaning that the inscription concerning him and these restoration works was added to the Porphyry Obelisk between 409 and 419 – the dates within which Muselius is known to be in office[44]. With an Armenian name and possible status as a eunuch, he was likely a non-Roman[45]. Jean-Pierre Mahé suggested he may even have been a noble hostage sent to court by one of the Armenian families, even from the Mamikonian dynasty, among whom the name Mušel is well attested[46]. The Porphyry Obelisk's Greek inscription actually names the surrounding city – Constantinople, as in the translation quoted above – as »Rome«. It is striking that a major monument of »Roman marble« also describes itself as being in »Rome« and having been dedicated to Rome by a non-Roman. The form of the obelisk too is itself exotic, displaying the grandeur and extent of the *imperium*.

As Feissel has reasoned, the Porphyry Obelisk was, together with its inscription, repaired and set up again – nominally by Muselius but surely at the emperor's behest – as part of the renovation of the Byzantine Capitolium after the damage in 407 recorded by the »Chronicon Paschale«.

39 Patria Constantinopoleos 2, 48–50 *apud* Berger 2013, 82–85.
40 Delbrueck 1932, 84–91; Feissel 2003, 504 f. 507–509; Del Bufalo 2018, 96 fig. C50; 177 fig. C2.
41 Feissel 2003, 497; Lavan 2021, 494.
42 Feissel 2003, 507.
43 Anth. Gr. 9, 799–801 *apud* Paton 1917, 430 f.
44 Lavan 2021, 494.
45 Feissel 2003, 512–515.
46 Feissel 2003, 522 f.

Preserved in the Codex Theodosianus are extracts of a 425 law by Theodosius II on the university system which link the Theodosian restoration of the Capitolium as the Byzantine seat of public education with Muselius's inscription about the restoration of the premises. The repaired obelisk, with new inscriptions commemorating its restoration, stood at the complex known as the Capitolium and now also called the »museum« (the Muses being appropriate for a place of learning), attested later as »Helicon«, and finally known as the Philadelphion[47].

Since Feissel identified these verses as having belonged to the Porphyry Obelisk monument, reconstructions have appeared proposing how this obelisk may have looked in its original context in front of the Capitolium building. A digital architectural reconstruction by Pelin Yoncaci-Arslan shows the obelisk at full height midway along the main street of Constantinople, the Mese[48]. Confusingly, Lavan's discussion of it repeatedly refers to the inscribed pedestal as porphyry, but unlike the obelisk itself, the base is ordinary marble[49]. Del Bufalo – ignoring Iversen and Feissel – erroneously reconstructs the apex fragment in the Revan Kiosk wall as part of the Porphyra[50]. I suspect other obelisk parts were reused in the city's Ottoman mosques.

5 Pedestal of the Porphyry Obelisk inv. 145 in the garden of Hagia Sophia (May 2022) (photo: G. Pinkerton)

When the Porphyry Obelisk and the Venice tetrarchs on their columns were all three in the same place in Constantinople, they would have been a formidable display of imperial *virtus*, an unrivalled collection of imperial purple porphyry megaliths. Their location together at this monumental ensemble has led to confusion.

Urs Peschlow has shown that a large porphyry fragment in the cloister of Sant'Apollonia was formerly part of one of the two columns, as well as the nearby »Pietra del Bando«[51]. The »Pietra del Bando« – a porphyry column fragment – was recognised by Delbrueck as having come from the porphyry column to which one of the embracing tetrarch pairs was attached, which he calculated had a diameter of around 80 cm based on the curvatures of the fragments attached to the

47 Feissel 2003, 510 f. 515–521; Cod. Theod. 14, 9, 3; 15, 1, 53.
48 Yoncaci-Arslan 2018, 19 fig. 13 a.
49 Lavan 2021, 494.
50 Del Bufalo 2018, 31 fig. 28; 200 fig. C124.
51 Niewöhner – Peschlow 2012, 343–345.

backs of the statues[52]. In the same publication, Philipp Niewöhner argued that the Porphyry Obelisk was cut from one of the two columns to which the Venice tetrarchs were once attached[53]. This has been accepted by authorities like Albrecht Berger[54], but it is certainly untrue.

Cut from the base end of a column, the »Pietra del Bando« is 2.8 m in circumference and around 89 cm in diameter[55]. The obelisk fragment in the Istanbul Archaeological Museum is 114–115 cm broad at its lower edge[56]. In its original form, the obelisk must have been about 130 cm broad at its base[57]. The Porphyry Obelisk was also taller than the Venice tetrarchs' columns. Rightly assuming the Venice tetrarchs attached to monolithic columns, like those in the Vatican Library, Delbrueck and Paolo Verzone both reasoned that the Venice tetrarchs attached to columns around 7 m tall. They estimated the overall heights of the Venice tetrarchs' original monuments as 10–12 m, with their bases[58]. Even this height is still less than the Porphyry Obelisk monolith's height as calculated by Iversen: 11.98 m. Furthermore, the apex fragment in the Revan Kiosk wall is 130 cm broad[59]. The smallest surviving piece of the Porphyry Obelisk is bigger than the largest piece of the Venice tetrarchs' monument, and this refutes Niewöhner's proposal that Byzantine masons carved the obelisk from a column smaller than itself; it is impossible that they made the Porphyry Obelisk from the Venice tetrarchs' column monument in Constantinople.

The likely explanation for the obelisk's existence is that craftsmen made it who were apprised of the formula recommended by custom for the design of obelisks and that it came to Constantinople directly from Mons Porphyrites at imperial behest in the time of Theodosius I. As with imperial column monuments in Rome and in Constantinople, emperors erected obelisks in both capitals, wanting to demonstrate their *virtus*. The Capitolium was itself a site dedicated to Rome's own sacred hill, where triumphs were celebrated[60]. With the Byzantine Capitolium's labelling of Constantinople as »Rome« by the most conspicuous of its many monuments, the restoration works of Theodosius II in the early 5th century (under Muselius's direction) celebrated *romanitas* even further, inscribing on the Porphyry Obelisk's base the empire's name and asserting the city's status as Rome's equal. The legends which became attached to the Porphyry Obelisk and its monumental cross, omitting the Theodosian saint-emperors, remembered it as a relic of the victorious conversion of Constantine to Christianity, as an enduring wonder attesting the divinely guided destiny of Constantine's city and *imperium*, and as a monument of imperial purple »Roman marble«.

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52 Delbrueck 1932, 86.
53 Niewöhner – Peschlow 2012, 358–363.
54 Berger 2021, 34.
55 Niewöhner – Peschlow 2012, 350 f.
56 Delbrueck 1932, 145; Iversen 1972, 46–48; Niewöhner – Peschlow 2012, 359.
57 Iversen 1972, 48.
58 Delbrueck 1932, 86; Verzone 1958, 11.
59 Iversen 1972, 46–48.
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PIGMENTS AND PAINTINGS ON MARBLE

Patricia A. Butz

ENCAUSTIC PAINTING ON MARBLE STATUARY

HARD (OR NOT SO HARD) EVIDENCE FROM THE GROUP OF BOSTON 00.348 COLUMN KRATER (MMA 50.11.4)

Abstract
This paper presents the column krater attributed to the Group of Boston 00.348, dated ca. 360–350 BC, in the collection of the Metropolitan Museum of Art (inv. 50.11.4). The Apulian vase is most famous for its subject matter on the obverse side: a statue of Herakles, believed to be made out of white marble, in the process of being painted by an artist. The once-controversial subject of whether ancient stone sculpture was painted or not should have been answered definitively when this vase was first discovered, since the act of painting is actually shown, hence making it a metatext. This paper argues, however, for the lion-skin being the only definite recipient of the encaustic technique. In view of the fact that the vase has largely been used to explicate the encaustic method and its tools, it has been underdiscussed, even lightly published in its own right, as I stated in the book of abstracts for the ASMOSIA XIII conference. In this paper, what it means to paint on stone is the focus as well as how this remarkable composition can be interpreted transformationally, thanks to the mixed media depicted. Coloured and variegated marbles and other stones have long been of interest to papers presented at ASMOSIA conferences, myself included, as in a previous contribution on Greco scritto marble. Although not the subject of this paper, coloured stone should be kept in mind as relevant to these larger issues. The materialism of colour itself is the subject of much discussion right now, and the Metropolitan Museum of Art's column krater is used to introduce the first chapter, entitled »Material Color, Language, and Khroma«, of Jennifer Stager's 2022 study, »Seeing Color in Classical Art. Theory, Practice, and Reception from Antiquity to the Present«. The paper concludes with the theory that the apotheosis of Herakles happens through encaustic treatment, activated by the artist and in the sight of the gods.

INTRODUCTION

To say that the subject of this paper, the red figure column krater depicting the painting of a statue of Herakles from the collection of the Metropolitan Museum of Art (MMA) in New York and attributed to the Group of Boston 00.348, is underdiscussed might well be disputed (fig. 1). No fewer than 63 references are currently listed on the MMA's object page for the Late Classical vase, attesting to its importance for the archaeological record and as evidence of painting on stone[1]. The first entry is the 1946 PhD dissertation of Phyllis Williams Lehmann, dealing with the occurrence of the »contrapposto« statue type seen on the vase as it appears on coins[2]; the 2021 publication by Sean Hemingway, »How to Read Greek Sculpture«, confirms the unique role of the vase in understanding Greek sculpture, and the list is ongoing[3]. The vase was included in the recent MMA exhibition, »Chroma: Ancient Sculpture in Colour«, on view from 5 July 2022 to 26 March 2023, although no catalogue was produced for the show[4]. Yet the majority of these references are short,

1 The MET, Terracotta column-krater (bowl for mixing wine and water), <https://www.metmuseum.org/art/collection/search/254649> (30.06.2023).

2 Lehmann 1946, 53.

3 Hemingway 2021, 35 f. 142 fig. 21; to be added is Stager 2022.

4 For the Chroma exhibition, see <https://www.metmuseum.org/exhibitions/chroma> (30.06.2023); for the two-day symposium held on 24–25 March 2023, see <https://www.metmuseum.org/events/programs/met-speaks/symposia/chroma> (30.06.2023).

1 Obverse side of the red figure column krater attributed to the Group of Boston 00.348, ca. 350–360 BC (MMA, inv. 50.11.4). Encaustic painting of a statue of Herakles (photo: © MMA, New York)

and the information often revolves around the subject of encaustic painting, its materials and process, because the equipment for the technique is also part of the vase's decoration.

That technique was very well explicated in Dietrich von Bothmer's inauguratory article entitled »Enkaustes agalmaton«, written for the MMA Bulletin in 1951, one year after the acquisition of the vase. Von Bothmer translates the title of his article as »painter of statues« crediting Plutarch[5], but his translation should really be »encaustic painter of statues«. The title is very important because encaustic is a painting technique that primarily uses wood as the carrier, not stone[6]. I mention this at the outset because what one sees on this vase is the painter, identified by

5 von Bothmer 1951, 156: »ἀγαλμάτων ἐγκαυστής«, but he does not cite Plutarch directly; see LSJ, s. v. ἐγκαυστής, ὁ for the definition »encaustic painter« (Plut. mor. 2, 348f).

6 The most important ancient source for the technique is Plin. nat. 35, 41, who says that in ancient times (i.e. referencing

the cap and exomis[7], painting not the statue but the lion-skin of Herakles. It is conceivable that the lion-skin was not made of stone but is a different material, perhaps a cut textile or a pelt rubbed down to the skin, especially given the way the front paws are hanging free; they could easily be broken if made of marble. The artist may just be applying the finishing touches after the garment has been suitably draped. Looking closely, it is clear that he is working on a scumbled area which must be the mane of the lion[8]. The head of the lion with closed mouth is just below, painted with a very fine line and absorbed into the pattern. In short, the lion-skin could be executed in encaustic while the rest of the statue is handled differently. The bow under Herakles' arm, covered by the lion-skin garment and depicted in red, would be expected to be in bronze and is left in the red figure terracotta[9]. The sculpture has great potential to become a significant example of mixed media.

Given the fact that this is a vase and the reality of painting an actual statue is already filtered through a different medium, it is wise to be cautious on all points relating to technique and colour. It is very useful that the encaustic method being shown is accurate according to the ancient description, but we cannot be certain it was used on the statue per se. Von Bothmer clearly thinks of the whole as executed in encaustic but is aware of coloration being an issue: »It would have been interesting to see the painter work on the flesh of the statue, if only to settle once and for all the vexing question of its coloring.«[10] While there is also precious epigraphical evidence that helps support the encaustic painting of sculpture[11], it is rare. I propose that the technique needs to be carefully reconsidered, even if arriving at the conclusion the entire sculpture was executed in encaustic.

Von Bothmer goes on to explain the two-part process of encaustic painting: first, that the pigment is mixed with wax – Punic wax being specified in the ancient sources as giving special results – the paste then applied with a spatula, what Pliny calls a *cestrum*[12]; and second, that the

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the Greeks), there were only two types of encaustic: in wax and on ivory. The next stage was the employment of the technique for warships: caulking them with a brush using the melted wax mixture and ultimately decorating them. This is clearly the stage that leads to the painting of wooden panels that we know. In Plin. nat. 35, 39, Pliny discusses who invented the technique, a subject on which, he says, no one agrees. Again, he refers to the technique in two parts, this time painting in wax and in encaustic. Two tools are used, the cestrum or the graving pencil. Mention is made of Aristides and interestingly of Praxiteles, the latter bringing the technique to perfection, meaning that a sculptor could also become proficient in the technique, so the sculptor and the encaustic painter could be one and the same.

7 The garment the painter wears is an exomis. Maria Pipili (2000, 154) correctly describes the exomis with one shoulder exposed versus the loincloth, also the hat that workmen may wear. Clemente Marconi (2011, 150 n. 18) calls it only a loincloth of the type worn by craftsmen.

8 Dietrich von Bothmer (1951, 158) identifies it as such and is cited by Marconi 2011, 150.

9 See below for the same treatment of Athena's helmet on the vase, also presumed to be bronze.

10 von Bothmer 1951, 158. He is not speaking of the red figure terracotta that shows through the added white, of course, which is a sign of the wear and tear the latter is subject to. He must be referring to the yellowish coloration that Clemente Marconi also observed. Marconi (2011, 148) writes, »von Bothmer first suggested that the material of the statue is marble, based on the bright white color that covers most of the surface of the sculpture, and on the fact that this is being painted in the encaustic technique. Further support for this suggestion comes from the fact that the white and diluted yellow used on the statue are quite different from the uniform, dark yellow used for the brazier, the phiale, the bowl with the color [held by the artist], and the finial of Zeus' scepter, all meant to be bronze«. Marconi agrees that the whole statue is executed in encaustic.

11 LSJ s. v. ἀγαλματοποιός ἐγκαυστής, ὁ: IG XIV 1494 (Sicily, Italy, and the West); for IG XIV, see <https://epigraphy.packhum.org/book/26?location=1696> (08.07.2023). Inscription not available. LSJ s. v. ἀγαλματοποιὸς ἐγκαυτής, ὁ: IG I^2 374 = IG I^3 475 and IG I^3 476; for IG I^3 475, see <https://kb.osu.edu/handle/1811/99630> (08.07.2023); for IG I^3 476, see <https://kb.osu.edu/handle/1811/99895> (08.07.2023). Both are fragments of the building accounts of the Erechtheion, 409/408 BC and 408/407 BC, respectively. LSJ s. v. ἀγαλματοποιὸς ἐυκαυτής, ὁ: CIG 4958c; for CIG, see <https://inscriptions.packhum.org/book/122?location=1703> (08.07.2023). Inscription not available. The above attestations mean that the sculptor and the encaustic painter could be one and the same individual, a proposition tentatively suggested by Luigi Todisco and cited by Marconi (2011, 151 and n. 7).

12 von Bothmer 1951, 158, but no ancient reference for Punic wax is given, and Pliny is not specifically referenced for the *cestrum*. Lewis – Short s. v. cestrum (= κέστρον in Greek): a graver, graving tool used in encaustic painting, citing Pliny, Plin. nat. 35, 11, 41. LSJ goes further, see s. v. κέστρον: serrated implement used in encaustic painting, Plin. nat. 35, 11, 41.

paste is warmed and spread by applying a hot iron tool (τὸ ῥαβδίον, τὸ κατηρίον)[13], a set of which is being heated in the brazier by an assistant, identified by some scholars as a slave[14], to expertly spread the colour. It is for this reason, von Bothmer explains, that the artist's signature is sometimes known to read »so-and-so burned it in«[15].

There has been a strong resurgence in encaustic painting and artwork by contemporary artists in the last decades[16]. But one of the most notable ›revivals‹ in any period was by Josiah Wedgwood (1730–1795), consisting of a polychrome technique which could be combined with his famed basalt ware. Although not encaustic in the ancient sense because it did not include wax, heat was involved in the application of the colour, colour being Wedgwood's main interest in the whole experiment. It is important to emphasise, as von Bothmer ultimately did, that the word ἐγκαστικός means »burning in« and does not reference wax or colour. Wedgwood patented the method in 1769[17].

PURPOSE

It is the purpose of this paper in the context of ASMOSIA XIII and the broader subject of painting stone in antiquity to consider first the evidence provided by the Group of Boston 000.348 krater for the act of painting a 3D stone sculpture; and second, the materials and tools for the encaustic technique shown on the vase as direct catalysts to a larger meaning for both the sculpture and the ceramic. The 2011 article by Clemente Marconi, »The Birth of an Image. The Painting of a Statue of Herakles and Theories of Representation in Ancient Greek Culture«, offers one of the most extended treatments of the vase and its subject matter[18]. Marconi discusses the »continuous drive towards self-reference and quotation« in Greek art and considers this vase to be one of the masterpieces of that propensity[19]. Once again, the vase, a painted artwork, depicts on its obverse side[20] a painter completing a work of sculpture by painting it, apparently within a sanctuary setting: the freestanding Ionic column on the left and the libation bowl placed along the top border of the picture plane near the column are markers for this[21]. It has also been pointed out by von Bothmer that the positioning of Zeus on the left and Nike on the right

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13 LSJ s. v. ῥαβδίον, diminutive of ῥάβδος: a little rod or shoot; iron stile used in encaustic painting, Plut. mor. 2, 568a, Athen. 15, 687b; LSJ s. v. κατηρίον: branding iron, E. fr. 815 (cj), etc.; burnt mark, brand, Strab. 5, 1, 9, BGU 469, 7 (ii AD).

14 See Hemingway 2021, 142; on the African heritage, see also Marconi 2011, 151 f., in addition to von Bothmer 1951, 156 and Pipili 2000, 160.

15 von Bothmer 1951, 158. Since wood is the main material to receive encaustic painting, »burning in« relates to such a signature.

16 An important museum showcasing contemporary works of encaustic art is the Museum of Encaustic Art, located in New Mexico, see <https://www.moeart.org/> (29.05.2025).

17 In fact, Wedgwood was much closer to the ancient definition of »burning in« than he is credited for. For comparative examples of ancient ceramics with Wedgwood, see Shrives 2020. Two outstanding examples of Wedgwood encaustic are on display in the collection of the Huntington Library, San Marino, CA: »Black Basalt Canopic Jar with Encaustic Decoration«, ca. 1773 (inv. 2010.24.8), consisting of only red as the added pigment, hence giving the appearance of red figure; and »Black Basalt Covered Vase with Polychrome Encaustic Decoration«, ca. 1774 (inv. 2010.24.7), which features full polychrome treatment of its mythological figures. This is an area of my further research.

18 Marconi 2011.

19 Marconi 2011, 145.

20 The obverse, normally defined as the more important side in terms of the subject matter, innovation and narrative focus, is unarguably that of the painting of the statue for this vase. It is interesting, however, that Marconi shows the full reverse side as his figure 1 on p. 146. The caption does not, however, refer to it as the reverse, only »Apulian red-figure column krater«. Figure 2 on p. 147 is labelled »Alternate view of figure 1« and is a close-up of the painting scene. It may be that figure 1 is an error and should have offered the full view of the obverse of the krater.

21 von Bothmer 1951, 156 (col. 1), identified the setting as indoor and religious; Marconi 2011, 152, offers more discussion on the setting, pointing out the variety of ways a libation bowl »hanging on the background« can be used in South Italian vases, but settles on »either an open-air sanctuary or temple« for the krater.

2 Detail of Herakles on the right. Obverse side of the Group of Boston krater (photo: © MMA, New York)

3 Detail of Athena seated in the centre. Reverse side of the Group of Boston krater (photo: © MMA, New York)

suggests a pedimental arrangement[22]; the triangulation of their bodies, despite their suspension, would support the idea of a sanctuary setting in the abstract. Furthermore, the subject of the statue, Herakles himself, is situated behind the painter, looking on at the action from the right side. His appearance compared to the glory of the statue translates very differently out of this cramped side space – especially given his more tentative »contrapposto«, his own right hand gesturing towards his face and the clinging quality of the lion-skin as a hood (fig. 2). There is added white for the lion's teeth, which are fiercely bared. Yet the basic iconography of club, bow, and lion-skin are shared with the youthful Praxitelean-styled sculpture with its strong S-curve. It is important to note that neither of the two renderings of Herakles has a beard. It may further be noted that whereas the position of the hands differs, the curvature of Herakles' arm on the right side, behind the painter, echoes the gesture of the artist as the latter does the painting; we will return to the hand gesture below. The painter wears a cap, reminiscent of the hero's hood, but as already stated, his garment is the workman's exomis. Except for the hooded lion-skin, Herakles is heroically nude, even if his stance is not equal to the statue's. In the end, what makes this vase qualify as a metatext is the painting of the statue as subject matter on a vase that is itself painted. The vase becomes self-referential and self-conscious in meaning and opens the path to an exceptionally rich visual play on the subject matter. We have seen some visual connections already between the artist and the hero looking on. The visual play can extend to very small things: the different treatment of the swan finials of Herakles' bow, for example – in red figure with a contour line, strongly held by the statue and fully visible on the outside of the elaborately patterned lion-skin ›cloak‹ versus in black profile, cradled and barely visible under the hero's natural-appearing lion-skin as he stands on the right.

The added white for the statue and the club are the most striking, eye-catching elements on the obverse side. Beginning with von Bothmer, most scholars agree that the material for the Herakles statue and the club is white marble and this paper is in accord on that point[23]. On the reverse, the helmet of Athena, ostensibly in bronze, is left in red figure terracotta, while only the crest, sub-

22 von Bothmer 1951, 156.

23 von Bothmer 1951, 156; Marconi 2011, 148 n. 7. Furthermore, marble is a prestige stone, and the content of the vase is elitist. See LSJ s. v. μάρμαρος, for the element of light always contingent on the meaning of marble; the verb μαρμαίρει, to sparkle or to gleam, is inherent in that meaning. In the case of the vase, the presence of the golden hair of Herakles signals the quality of the materials involved, so marble is the most likely stone to be represented, even Parian due to its famous capacity to give off light. Marconi summarily dismisses the possibility of bronze, the only other option, see Marconi 2011, 148.

stantial in size and centrally located, is executed in added white, serving to balance the statue on the front (fig. 3).

We see many other well-placed touches of white colour all over the vase: the *cestrum* of the artist thought to be bone or ivory[24]; the outline of what might be the cartilage of Nike's and Eros' wings; the stem of the plant-like form with a golden-coloured finial held by Zeus like a sceptre, together with the rhythmically-placed dots of white in his crown, echoing the regularity of the dots, like ornamental burls, of Herakles' club below him; the bared teeth of the lion-skin hood worn by Herakles, already mentioned; the star on the reverse that I suggest represents the second of the Dioscouri (one present in the body and one more abstracted, like Herakles and his statue), the leaves on the tree to the far right of the reverse composition: all of these are white. The bosses dotting the edge of the libation bowl next to Zeus are white. The brazier, used for heating the metal rods for the encaustic treatment, is also dotted; yet the actual brazier must be bronze. If the white is consciously applied for aesthetic and compositional reasons as much as for the identification of special materials, inconsistency is not an issue and the case for the statue being marble is strengthened. Jennifer Stager makes an interesting observation, that instead of the stone surface for the statue, the white should represent a ground: »The white pigment likely corresponds to the white base layer often applied to sculpture in marble, terracotta, and limestone as support for additional pigments.«[25] Yet strong contour lines have already been employed on the statue to articulate the parts of the body (fig. 4). The lids and pupils of the eyes are detailed and expressive, together with the chin line and the wrinkling of a crow's-foot in the middle of the forehead. The hair is an added yellow with abundant contour lines. Some very strong contouring is visible in the rendering of the musculature of the »contrapposto«, both in the torso and in the legs. The pectorals are defined. What we see is the completed surface of the statue, however it was handled sculpturally. The artist has moved on to the last item, the encaustic painting of the detailed lion-skin, and in fact has finished with the body of the statue. Eyes could be painted or inlaid; hair could be painted and/or gilded. The contour lines, which vary in weight and dilution, are effectively rendering the plastic nature of the sculpture to the viewer in the language of vase painting. In the end, it may not be possible to say definitely if the sculpture we see is bare marble or painted over for the appearance, but an undercoat does not really fit with the use of the contour lines[26]. The surface is finished and intended for eternity, as discussed below.

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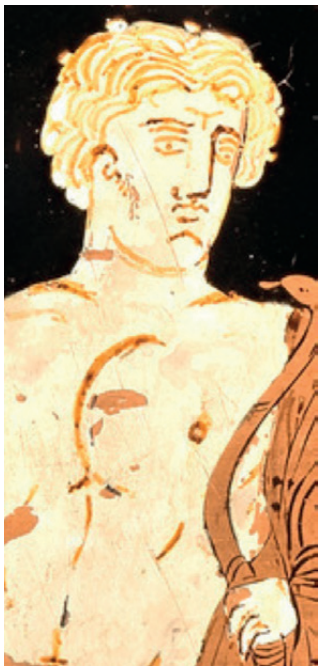
[24] Plantzos 2018, 32.

[25] Stager 2012, 40. See also Stager (2022, 83. 101) mentioning base layers for limestone and terracotta (pers. comm. 04.07.2023), for which I am highly appreciative. In the two-day symposium accompanying the MMA's »Chroma« exhibition (see n. 4), material considerations in polychromy were the focus, including the highly scientific methods used by Vinzenz Brinkmann and Ulrike Koch-Brinkmann in reconstructing the marble finial in the form of a sphinx on the MMA's funerary monument of Megakles (inv. 11.185 a–d. f. g. x) in its original colour. These matters were discussed at the symposium by both speakers and also in an online version, »Reconstructing the Archaic Greek Sphinx« produced by Vinzenz Brinkmann, Ulrike Koch-Brinkmann and Heinrich Piening, see <https://www.metmuseum.org/perspectives/articles/2022/8/archaic-greek-sphinx> (12.08.2022). The use of marble stucco test panels for the accuracy of the study and the attention to the organic binder originally used on the surface of marble prior to painting, but now gone, were very important points that were made. The same considerations, in my opinion, are necessary for the future study that is needed for encaustic on stone, which is so different from tempera. The yellow coloration noted on the Herakles statue in figure 4 (see also n. 10) could be documenting some of that process. Von Bothmer believed the statue was more fully painted. Returning to the subject of primers, the use of undercoats in antiquity is a problematic subject in conservation (pers. comm. with the J. Paul Getty Museum and the MMA, both on 29.06.23). According to the MMA, no tests have been done on the chemical composition of the added white for the column krater.

[26] While not describing the weight of the contour lines as such, Marconi (2011, 148) remarks: »Some details, such as the hair and elements of the anatomy, are added in dilute yellow.«



4 Detail of the statue of Herakles. Obverse side of the Group of Boston krater (photo: © MMA, New York)

5 Detail of club and statue bases. Obverse side of the Group of Boston krater (photo: © MMA, New York)

RENDERING STONE AND PRECIOUS MATERIALS

There are at least two different kinds of stone shown on the vase. It is important to note that the statue and the club receive their own base (fig. 5). Both are depicted in the normal red figure terracotta, and this must indicate something other than marble, limestone being a logical option[27]. Both bases are decorated at the top: an abbreviated meander pattern for the cornice of the stepped block base supporting the statue, and an overlapping chevron pattern for the capital of what may be a columella or a narrow pier[28]. Both designs are executed in black linework, implying a relief frieze. The front face of the pedestal base is textured with a series of roughly horizontal lines but curved downward, not present on the side flank. I suggest that this could indicate, in an abbreviated way, an inscription or guidelines for one. Given the number of horizontal lines, the implication is for a longer text, and it is interesting to speculate what such an inscription could be[29].

The most extraordinary indication of another added material, not mentioned by von Bothmer but included by Marconi in his analysis, is the golden yellow for the mass of hair, also modelled with dilute contour lines for the locks. The yellow must indicate gilding, whether it occurs on the

27 Many examples from the Acropolis of Athens come to mind, the »Moschophoros« (inv. Akr. 624) with its inscribed base being just one, see Raubitschek 1949, no. 59. The statue is Hymettan marble and the base is grey limestone, the same combination discussed below for the Columella of Hieronymos.

28 Figure 5 shows a long vertical line on the right of the base, suggesting the hard edge of a squared support, but a columnar form may still be implied by the way the capital is treated. This base is fixed into the groundline with its meander pattern, the same as the architectural element on the left.

29 The lines on the front of the base could be expressing the x-height of the inscription, so between 15 and 20 lines in length would be possible, even longer if these are just baselines. What comes to mind is the Homeric Hymn 15, »To Herakles the Lion-Hearted«, encapsulating very efficiently Herakles' birth and life as a man meeting enormous challenges but dwelling now on Olympus, in the context of victory. It would be unprecedented, but so is the vase. I am very grateful to John Pollini for making the observation that, because the series of lines on the front face of the base have a draped appearance (continuing around the lower right corner), the base could have been covered, perhaps to keep it from damage during the painting of the statue. This would especially be true if any inscription were already cut and inpainted on the front face.

6 The Archelaos Relief showing the apotheosis of Homer. Marble, 3rd century BC (British Museum London inv. 1819,0812.1) (photo: J. Pollini)

vase or not, and the hair becomes the crowning glory of the statue. It appears that Zeus cannot keep his eyes off of it, likewise Nike[30]. There is also a set of rounded protrusions visible along the outside perimeter of the hair mass, implying an actual *stephanos*. The heroic statue, embellished with golden hair, possibly with an inscribed pedestal, accompanied by the sculptured marble club, which is monumentalised by being given a separate base[31], and the ornamental lion-skin, definitely executed in the encaustic technique, may be argued to project the concept of transformation.

30 Close inspection of the way in which the artist renders the eye indicates that Zeus could be looking directly at his son behind the painter, rather than just the statue; and likewise Herakles' own sightline could lead to his father. There is a subtle depth in the picture plane implied by the placement of the statue and its base and the ranking of the elements around what amounts to a central emblem.

31 While our statue is not intended to be colossal, monumentality comes through the treatment of the club, immortalised as an icon set vertically on its own base, and not without a sense of humour.

And it is this transformation of himself that Herakles is witnessing, no matter how the exact gesture of putting his hand to his face is interpreted[32]. The witnessing begins with recognition of the self, concretised in the statue, which Herakles and everyone else clearly sees. The recognition is necessarily prior to the actual apotheosis. That is what the vase is telling us with the artist applying the last of the pigmented wax to the lion-skin before the hot irons are brought to fix the colour. It was said above that the gesture of the artist as he applies the paste echoes that of Herakles behind him, both the right arm and the hand, except that the fingers of the son of Zeus are fanned and turned inward (the index finger is almost touching his mouth), whereas for the artist, holding the *cestrum* in the same way as the brush is held in Chinese calligraphy or as one would hold Pan pipes, the fingers are turned out and lined up on the tool[33].

The transformation of Herakles, ultimately the subject of the obverse side of this vase, is achieved through the mechanism of depicting specific materials and an actual series of metatexts: the statue and its possibly inscribed base, the iconography of the club with its base, the bow, as well as the patterned lion-skin being of central importance. The position and height of the ›physical‹ Herakles, albeit to the side, roughly matches that of the statue, and both occupy the middle zone of the picture plane. This allows Herakles himself to perform the rite of passage between the worlds by means of the statue: the embodiment of apotheosis.

COMPARANDA

There is another major artwork, Hellenistic in date, known as the Archelaos Relief, that deals with apotheosis, this time of Homer[34] (fig. 6). The zones in this marble relief are far more delineated as bona fide registers, and the narrative reads differently, with Homer seated at the bottom left receiving accolades and Zeus at the apex of the top, depicted as another Homer and vice versa. But at the right end of the second register, as it curves past Apollo and the Muses and transitions into the third, a prominent figure on a statue base is located. It has been proposed in the scholarship that this is a statue of Homer as a young man, which would mean his transformation occurs in stages and through a work of art[35]. It may be argued that that is what is happening on the krater as well as on the relief.

The fruits of Herakles' apotheosis are also achieved through the medley of gods on the reverse of the krater (fig. 7), including Hermes, Eros, and the Dioscouri. But there is more than that. Athena's seated position in the centre of the composition is dominant, the equivalent of the statue of Herakles on the other side. One is reminded of an observation by Christine Havelock in her seminal article, »Mourners on Greek Vases. Remarks on the Social History of Women«. Herakles stands as the most popular of subjects in Greek art, serving unequivocably as the heroic role model for the male. When searching for the female equivalent, Havelock says Athena comes to mind first but is more problematic, complicating the foundational issue of motherhood by being Zeus-born and a virgin[36]. Yet Athena is the protector and tutelary goddess of Herakles, whom she loves. Seeing Herakles and Athena back-to-back, obverse and reverse, on this vase, is extremely provocative. There is no question that the two sides relate strongly to each other. Another divine relationship exists between Athena and Nike, Nike paired with Zeus on the obverse even as she

32 Marconi 2011, 154 f., interprets the gesture as one of wonder, and claims that, together with the expression in the eyes, it has »thus far been generally misunderstood«.

33 von Bothmer (1951, 158) also saw an Asian quality to the way the artist holds the *centrum*, common to representations of Attic vase painters at work.

34 British Museum, inv. 1819,0812.1; Butz 2017, 49 n. 15. The dimensions are ca. 121 × 76 cm.

35 Butz 2017, n. 14–15. This interpretation was brought up for discussion before ASMOSIA XIII in my art history class, ARTH 468 at California State University, Northridge, and that discussion solidified my opinion about the statue proper on the krater as the definitive catalyst or vehicle for apotheosis, in accord with the relief, which is an artwork documenting the event.

36 Havelock 2019, 46–48.

7 Reverse side of the red figure column krater attributed to the Group of Boston 00.348, ca. 350–360 BC (MMA, New York inv. 50.11.4). Encaustic painting of a statue of Herakles (photo: © MMA, New York)

is in the literary sources describing the Gigantomachy and Zeus' victory, the victory that could never be achieved without Herakles. How fitting that the application of added white unites them all by virtue of the physical application of that particular pigment[37]. The material constitutes, in fact, another and more pure level of abstraction and relates to another victory: the successful transformation of materials into artwork – and the painter at work reminds us that it is happening before our eyes.

This brings us back once more to the vase itself: a red figure column krater produced in Apulia around the middle of the 4th century BC[38]. There is something in the very designation ›column

37 Plantzos 2018, 32, for the pigment being lead white; LSJ s. v. ψιμύθιον for white lead, ψυμυθίζω for painting with white lead, especially the face.

38 The MET, Terracotta column-krater (bowl for mixing wine and water), <https://www.metmuseum.org/art/collection/search/254649> (30.06.2023).

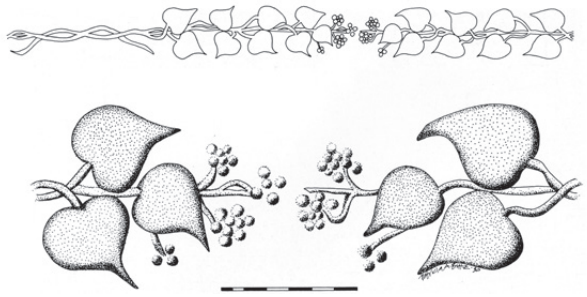
krater‹ that accurately reflects the architectonic quality of the type. The natural verticality of the minimally curved body of this vase continues right beyond the shoulder thanks to its straight handles, allowing for the widest of neck zones. The MMA example achieves this more perfectly than most column kraters. The vase is only 51.5 cm high, yet the neck stands in a 2-to-1 ratio with the framed picture plane below it. The ivy wreath that horizontally adorns the neck takes full advantage of the space allotted to it by the effect of two red figure ›labels‹, individualised for the front and back rather than treated continuously, each label framed by the black glaze of the vase proper, passing under the handles (figs. 1. 7). It is to this powerful ornament, and the various other framing devices, that we now turn.

The wreath has two levels of ivy leaves, arranged in strict pairs, alternating with the »rondelles« of berries, likewise placed in alignment. The thickened stem of the band undulates, and the linework for the thinner stems of the leaves and berries is diluted, easing the overall weight. The number of ivy leaves is significant. For each label, there are twelve ivy leaves, evenly distributed, six on top and six on the bottom. This recalls the twelve labours of Herakles as well as the twelve Olympian gods, which the hero now joins. Altogether the plant's form projects a vitality not at odds with its regularity. Above, the double dots of the decorated lip of the vase are separated by a thin line, continuing the aesthetic of the wreath and acting as a minimalised circuit. Similarly, identical dotted strips frame the sides of the main picture plane, so that the particular pattern is rendered a total of six times on the vase. The borders of the shoulder and bottom of the picture plane are more elaborate and carefully executed: a tongue pattern for the shoulder and a meander for the bottom. While no added colour is visible, this is nevertheless a highly ornamental display.

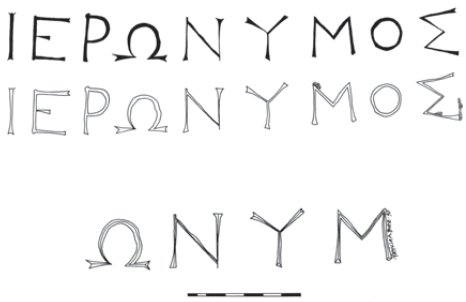
There is no doubt that the ivy wreath, to begin with, is to be associated with Dionysos and coincides with the very purpose of the vase in a symposiast setting. This, as already stated, is not a large vase; its height gives it a great sense of personalisation, borne out by the subject matter of the obverse and reverse. Dionysos does not appear in Athena's group, nor does he have to: his encircling presence is there in the wreath, introducing another level of abstraction through ornament. There is potentially a second Dionysiac reference that is worth mentioning: the libation bowl identified as among the sanctuary markers. As Marconi points out, libation bowls occur profusely in south Italian vases and in a series of contexts, including »hanging behind statues inside naiskoi in scenes of the cult of the dead; hanging together with other paraphernalia in symposium scenes and in representations of Dionysos and his retinue; or hanging between gods watching mortals from the Olympus«[39].

The generous, even outsized, ivy wreath and its prominent placement on the neck of such a column krater prompts another comparison and metatext. Could the krater be resonating with a stone vase or monument, given the subject matter of apotheosis through material substance, crowned by the Dionysiac wreath – even a stone columella (one may already support the club)? Introducing this interpretation is not counter to the krater's intended use in the symposiast setting, nor ›simple‹ association with the god Dionysos. The technique of full grisaille is not seen on Greek vases, but it would work wonderfully with this theory. We hardly need it, however, because colour on its own, when applied to the stone surface, takes on transformative qualities. In his article »Colour and the Deceptive Gift«, Michael Duigan approaches the colour on the MMA krater cautiously, beginning by acknowledging »[…] adornment or kosmesis (imparting colour by using polychrome accessories) is an important concept«[40]. He goes on to say that colour is not fully understood. The MMA vase »celebrates the painting of a statue« and hence the value in time and work involved, also the pleasure and the grace imparted by the product. On the other hand, analysing the statue of Herakles from the standpoint of deception, Duigan considers it illusionary and asks if the god is going to be taken in by the illusion or even seduced (Herakles never being

39 Marconi 2011, 152.
40 Duigan 2004, 78.



8 Ivy wreath of the actor Hieronymos from the Columella of Hieronymos, IG II², 11710, EM 10895 (drawing: P. A. Butz)



9 Inscribed name of the actor Hieronymos from the Columella of Hieronymos. Average height of letterforms: 2.9 cm (drawing: P. A. Butz)

known for his high intelligence)[41]. Duigan interprets the hand gesture of Herakles as denoting perplexity[42], but then closes by citing Pliny, who asserted paradoxically that the »touchstone« itself was known in antiquity as the »Heraclian stone«[43].

There is one columella that compares uniquely with the ivy wreath on the neck of the column krater: the Columella of Hieronymos, IG II², 11710, in the Epigraphical Museum in Athens[44]. Made out of blue-grey Hymettan marble, it stands strongly at a height of 76 cm[45], reminiscent of the robust impact of the column krater. The important parallel is obvious in the relief decoration of the head of the columella, which is carved with a magnificent ivy wreath, woven as a true *stephanos* and with the berries meeting like an emblem at the centre (fig. 8). The beautifully inscribed name of Hieronymos (fig. 9) imitates the regularity of the wreath, letter by letter, and secures the funerary aspect of the monument, which is also shared with the subject matter of the Group of Boston krater through the apotheosis of Herakles. It resembles the neck of the krater in its precision and dominance. Centred below the projecting moulding, is inscribed the name Hieronymos, minus patronymic or demotic. Hieronymos was an actor and the literary record supports choragic victories in multiple venues, including Delos, in the 3rd century BC[46]. Inpainting would be expected of the inscription and very likely for the bas relief of the wreath as well. The wreath celebrates Hieronymos' victories and is reminiscent of the use of the ivy wreath on the column krater. In addition, the base in which the columella was originally installed was rediscovered: a block of grey limestone 53.5 cm long by 43.9 cm wide and 22.3 cm high, affirming what we know to be the case so often: the base is of a different material than the statue[47].

CONCLUSION

The focus of this article remains the column krater attributed to the Group of Boston 00.348, the issues it raises and also helps solve concerning the encaustic painting of stone sculpture. In the spirit of the metatext, the method of achieving the many areas of added white on the MMA column krater besides the statue can be explored as self-referential of the encaustic process and of

41 Duigan 2004, 82.
42 Duigan 2004, 82.
43 See Plin. nat. 33, 42.
44 Butz 1990/1991, pls. 15–16.
45 Butz 1990/1991, 67 n. 1.
46 Butz, 1990/1991, 68 f.
47 Butz 1990/1991, 73. The rediscovery of the base occurred during my study of the Columella of Hieronymos and the join was made by Chara Karapa-Molisani. It is very rare for a columella to have its own base, as would a statue, and it humanises the monument. I am grateful for the encouragement and permission from the ephor of the Epigraphical Museum, Dina Peppas-Delmousou, for studying and publishing this columella.

the growing elaboration in Greek ceramic design in the 4th century BC. While not an example of the full-blown Kerch style, it is valuable to compare the column krater with a vase like the J. Paul Getty Museum's red figure pelike showing the Judgment of Paris[48]. Attributed to the Painter of the Wedding Procession, it is dated ca. 360 BC, which is concurrent with the krater[49]. The coloration of this vase, use of ›nonceramic pigments‹ and extrusion for details goes beyond the krater, but the latter is highly inventive, as we have seen, and can be interpreted as ready to cross the line. In this description of the complexity involved with the pelike, the technical method for affixing the white for the flesh of two of the statuesque goddesses and of Eros is of special interest, and I believe reflects the type of encaustic painting Wedgwood was aiming for. Beth Cohen describes the process: »This vase-painting required careful advance planning, for its mixed media necessitated dividing the execution into pre- and post- firing stages. While extruded clay and traditional black gloss with reserve were applied before firing, bright color and gilding had to be applied afterward. In addition, the flesh of Hera and Athena and of the little Eros, who reaches for his mother, is painted with a white, similar to a white ground, which scientific testing has shown was fired onto the vessel, along with the linear black facial features of these figures. Hera's jewelry, dress pins, foliate crown, and scepter are all gilded relief; her dress was painted with a thick white pigment after firing.«[50]

With regard to the theme of apotheosis on the MMA column krater through its materials and iconography, two other artworks were introduced for comparative purposes: the Archelaos Relief, also known as the Apotheosis of Homer, sculpted in marble by Archelaos of Priene; and the Columella of Hieronymos from Athens, the marble funerary monument of the actor crowned in final victory. In the Archelaos Relief, Homer is being crowned with an oak wreath[51] as part of the process of his apotheosis, which includes a statue and ascension to the realm of Zeus. The ivy crown of Hieronymos encircling the head of the columella suggests recognition in perpetuity of his theatrical victory through the abstraction of the stone monument. The MMA column krater also ensures victory and the actual apotheosis of Herakles via the statue sanctioned by the gods, especially Zeus, Nike, and Athena, who cover the obverse and reverse and are marked with added white details. The guarantee of transformation is made through the material of the two crowning elements: the golden hair of Herakles with its own *stephanos*, already put in place before the lion-skin that we see the artist is still working on; and the remarkable Dionysiac ivy wreath secured through two painted plaques on the neck of the vase. Above all, the encaustic technique is itself a transformation, present on the vase, whether used only for the magical lion-skin or the whole of the marble sculpture. The column krater attributed to the Group of Boston 00.348 at the MMA could very well be renamed »The Apotheosis of Herakles«, the apotheosis achieved through the creation of such a masterpiece employing the heat and burning of the encaustic technique in the presence of the gods.

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48 Cohen 2006, 337 no. 104.

49 Cohen 2006, 337.

50 Cohen 2006, 338.

51 Homer's wreath is oak, and there are reasons for it. He is being crowned by the personifications of Kronos and Oikomene (most probably Ptolemy IV and Arsinoë III), and there is a political worldlines and universality in so doing. Homer is grounded on the first register, and his influence goes out horizontally as well as vertically.

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REFLECTIONS ON MARBLE, COPIES AND PAINT

Abstract
Many museums show brightly painted copies of ancient marble statues, presented as the results of scientific and scholarly studies, and on those premises they are claimed to mirror what the statues really looked like. I would say that they are interpretations based on selected facts, and therefore only suggestions of how the originals might have looked in antiquity. The selected facts presented in this paper spring from the same kinds of sources. I will, in addition, pay some attention to artists' materials and to painting and copying. Pigments are easily identified, paint is not, and the way in which paint was once applied can only be imagined. As copies are not identical to originals and remnants of paint can be interpreted and reproduced in many ways, the main question is how it is possible to claim that modern reconstructions correspond to ancient works of art which we did not see with their original appearance. I understand the painted copy as a new product, and as such, it can be useful in discussions regarding ancient polychromy. The present paper addresses issues related to the production of painted copies, i.e. archaeological evidence, literary sources, scientific research on materials, and artists' materials, marble, plaster and paint.

INTRODUCTION

Copies of ancient statues, meticulously painted in bright colours, have been shown in museum exhibitions all over the world during the last decades, often placed alongside the originals, which still bear some remnants of paint[1]. Information in connection with exhibitions and in museum catalogues presents them as mirroring the original polychromy[2]. Mostly it is not explicitly said that they are true to the originals, but they are presented as being the results of scientific research. By referring to concepts such as science, research, analyses, knowledge, we are led to believe that these reconstructions are scientifically correct and therefore provide a true picture of what the originals looked like. In one article it says that research and modern technology has permitted us to »reconstruct the original surface colour on ancient objects«[3]. In an instructive, systematic, and questioning paper regarding what Amalie Skovmøller justly describes as »experimental reconstructions« she defines white marble statues as originally »fully painted«, or »vividly painted« which allows us to imagine that brightly coloured statues are representative for ancient art[4]. When discussing the original polychromy of ancient statues, Mark Bradley describes their colours as bold, bright, intense or vivid[5]. Vincent Brinkmann mentions that Quatremere de Quincy wanted his concept of polychromy to be understood as »a term denoting an application of colour which did not cover completely«, on which Brinkmann disagrees, stating

1 Exhibitions and catalogues, e.g. »Bunte Götter« in Munich 2004, »I colori del bianco« in Rome 2004 and Basel 2005, »Gods in Colour« in Cambridge 2007, »The Color of Life« in the USA 2008, and »Vita lögner« in Stockholm 2010. See also »Focus on the Mediterranean. Antiquity in Colours« in Stockholm 2012. For discussions on the exhibitions, see e.g. Bradley 2009; Barry 2011; Pollini 2015.

2 One such example is the introduction in the exhibition catalogue at Ny Carlsberg Glyptotek in Copenhagen, which says »new research has given us the opportunity to reveal to the public the true state of affairs regarding colour on antique sculpture«, see Friborg 2014, 8.

3 Hodne 2020, 1.

4 Skovmøller 2020, 2.

5 Bradley 2009, 431.

1 The two discus throwers in the Museo Nazionale Romano, Palazzo Massimo. Both are made of Parian marble and dated to the middle of the 2nd century AD. In the foreground, the sculpture from Castelporziano, inv. 56039, and in the background, the Discobolo Lancellotti, inv. 126371 (photo: A. Freccero, published with the kind permission of the Ministry of Culture – Museo Nazionale Romano – Palazzo Massimo)

that »[t]oday we know that the colour was probably always applied in a covering layer, but sometimes this was very thin«.[6]

Some statements are more restrained. Paolo Liverani's reference to the statue of Augustus of Prima Porta is one example. He points out that some details and nuances on the plaster copy are suggestions based on hypotheses, but that the copy provides a good idea of the statue's original appearance[7]. Jens Stubbe Østergaard affirms that the reconstruction of the head of Caligula is not similar to the original sculpture, because reconstructions cannot refabricate antiquity[8].

Reconstructions of original colours on ancient works of art are hypothetical, because no statues with intact painted polychromy have survived; we have to rely on our imagination combined with archaeological evidence and the limited literary accounts available, a combination which cannot be used as reliable proof. Statues that were made of a mixture of materials have a more unchanging kind of polychromy, and material mixtures are often described by ancient authors[9]. Many large-sized statues in the Roman period were made of two types of marble; white Parian or Pentelic marble was preferred for the head, and the garment was sculpted in another type of stone[10].

6 Brinkmann 2014a, 29.
7 Liverani 2004, 238.
8 Østergaard 2004, 259.
9 Paus. 5, 11, 1–11; Plin. nat. 34; Plut. mor. 674a; Strab. 8, 3, 30; Vitr. 2, 8, 11.
10 One example is the Hellenistic statue of Victoria of the Simmaci in the Centrale di Montemartini, inv. MC2845, made of Bigio antico with head and limbs of white marble. Another impressive statue is the Kneeling Barbarian in

Modern reconstructions are mostly made on plaster casts, which leads to questions regarding artists' materials. Plaster casts of ancient sculpture are, as a tradition, studied and drawn by artists and analysed by historians to learn about form, proportions and the ideals and conceptions in art. They are not intended as anything but copies of famous works of art. As long as the cast is unpainted, it is understood as a copy of a cherished work of art, but painted it becomes something else: it becomes a modern object.

As a modern object, claimed to be the true version of an antique original, the item becomes problematic – it raises a set of questions. How is it possible to prove that the reconstructions are correct and not fanciful interpretations? We are fully aware of the sensibility with which ancient sculptors completed their works, so why assume that the painters were less sensitive? Would an artist in antiquity have used opaque layers of paint to cover an exquisite form and the underlying precious material? What do we actually know about ancient paints, tints and coatings? Where are the examples with sufficient undamaged painted areas to prove the works were originally covered with paint? What can we learn from remnants from the past, such as archaeological finds and ancient written sources?

Examinations aiming at the conservation of an object provide relatively non-subjective data, because the intention is to gain a profound understanding of the item's material and of the techniques applied. Further non-subjective data can be acquired by a set of scientific analyses[11]. The selection of data, on the other hand, is rather more subjective, and so is the interpretation of the data acquired. With a collection of different data at hand, it is possible to imagine what an object might have looked like thousands of years ago, but imagination is not equal to fact. However, imagining is the wonderful aspect which makes a hypothetical reconstruction possible. What a painted reconstruction finally looks like depends on personal conception, capacity and the sensibility of the professional or the dilettante painter who provides the copy with colour. Every person has his or her personal touch.

A few ancient works of marble with reconstructed polychromy are used as examples in this paper: the Alexander sarcophagus in Istanbul, the statue of Augustus from Prima Porta in Rome and the head of Caligula in Copenhagen. They represent different types of sculpture and different projects; the originals have been thoroughly studied by several scholars, and I have seen the originals as well as the reconstructions in reality, not only in photos.

Before getting started on the subject, I want to explain my view on the conceptions behind the terms »copy«, »replica«, »reproduction« and »reconstruction«. »Copy« refers to an exact reproduction of an original. A plaster cast is a true copy which provides an exact »reproduction« of the original's exterior form but not of its material character. There is no resemblance between the materials plaster, marble and bronze. A marble statue is not a »copy« of a bronze sculpture but rather a »replica« that provides an idea of what the bronze original might have looked like, as explained by the following example.

In the Palazzo Massimo in Rome, there are two marble statues representing a discus thrower, the Discobolo Lancellotti and the Discobolus from Castelporziano[12]. Both are regarded as Roman copies of a statue made by Myron. The two bodies are of the same size but not identical in form, surface treatment or details. They lean on supports which would not have been needed by the original. The statues are made of Parian marble, they are unpainted, and they are appreciated as exquisite marble statues. I would say they are »replicas« of an original that nobody has seen and

Copenhagen, made of Pavonazzetto, now with reconstructed head, hands and feet in Nero antico which originally would have been white.

11 For methods of scientific analyses on marble and paint see e.g. Attanasio – Brilli – Ogle 1967; Stulic – Porto – Palet 1993; Attanasio 2003; Santamaria – Morresi 2004; Østergaard 2011; Prochaska – Attanasio 2012; Stein – Gustavsen 2013; Bracci – Galli 2016; Scardozzi 2016.

12 Discobolo Lancellotti, inv. 126371, dated to the middle of the 2nd cent. AD. Discobolo tipo Lancellotti, from Castelporziano, inv. 56039, dated to the Hadrianic period AD 117–138. The statues are exhibited in the Museo Nazionale Romano, Palazzo Massimo, Rome. Myron was a Greek sculptor active around 480–440 BC.

2 Paints applied on different preparations. At the top, lime paint (pigments dissolved in lime water) in 1–4 applications on stucco (lime plaster with crushed marble). In the middle, Punic wax paint in 1–4 applications on stucco. At the bottom, lime paint in 1–4 applications on plaster of Paris (photo: A. Freccero)

which probably stood without any supports. Furthermore, we do not know which of the two has the body movement or surface treatment that most resembles the original. Therefore they can also be regarded as two original Roman marble statues which refer back to a Greek original in bronze (fig. 1).

White marble is often the material of the original statue. But the concept »white marble« does not imply just one colour, as white appears in different shades and with different depths. Some marbles are pure white without any kind of pattern and those are the rarest, most expensive and the ones preferred for portraits. Some marbles are cold white, others are warm white, some have small grains, others have large, and the colour perceived depends on the grain size and the natural white colour of the stone, as well as the light that touches the stone or penetrates the surface. A white marble with an application of bleached wax is still white, but the lustre is different, and a tiny addition of colour in the wax will not hide the marble but let the crystals shine through.

»Hypothetical reconstructions« of painted marble sculptures are generally made on plaster casts. Plaster of Paris is dull white, and it is a material that sucks up paint. These are two reasons why reconstructions of polychromy on plaster cannot show what a painted marble statue looked like (fig. 2).

ARCHAEOLOGY AND SCHOLARLY RESEARCH

Whether marble statues were painted or not has been debated ever since it was accepted that Johann Joachim Winckelmann's perception of pure, white marble was an ideal not founded in reality[13]. The discussion that followed is conveyed in Patrik Reuterswärd's comprehensive study of polychrome plastic works of art[14]. Some scholars claimed that opaque paint layers concealed the stone, and others held that paints were only applied to details such as the eyes and hair or

13 There is no absolute agreement among scholars regarding Winckelmann's philosophy in relation to white statuary, but a discussion on that topic is beyond the scope of this paper. See e.g. Hodne 2020.

14 Reuterswärd 1960.

to highlight specific patterns or, perhaps, to give a hue to the stone. One understanding was that in sculpture in the Late Archaic and Classical periods naked skin was unpainted, although it might have been treated with wax to render the marble less white[15]. Other scholars, such as Gisela Richter, claimed that skin was always painted light pink or brownish pink[16]. Colour was often detected on marble at the time of excavation. Charles T. Newton, for example, observed red and blue colours and even gold on the white marbles from the Mausoleum at Halikarnassos and noted that the paint was rapidly peeling[17]. The yellow-brown patinas observed on the white marble and on the painted parts on the Amazon frieze were regarded as coating intended to harmonise the three colours[18]. Successive scientific analyses confirmed his observations. The blue was identified as Egyptian blue, the red was iron oxide, and there was no paint on the skin. A later study showed that different kinds of marble had been used, and these were in »an almost infinite range of ›white‹ from cream through to pale grey«[19]. Parian marble was used for the heads of the most important figures, Pentelic and Proconnesian marble were identified in other parts of the monument, and some stone was of unidentified provenance. No traces of paint could be identified on the skin.

Valentina Manzelli's study of Archaic Greek statuary and figural reliefs showed that the skin of some male statues had been painted and a few females had hints of red or pink on the cheek[20]. Most figures had traces of red ochre in the hair, and some had red on the lips or on the iris. Brigitte Bourgeois found that several antique layers of paint could be noted on many objects in the Hellenistic and Roman periods[21]. She observed that beeswax was a common coating material, as for example, on the portrait head of Berenice II[22]. Great efforts were made to preserve and restore works of art in ancient times, or in Bourgeois' words: »to paint, to clean, to remove paint, to re-paint, to embellish and to protect with coating.«[23] Bourgeois further explains that the *ganosis* treatment had the double function of protecting the surface and giving it lustre[24]. Archaeological evidence and scientific analyses show that the skin of some statues was painted and on other statues the skin was never painted at all.

A different kind of approach was used by Erich Moormann, who studied the manner in which human figures and sculpture in garden paintings were represented on wall decorations in Pompeii. According to Moormann, statues during the Second Pompeian style were distinguished from living people by being placed on pedestals. Polychromy on statues became restrained in the Third and Fourth styles, when colours were used for details in contrast to the white marble, as for example, on the statue of Mars in the garden painting in Casa della Venere in Conchiglia[25]. Statues portrayed in wall paintings can, however, not be taken as evidence of any factual polychrome statue, but being integral parts of paintings, they show the painter's capacity and sensibility as well as the fashion of the period and possibly the commissioner's demands as well. They give an insight into how statues were integrated in the context and collaborated with the environment for which they were made (fig. 3).

15 Berger 1904, 239; Reuterswärd 1960; Boardman 1995, 13; Walter-Karydi 2004, 227.
16 Richter 1929, 25. 30.
17 See Jenkins – Gratziu – Middleton 1997, 35. The monument was completed two years after the death of Maussollos in 353 BC.
18 Jenkins – Gratziu – Middleton 1997, 36.
19 Walker – Mattews 1997, 49. The techniques used were stable isotope ratio mass spectrometry and ocular examination of grain size.
20 Manzelli 1994, 110. 280. The study consisted of 230 statues and reliefs. 94 % had traces of red, followed by blue, 29 %, and black, 21 %. Other colours noted were green, yellow, and white.
21 Bourgeois 2014, 202. She mentions as an example, how an original application of red was repainted in a scarlet hue, which might be explained by a change in tastes.
22 Bourgeois 2014, 205 f.
23 Bourgeois 2014, 191.
24 Bourgeois 2016, 75 f.
25 Moormann 1988, 106–108. The white parts were presumably treated with *ganosis*.

3 Pompeii, wall painting in the Casa della Venere in Conchiglia (II 3, 3), showing the statue of Mars in a garden (photo: A. Freccero, published with the kind permission of the Ministry of Culture – Parco Archeologico di Pompei)

ANCIENT WRITTEN SOURCES

How do ancient writers describe statuary, and what importance do they give to colour? As a principle, the sculptor, his name and fame is defined, and usually there are accounts on the size and location of the monument. From Vitruvius we learn about »the colossal statue of Mars with marble extremities, made by the famous hand of Leochares« which was set up at the Temple of Mars on the hill above the Mausoleum at Halikarnassos[26].

The materials used are usually accounted for when acrolithic statues are described. The head, hands and feet were usually made of marble, and the body of ivory or wood, sometimes painted or even dressed. One statue of Athena, for example, was overlaid with gold, except for the face, hands and feet, which were of Pentelic marble[27]. Pausanias' description of Phidias' colossal statue of Zeus at Olympia begins »[t]he god sits on a throne, and he is made of gold and ivory«[28]. Around him were painted fences functioning as a barrier: those in front of the monument were dark blue, and the side fences had pictures of gods and heroes painted by Phidias' brother. Strabo lets us know that Panaios helped Phidias »greatly in decorating the image, particularly the garments, with colours«[29]. Plutarch provides one of the few existing notes about colour on a sculpted portrait, explaining that silver was mixed into bronze to give Jocasta's face an impression of life

26 Vitr. 2, 8, 11. He continues: »The statue, some think, is by Leochares, others by Timotheus.«
27 Pollitt 1990, 63.
28 Paus. 5, 1, 11.
29 Strab. 8, 3, 30.

fading away[30]. Plutarch again provides further information on what was important in a work of art: what made a masterpiece was not primarily the form, the material or the colour, but the expression of life and of catching the character of the individual depicted[31]. Homer describes the beauty of Penelope and her maids by saying they had »skin more brilliantly white than polished ivory«[32]. I can only draw the conclusion that untanned skin aligned with the concept of beauty.

Then there is the often cited example of Pliny explaining that Praxiteles was once asked which of his works he liked. His answer was »[t]he ones to which Nicias has set his hand, – so much value did he assign to his colouring of surfaces«[33]. That does not mean he painted the skin. The statement indicates that colour applied in Nicias' manner was compatible with Praxiteles idea of aesthetics, and as Nicias was known to be a master of the chiaroscuro technique, he did not use uniform layers[34].

Pliny uses the term *circumlitioni*, which has been translated as »colouring of surfaces«[35]. The expression is vague, and could mean giving a slight hue to the surface, painting or coating. What was actually done is not quite clear, because Pliny, in another context mentions heated Punic wax mixed with oil, a treatment used on walls, and when cooled, the surface should be rubbed »with candles and clean linen cloths as marble is made to shine«[36]. Vitruvius describes this as a coating process on vermilion with Punic wax, »as nude marbles are treated. This process is called ganosis by the Greeks«[37]. So, we may assume that nude marbles were treated with Punic wax, i.e. they were coated with a wax mixture[38].

Wax coatings are documented. A document regarding the annual coating of the cult statuary at Delos includes an estimation of the costs and amounts of beeswax that were needed[39]. Another document shows that the Jupiter statue on the Capitol was coated with wax on a regular basis[40]. Coating was part of the premeditated and continuous maintenance.

RESEARCH AND RECONSTRUCTIONS

Research precedes reconstruction. Colour observed on marble might, or might not, be the original, and the colour observed is not always paint: it could be residues of surface coating or unintentional stains[41]. The conservator's methodology has a great impact on understanding material and technical issues, because the task is primarily to register what is perceptible and to suggest possible explanations based on observable facts[42]. When facts cannot be explained, that is mentioned too. The mysterious might be clarified in a later phase, maybe when samples of materials are scientifically analysed. The conservator's practice, on the other hand, follows guidelines

30 Plut. mor. 674.

31 Plut. mor. 334–335.

32 Hom. Od. 18, 280.

33 Plin. nat. 35, 133: *hic est Nicias, de quo dicebat Praxiteles interrogatus, quae maxime opera sua probaret in marmoribus: quibus Nicias manum admovisset; tantum circumlitioni eius tribuebat*.

34 Plin. nat. 35, 131: *lumen et umbras custodiit atque ut eminemerent e tabulis picturae maxime curavit*. See Rackham 1952, 356 f.: »Nicias kept a strict watch on light and shade.«

35 Ermanno Malaspina explains that the etymologic meaning of the Latin term is composed of *circum*, »all around« (»tutt'intorno«) and *lin(i)o*, »to spread a fat, unctuous« (»spalmare una sostanza grassa, untuosa«), see Malaspina 2020, 158 f. According to him it is to be understood as »colouring« or applying the necessary paint to the statue, see Malaspina 2020, 174. Valentina Manzelli gives the same explanation but understands the treatment as a coating, see Manzelli 1994, 109. See also Reuterswärd 1960, 70–74.

36 Plin. nat. 33, 40.

37 Vitr. 7, 9, 3; g*anosis* comes from a Greek verb signifying polishing, making lustrous, or glazing.

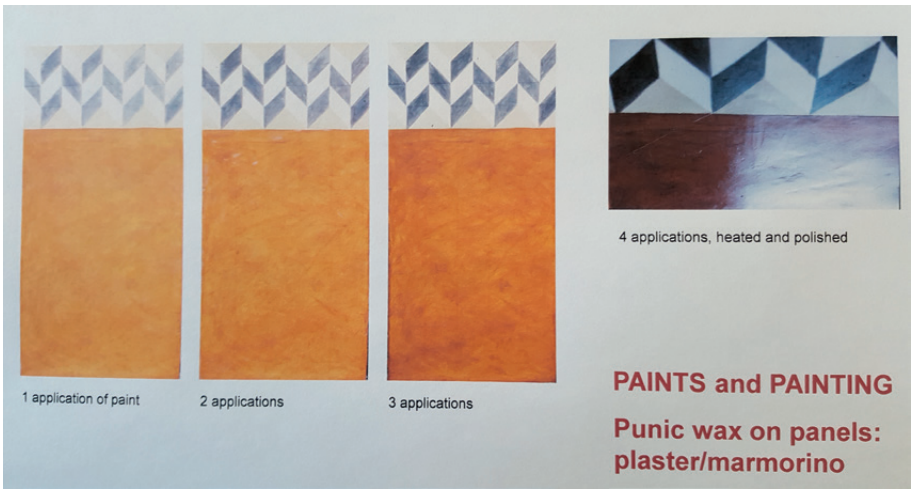
38 On Punic wax, see e.g. Freccero 2000; Freccero 2002; Freccero 2011; Freccero 2012.

39 Manzelli 1994, 108.

40 Berger 1904, 239; Manzelli 1994, 101, quoting Plut. qu.R. 287b–c.

41 On pigments and ancient paints, see Forbes 1965; Augusti 1967; Ashok 1993; Gettens – Feller – Chase 1993.

42 See e.g. Cantisani et al. 2016.



4 Punic wax with Terra di Siena pigment applied on stucco in 1–4 layers. The final layer was heated and polished (photo: A. Freccero)

which reflect each specific period in time, and in the past, that practice could be anything from the reinvention of partial losses to the explicit exhibition of the losses within the totality. Today the work of the conservator relies on scientific research. So does the work on reconstructing ancient polychromy. Painting should be undertaken by professionals too.

A range of modern equipment is available to identify pigments, binders and patterns, as systematically explained by Østergaard[43]. He presents all methods applied on the Sciarra Amazon in the Ny Carlsberg Glyptotek and the painted replica in the Museo Histórico Municipal of Ècija[44]. The pigments were identified by these methods but it was not possible to identify any organic binding media[45]. Similarly, in the examination of statues at Hierapolis, the Italian team was able to detect the pigments, but the organic binder could not be established[46]. Volkmar von Graeve and Frank Preusser could not identify the binder in their study of painted Greek marbles, but observed that paint had been applied in thin and transparent layers, allowing the sheen of the marble to come through[47]. Michael Price, who is an artist, discusses how to avoid tempera paints on marble becoming dull[48]. He points at the necessity of using only a little pigment in thin layers since numb applications of paint can make the sculpted marble seem rather flat. Even though pigments can be scientifically identified, that does not tell us what the paint layer looked like; it might just be a subtle hue (fig. 4).

The rich polychromy on the Alexander sarcophagus from Sidon has been addressed in many studies[49]. A hypothetical reconstruction of the sarcophagus' original polychromy was made by

43 Østergaard 2011, 23–30 explains how necessary data was collected in the international multidisciplinary collaboration in the Copenhagen Polychromy Network.

44 Østergaard 2011, 24–26: UV – ultraviolet luminescence; IR – infra-red luminescence; VIL – visible induced luminescence; SEM/EDX – scanning electron microscopy/energy-dispersive X-ray spectroscopy; SEM/XRD – scanning electron microscopy/X-ray diffraction; FTIR – Fourier transform infrared spectroscopy; GC-MS – gas chromatography-mass spectrometry; Raman laser spectroscopy; XRF – X-ray fluorescence spectroscopy; ICP-MS – inductively coupled plasma-mass spectrometry.

45 Therkildsen 2011, 33–38.

46 Bracci – Galli 2016, 575–581.

47 von Graeve – Preusser 1981, 139.

48 Price 2010, 63–66.

49 See e.g. von Graeve 1970; Houser 1998. The sarcophagus, depicting the battle at Issos, is dated to around 320 BC and exhibited in the Istanbul Archaeological Museum.

5 Augustus of Prima Porta in the Vatican Museums, Braccio Nuovo, inv. 2290. The statue, supported by a little Cupid riding a dolphin, presumably refers back on an original in bronze (photo: A. Freccero, published with the kind permission of Governatorato SCV – Direzione dei Musei. All rights reserved)

Brinkmann and his team. All methods applied to identify colours were listed[50]. As far as I can understand, these were photographic methods. 22 pigments and two colorants were identified. The binding media is not mentioned. A small-size reproduction was made and painted with egg-casein tempera. Brinkmann informs us that »[t]he section of the long side with Alexander the Great on horseback was also restored in colours as analogous with the other parts of the relief and the Alexander mosaic in Pompeii«[51]. What links the marble sarcophagus in Istanbul and the mosaic in Pompeii, except for the battle, might be the delicate colours, which are absent on the reconstruction.

The statue of Augustus as a victorious general, presumed to be a replica of a legendary bronze statue in the same posture, was found during excavations of the Villa of Livia at Prima Porta[52].

50 Brinkmann 2014b, 114: UVF – ultra violet fluorescence; UVR – ultraviolet reflectography; VM – visual light stereo microscopy; DM – digital microscopy; RL – raking light; NLBW – photography in visible light, black and white; NLCOLOR – photography in visible light, full colour; MPH – macro photography; 3DSCAN – structured light scanning; UV-VIS – absorption spectroscopy. See also Brinkmann – Brinkmann 2020, 200 f. cat. figs. 48–50.

51 Brinkmann 2014b, 114.

52 The Prima Porta statue, dated to the 1st cent. AD, was found on 20 April 1863. It is now in the Vatican Museums, Rome.

The exact find-spot was not recorded at the time, but the statue was presumably placed in the atrium so that it would be seen immediately by visitors. A metal rod on its back suggests it was placed against a wall[53]. The extensive remains of polychromy on the cuirass, clothing, hair and eyes, which were seen at the time, were gradually lost (fig. 5).

A study of the remnants of paint was made in the late 1990s and the pigments identified. Lime casein, which is a mixture of lime water and casein, was considered the most probable binding medium and therefore chosen for the paint[54]. The statue had been partially repainted in antiquity, although the emperor's skin had never been painted at all, but possibly treated with coating. Liverani points out that a thin organic transparent paint had been applied. The statue received what Liverani so elegantly formulated as the »fourth dimension«, the final layer without which a work cannot be fully understood[55]. A dense paint layer, on the other hand, would have hidden the Parian marble, which would have given rise to the suspicion that it was of an inferior quality[56].

The polychromy was recreated on a gypsum copy, which appeared as a combination of unpainted snow-white areas between thick layers of bright paint. Such a polychromy would have looked strange in the atrium, where remnants of the decoration show quite a different set of colours[57]. I agree with Fabio Berry, who states that these applications of grease-paint would also have been uncomfortable for ancient viewers, because »such aggressive polychromy not only obliterates the fine surface modelling but disgregates the body, like camouflage«[58]. On my last visit to the Vatican Museums in 2022, the copy looked quite different: either the copy has been altered or it has been substituted by a new one, where the face and the visible parts of the body have been treated with a coating that makes the plaster less white. The lips are no longer brilliant red, and the paint layers on the garment are reduced. As a consequence, the copy looks more like a credible suggestion of what the statue might have looked like (figs. 6–7)[59].

When copies are obtained by taking forms, any remnants of paint are in danger. Digital reproduction does not cause any damage to the original. The method was used on the portrait of Caligula in the Ny Carlsberg Glyptotek, a head with remnants of paint, which was digitally reproduced in Carrara marble[60]. Pigments were identified, and the results used to paint a marble copy, called Version A. Further analysis, and comparison to high quality Fayum portraits, led to a revised version on synthetic marble, called Version B. There is yet another three-dimensional copy, Version C in Copenhagen, and also a Version D in Gothenburg[61]. As the colours of the three-dimensional heads vary, they offer the viewer the possibility to consider the problem of colour and form, and allow them to see the representations as suggestions. In addition, there is the original head of Caligula with the original traces of colours to enjoy[62].

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53 Bradley 2009, 449.

54 Spada 2004, 251.

55 Liverani 2014, 49.

56 Liverani 2004, 240.

57 Freccero 2022.

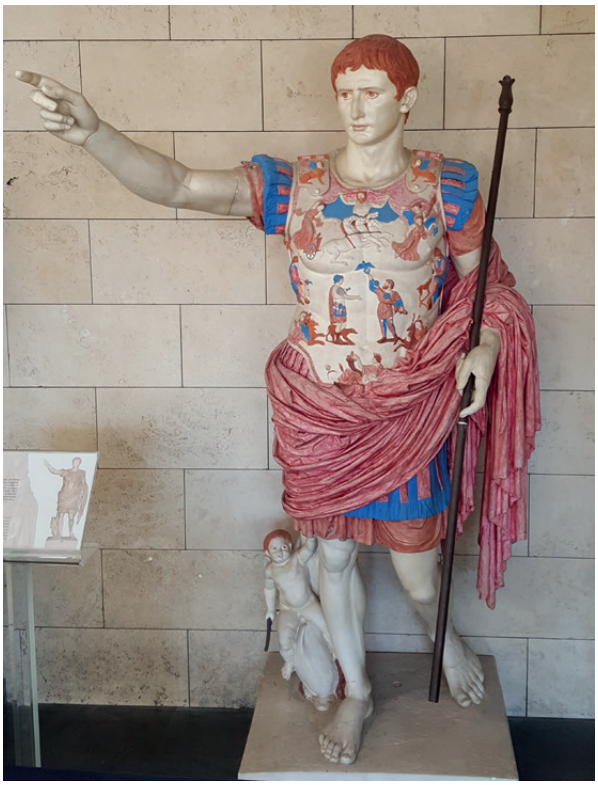
58 Barry 2011, 45 f.

59 The copy is now placed in a space behind the elevator, close to the entrance to the »Pinacotheca«.

60 Østergaard 2004, 255.

61 The four variations were presented in the catalogue »Bunte Götter« 2020, 220 f. Version A was made in 2003, Version B in 2005, Version C in 2011, and Version D in 2014. Another attempt was made by John Pollini, who manipulated a photo of Version B in Photoshop and created what he at the time named »Version C«, as an economic way of experimenting with polychromy on white marble. The digital version was first published in 2012, see Pollini 2015, 904.

62 Digital reconstruction of polychromy is another non-invasive method, used by Giovanni Verri, Thorsten Opper and Lorenzo Lazzarini for the tentative reconstruction of colour on the Treu head. They used photos of the carnation of a female on a Fayum portrait to create the facial colour on the marble head, thereby applying an ancient painter's sensibility for painting, see Verri – Opper – Lazzarini 2014.



6 Augustus of Prima Porta, hypothetical reconstruction in the Vatican Museum, Braccio Nuovo, inv. 36858 (photo: A. Freccero, published with the kind permission of Governatorato SCV – Direzione dei Musei. All rights reserved)

7 Augustus of Prima Porta outside the Roman Forum in Rome. Bronze copy of the marble statue. The bronze statue stands without any support from the Cupid (photo: A. Freccero)

DISCUSSION

Most copies reproduce originals in marble. Representations of important individuals and gods were partially or completely made of the most precious stone, because those marbles signalled dignity, prosperity and power, which were further underlined by the use of costly pigments. However, scientific identification of a cinnabar pigment does not indicate that the area was painted as a brilliant red layer; the colour might have been applied as a subtle shade. Colour was a marker; the density of paint was not. Expensive marbles were meant to be seen and admired, not concealed under layers of paint.

Art is the reason for research on materials and tentative reconstructions. A work of art begins as an idea, a vision shaped in the mind and the heart of an artist, and is formed by the artist's hands. The practical side of making an idea visual is the creative process. The sculptor, who once worked on the statues, which are now objects for research and reconstructions, not only knew how to handle the material but was also aware of the influence of surrounding light and reflections and of their effects on the statue. Form and colour were a unit even when the sculpted material was exclusively white marble. The addition of an extra hue by means of coating or paint had to be in accordance with the sculptor's vision and suit the environment for which the sculpture was intended. The vision combined with the artist's skill made a work of art, which could be anything from a masterpiece to a failure.

Reconstruction is a creative process too. Unlike the vision of the artist, who creates a heretofore unseen object, and who is therefore free to invent and express, the reconstructing person, like the copyist, has an existing object to relate to, interpreting what might have been the artist's intensions. Such interpretation is a subjective vision obtained by looking at the statue, the

observation of some remnants of paint and imagining what it might have looked like, combined with painstaking preceding research. Modern laboratory equipment is astonishing, fascinating, and it is remarkable that so many details can be identified which cannot be observed by ocular inspection. But you cannot recreate the original.

CONCLUSIONS

Hypothetical reconstructions of the original polychromy on white marble statues involve several disciplines, and substantial studies precede the attempts to provide the copies with colour or gold. The archaeological, historical and cultural contexts are studied and so are ancient written sources, all in order to understand what the item might have looked like a long time ago. Laboratory equipment is used to study surfaces and for the identification of pigments. The binder, which gives paint its specific character, is hardly ever identified, because organic matters gradually decay, and paint used for these experiments is a hypothetical choice. With all the knowledge accumulated by highly professional scholars and scientists, the copy is handed to a non-professional painter, who generally uses the unidentified paint in opaque layers that completely hide the material and structure of the underlying material. I think such copies discredit ancient painters' sensibility and believe that the sculptors would not have wanted their delicate works to be manipulated with disturbing layers of paint. I would say that uniform paint layers are not characteristic of ancient art. In naturalistic art, even in the Archaic period, there are natural variations of hues, not least because paint was, and is, applied with brushes. Flat and uniform paint layers like the surfaces on the painted copies became distinctive in modern non-figurative art. Flatness is also intimately linked to modern prints, such as cartoons by Walt Disney. Some people believe ancient statuary looked like this; others do not. In my opinion, they are a new type of statuary: modern painted copies. As such, they are useful for further research and innovative methods and not least, for vivid discussions on ancient polychromy.

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PRODUCTION AND TRADE OF MARBLE AND OTHER STONES IN THE ALPINE AND DANUBE PROVINCES: REGIONAL RESOURCES AND MEDITERRANEAN IMPORTS

Cristina-Georgeta Alexandrescu – Albert Baltres

ROMAN STONE MONUMENTS FROM NORTHERN DOBRUJA (ROMANIA)

PETROLOGICAL CHARACTERISATION AND PROVENANCE DETERMINATION IN A HISTORICAL CONTEXT

Abstract
The currently ongoing project is focused on petrological and lithostratigraphic investigations of well-dated Roman stone objects and fortifications in northern Moesia inferior and concluded that the majority of the examined monuments are made from local Turonian and Cenomanian limestone varieties, sedimentary breccias and sandstones, but also from younger Mesozoic limestones. Marble is rare and was imported. So far, provenance areas in the immediate surroundings of main ancient sites along the Danube, in the Măcin Mountains and in the Babadag Plateau have been localised. The ancient quarrying areas are sometimes difficult to localise due to the continuous use in modern times. This interdisciplinary approach provides insight not only into the provenance of stone material used during different historical periods (6th cent. BC – 13th cent. AD) and for specific purposes (sculpture, building, etc.) but also into matters of transportation, production and economic interaction at regional and provincial levels, as well as with the main harbour of the province in Tomi and, from there, with the Mediterranean region.

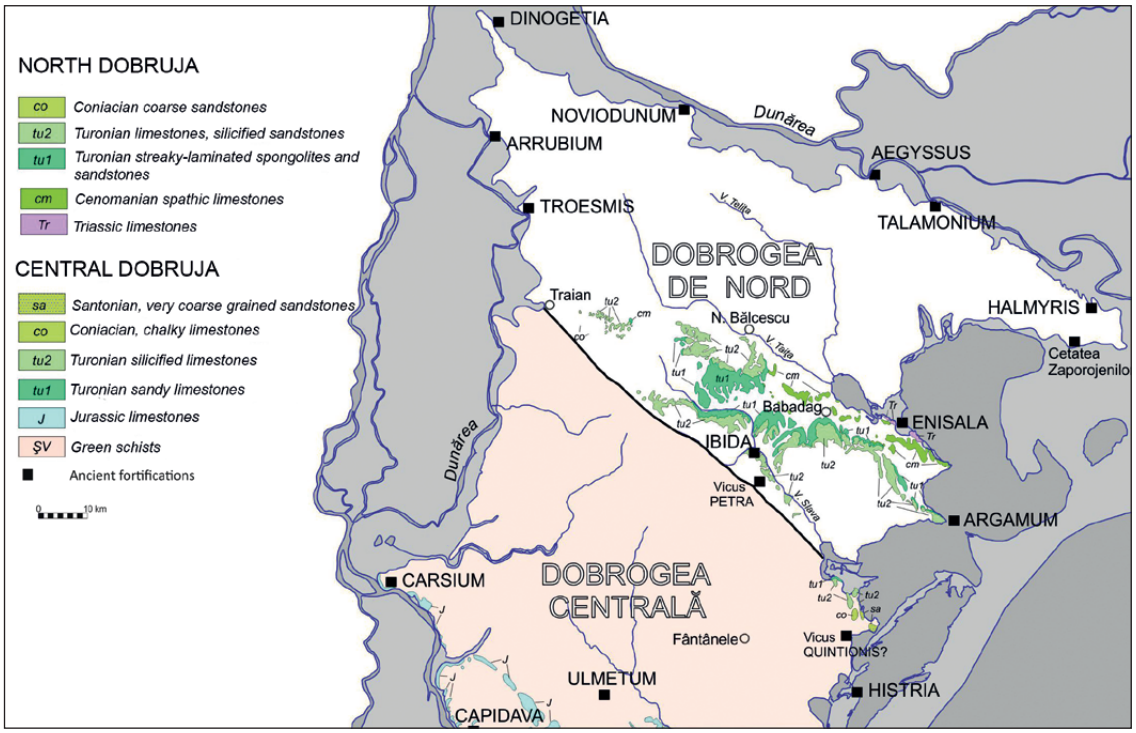
INTRODUCTION

The ongoing project on the »Roman Stone Monuments from North Dobruja« (PN-III-P4-ID-PCE-2020-1031) focuses on petrological and lithostratigraphic investigations of well-dated Roman stone objects and fortifications. Those are less numerous than expected, mainly due to the state of research in the region. In Roman times, the area belonged to the province Moesia inferior, which occupied – from the end of the 2nd century AD – virtually the whole area between the Balkan Mountains, the Danube and the western Black Sea coast[1]. The limes zone along the Danube and the western part of the province had a predominantly Latin influence, while the poleis on the western Black Sea coast, some of which had already been founded in Archaic times, and the cities founded by Trajan – Marcianopolis, Nicopolis ad Istrum –, with their city territories, were organised according to Greek principles.

This ambivalence is reflected in many areas of the provincial society, such as the economy and trade, crafts and especially in the field of material culture. The funerary monuments provide relevant evidence, as they reveal a reception of types and iconographies from the eastern and western provinces of the Roman Empire, as well as a coexistence of Greek and Roman sepulchral symbolism, whereby the development of mixed forms and local variants can be increasingly observed in the 2nd and 3rd centuries[2]. In the late 3rd century, the northern part of the province became the province Scythia.

Even if the epigraphic evidence from the province is one of the most investigated categories of finds, questions relating to the lithic materials and their provenance were almost neglected or

1 For a short historical overview, see Petculescu 2006.
2 Conrad 2004.



1 Geological map of northern Dobruja, with the main stone sources used for sculpture and building in the ancient sites. The Mezozoic formations around Halmyris that were used are not mapped here (graphics: A. Baltres)

generalised, based on quite old overview publications[3]. Thus, aiming to fill that gap, the present project has as its focus only the northern part of the province, corresponding to the geological northern Dobruja (fig. 1), in order to establish a methodological approach and protocol which can subsequently be used for appropriate holistic investigation of the Roman stone monuments.

The geomorphology of the northern part of the province shows the presence of the old Dobruja Mountains, with heights of only 485 m, and important landscape changes caused by natural transformations (major shoreline displacement) suffered by the Black Sea shores and the course of the lower Danube branch over long periods, which were both particularly important for the founding, development, transformation and eventually the decline of ancient settlements.

Besides the observations that could be made macroscopically, when sampling was safely possible, the material provenance analyses made use of thin sections and their investigation under the microscope. Once provenance areas were determined, the region was further investigated for images, maps and other possible archival data regarding the stone exploitation, but also visited in field trips, looking for possible traces of quarrying. So far, given the logistic circumstances, but mostly due to the limitations of access and documentation conditions as well as permits for airborne laser scanning (ALS) flights, suitable research from the air was limited to the available light detection and ranging (LiDAR) images, which in most cases proved to be not sufficiently detailed for our purposes. The extent of the areas to be appropriately investigated, especially the ones covered with vegetation, make necessary, in the near future, a dedicated project, with adequate infrastructure and know-how. However, during our project, it was possible to initiate and organise a collection of quarry samples and thin sections, which proves to be a particularly useful working tool for archaeologists, especially when sampling in order to investigate the monuments is not allowed.

3 See e.g. Inscripţiile din Scythia Minor (ISM) Series; Covacef 2002 (with further references); Mihailescu-Bîrliba 2018.

THE TURONIAN LIMESTONE AND SANDSTONE, A FAVOURITE MATERIAL FOR SCULPTURE AND BUILDING

This survey started with the case study on the fortification in Halmyris (›La Cetate‹, Murighiol) and several monuments uncovered in major urban and military centres in northern Dobruja, such as Troesmis/Turcoaia (headquarters of the *legio V Macedonica*, later a municipium) and Noviodunum/Isaccea (headquarters of the Danubian fleet, *classis Flavia Moesica*, municipium), but also in their hinterlands. In all these sites, a sedimentary rock with the macroscopic appearance of rough, well-cemented, yellowish-brown sandstone was used on a large scale[4].

The physical properties of the lithic material are yellowish-brown (tan, drab) rock resembling sandstone, consisting of three endmember components: carbonate bioclasts, siliceous sponge spicules, and quartz sand grains that form a gradation relative to the amount of each of them. The resulting rocks vary from nearly pure limestones, to cherty, spiculitic or sandy limestones, spiculitic sandstones and, sometimes, spongolites. These sedimentary rocks belong to the Turonian section of the geological record of northern Dobruja and are of marine origin[5]. The widespread use of this rock, with its faint colour, is well attested. It was probably considered a perfect material for architecture and sculpture (figs. 2–4), so that the geological identification and tracking to source would help explain ancient economic interactions.

The first evidence of use of this rock in the region could be traced back to the Greek period, in the sacred area of Histria (Histria, the Temple of Aphrodite, dated to the 6th cent. BC). The quarrying of this stone had a second period of strong development in Roman times[6].

The Turonian rocks with characteristics matching well those of the material used in ancient monuments and buildings were provided by a large supply district coincident with a geomorphic unit called the Babadag Plateau (fig. 1). The Babadag Plateau, stretching between Razelm Lake (Cape Dolojman) in the east and the Danube River (near the village of Traian) in the west, consists of a series of low-lying, gently sloping hills with altitudes of

2 Large funerary stela of Memmia Marcia from Halmyris, carved in Turonian limestone (photo: C.-G. Alexandrescu)

4 For already published overviews and results on this, see Baltres 2011; Baltres – Stanciu 2011; Bîrzescu – Baltres 2013 (with further references).

5 For a detailed overview on the characteristics of these rocks, see Baltres 2011.

6 Bîrzescu – Baltres 2013.

3 Architectural elements from Histria and Troesmis, carved in Turonian rock (photos: C.-G. Alexandrescu)

up to 325 m. The large Codru quarry, near Babadag, cut in massive beds (lower half) and decimetre-thick beds (upper half) of yellowish-brown rocks, is largely composed of Turonian spongolites. From here, important volumes of stone were carried to many destinations, indicating an extended use in most sites of northern Dobruja. Here surface layers of a gently folded syncline formed after Upper Cretaceous crop out, the axis of which runs in a West-East-direction. The dip of the beds varies between 5° and 15°. The yellowish-brown rocks filling up this syncline, belonging to the Dolojman formation, range in age between the Lower and the Upper Turonian.

The Dolojman formation consists of a lower member, 20–100 m thick (Jidini member), with a large content of sandstones and spongolites, and an upper member, 50–200 m thick (Harada member), dominated by sandy limestones and limestones. Lateral and vertical facies variations are common in the sedimentary successions of both members, so that there are also variations in quality, even within one single outcrop[7]. The lower member of the Dolojman formation was seemingly preferred for extracting material employed in architecture and sculpture, as the availability and efficient quarrying were favourable to the distribution of the products (raw blocks or half-fabricates). A large variety of products were made of this material, which seems to hold a large market share, especially during the Roman period. Besides the quite large ashlars, other building and architectural elements, also differing in size, were used for fortifications, but also for public and probably private buildings. Furthermore, the Turonian rocks were chosen for reliefs, inscriptions and funerary monuments (fig. 2), but also for sarcophagi and milestones. In the Late Roman and Byzantine periods, the supply and demand for building material changed radically, which resulted in the practice of sometimes even repeated reuse of early Roman monuments.

The relatively soft Turonian rock was not suitable for carving many everyday items or items for domestic use like basins, vessels, etc.[8] For portable millstones and even more complex elements for animal traction mills, there is evidence only of examples carved in the more resistant cochiliferous Sarmatian limestones from southern Dobruja, most probably delivered as finished products within the province.

REGIONAL SOURCES: THE HARD CONIACIAN SANDSTONES FOR SCULPTURE IN THE TROESMIS AREA

The in-depth analyses of individual monuments enabled insights into regionally used sources or even of preferences at micro-regional level[9]. Thus, the provenance from the western part of the outcrop in the Babadag limestones was determined for several inscriptions from Troesmis.

7 For the detailed presentation of the characteristics of the rocks, see Baltres 2011.

8 E.g. two elements from the water supply system, with the connection to the terracotta pipes, see Baumann 1984, 221 no. 27 (from Noviodunum, carved in Turonian rock). nos. 28–29 (from Troesmis, made of Sarmatian limestone). The material was identified by A. Baltres.

9 The monuments from Troesmis and its surroundings will be published in a dedicated volume, including their geological analysis, within the present project.

4 a: Sarcophagus of Ulpia Iulia from Tumulus XXX in Noviodunum (photo: C.-G. Alexandrescu). b: Siliceous spicule proving the primary nature of the sediment, which was a spongolite. Image in parallel nicols (microscope images: A. Baltres). c: Microquartz (chert) formed by opal diagenesis of the spongite spicule constitution (m), relicts of calcareous material (c) and tertiary quartz grains (q) revealed by microscopic examination in crossed nicols. The long side of images b and c measures 0.9 mm (microscope images: A. Baltres)

Furthermore, there is the hard Coniacian sandstone from Traian and Cerna (Tulcea county), in the surroundings of ancient Troesmis (fig. 1), which was identified in inscriptions (fig. 5), but also in large votive or possible cult reliefs (fig. 6), and even in a sarcophagus found on the other side of the Danube, near the Roman centre in Barboşi (Galaţi county). The extent of the use of this rock in the province, as well as the identification of quarrying places is rather problematic at the moment.

MARBLE: THE MEDITERRANEAN CONNECTION

The region under study is quite different from other parts of the province. The locally available stones were used and reused for certain purposes, the financial factor certainly playing a significant role. Based on the available evidence, marble was imported from Paros, Thasos and Prokonnesos only for small and middle-sized objects used as votive elements or eventually for decoration. They might have reached the province in a finished state, being only inscribed locally on demand. A further category comprises the funerary statues (of Proconnesian marble) found in Noviodunum, but also in the areas of probable rural settlements or estates, near Troesmis and Halmyris. Also significant is the import of Proconnesian sarcophagi[10], which reached the north of the province and were immediately replicated in local stone. Most of them are roughly worked and anepigraphic. Only the sarcophagus of Ulpia Iulia (W 2.33 m), found in Tumulus XXX from

[10] Found in Barboşi and the area of Noviodunum, see Alexandrescu-Vianu 1970, no. 26 (Noviodunum). no. 29 (Barboşi). More Proconnesian sarcophagi have been found in the Greek cities on the Black Sea coast, especially in Tomi (Constanța).

5 The honorary inscription from Troesmis ISM V 146 (photo: C.-G. Alexandrescu)

Noviodunum (fig. 4), next to the already mentioned marble statues[11], left rubbed smooth and engraved, allows a reliable attribution to a rich private person, mirroring their social status.

Marble for architecture is currently limited to the evidence from the Late Roman period (architectural elements, mainly capitals, in Christian basilicas, etc.)[12]. Fragments of cladding and incrustation capitals were found and documented during recent surveys in Troesmis, but their early Roman date is only hypothetical, for the time being. In the more in-depth analysis of these kinds of finds from the mosaic-floored building in Tomi (Constanța), the marble was recently investigated, including some comparanda samples from Troesmis[13]. The results show the material to be white marbles of medium grain size, with a low content of rare earth elements (Group 1), of Proconnesian provenance. Several other samples belong to white marbles of medium grain size, with a high content of rare earth elements (Group 2), of the same provenance.

Furthermore, there are several inscriptions on slabs, dated starting with the 2nd century, fragmentarily preserved, reported as occasional finds in Noviodunum and Troesmis[14]. In our opinion, their macroscopically observed appearance makes identification as Proconnesian marble also probable.

QUARRY LOGISTICS, TRANSPORT AND SUPPLY

One can only imagine the effort made to extract huge stone slabs in a quarry in ancient times simply by calculating the volume and weight of the raw material extracted for some of the pieces subject to this study. For example, the largest gravestone from Halmyris measures 0.576 m³ and 1.44 t in weight. However, a sarcophagus is much larger. The raw block for the largest piece of this type from Noviodunum occupied a space of 2.48 m³ and had a weight of 6.2 t[15].

11 Simion 1994/1995.
12 Baumann 1984, 218–220 no. 10 (from Nifon). no. 11 (from Noviodunum). nos. 12–15 (from Ibida).
13 See the contribution of C.-G. Alexandrescu – I. Sodoleanu – W. Prochaska – V. Anevlavi, in this volume.
14 Baumann 1984, 224 f. no. 5.
15 Baltres 2011.

The tabular slabs for stelae were cut from the bed in dimensions matching the length and width: the largest stela from Halmyris[16] is 2.56 m high and 0.9 m wide (fig. 2), but other such pieces are shorter. The maximum dimension of the blocks extracted in a quarry was controlled by the thickness of the beds. Only some rare quarrying areas, with massive, thick beds could provide larger blocks for carving such bulky elements as sarcophagi, making them the most highly valued.

6 Large votive/cult (?) relief of a Thracian Rider from Traian, near Troesmis (photo: C.-G. Alexandrescu; microscope image: A. Baltres)

Besides the possible considerations enabled by the dimensions of the monuments, their shape and ornamentation provide insights into the skills of the ancient stonemasons and sculptors. In ancient times, some rocks were more highly regarded than others, and specialised quarries and stonemasons were very selective in their choice of stone. Among the rare and finest examples of architectural decoration carved in Turonian limestone are exquisitely carved 2nd–3rd-century Corinthian capitals and the pseudo-Corinthian pilaster capital (H 26 cm)[17] found on the territory of the civil settlement of Troesmis (fig. 3). They are carved in Turonian rock, using locally adapted schemata following models from Asia Minor. The use of this rock for architectural elements is attested as early as the Archaic period, through an anta capital from Histria (fig. 3 above), which means the local resources were known from the beginnings and used for both building and decorative purposes[18].

Late Roman epitaphs carved on stelae similar in layout and dimensions to the early ones raise the question of whether the slabs might have been available as half-finished objects and simply used through the carving of the epitaphs, which was the most valuable form of expression in the period.

The highly organised system involved the facilities of the Roman road network, but also, up to a point, depending on the conditions of the waterways, along the Danube and the shores of the Black Sea. The quality of the blocks allowed for the intensive reuse of earlier monuments especially since the 4th century, and this applies not only to the sculptural and/or epigraphic ones, but also to some of the ashlars initially delivered as building materials.

Details on the administration and chronology of the main stone quarries and their supply network in antiquity in the northern part of the province are not known. For the Late Roman, Early Byzantine and later periods, the practice of intense and even repeated reuse of earlier monuments is noticeable, especially of the skilfully cut and prepared ones and in particular for the fortifications, which needed to be built up and/or repaired quickly. Thus, for a long time, information on the early Roman period in the area of interest came mainly from the reused epigraphic monuments.

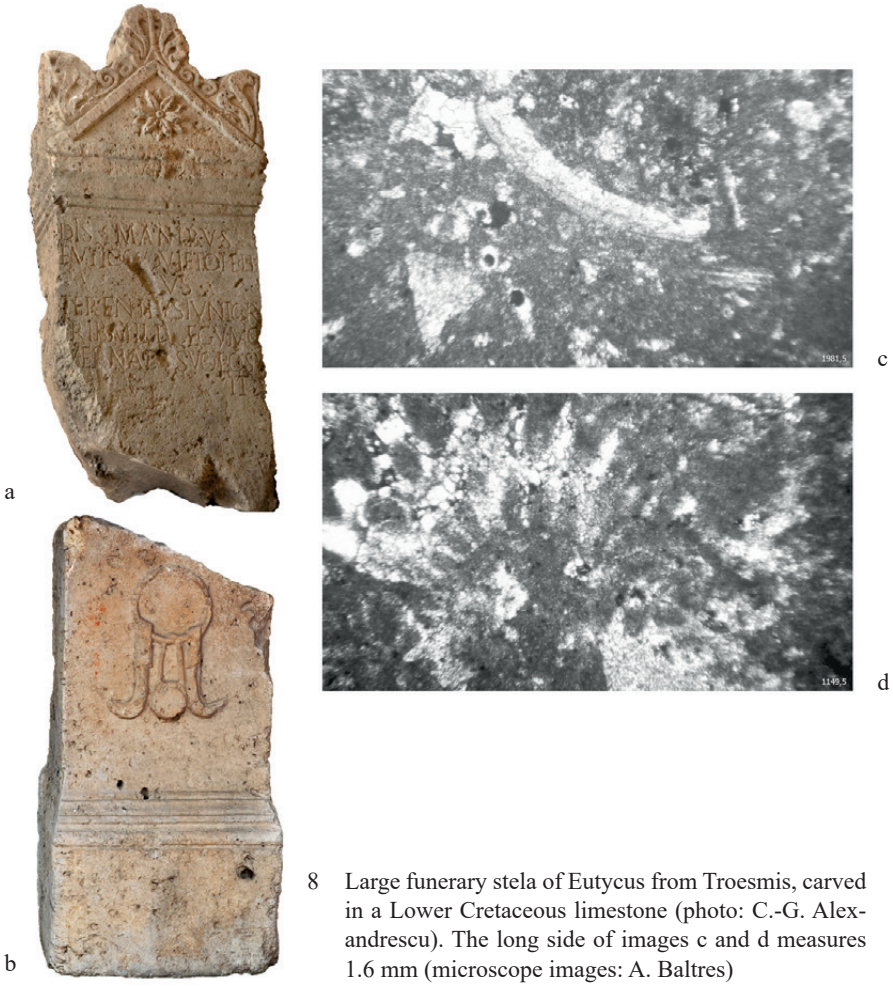
One very eloquent example of this repeated reuse of the Turonian rocks is the fortification in Halmyris. Three incomplete rows of large, squared and carefully fitted ashlars are standing *in situ* as remains of the northern gateway. All these blocks were cut in the well-known yellowish-brown

16 Zahariade – Alexandrescu 2011, no. 25.

17 ISM V 168.

18 In the stone revetment of the Temple of Theos Megas from Histria there was a very large block measuring 2 × 1.7 × 0.5 m, see Bîrzescu – Baltres 2013.

7 Inscription carved in one block of Anisian grey limestone from the Murighiol formation, near Halmyris, used as the main building material in the Late Roman fortification (photo: D. Hălmagi)



a

b

c

d

8 Large funerary stela of Eutycus from Troesmis, carved in a Lower Cretaceous limestone (photo: C.-G. Alexandrescu). The long side of images c and d measures 1.6 mm (microscope images: A. Baltres)

rock, with a streaky laminated internal structure, which is better shown in the weathered side of the uppermost stone, but can be seen best in the western gate situation. The few still available and usable large Turonian blocks were used in foundations and in strategic places within the walls, like large towers, gates and corner situations, i.e. as building material, even cut into smaller and easier-to-handle blocks.

In its later phases, the fortification curtain segments and the elevation of the gateways, as well as most of the structures in the interior of the fortification, made use of Mesozoic limestones and sandstones, available within a distance of up to 5 km in the vicinity, cut in small blocks and easily accessible[19]. From Halmyris a single example of intended use of the local Anisian dark-grey limestone block (Murighiol formation) for an inscription (fig. 7) is known[20]. Its undocumented finding context made further observations on this impossible: was it really reused (as stated by the archaeologist)? Was it inscribed after the block was walled in and did the initial text cover several blocks? Only during our survey did the importance of the find become evident, not as much as epigraphic evidence, but more as a hint towards a quite different aspect of the local stone supply. What is, however, obvious, is that this particular limestone cannot be quarried in large blocks.

The two still visible fortifications in Troesmis, the eastern (Late Roman) and the western, dated to the Byzantine period, show a different situation. In Troesmis, blocks of Turonian rock were ordered to be used for a particular purpose at least for building the U-shaped and corner towers of the eastern fortification, dated to the 4th–6th century. Further earlier monuments made of Turonian and Coniacian limestones and sandstones, from the early Roman settlements in Troesmis, were extensively reused in both fortifications from Troesmis[21].

Reused blocks made of a cream-coloured and relatively soft Lower Cretaceous bioclastic limestone, possibly from southern Dobruja, were, at the time of the documentation of the eastern fortification, an exotic occurrence[22]. Recently, it was possible to investigate a stela from Troesmis (fig. 8), found not in reuse but accidentally, during agricultural works, in an area currently known as one of the necropolises[23]. It is worth noting that the stone is the same bioclastic limestone and that it most probably belonged to a round funerary building similar to the ones from northern Italy and also attested in other Danubian provinces. Being one of the earliest monuments in the area, it seems that parts of it were collected for reuse, while others (the stela) were left on-site. This example has further significance for the area under study – in the early 2nd century the local quarrying was not as advanced as needed, thus regional imports were acquired from other sites along the Danube, as a compact delivery for a particular project.

PERSPECTIVES

One of the main issues to be addressed in the near future, most probably correlated to the already mentioned dedicated ALS of the potential ancient stone quarry sites, is that of the road network, particularly the conditions that would enable the transport of stone over land.

The material provenance investigations need to be continued and extended to special categories of objects and artefacts, like, for example, the millstones.

Based on these preliminary results, further study cases on the building materials and methods for fortifications in the area are necessary so as to properly understand whether the observation on

[19] The detailed analysis on the lithic materials used in Halmyris is presented in Alexandrescu – Baltres (forthcoming).
[20] Zahariade – Karavas 2019, no. 1.
[21] Alexandrescu 2016.
[22] Alexandrescu 2016, 51. 56.
[23] Alexandrescu 2021.

the limited use or even lack of spolia is real or whether this is just due to the state of research[24]. If this is the case, it is necessary to identify the reasons for this situation.

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[24] The importance of such dedicated approaches has been proven for Enisala (Baltres – Stanciu 2011) and Noviodunum (Stănică – Livanov 2022). Their use still lags behind the scientific interests, as the results can be used for the management of the archaeological sites and the necessary maintenance, conservation and restoration interventions.

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THE MARBLE DECORATIONS OF THE MOSAIC-FLOORED BUILDING IN TOMI/CONSTANȚA (ROMANIA)

PRELIMINARY STUDIES

Abstract
The mosaic-floored building in Constanța was uncovered between 1959 and 1966. Our project started in 2019 with the investigation of archival materials, aiming to gather information and locate the place or even the context of discovery for some of the unearthed archaeological materials. The research started with the marble wall cladding of the large mosaic hall. The objective is to investigate the pieces and the context in which they were uncovered using a combination of methods for analysis in order to establish the provenance of the materials, to which stage of the building's functioning they belong, etc. A selection of relevant specimens of marble decorative elements (architectural elements, decorative slabs, as well as unspecific veneer fragments) was made. The results of 25 analyses (by means of thin section and stable isotope analysis, chemical composition/trace elements) on different white marble pieces from the mosaic building and 9 comparanda from Moesia inferior are the subject of this paper. The main provenance sources determined are Prokonnesos and Dokimeion, while an incrustation capital was carved in marble from Herakleia/Miletos.

INTRODUCTION

The Roman mosaic-floored building, discovered accidentally in ancient Tomi (nowadays Constanța) was systematically investigated between 1959 and 1966. The commercial building complex located on the southwestern cliff of the old Tomi, on three terraces, near the harbour area[1], has drawn scientific interest since its discovery, its dating and pavement giving rise to different opinions. Although an early dating was discussed, the late dating, at the beginning of the 4th century AD, is that currently accepted[2].

The archaeological inventory, including the numismatic material, was dated to the 4th–6th centuries AD. The style of mosaic work is specific to the 4th century AD, with complex repairs, whose rendering is representative of the middle of the same century or the beginning of the next.

A small part of its inventory was published partially and selectively or only illustrated in scientific articles or in materials designed to attract popular interest, such as the museum guidebook versions published so far[3]. Building investigations were resumed starting with research on archival materials from the institutions involved (the museum in Constanța and the former Commission of Historical Monuments), which created the conditions for obtaining new information and locating the place or even the context of discovery for some categories of uncovered archaeological materials[4].

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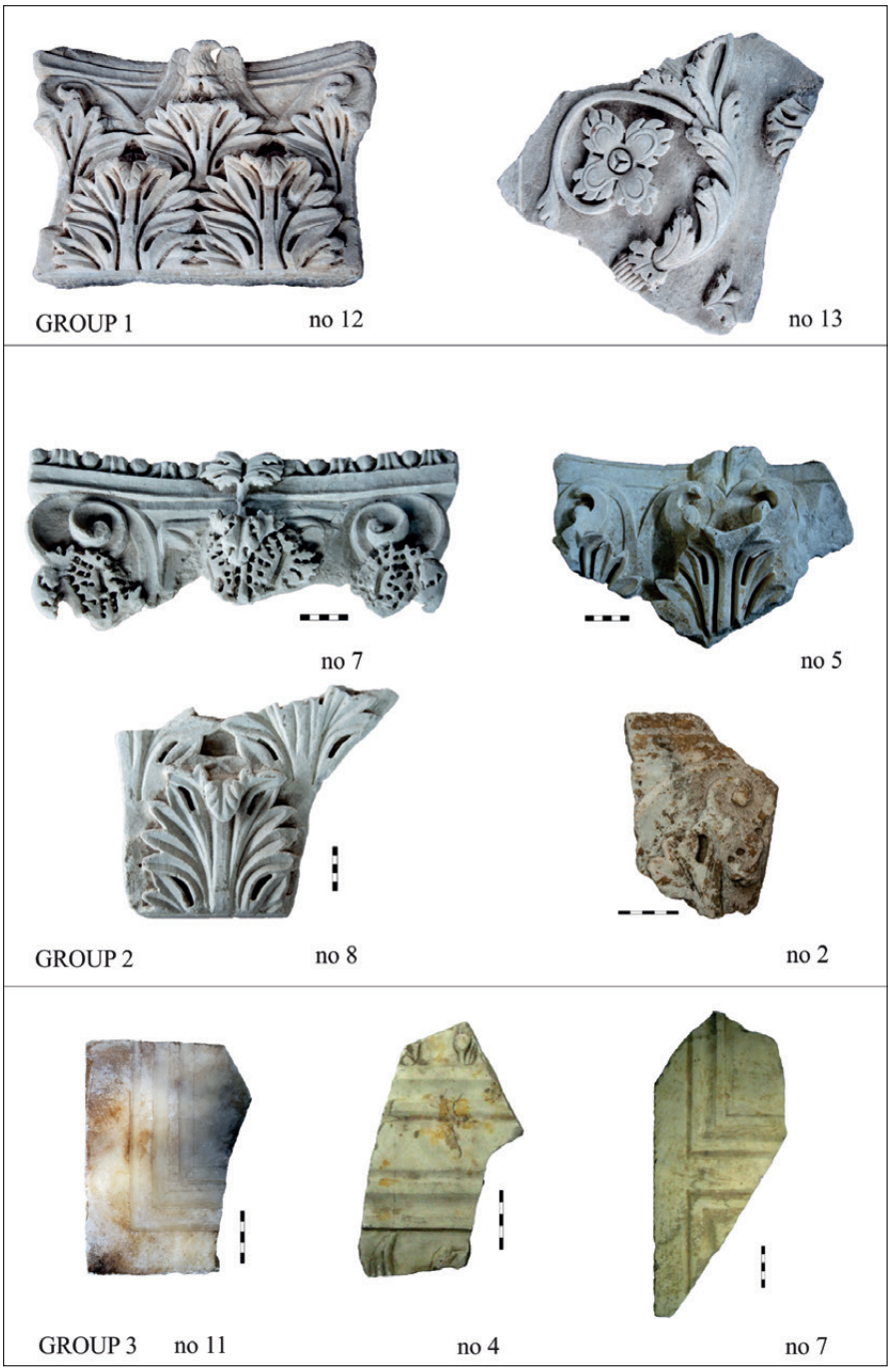
1 Sodoleanu 2019, with the plan of excavations in fig. 3.

2 Canarache 1960; Suceveanu 1969; Rădulescu 1970; Sâmpetru 1973; Barnea 1976.

3 Amphoras: Rădulescu 1973; Sâmpetru 1973; Rădulescu 1975. Stamped pottery: Papuc 1973; Munteanu – Papuc 1976. Oil lamps: Papuc 1976. Oil lamp moulds: Iconomu 1976. Sculptures: Covacef 1990; Covacef 1997; Covacef 2002. Metal objects: Petcu – Nuțu – Nastasi 2014; Nastasi 2016. Other objects are briefly mentioned in Canarache 1960; Bucovală – Lungu 1997.

4 Nastasi 2014.



1 Selection of sampled and analysed marble items from Constanța. The numbering is that used in the statistical analysis (see n. 6 and tab. 1) (photos and graphics: C.-G. Alexandrescu)

The marble cladding of the large hall with mosaic pavement, hitherto known only through photographs and brief references, sometimes only tangential, in guidebooks and technical studies on the architecture of the building[5], is the first category of material covered by a collaborative project initiated in 2019. The main objective was to investigate the pieces and the context in which they were uncovered using combined methods of analysis in order to establish the provenance of the

5 Canarache 1967; Bucovală – Lungu 1997; Mărgineanu-Cârstoiu 2018.

materials, their classification in one of the stages of the building's functioning, their relationship with the proposed chronology, etc. The study of the marble architectural decoration of one of the public buildings in Tomi is what makes our project different from the prior research on the provenance of the marble from different Greek and Roman finds in Romania.

METHODOLOGY

At first, in the pilot phase of the project, a selection was made of relevant specimens of white marble decorations (capitals, plinths, and rectangular slabs with two decorative fields, pavement slabs as well as veneer fragments) in the museum's depot in order to establish the provenance and terminology of the marbles, as well as the requirements and further procedures for the sampling and analysis using petrographic and geochemical methods (fig. 1).

Analyses by means of stable isotopes and chemical composition/trace elements were possible for 25 samples of different white marble pieces from the mosaic-floored building. Thin section analyses were limited given the available/possible samples. Further nine samples of marble cladding, architecture and votive reliefs from the same ancient city and several other sites within the same province were also investigated for the purposes of comparison. In the northern part of the Moesia inferior province (and the later Scythia province), marble was an imported material. With its harbour and strategic location, Tomi was the main trade hub in the region, including for the marble imports, for several historical periods.

RESULTS AND DISCUSSION

The 34 analysed samples can a priori be divided into three groups.

Group 1: White Marbles of Medium Grain Size with a Low Content of Rare Earth Elements (REE) (15 Samples)

This group has a relatively uniform composition and only two samples (nos. 12. 15)[6] are somewhat outside the cluster. The isotope diagram shows an appreciable overlap of the compositions; thus, assigning the samples to one of the groups is problematic.

In the bivariate diagram (fig. 2) showing the two most significant canonical factors of the multivariate analysis, the main group coincides very well with the composition of the Proconnesian marbles.

Given the suitable size of some samples in this group, microscopic slides could be prepared. The textural feature of these samples shows a heteroblastic fabric, which matches very well those of Proconnesian marbles. Usually, these samples are calcite marbles, but in one case a minor amount of dolomite can be found.

Sample no. 12 (incrustation capital) is a relatively good fit with the marbles from Herakleia/Miletos.

Sample no. 15 (a mosaic tessera) cannot be assigned at present. According to the higher manganese (Mn) numbers (fig. 3; tab. 1), a Proconnesian origin can be ruled out for this sample.

The samples in this group (fig. 1) come from incrustation capitals (nos. 7–8. 10–12), a plinth (no. 9), tesserae (nos. 14–15) and a »Rankenfries« fragment (no. 13) found in the building of interest. A pavement slab (no. 6) belongs to the nearby baths building, the Lentiarion[7]. Samples nos. 1 and 2 belong to similar architectural decoration from Troesmis, while nos. 3 and 4 are from Mithras votive reliefs from the same site on the Danube.

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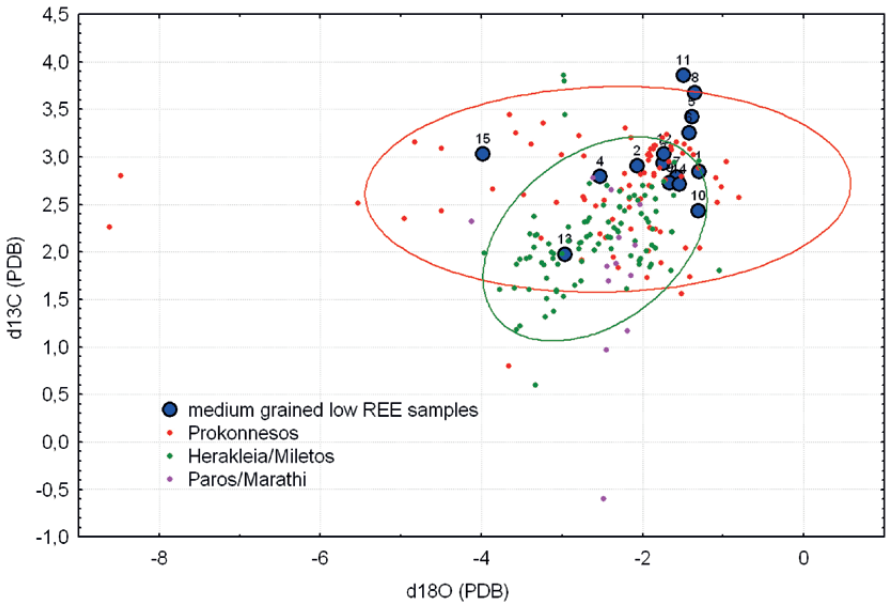
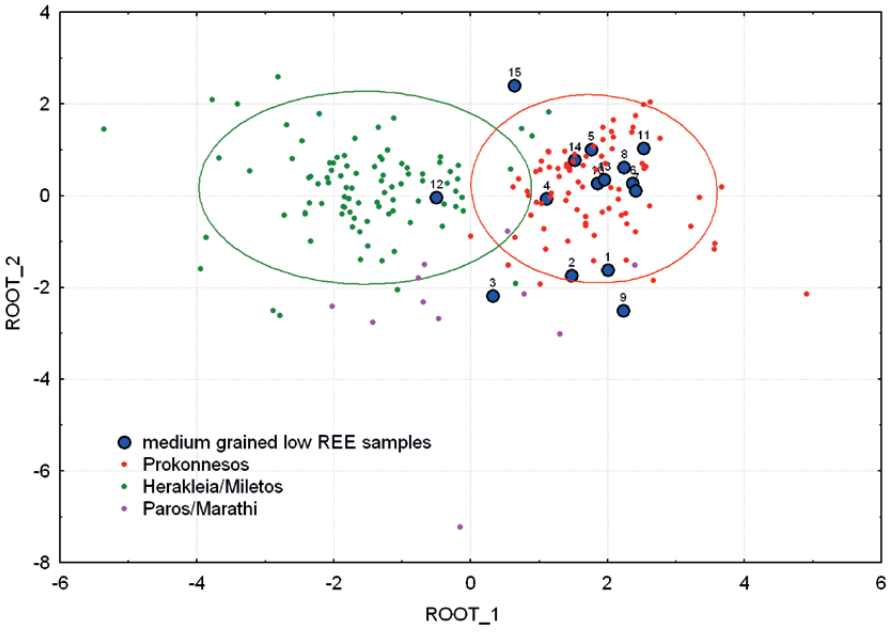
6 The numbers generated in the statistical analysis software are listed in tab. 1, followed by the numbers in the laboratory. Their correspondence with the samples, as well as the identification of the sampled items, is also included.

7 Sodoleanu 2019.



2 Group 1: White marbles of medium grain size with low REE content, the isotope composition (graphics: W. Prochaska, V. Anevlavi)



3 Group 1: White marbles of medium grain size with low REE content, multivariate discriminant analysis (graphics: W. Prochaska, V. Anevlavi)

Group 2: White Marbles of Medium Grain Size with a High REE Content (8 Samples)

This group consists of two subgroups according to the isotopic (fig. 4) and chemical composition (fig. 5; tab. 1). Samples nos. 4, 7 and 8 can clearly be attributed to Prokonnesos III marbles originating in the Proconnesian quarries of Harmantas and Aksoy.

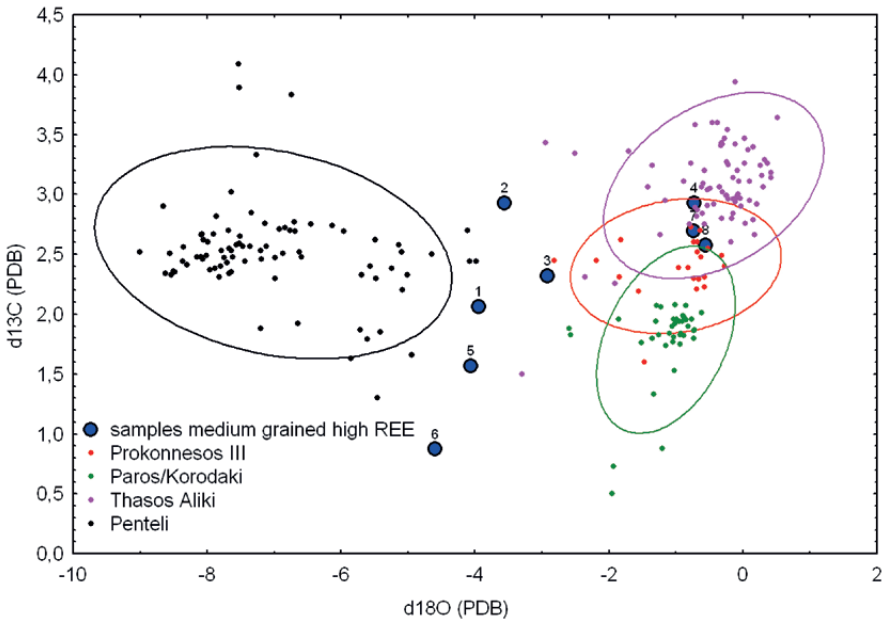
The isotopic and chemical parameters are somewhat similar to the very low metamorphosed limestones of Lesbos, which match to some extent the composition of the Proconnesian marbles. However, a major disadvantage for the analysis of this group is that no thin section of these samples could be prepared, which could have resolved this question easily.

Group no.	Lab no.	Sample	Artefact	$MgCO_3$%	$\delta^{18}O$ (PDB)	$\delta^{13}C$ (PDB)	Cr	Mn	Fe	V	Sr	Y	Cd	Ba	La	Ce	Pr	Dy	Ho	Yb	Pb	U
Group 1																						
1	ROM 01	TR12/0048	Capital	1.13	–1.30	2.84	1.87	2.43	79.29	0.31	283.74	0.31	0.19	1.71	0.115	0.148	0.023	0.030	0.007	0.020	1.348	0.066
2	ROM 02	TR14/ passim01	Capital	3.54	–2.07	2.91	1.18	7.01	137.59	0.51	264.12	0.38	0.13	1.92	0.213	0.362	0.046	0.042	0.009	0.026	2.102	0.086
3	ROM 07	TR 08	Mithras relief	11.39	–1.74	2.94	2.19	7.31	65.07	1.69	321.03	0.12	0.44	4.61	0.081	0.083	0.010	0.012	0.003	0.008	6.544	0.085
4	ROM 09	MNA L957	Mithras relief	1.39	–2.52	2.79	1.14	2.37	64.49	0.10	170.16	0.11	0.14	1.23	0.058	0.080	0.009	0.010	0.002	0.007	1.368	0.018
5	ROM 11	ERM 7	*mortarium*	1.11	–1.39	3.42	1.76	1.36	48.04	0.45	152.70	0.19	0.13	0.70	0.045	0.029	0.004	0.009	0.003	0.008	0.625	0.009
6	ROM 24	ERM 36	Pavement slab	1.16	–1.42	3.25	2.22	3.04	112.91	0.54	189.26	0.32	0.22	0.36	0.141	0.172	0.028	0.029	0.007	0.023	0.395	0.139
7	ROM 26	ERM 38	Capital	5.81	–1.57	2.78	0.80	6.97	121.82	0.50	226.45	0.89	0.13	0.29	0.237	0.141	0.038	0.053	0.014	0.042	1.420	0.035
8	ROM 27	ERM 39	Capital	0.95	–1.35	3.67	1.26	1.64	41.44	0.47	192.92	0.15	0.16	0.52	0.058	0.058	0.010	0.012	0.003	0.010	0.409	0.040
9	ROM 29	ERM 41	Plinth	4.51	–1.66	2.72	1.43	5.21	145.36	0.76	334.16	0.27	0.19	2.04	0.243	0.398	0.054	0.036	0.008	0.021	5.081	0.107
10	ROM 30	ERM 42	Capital	0.99	–1.31	2.43	2.54	1.14	49.02	0.17	180.71	0.13	0.31	0.29	0.061	0.070	0.011	0.011	0.003	0.008	0.517	0.020
11	ROM 31	ERM 43	Capital	1.21	–1.49	3.86	1.42	1.41	63.67	1.19	218.57	0.14	0.15	0.41	0.045	0.046	0.007	0.011	0.003	0.008	0.981	0.270
12	ROM 32	ERM 44	Capital	1.09	–1.73	3.03	2.36	9.04	42.18	0.28	158.58	0.35	0.12	1.74	0.264	0.049	0.020	0.026	0.007	0.019	0.879	0.137
13	ROM 33	ERM 45	»Ranken-fries«	21.19	–2.96	1.97	2.98	6.19	236.20	1.80	167.27	0.13	0.25	1.22	0.128	0.193	0.022	0.013	0.003	0.010	1.050	0.048
14	ROM 34	ERM 47a	Tessera	1.27	–1.54	2.71	0.62	1.63	91.12	0.06	136.88	0.42	0.12	0.53	0.120	0.024	0.017	0.023	0.006	0.019	0.837	0.070
15	ROM 35	ERM 47b	Tessera	0.83	–3.99	3.03	0.09	21.08	202.74	0.89	168.94	0.99	0.10	0.70	0.713	0.382	0.085	0.073	0.019	0.033	0.470	0.190
Group 2																						
1	ROM 03	TR14/ passim02	Panel	1.11	–3.94	2.06	0.16	14.47	131.85	0.15	164.99	4.99	0.12	1.03	2.139	1.452	0.330	0.317	0.072	0.148	0.934	0.110
2	ROM 04	TR13/0044	Capital	1.27	–3.56	2.93	0.15	13.00	77.61	0.07	179.63	1.51	0.04	1.26	0.897	0.581	0.126	0.127	0.027	0.043	0.867	0.048

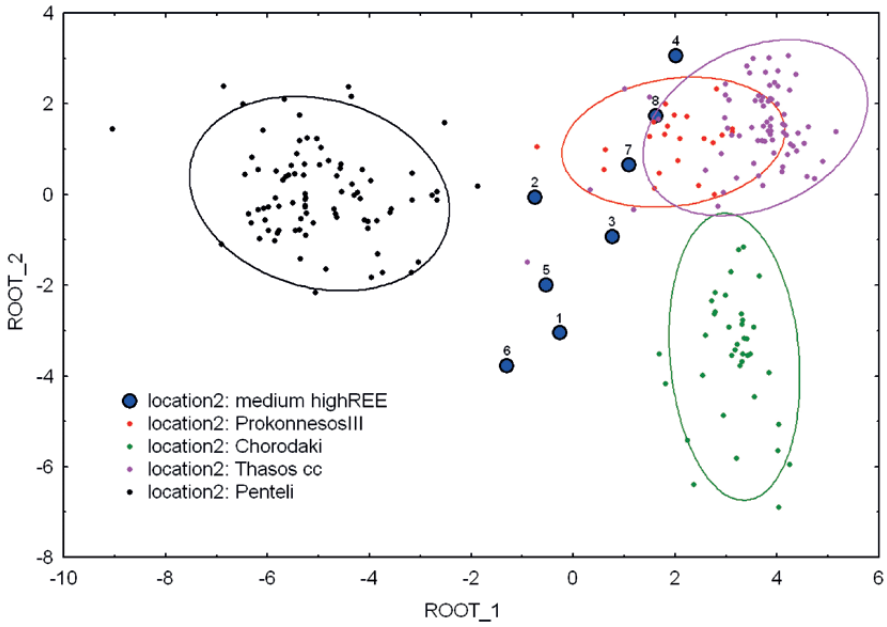
Table 1 Composition of marble items under analysis, with an indication of the statistical numbering (column 1) in the interpreted groups. The variables used are: $\delta^{18}O$ ‰, $\delta^{13}C$ ‰, chromium (Cr), manganese (Mn), iron (Fe), vanadium (V), strontium (Sr), yttrium (Y), cadmium (Cd), barium (Ba), lanthanum (La), cerium (Ce), praseodymium (Pr), dysprosium (Dy), holmium (Ho), ytterbium (Yb), lead (Pb), uranium (U); n.a.= not allocated

Group no.	Lab no.	Sample	Artefact	$MgCO_3$%	$\delta^{18}O$ (PDB)	$\delta^{13}C$ (PDB)	Cr	Mn	Fe	V	Sr	Y	Cd	Ba	La	Ce	Pr	Dy	Ho	Yb	Pb	U
3	ROM 05	TR14/0002	Panel	0.80	–2.92	2.32	0.12	24.90	94.34	0.24	134.88	2.95	0.17	3.09	1.121	0.568	0.166	0.217	0.050	0.108	0.527	0.068
4	ROM 06	SAC16/B4	Ashlar	1.44	–0.73	2.93	0.46	12.18	88.11	0.13	226.05	3.37	0.24	2.73	0.875	0.414	0.150	0.235	0.057	0.162	0.786	0.066
5	ROM 08	MNA L1591	Capital	0.69	–4.07	1.57	0.66	30.40	151.07	0.29	97.81	1.23	0.13	3.45	0.472	0.255	0.090	0.118	0.026	0.063	4.972	0.188
6	ROM 12	ERM 8	Panel	0.42	–4.60	0.87	0.36	55.15	164.14	0.07	113.88	1.22	0.36	1.07	0.602	0.405	0.092	0.089	0.021	0.059	1.256	0.071
7	ROM 25	ERM 37	Capital	1.42	–0.74	2.69	0.49	6.90	949.90	0.10	203.41	1.86	0.39	0.46	0.506	0.269	0.086	0.128	0.032	0.090	3.854	0.168
8	ROM 28	ERM 40	Capital	1.01	–0.56	2.58	0.35	8.91	77.54	0.14	214.23	1.31	0.13	0.94	0.370	0.330	0.072	0.098	0.024	0.063	1.334	0.032
Group 3																						
1	ROM 13	ERM 11	Panel	0.57	–5.08	0.98	0.60	5.47	397.66	0.21	66.77	0.24	0.17	0.11	0.193	0.376	0.049	0.027	0.006	0.017	1.363	0.034
2	ROM 15	ERM 13	Panel	0.49	–6.29	0.58	0.95	4.06	131.23	0.16	69.77	0.10	0.10	0.09	0.074	0.125	0.015	0.012	0.002	0.007	2.555	0.012
3	ROM 16	ERM 16	Panel	0.75	–5.74	1.14	0.62	5.71	125.32	0.20	63.09	0.10	0.13	0.30	0.095	0.178	0.022	0.014	0.003	0.007	0.655	0.028
4	ROM 17	ERM 17	Panel	0.42	–4.53	1.26	0.34	6.54	150.29	0.22	65.51	0.15	0.12	0.76	0.155	0.257	0.031	0.019	0.004	0.010	0.832	0.064
5	ROM 18	ERM 18	Panel	2.46	–4.58	1.29	0.43	5.77	146.30	0.52	64.00	0.11	0.19	3.31	0.097	0.136	0.017	0.012	0.003	0.007	0.839	0.048
6	ROM 19	ERM 19	Panel	0.28	–4.55	1.14	0.46	3.96	79.14	0.28	67.37	0.08	0.06	0.05	0.059	0.109	0.014	0.010	0.002	0.006	2.679	0.405
7	ROM 20	ERM 20	Panel	0.66	–4.78	0.79	1.20	8.22	117.36	0.20	65.19	0.08	0.08	0.31	0.117	0.220	0.025	0.012	0.002	0.007	0.971	0.024
8	ROM 21	ERM 22	Panel	0.49	–4.60	1.33	0.38	4.57	145.79	0.27	62.61	0.11	0.20	3.83	0.211	0.146	0.020	0.012	0.003	0.007	0.440	0.018
9	ROM 22	ERM 23	Panel	0.38	–4.61	1.18	0.45	6.95	131.13	0.32	62.90	0.10	0.19	0.05	0.095	0.149	0.020	0.011	0.002	0.006	0.502	0.019
10	ROM 23	ERM 24	Panel	0.71	–4.51	0.55	0.42	9.49	99.60	0.20	75.40	0.19	0.10	0.66	0.144	0.264	0.030	0.021	0.005	0.012	1.179	0.034
11	n.a.	ERM 48	Panel	1.01	–5.33	–0.14	0.53	6.77	206.67	1.30	62.06	0.11	0.11	0.65	0.105	0.210	0.023	0.016	0.003	0.007	1.243	0.075

Table 1 continued



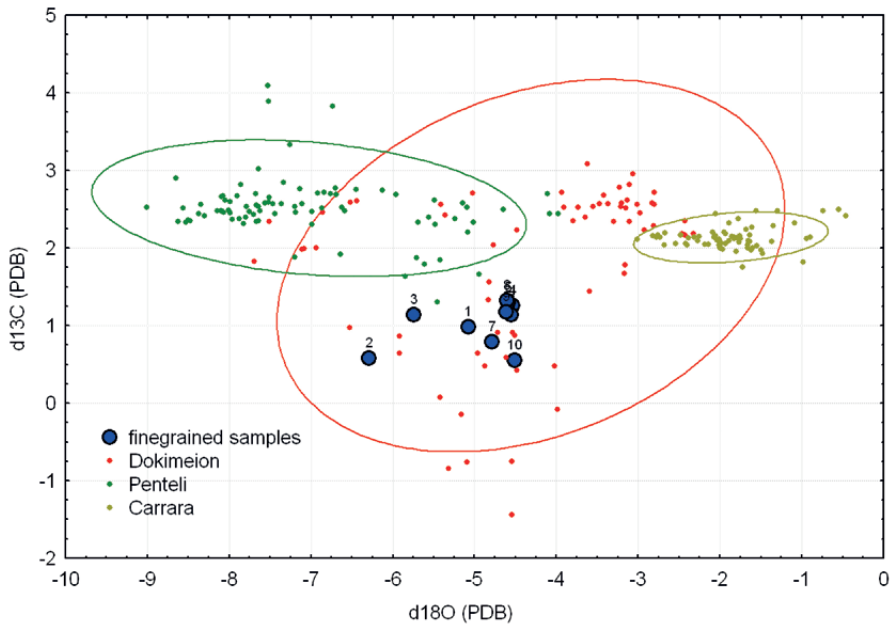
4 Group 2: White marbles of medium grain size with a high REE content, the isotope composition (graphics: W. Prochaska, V. Anevlavi)



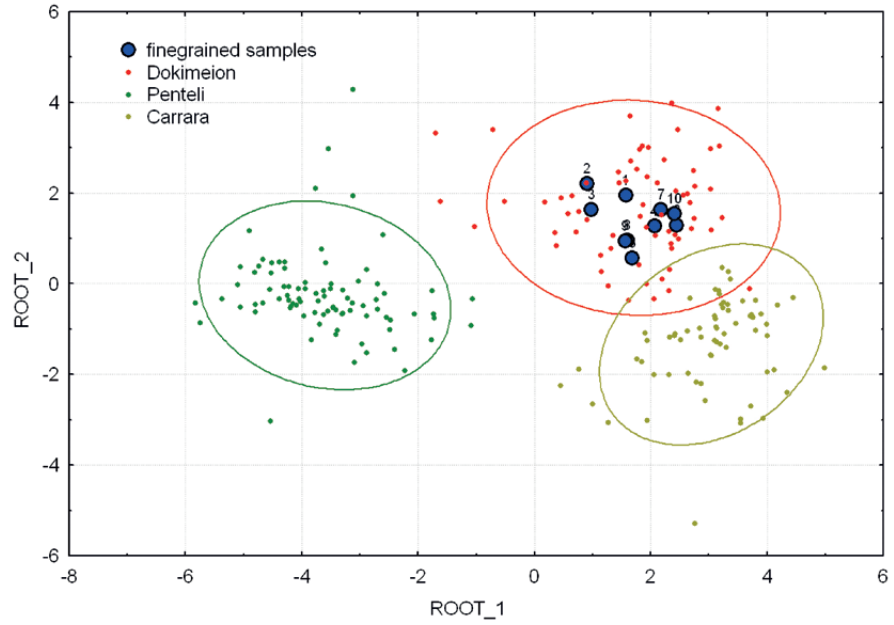
5 Group 2: White marbles of medium grain size with a high REE content, multivariate discriminant analysis (graphics: W. Prochaska, V. Anevlavi)

The samples in this group come from incrustation capitals (nos. 7–8, from the mosaic-floored building; no. 5 is an old collection item, presumably from Tomi) and slabs, in a very fragmentary state (no. 8). Sample no. 4 is a large ashlar reused in the Late Roman fortification from Sacidava/Dunăreni on the Danube. The slab fragments (nos. 1. 3) and the incrustation capital (no. 2), all dated to the 2nd century, come from Troesmis.

These marbles seem to have been used similarly to those in Group 1. The chronology is of great importance, given the different samples from other sites. Thus, the analysis of marble provenance, although preliminary, hints at an early dating of the decorative elements. This does not



6 Group 3: Very fine-grained white marbles, the isotope composition (graphics: W. Prochaska, V. Anevlavi)

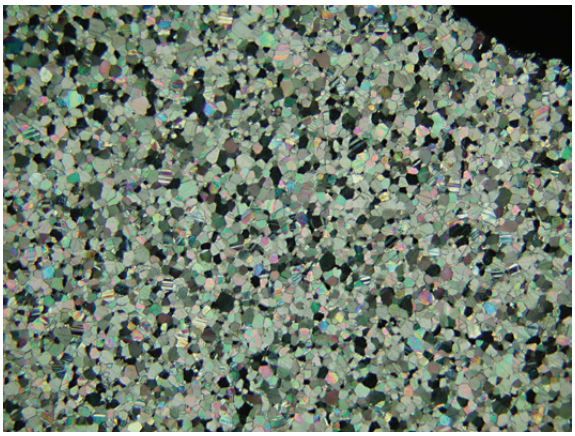


7 Group 3: Very fine-grained white marbles, multivariate discriminant analysis (graphics: W. Prochaska, V. Anevlavi)

mean, however, that the 2nd–3rd-century ornaments might not have been reused in a 4th-century building, a well-attested practice in Tomi, observed particularly in the Christian buildings.

Group 3: Very Fine-grained White Marbles (11 samples)

This group is very homogenous in terms of isotopic and chemical composition. The isotope diagram (fig. 6) and the multivariate diagram (fig. 7) show that these samples match very well with those from the Docimeian imperial quarries in Asia Minor.



8 Microphoto of sample no. 11 (Group 3), with a very regular polygonal texture and very fine grain (polarised light, image length: 6 mm) (photo: W. Prochaska)

However, this result is not in agreement with the visual and microscopic characteristics of these samples. Unfortunately, only one sample (no. 11) was available for the preparation of a thin section (fig. 8). The very low strontium (Sr) content (tab. 1) and, to some extent, the very fine grain of 0.1–0.2 mm, as well as the polygonal even grain boundaries, do not correspond to the Docimeian marbles known so far. Based on the current available data, the most probable provenance is the area of the Docimeian quarries. The samples in this group come exclusively from veneer slabs with mouldings and additional ornaments, in some cases figurative (animals, Dioscuri[8], etc.)[9]. They seem to have been a special order for the purpose of decorating the building in Tomi with mosaic pavement. Despite the scarcity of records regarding where they were found, the quantity of slabs, combined with the results of marble provenance analyses, highlights the need for systematic documentation (in the next phase of the project), as soon as the storage, access and work conditions in Constanța allow it.

ACKNOWLEDGEMENTS

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9 Recently, a sculptural group found in Tomi was also investigated for marble provenance, see Alexandrescu – Mototolea – Potârniche (forthcoming). The results of the marble analyses showed the same characteristics as the samples in Group 3. This opens up a number of questions and needs to be pursued in future research on the marble finds from Constanța.

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STATUARY IN THE MARBLE TRADE NETWORKS OF ROMAN THRACE

A CASE STUDY OF UNFINISHED AND REPLICATED PRODUCTS

Abstract
This paper presents the first step toward considering the potential of sculpture for the study of the marble trade in Roman Thrace. The study is focused on unfinished statuary and replicas, which are highly relevant to understanding the internal dynamics of the market and highlighting the characteristics of distribution patterns. The bottom-up approach based on marble provenance investigation allows us to outline the diachronic development of interaction between cities and quarries, indicating the level of connectivity of the area south of the Lower Danube to the empire-wide marble networks.

INTRODUCTION

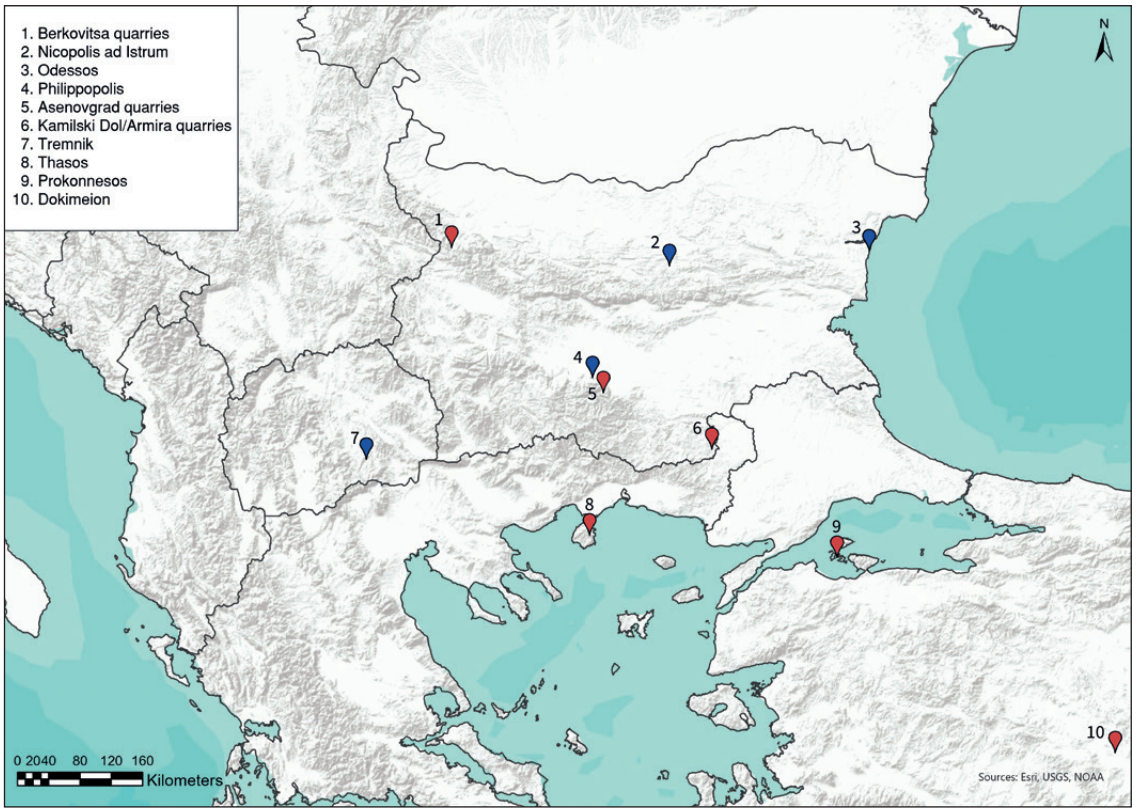
The development of trade networks in Thrace was greatly enhanced by the steady progress made during the Roman period in constructing new roads to connect the Lower Danube with the Aegean coast and the settlements in the interior with the Black Sea coast and the Bosporus. The provincial policy of Trajan (AD 98–117) boosted urban development, leading to increased demand for lithic material and the involvement of skilled craftsmen in the implementation of building programmes and the embellishment of public spaces with statues. The archaeological data indicate the existence of stonemasons' workshops in the major cities of Roman Thrace. The epigraphic records, however, confirm the prevalence of craftsmen originating from Asia Minor, which accordingly opens up discussions about the ›eastern‹, ›Roman‹, and ›local‹ traditions in stone-working, particularly in marble production.

THE INVESTIGATED ARTEFACTS

The study is based on an archaeometric investigation of unfinished and replicated sculptures and reliefs, carved out of white marble, from three cities situated at strategic locations north and south of the Haemus Mountains and on the Black Sea coast: Nicopolis ad Istrum (the present-day village of Nikyup), Philippopolis (present-day Plovdiv), and Odessos (present-day Varna). A statue from Tremnik, North Macedonia, in the collection of the National Archaeological Museum in Sofia is included because of the need to provide a broader basis for comparative arguments (fig. 1). The marble samples have been taken as part of the Austrian Science Fund (FWF) project »Fingerprinting White Marbles. Quarries and Cities of Roman Thrace, 1st–3rd century AD«, directed by Sabine Ladstätter (†).

METHODS

The analytical methods applied to the samples are petrographic investigations, chemical analysis with a large range of elements (manganese [Mn], magnesium [Mg], iron [Fe], strontium [Sr], yttrium [Y], vanadium [V], cadmium [Cd], barium [Ba], lanthanum [La], cerium [Ce], ytterbium



1 Locations of the ancient cities (in blue) and marble quarries (in red) mentioned in the text (graphics: OeAW-OeAI/ P. Andreeva)

[Yb], uranium [U]) using the inductively coupled plasma mass spectrometry (ICP-MS) method and isotopic analysis ($\delta^{18}O$ ‰, $\delta^{13}C$ ‰)[1].

A statistical treatment was applied for each sample. All samples were compared with the large database of quarry samples built up by W. Prochaska from the University of Leoben and the OeAW-OeAI respectively, which covers the most important marble quarries in Asia Minor, Greece, Italy, Bulgaria, etc. The collected database includes approx. 5,500 geological samples. Due to the small size of the specimen from each sampled artefact, a limited collection was selected for the preparation of thin sections.

RESULTS

Statistical programs are employed for the data evaluation and the provenance definition (STATISTICA and SPSS). The following table presents the numerical probabilities and accurate results based on a selection of variables in SPSS (tab. 1).

The results showed that in the city of Philippopolis, the main type of marble used is that from Asenovgrad, which is located near the city. It has the typical characteristics of Rhodopes marble, with a white colour, a medium grain size, and layers of fine-grained material. The use of this marble is linked to the major architectural constructions of the city. It can also be found as regionally exported material for use in funerary monuments[2]. Regional marble from the area

[1] For the analytical sample preparation and methodology, see Prochaska – Attanasio 2021; Prochaska – Attanasio 2022. For the new additions to the database of local marble sources in Thrace, see Anevlavi et al. 2022.

[2] V. Anevlavi – P. Andreeva – W. Prochaska – S. Ladstätter (†) – H. Popov, in this volume.

Lab no.	Sample	Distance	Abs. Prob. (in %)	Rel. Prob. (in %)	Provenance	Rel. Prob. (in %)	Provenance
		1st Choice				2nd Choice	
9819	FWM0464	0.3	98.5	100.0	Asenovgrad	0.0	SE Rhodopes
9820	FWM0465	1.2	86.3	100.0	Asenovgrad	0.0	SE Rhodopes
9821	FWM0466	15.0	0.5	100.0	Asenovgrad	0.0	SE Rhodopes
9822	FWM0467	16.6	0.2	100.0	Asenovgrad	0.0	SE Rhodopes
9925	FWM0570	9.3	5.3	100.0	Asenovgrad	0.0	SE Rhodopes
9790	FWM0435	2.1	54.9	100.0	Asenovgrad	0.0	Prokonnesos
9789	FWM0434	0.9	82.0	100.0	Asenovgrad	0.0	Prokonnesos
9802	FWM0447	0.1	99.8	81.1	Herakleia/Miletos	12.8	Aphrodisias
9804	FWM0449	9.4	5.2	99.9	Thasos Aliki	0.1	Prokonnesos
9805	FWM0450	0.5	74.2	100.0	Asenovgrad	0.0	SE Rhodopes
9810	FWM0455	3.0	55.7	69.3	Prokonnesos	28.8	Aphrodisias
9811	FWM0456	0.2	91.3	100.0	Asenovgrad	0.0	SE Rhodopes
9930	FWM0575	5.4	24.3	100.0	Prokonnesos	0.0	Thasos Aliki
9931	FWM0576	2.9	23.2	94.1	Asenovgrad	5.9	SE Rhodopes
9252	FWM0067	9.9	0.7	81.2	Berkovitsa	17.7	SE Rhodopes
9271	FWM0124	1.7	79.3	88.4	Prokonnesos	9.5	Herakleia/Miletos
9379	FWM0056	4.4	35.1	63.0	Dokimeion	25.9	Asenovgrad
9380	FWM0068	2.4	66.0	88.2	Dokimeion	8.5	Asenovgrad
10598	FWM0957	2.5	63.4	99.9	Prokonnesos	0.1	Dokimeion
10599	FWM0958	46.2	0.0	83.3	Berkovitsa	16.7	Asenovgrad
10727	FWM1086	0.2	99.0	99.3	Prokonnesos	0.7	Dokimeion
10734	FWM1093	2.0	72.4	99.4	Prokonnesos	0.6	Dokimeion
10735	FWM1094	3.2	51.4	100.0	Prokonnesos	0.0	Dokimeion

Table 1 The calculated statistical parameters of the investigated marble samples. Variables: Mg, Fe, Mn, Sr, V, Y, Yb, Cd, La, Ce, U, $\delta^{18}O$ ‰, $\delta^{13}C$ ‰ (V. Anevlavi, W. Prochaska). Abbreviations used: Abs. = absolute; Rel. = Relative; Prob. = Probability

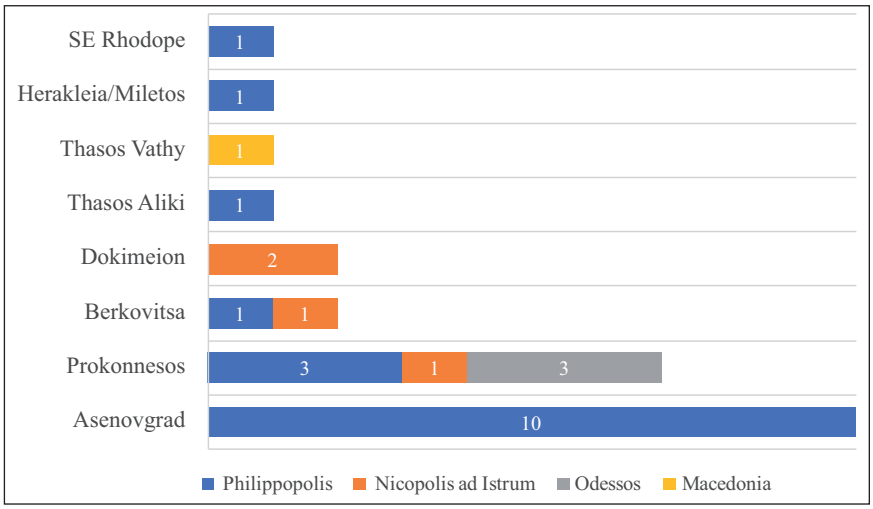
Related commentary on table 1:

Distance: Distance of the sample under consideration from the centre of the ellipse that represents the quarry probability field. The central point of the ellipse expresses the average and hence most characteristic values of a quarry. The closer a point is to the centre of an ellipse, the more likely the provenance from that marble site.

Relative (posterior) probability: Probability of the sample belonging to some group within the assumption that it originates in any case from one of the groups in the selection. The threshold is 60 %. Low values indicate that the sample's assignment is dubious and could fall in two or more groups.

Absolute (typical) probability: This is a distance-dependent parameter measuring the absolute probability that the sample belongs to the chosen group or, in other words, is a typical representative of the group properties. The threshold is 10 %, corresponding to samples on the edge of the 90 % probability ellipse. Low values indicate anomalous samples (outliers) or samples possibly not belonging to any group in the selection.

of Berkovitsa was used for one of the artefacts (FWM0067). The objects share most of the geochemical characteristics of Berkovitsa, but we should consider a larger number of extraction pits with ancient use in the area. A similar situation can be observed with the sample FWM0454, and a clear provenance cannot be determined at present. Nevertheless, the analysed data point to the provenance of the southeast Rhodopes (Kamliski Dol and Armira). The southeast Rhodopes is a location currently under study, with numerous pits and extraction areas. Future investigations of the geological datasets from more areas of interest will enable us to pinpoint the exact location of origin. Other regional and supraregional quarries can be detected in Philippopolis, and these are Thasos (Aliki/calcite), Prokonnesos, and Herakleia/Miletos. All these areas were of great importance for marble production and exportation in Roman times.



2 Graphic presentation of the sampled elements (graphics: OeAW-OeAI/V. Anevlavi)

At Nicopolis ad Istrum, the cases show similar diverse uses of marble but mainly imported from the supraregional quarries of Prokonnesos and Dokimeion. Examples of special importance are the two Docimeian samples, due to the long distance from the source. New evidence based on the research of J. J. Hermann and R. H. Tykot confirmed that Docimeian marble was used as a prestige material in the Roman Empire, and it was used, aside from for architecture, for various objects such as craters (which were exported in a pre-shaped stage), etc.[3]. The only regional quarry that was represented in the investigated artefacts at Nicopolis ad Istrum is Berkovitsa. However, the data show similarities with FWM0067, and both of these artefacts indicate the existence of more extraction zones.

In the case of Odessos, the two sampled artefacts show the same origin of Proconnesian marble. The results complement the study by A. Minchev, in which artefacts that have been found in Odessos and Marcianopolis in an unfinished state come from the Proconnesian quarries. Among these objects are sarcophagi, capitals, and two statues. These findings evidence an important connection between Prokonnesos and the Black Sea coast[4].

The different material of FWM0125, from Roman Macedonia, shows the dolomitic nature of the source, and the analysis showed the origin of Thasos Vathy.

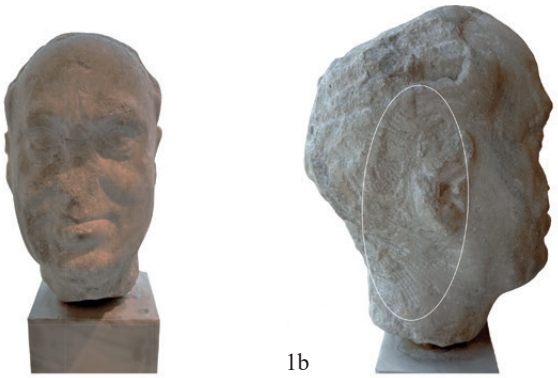
The general overview of the analysed set shows the importance of the Asenovgrad marble for the city of Philippopolis, but also the export power and importance of Prokonnesos, which were detected in each city (fig. 2). Another important aspect is the use of local materials and their regional exportation (southeast Rhodopes, Berkovitsa, and Thasos). Finally, the appearance of supraregional quarries such as Dokimeion and Herakleia/Miletos shows the strong trade network of the province with raw materials and other provinces.

The analysis of the finished products of each area/city will give us the opportunity to provide a more complete outline of the marble choices and the material used, as well as the distribution patterns of each set of objects and the trade network of each city.

DISCUSSION

Roman Thrace underwent sustainable urban development in the 2nd and early 3rd centuries AD, although Philippopolis seems to have witnessed the process of metropolis image construction already

3 Hermann – Tykot 2009.
4 Minchev 2012.



1a 1b

2

3

3 1 a–b: Head from a statue of the Emperor Vitellius (AD 69). 2: The »Frieze of Deities of Health and Healing«. 3: Altar (photos: OeAW-OeAI/P. Andreeva)

in the 1st century AD due to its location close to major trade routes and the strategic control of access to local and imported goods[5]. The marble trade of Philippopolis, however, has never been the focus of any study, and the investigated sample, taken from the sculptural portrait, most probably a likeness of the Emperor Vitellius[6] (FWM0447), is therefore of great importance in providing more

5 Lozanov 2002.
6 Unpublished.

insight into the marble supply for the 1st-century statuary of the city. The archaeometric analysis identified the head as carved in marble from Herakleia/Miletos, and it would be safe to assume that the portrait was not a product of a local workshop. Accordingly, the traces of a claw chisel could hardly be interpreted as a result of an unfinished sculpture (fig. 3, 1 a–b). They must rather be related to the process of reworking the portrait of Vitellius, most probably into the likeness of Vespasian[7]. The uncompleted recarving phase might be considered unusual, given the costly marble extracted from the quarries at Herakleia at Latmos and Miletos in antiquity[8]. It could therefore be inferred that the unfinished reworking process might indicate a lack of highly experienced sculptors in 1st-century Philippopolis who were familiar with the specific techniques involved in recarving.

The meticulous study of Philippopolis' architecture and urban environment has always been brought into focus in the context of the urbanisation process in Roman Thrace. The stadium, lying in a north-south direction between Teximtepe and Sahattepe, is to be considered one of the architectural highlights of the city. The pilasters of the main entrance to the building[9] (figs. 4, 2–5; 8, 2) are proven to be made of marble extracted from the quarries at Asenovgrad (FWM0464. FWM0465. FWM0466. FWM0467. FWM0570). The relief decoration[10] was most probably carved after the installation of the roughed-out marble blocks at the destination site[11]. Some of the reliefs exhibit different degrees of unfinished carving, from roughing out the general frame to leaving the background unsmoothed (fig. 4, 2. 5). The unfinished relief sections might be explained on various grounds, such as lack of time, funds, or craftsmen, among others, but the same ›working style‹, featuring an uncut background[12], is observed on a 2nd-century altar from Philippopolis (fig. 3, 3) made of marble from the Asenovgrad quarries (FWM0435)[13]. Given the stylistic similarity with relief votive plaques, the altar is considered to have been produced by an *extra muros* workshop[14].

When the »Frieze of Deities of Health and Healing« (fig. 3, 2) was subjected to archaeometric analysis, the marble was proven to be from the Asenovgrad quarries (FWM0434), indicating a locally crafted work. A workshop is assumed to have been located in the area of the Eastern gate of Philippopolis[15], where the relief was discovered[16]. The grave stelae and votive plaques supposed to be made there, however, exhibit a low standard of craftsmanship, particularly apparent in comparison with the skilfully crafted frieze in high relief featuring good composition, classical proportions of the figures and elaborate rendering of faces, bodies, and draperies[17]. In any case,

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7 Portraits refashioned from the Emperor Vitellius into the likeness of the Emperor Vespasian are known from several museum collections, see Varner 2004, 259 figs. 104–107.

8 Attanasio 2003, 180. Even if the marble prices listed in Diocletian's Price Edict (AD 301) were mainly determined by current tastes and market choices (Russell 2013, 33–36), the marble from Herakleia seems to have been one of the most expensive white marbles (Peschlow-Bindokat 1981, 210).

9 Tsontchev 1947, pls. 11–14. It is not yet clear whether the pilasters belonged to the first construction phase of the stadium at the time of Trajan/the beginning of Hadrian's reign or to the second construction phase of the 3rd cent. AD, when the architectural decoration of the stadium was renovated, see Dimitrov 2009a, 103; Topalilov 2012, 124.

10 Two of the sides of each pilaster bear identical relief representations of Herakles' attributes (club, lion's skin, a quiver of arrows at the top) and Hermes' attributes, with a central depiction of a herma mounted with the head of the deity. FWM0570 is a preserved fragment of the lowermost section of a pilaster bearing a similar iconographic scheme in relief.

11 FWM0467 (fig. 4, 4) must have been broken during installation and subsequently secured with iron clamps to join the pieces of the pilaster together.

12 The question of whether some of the craftsmen were occupied only with the final stages of the labour of flattening the background still remains without a definite answer, see Plattner 2022, 77.

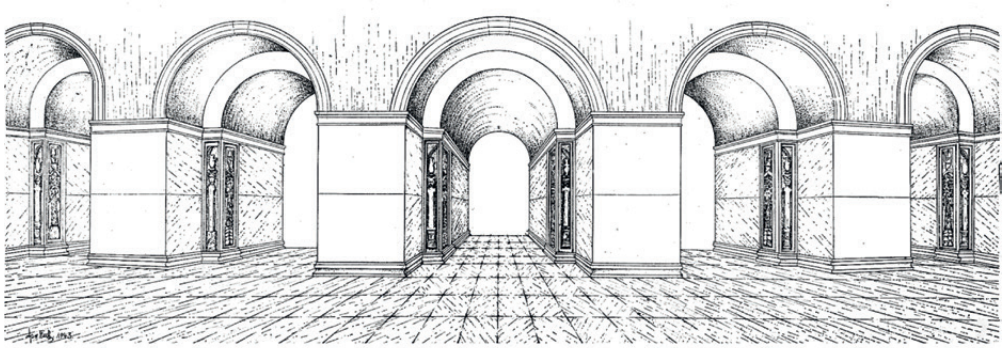
13 The relief panels on three of the altar's walls represent the figures of Hermes and Fortuna, Asclepius and Telesphorus, and an ox in profile facing right. The excess marble to the left of Asclepius has not been cut away.

14 Cherneva 2009, 131.

15 Cherneva 2009, 130.

16 Topalilov 2012, 142. 144.

17 Despite different interpretations of the depicted figures (Dyakovich 1923; Oppermann 1984; Stoyanov 1987; Tacheva 2000), it is suggested that the frieze should be dated to the reign of Marcus Aurelius (Dyakovich 1923, 164; Stoyanov 1987, 27; Topalilov 2012, 144) or even more precisely to AD 175/176 (Tacheva 2000, 235 f.).



1

2 3 4 5

4 1: The entrance to the stadium of Philippopolis, hypothetical reconstruction (from Tsontchev 1947, pl. 16). 2–5: Pilasters at the entrance to the stadium of Philippopolis (photos: OeAW-OeAI/P. Andreeva)

later interventions by a mediocre craftsman could be identified in the roughly executed and unfinished depictions of Helios and Selene flanking the entire composition on either side[18].

The region north of the Haemus Mountains entered a new stage of urbanisation after the foundation of Nicopolis ad Istrum by the Emperor Trajan (AD 98–117). The limestone deposits near the city were intensively exploited for the construction of a monumental urban centre[19] appointed with marble statues. The archaeometric analysis of the statue of Eros found near the remains of a Corinthian architrave of the western façade of the propylaea[20] (fig. 7, 1) highlighted Dokimeion as the source of the marble (FWM0056). Even though the exact place where the statue was displayed is not known for certain, its discovery close to the building embellished with rectangular

18 Stoyanov 1987, 26. 28. There is also a difference in the width of the upper and lower frames.

19 For the results of the long-term archaeological investigations conducted in the city, see Slokoska et al. 2002; Vladkova 2021; for the limestone quarry area in the vicinity of Nicopolis ad Istrum, see Petrova – Ivanov 2008, 179–181; Dimitrov 2009b, 304–306; Chakarov 2019.

20 Filow 1909, 60. The building inscription engraved on the architrave records the boule and demos of Nicopolis ad Istrum, and the names of the Emperor Antoninus Pius, the Emperor Caesar Marcus Aurelius, and Faustina the Elder, and may thus be dated between AD 145 and 161. It is assumed that the statue belongs to the mid-2nd cent. AD, see Manzova 1978, 50 f.

5 1: Statue resembling the Small Herculaneum Woman type (?). 2–5: Large Herculaneum Woman statues. 6 a–b: Statue of a muse (photos: OeAW-OeAI/V. Anevlavi)

and semicircular statue niches immediately north of the propylaea[21] should be taken into consideration. It has been ascertained that some of the pedestals were installed after being reshaped, implying adjustment and/or replacement of statues in the niches[22]. The base of the statue of Eros also seems to have been reworked, and certain parts of the figure's original appearance turned out to have been broken off and removed[23]. Whether or not the sculpture was placed in the interior of the building north of the propylaea still remains an open question, but the roughly smoothed surface of the back and carelessly crafted wings indicate that the statue was not intended to be seen from all sides[24].

The life-size statue of Asclepius of the Giustini type[25] found at the palaestra of Nicopolis ad Istrum[26] (fig. 7, 2) provides valuable insight into the adorned cityscape. The figure, made of a

21 The main entrance faced east to the area, although another entrance in the wall connected the building with the propylaea. The function of the building remains unclear (Vacheva 1992, 36; Dinchev 2009, 74), although it certainly formed part of a larger architectural ensemble together with the propylaea and the odeon to the south (Vacheva 1992, 32).

22 Vacheva 1992, 37.

23 Cf. the smoothed surface of the break on the outer left thigh from the original strut.

24 Filow 1909, 61–63.

25 The statue is dated to the 2nd half of the 2nd cent. AD, see Ivanov 1992, 34.

26 The palaestra is located about 100 m north of the agora, see Ivanov 1992, 30.

6 1: Unfinished *palliatus* statue (photo: OeAW-OeAI/P. Andreeva). 2–3: *Palliatus* statues from Philippopolis (from Tsontchev 1959, figs. 21–22). 4–5: *Palliatus* statues (photo: OeAW-OeAI/V. Anevlavi). 6: Statue of a man (photo: OeAW-OeAI/V. Anevlavi). 7–8: Statues of *palliata* type (photo: OeAW-OeAI/P. Andreeva)

single block of Proconnesian marble (FWM0957), is the tallest statue of Asclepius discovered so far in Roman Thrace.

The embellishment of urban space with statuary carved in marble from the quarries of Prokonnesos and Dokimeion should be attributed to the Bithynian settlers, as widely attested in the epigraphic archive of Nicopolis ad Istrum[27]. The existence of an active community of Nicomedians in the city is further implied by the professional association of Nicomedian stonemasons[28]. Given that the shipping routes of Proconnesian and Docimeian marble passed through Nicomedia, located at a strategic point between Asia Minor and the sea[29], they would have acted as middlemen in the commissioning and distribution of marble imports.

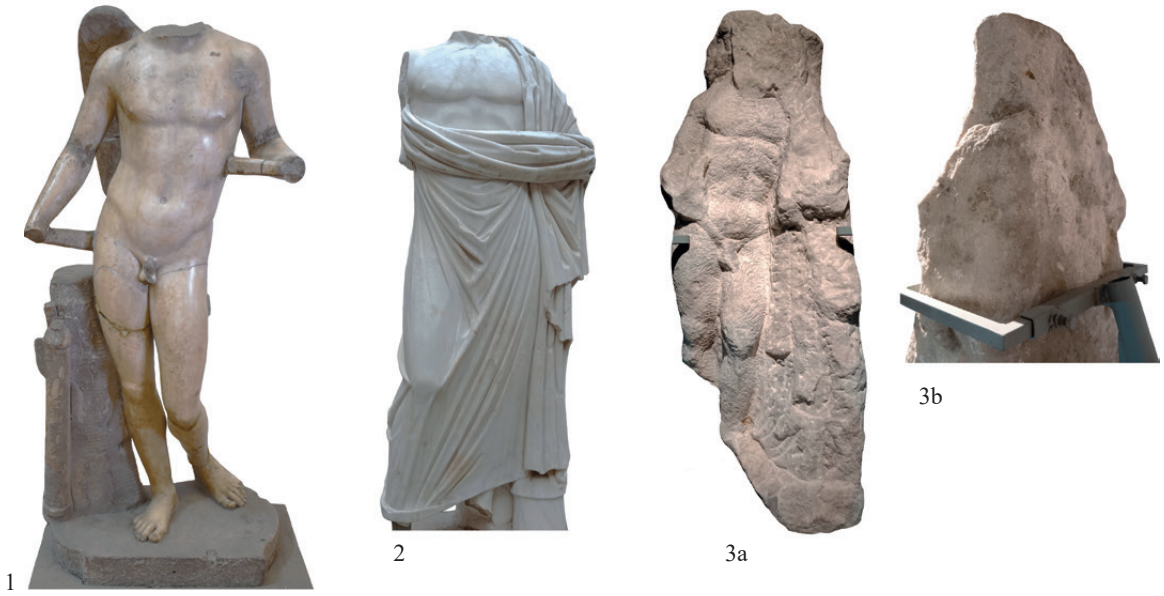
The access of Nicopolis ad Istrum to marble extracted in quarries in far-flung locations must have been greatly facilitated by the road connection with the port city of Odessos on the Black Sea coast[30]. The archaeometric analysis confirmed the long-standing assumption of the Proconnesian

27 Tačeva 1970; Karadimitrova 2003.

28 IGBulg II 674.

29 Ward-Perkins 1980; Russell 2013, 206; Alexandrescu-Vianu 2021, 66.

30 Madzharov 2009, 224; Panaite 2016, 159. The western Black Sea coast made great use of a direct sea route to connect with the Prokonnesos and Dokimeion quarries and to import not only the marble products but also the casts copied by the destination workshops, see Alexandrescu-Vianu 2021, 72.



7 1: Statue of Eros (photo: OeAW-OeAI/V. Anevlavi). 2: Statue of Asclepius (photo: OeAW-OeAI/P. Andreeva). 3 a–b: Unfinished statue of Herakles (photo: OeAW-OeAI/P. Andreeva)

provenance (FWM1093) of an unfinished garland sarcophagus from one of the *necropoleis* of Odessos (fig. 8, 1 a–b)[31]. It belongs to the most common sarcophagus type exported in schematic shape from Prokonnesos[32]. The previous conjecture that the unfinished statue of Herakles from Odessos (fig. 7, 3 a–b) embedded in a medieval wall[33] was made of Proconnesian marble[34] has also been proven to be valid (FWM1086). The dimensions of the figure and the body proportions are predetermined, and the body posture is set, while the plain surface of the back side features only the initial dressing of the block. The lion's skin is outlined with a sharp tool below the assumed place of the outstretched left arm, which has not been roughed out[35]. Balustrade pillars carved with replicas of Herakles in a single block have been found in the Odessos thermae[36] and the region of Odessos[37]. They represent the same iconographic type, featuring the sculpted figure of Herakles holding the apples of the Hesperides in his outstretched left arm, which is covered with the lion's skin[38]. They were intended to be connected to other architectural elements, as evidenced by the sockets on the side walls of the columns found in the Odessos thermae[39]. The number of replicas of the same iconographic type implies a serial production, which is further indicated by the disproportionately large

31 Getov 1978.
32 Trimble 2011, 78–81.
33 Toncheva 1958, 539; Minchev 2012, 56.
34 Minchev 2012, 56.
35 The incised outlines on the stone to the left of Herakles' figure could be distinguished as the folds of the lion's skin (shorter fold located closer to the body).
36 Georgiev 1975, 145 no. 7 tab. 3, 1. 2. The arm is broken at the wrist, now missing.
37 Cf. a statue from the village of Chernevo, Varna region (Toncheva 1960, 80 no. 11 tab. 10 fig. 55) and a statue fragment from the Varna region (Toncheva 1960, 79 no. 4 tab. 9 fig. 47). Another fragment of a statuette from the same region representing the left arm of Herakles holding the Hesperides' apples and with the lion's skin thrown over it should be assigned to the parallels (Toncheva 1960, 79 no. 7 tab. 10 fig. 52).
38 It is worth mentioning that the same iconography of Herakles was employed in the relief repertoire of votive plaques, cf. complete and fragmented votive plaques from the Varna region, see Toncheva 1960, 78 nos. 1–2 tab. 9 figs. 45–46; 79 nos. 3. 8–10 tab. 9 figs. 48–49. 53.
39 Cf. a balustrade column with the statue of Nike from the last 3rd of the 2nd cent. AD from the northern frigidarium of the Odessos thermae, see Georgiev 1975, 142 no. 1 tab. 1, 1–2; 144 nos. 2–6 tabs. 2, 1–5; 4, 1–2.

1a

1b

2

8 1 a–b: Unfinished sarcophagus. 2: Pilaster fragment at the entrance to the stadium of Philippopolis (photos: OeAW-OeAI/P. Andreeva)

head of the sculpture from the tepidarium[40]. The prefabricated statue of Herakles should therefore be considered a product of the mass production of Prokonnesos exported to Odessos, where the final carving stages would have been completed in the local workshops[41]. Whether or not the statue would have been finished as a balustrade pillar remains only a matter of conjecture, but the shapeless mass of unremoved marble on both sides of the head may have been intended to form a pillar behind the figure. It may be safely stated, however, that serially-produced statues were commissioned for the

[40] The mass-produced statues of the Large Herculaneum Woman might exhibit the same feature, see Sokolovska 1978, 82.

[41] J. Trimble (2011, 81) aptly defined the predetermined statues as »a form of communication among sculptors«, given that such commissions must have also been the result of widespread expertise in craftsmanship.

thermae decoration in the second half of the 2nd century AD[42]. Even if the unfinished Proconnesian statue was also part of the same commission, the reason why it was left in a roughed-out stage of carving remains unclear: a defect in the stone, accidental cracking, a mistake in the carving pattern, incorrect dimensions, or simply a surplus could be listed among the possible answers.

The so-called Large and Small Herculaneum Woman statue types[43] enjoyed empire-wide popularity[44], which is commonly explained by the idea of the modest matron that they embodied. The impressive quantity of copies discovered proved that they were favourable objects for replication, making them part of the Roman system of serial production, together with pre-fabricated sarcophagi, grave stelae, etc.[45]. The archaeometric analysis revealed that a Large Herculaneum Woman in Proconnesian (FWM0124; fig. 5, 3[46]) and a statue resembling the Small Herculaneum Woman type (?) in Docimeian marble (FWM0068; fig. 5, 1) were exported to Philippopolis. Their 2nd-century date[47] makes them synchronous with the peak of the empire-wide distribution of the type and the growth of the marble market in the Roman period[48]. Despite the prevailing tendency to carve the head and body out of a single block[49], the Proconnesian import features a neck socket provided for additional setting of the head[50], now missing. Much like the Nicomedian community in Nicopolis ad Istrum, the epigraphically attested Bithynian settlers in Philippopolis[51] should be considered the main factors responsible for the connection with the quarries of Prokonnesos and Dokimeion.

The replication of the statue types under consideration has also been attested in the neighbouring provinces of Macedonia[52] and Dacia[53]. Herculaneum Woman statues left unfinished[54], featuring the neck socket pattern[55] and presenting a similar body posture and arrangement of the drapery folds[56], should be considered statuary from serial production[57]. A recent analysis

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42 The construction of the thermae is dated to the time of Septimius Severus, see Preshlenov 2002, 69; Oppermann 2007, 90. For architectural details in Proconnesian marble used in the construction of the thermae, see Toma 2012.

43 The statue types are thought to have been created in the Late Classical period, see Bieber 1962, 111; Daehner 2007, 114–119; Trimble 2011, 7. 32–41; Diaconescu 2012, 164; Katakis 2019, 635.

44 153 replicas of the Large Herculaneum Woman (Kruse 1975, 260–293) and 125 replicas of the Small Herculaneum Woman (Kruse 1975, 294–322) have been documented for the Roman Empire. The figures would increase if the bronze replicas that have not survived were also taken into account, see Trimble 2011, 65. Herculaneum Woman statues, mostly of unknown provenance, have been recorded in Moesia inferior and Thrace, as well as in the neighbouring Roman provinces of Macedonia and Dacia, see Sokolovska 1978, 84; Diaconescu 2012, 188–190. 192–195.

45 Sokolovska 1978, 79 f. 84; Trimble 2011, 64–67; Katakis 2019, 634.

46 Unpublished.

47 The head from the 40s BC (Milčeva 2005, 17 no. 1 pl. 1) wrongly attached to the 2nd-cent. body (FWM0068) after being restored in modern times may ironically provide a good opportunity to compare the idealised portrait features of the Hellenistic period with the Roman way of presenting faces (FWM0067) in a more realistic manner of the mid-3rd cent. AD, see Milčeva 2005, 38–40 no. 18 pls. 18–19. The Herculaneum statue types are thought to be conventional copies of low artistic value, featuring certain attempts to adapt to the general tendency of the epoch, and therefore, the missing heads of the Herculaneum Women statues would have represented more down-to-earth images, see Sokolovska 1978, 77. 85.

48 Trimble 2011, 68–74.

49 Trimble 2011, 76.

50 Sculptures made of different pieces that would be assembled are considered to relate to serial production. The reason for the separately crafted head being nested between the shoulders might have been the result of various factors affected by logistical, financial, commercial, or technical considerations, see Claridge 1988, 139–141.

51 Cherneva 2006.

52 CSIR North Macedonia I 1, nos. 41–60 pls. 39–52.

53 In Roman Dacia, the largest percentage is attributed to the Large Herculaneum Woman statues, see Diaconescu 2012, 125. 174.

54 Cf. CSIR North Macedonia I 1, no. 51 pl. 47.

55 Cf. CSIR North Macedonia I 1, no. 54 pl. 50.

56 An identical representation has been described for the replicas from Melnitsa, Styberra, Veles, and Stobi, see Sokolovska 1978, 81.

57 The difference in certain details is plausibly attributed to the level of craftsmanship in the local workshops, which is sometimes fairly low, see Sokolovska 1978, 82.

has revealed that these types of statues were made of local dolomitic marble extracted from the Sivec quarries[58] and commissioned for the embellishment of the urban environment[59]. It can be argued that Roman Thrace also witnessed replicas of the Large Herculaneum Woman carved in local marble, based on the present archaeometric investigation pointing to the quarries of the southeast Rhodopes (FWM0454; fig. 5, 5) and the Berkovitsa quarries (FWM0067; fig. 5, 2) as marble sources for the two replicas. The examples provided reveal that the statue made of Berkovitsa marble was commissioned by Nicopolis ad Istrum[60], while Philippopolis preferred to use the marble from the southeast Rhodopes quarries for the replica[61]. The exploitation of local sources, especially those located at not too great a distance, is hardly surprising considering the need to keep the transportation costs below the costs of marble extraction and the workshops in the major cities where the final carving stages of the statuary could be implemented[62]. The road connection between Nicopolis ad Istrum and Montana[63] must have facilitated the trade routes between the city and the Berkovitsa quarries. The existence of a stonemasons' workshop at the Sanctuary of Apollo and Diana near Montana could also contribute to a better understanding of the mass replication of statuary in the region. The statues of Diana made of Berkovitsa marble share common iconographic and stylistic characteristics[64], pointing to a certain tradition in the serial production of the workshop. Therefore, no definite answer can so far be given to the question of whether the Berkovitsa quarries exported pre-fabricated statues or whether the statues made of Berkovitsa marble were finished by the local craftsmen in the nearby workshops before shipping to the destination city.

The *palliatus (himatiophoros)* statues seem to share common carving techniques with the Herculaneum Woman type, characterised by two main stages of prefabrication at the quarries and finishing carving at the destination workshops[65]. The predetermined tight pose of the figures carved in a single block must have successfully fulfilled the requirements for relatively quick, easy, and efficient serial production. Besides, it is assumed that the fully-draped bodies were relatively easy to craft with no deep carving, thus exhibiting two major advantages: 1. they could be easily made even by mediocre craftsmen, and 2. since not much work was needed, they were made accessible to less well-to-do customers[66]. The unfinished statue from Philippopolis[67] (fig. 6, 1) represents a good example of a roughed-out *palliatus* statue made of Proconnesian marble (FWM0575), featuring prefabrication and initial carving of the himation's folds, while the head would have

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58 CSIR North Macedonia I 1, no. 47 pl. 45 = Niewöhner – Audley-Miller – Prochaska 2013, 107 no. 9. The increase in use of the dolomitic Sivec marble in the Roman period has been attributed to the ongoing process of monumentalisation of the provincial cities (Niewöhner – Audley-Miller – Prochaska 2013, 106) and its demand on the market is also evidenced in Late Antiquity (Niewöhner – Audley-Miller – Prochaska 2013, 104).

59 Two Small Herculaneum Woman statues were discovered in a public building in Styberra, see Sokolovska 1978, 84; CSIM North Macedonia I 1, nos. 45–46 pls. 43–44. Styberra has been designated as a major centre for the production of statuary in the round, see Niewöhner – Audley-Miller – Prochaska 2013, 107; see the commentary on CSIR North Macedonia I 1, no. 47 pl. 45. It is worth mentioning that the city was situated near the Sivec quarries, see Niewöhner – Audley-Miller – Prochaska 2013, 104. 107.

60 According to the ruins recorded at the find-spot, FWM0067 is assumed to have been installed in a mausoleum located in the vicinity of Nicopolis ad Istrum, see Venedikov 1946, 235. It is well known that the Herculaneum Woman statues were also employed in a funerary context, see Daehner 2007, 92 f.; Katakis 2019, 637.

61 The find-spot of the 2nd-cent. Herculaneum Woman is Cillae (Tsontchev 1959, no. 42 pl. 14), a road station subsequently developed into an emporium in the territory of Philippopolis (Boyanov 2014, 137 f.).

62 The prefabrication is commonly attributed to the reduction in cargo load and decreased risk of cracking during shipping, see Trimble 2011, 80. 109 f.; Niewöhner – Audley-Miller – Prochaska 2013, 107; Russell 2013, 215. 247. 261 f.

63 Torbatov 2004, 90; Madzharov 2009, 224–227; Panaite 2016, 159.

64 Ognenova-Marinova 1987.

65 Trimble 2011, 76.

66 The labour rather than the raw material appears to have been a crucial factor in fixing the final price, see Claridge 1988, 140 f.

67 Unpublished.

had to be added[68]. The popularity of the statuary type in Philippopolis is evidenced not only by the number of discovered copies[69] (fig. 6, 2–3), but also by the local production[70] (fig. 6, 5 a–b) employing marble from the Asenovgrad quarries (FWM0450) along with the imported stock *palliatus* bodies. The preference for fully-draped figures roughed out of a single block of Asenovgrad marble with no deep carving is further evidenced by a statue displaying similar stylistic features[71] (FWM0456; fig. 6, 6).

Two of the statues in the study belong to the *palliata*-type statues, which enjoyed widespread distribution in the Lower Danube region[72]. The figures, like their male counterparts, may be supposed to have been serially produced in the Roman period[73], as evidenced by the fragment of an unfinished sculptural body from Philippopolis[74] (fig. 6, 8) carved in Asenovgrad marble (FWM0576). Another *palliata* torso[75] made of Berkovitsa marble (FWM0958) was discovered in Nicopolis ad Istrum (fig. 6, 7). The massive marble body with a shallow neck socket carved from a single block was considered stable enough to be embedded into the pavement[76].

The archaeometric analysis confirmed Thasian imports among the investigated statuary: a Large Herculaneum Woman from Philippopolis and a *palliatus* from Tremnik, North Macedonia. The archaeometric analysis identified the 2nd-century Philippopolitan statue[77] (fig. 5, 4 a–b) as carved from calcite marble extracted from Thasos Aliki (FWM0449), which complements the previous conclusions about Thasos as a major source for the production of the Large Herculaneum Woman along with Prokonnesos, Pentelic, and Paros[78]. Although the *palliatus*-type statues in Roman Macedonia have been assumed to be made mostly of marble from Pletvar[79], the archaeometric analysis performed on a 2nd-century statue from Tremnik[80] (fig. 6, 4) has indicated marble from Thasos Vathy (FWM0125). It therefore belongs to the period of the most intensive use of dolomitic Thasian statuary marble[81]. The statue features an additionally attached head pattern[82], thus indicating a serial replication of predetermined stock bodies. Since the hard dolomite could have turned out to be quite challenging for crafting statuary[83], the mass production of less laborious statue types in dolomitic Thasian marble would have been a reasonable choice. The results of the

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68 For the reasons for heads being made separately, see n. 48.

69 Tsontchev 1959, nos. 17. 20–24 pls. 5–7.

70 Tsontchev 1959, no. 20 pl. 6 (2nd cent. AD).

71 Unpublished, 2nd cent. AD. The inverted contrapposto, in addition to the strut on the left side of the figure, has resulted in an additional width to the statue.

72 It appears that the second most common type of female statue in Dacia was the *palliata* replicated between the 2nd half of the 2nd cent. and the middle of the 3rd cent., probably due to its popularity among women of non-elite families, see Diaconescu 2012, 171–173.

73 The origin of the female counterpart of the pallium is assumed to belong to the Hellenistic period, see Diaconescu 2012, 172 f.

74 Unpublished.

75 Unpublished.

76 Two stratigraphic layers assigned to the late 2nd and the 4th cent. AD were identified in the excavation area, see Ivanov et al. 1985, 137. The recorded stratigraphic context of the torso corresponds to the empire-wide discarding of serially-produced statuary starting from the 2nd half of the 3rd cent. AD onward due to crucial changes in demand and the labour market, see Claridge 1988, 152.

77 Tsontchev 1959, no. 44 pl. 15.

78 Trimble 2011, 73 f.

79 See the commentary on CSIR North Macedonia I 1, no. 88 pl. 71.

80 Unpublished. The statue belongs to the 2nd cent. AD, thus corresponding to the period of greatest distribution of the type in Roman Macedonia. A number of replicas of *palliatus*-type statues have been found in Tremnik (CSIR North Macedonia I 1, nos. 78–80 pls. 64–65), as well as in other locations in Roman Macedonia (CSIR North Macedonia I 1, nos. 68–77. 81–91. 97–101 pls. 52–62. 66–72. 76–77). The distribution of *palliatus* statues could further designate Styberra as a major centre of mass production of sculptures in the round.

81 Herrmann 1999, 60.

82 The high price of Thasian marble (Russell 2013, 34 tab. 2.5), in addition to more laborious crafting, could be the reason for the additionally nested head, probably made of a cheaper grade of marble.

83 Herrmann 1999, 58.

investigation of the sculpture have the potential to supplement the discussion of the long-standing tradition of exportation of Thasian dolomite in ancient Macedonia[84] and contribute to the conclusions about the distribution of Thasian imports in the Roman period[85].

The examples of imported and local marble replicas discussed so far are only part of the overall picture of the statuary trade in Roman Thrace. A statue of a muse in Proconnesian marble from Philippopolis (FWM0455; fig. 5, 6 a–b) dated to the third quarter of the 2nd century AD[86] could be considered another piece of evidence of statuary from mass production[87] exported to Roman Thrace. The assumption might be justified by the easy-to-replicate columnar form with a narrow outline carved out of a single block, which is in line with the characteristics of the Herculaneum Woman type, and much less labour needed for carving, as indicated by the shallow long folds of the himation.

CONCLUSION

When summarised, the results of the presented preliminary study turn the discussion toward an assessment of certain essential aspects of the marble trade in Roman Thrace that have not been the focus of research. The large provincial cities were supplied with unfinished and replicated statues already proven to be carved in both imported and local marble, indicating not only the strong commercial connections of Thrace with the major marble centres of antiquity but also the exploitation and elaboration of the local marble market. The use of raw material from local quarries for sculpture seems to have been synchronous with the process of increasing monumentalisation of the cities in the 2nd and early 3rd centuries AD and, accordingly, the new degree of urban embellishment.

However, the production of statue replicas carved in marble from the quarries at Asenovgrad, the southeast Rhodopes, and Berkovitsa must have been a much more significant turning point in the economic landscape of Thrace. The presumed adherence to prefabrication and mass production patterns was one of the most characteristic aspects of the Roman marble market[88]. The local quarries were thus incorporated into the large system of serial replication of statues organised in separate carving stages. The practice of mass reproduction had already been followed by the major participants in the sculptural trade, such as Prokonnesos, Dokimeion, and Thasos. Their products seem to have been quite popular in Thrace, as can be inferred from the imported replicas discovered in the provincial cities.

The marble quarries at Asenovgrad, the southeast Rhodopes, and Berkovitsa must have used the proper extraction techniques to provide large blocks of the right size for the serial production of pre-determined fully draped figures in tight poses, in keeping with the empire-wide demand for more efficient and quick production[89]. The assumed commercial expansion of the statuary production of local quarries is further implied by the Large Herculaneum Woman statue in marble originating in the southeast Rhodopes found in Cillae, an emporium in the territory of Philippopolis[90]. The mass-produced types of statues carved in Berkovitsa marble might have been commissioned even to the north beyond the Danube, given that the raw materials in the Berkovitsa area were put

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84 The dolomitic Thasian imports in ancient Macedonia have been assigned to a considerably wide chronological framework from the 6th cent. BC up to the 6th cent. AD, see Herrmann 1999, 58–65.

85 The archaeometrically confirmed dolomitic Thasian statuary marble in Tremnik calls for a re-examination of the distribution of Thasian dolomite in Roman Macedonia, which is currently assumed to have been preferred in the southern areas up to the Demir Kapija Gorge, see Niewöhner – Audley-Miller – Prochaska 2013, 117.

86 Tsontchev 1959, no. 49 pl. 17.

87 Cf. another statue of a muse from Philippopolis, see Manzova 1978, 66 f.

88 Trimble 2011, 78.

89 Claridge 1988, 144.

90 Another fragment of a Large Herculaneum Woman found in the *mansio Bessapara* (Tsontchev 1959, no. 46 pl. 15) should also trigger further discussion on the statuary trade routes of Roman Thrace.

under Roman military control[91] and that the marble production could therefore have been easily organised and quickly channelled[92]. The discussion might go even further, suggesting that the replicas made of local marble would have been exported to neighbouring provinces[93], where they would have been preferred due to lower shipping costs and a cheaper grade of marble compared to the major quarries dominating the market.

These assumptions need to be considered in the long run. The future analysis of the large group of sculptures sampled under the FWF project »Fingerprinting White Marbles. Quarries and Cities of Roman Thrace, 1st–3rd century AD« will shed more light on the preferences in the supply of statuary marble. The present study provides only a brief insight into the multilayered relationships between imports, local production, and the export market in Roman Thrace.

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[91] Petrova – Ivanov 2008, 178 f.; Stoev 2016.

[92] It has already been assumed that the distribution of a female statue type combining the stylistic characteristics of the Large Herculaneum Woman and the *palliata* in Potaissa might have been the result of prototypes brought by craftsmen from Moesia inferior to Dacia after the transfer of *legio V Macedonica* in AD 167–170, see Diaconescu 2012, 172 f. For the exportation of Berkovitsa marble in Late Antiquity, see von Bülow 2020, 386 f.

[93] For the exportation of marble from the Asenovgrad and Kamilski Dol/Armira quarries in the province of Macedonia, see V. Anevlavi – P. Andreeva – W. Prochaska – S. Ladstätter (†) – H. Popov, in this volume.

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MARBLE TRADE BETWEEN THE BORDERS OF ROMAN MACEDONIA AND THRACE

THE CASE STUDY OF THE FUNERARY MONUMENTS

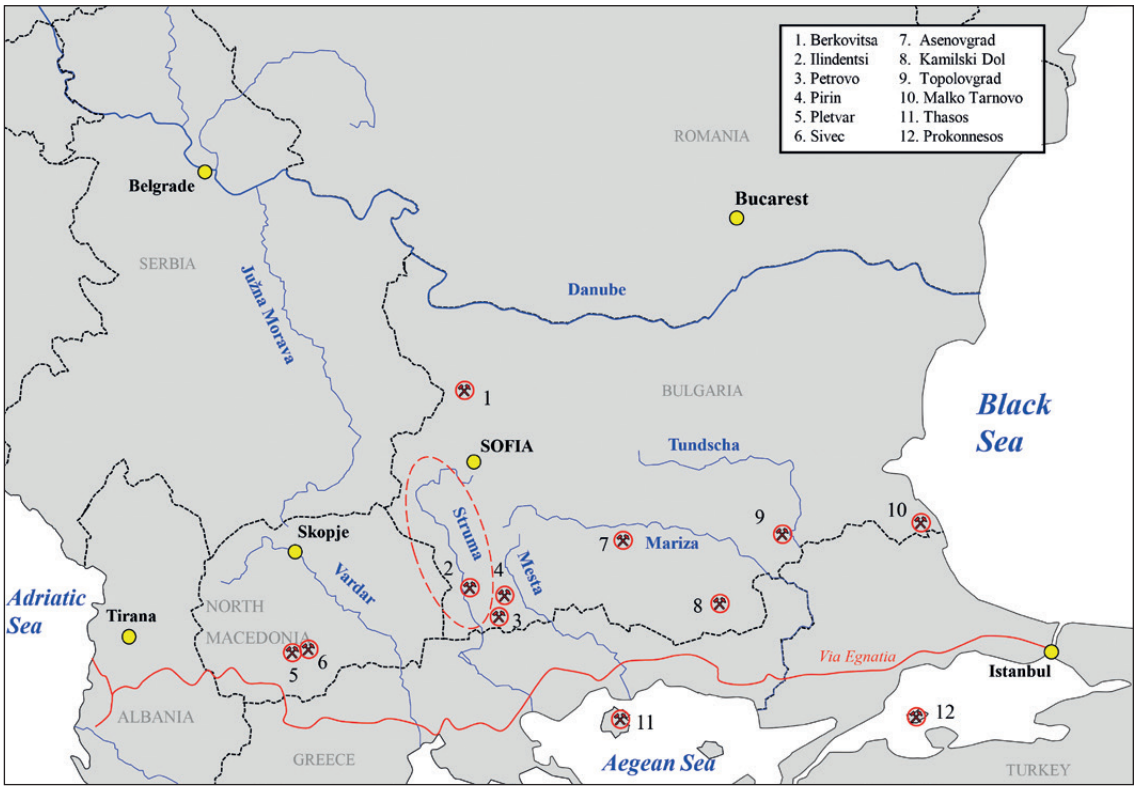
Abstract
The geographical location of the Struma Valley represents a major crossroads of ancient roads that ensured the connection between the Aegean world and the Balkan hinterland, crossed the borders between Roman Macedonia and Thrace, and constituted a link between East and West, crossed by the Via Egnatia in the southern area. Recent epigraphic and literary studies have shown that the provincial boundaries had a mainly political significance and were not associated with trade. The analyses of 22 artefacts from the Regional History Museum Blagoevgrad and National Archaeological Institute with Museum (NAIM) provide information about the trade network of this region. These artefacts are made of white marble, dating from the Roman period, and were found at various locations in the Struma region. The samples were analysed using various techniques, such as petrography, stable isotopes, and chemical analysis. The results of the analysis show that a large number of marble artefacts are made of local marble, while a smaller number of objects are produced with marble from regional and subregional sources. This research shows that trade networks extend beyond provinces and can be observed between neighbouring areas with no geographical boundaries. The catalogue of the artefacts discussed in this paper underlines the importance of an interdisciplinary approach which combines economic history, archaeology, and archaeometry in the study of ancient marble production.

INTRODUCTION

The geographical location of the Struma Valley represents a major crossroad of the ancient trade network that ensured the connection between the Aegean world and the Balkan hinterland. It crossed the borders between Roman Macedonia and Thrace and constituted a link between East and West, crossed by the Via Egnatia in the southern area. Recent epigraphic and literary studies have shown that provincial borders had a primarily political significance and were not associated with trade and the exchange of goods (such as imported and exported stone materials) (fig. 1).

Various sources of white marble can be found across this area in both Roman Thrace and Macedonia. More specifically, the research by B. Babić[1] refers to numerous locations in the area of Prilep and marks archaeological sites and artefacts, underlining the importance of the area and the connection of these spots with central Roman roads such as the Via Egnatia and Via Militaris as well as the river Axios/Vardar[2]. Among the archaeological sites are many ancient quarries, with the main large locations being the Sivec and Pletvar. Excavations and research from the 1970s brought to light ancient evidence, including tool-marks, architectural blocks and tools (iron chisels), in the Pletvar quarry[3]. The evidence shows multiple crater-shaped extraction pits, in combination with semi-finished objects[4]. However, modern extraction has nowadays destroyed a large number of them[5]. Analytical

1 Babić 1972.
2 Babić 1972.
3 Babić 1972.
4 Niewöhner – Audley-Miller – Prochaska 2013.
5 Prochaska 2013.



1 Map of the quarries and the related area (graphics: OeAW-OeAI/W. Prochaska, V. Anevlavi)

petrographic and geochemical data were produced by W. Prochaska[6], along with the analysis of archaeological objects. The material is an entirely white calcite marble with some grey tones and is coarse-grained (about 4 mm). This stone can be seen used for local architectural elements. The dolomitic marble of Sivec is of a white colour and fine-grained. It is also known as »Macedonian Carrara«, and the current operating company lists various dolomitic occurrences and qualities[7]. It should be underlined that Sivec marble is principally used for sculptural purposes, as well as for decorative usage[8]. In general, it is believed that prefabricated objects were worked in the quarries and later transported to local workshops, possibly based in Styberra, for the final steps of sculpting[9].

The area of Thrace consists of high-quality white marble deposits. In contrast to locations such as Prokonnesos and Thasos, which have been extensively studied, the locations of the southwestern and eastern Rhodopes (Strandzha Mountains, Berkovitsa, Topolovgrad and Asenovgard), and those of southwest Bulgaria (Ilindentsi, Pirin, Petrovo) have received far less attention[10]. Various marble deposits can be found in the area of southwest Bulgaria. These observations and studies within the study of the Roman city of Parthicopolis have the potential to disclose valuable information on the quarry organisation, material prefabrication, distribution, workshops and trade. Ilindentsi/Sandanski[11] (Pirin Mountains) is one of the prominent locations with large extraction pits, while in Petrovo, there are two main areas[12]. In detail, the material in Ilindentsi is a white

6 Prochaska 2013.
7 Prochaska 2013.
8 Babić 1972; Prochaska 2013.
9 Niewöhner – Audley-Miller – Prochaska 2013; Prochaska 2015.
10 Petrova – Ivanov 2008; Petrova 2017.
11 In the area of Sandanski, granite quarries have been observed. The material is light grey to greenish. This material was used already in Roman times and evidence can be seen across the vicinity, see Petrova 2017.
12 Petrova 2017.

marble with light-grey and grey variations. Modern extractions have been carried out above the ancient pits[13]. According to relevant studies, the earliest exploitation is at the village of Ermilovets, based on archaeological and archaeometrical research (analysis of tombstones) and dated in the 1st century AD. Later usage of this material is dated to the 4th and 5th centuries AD and is related to the Byzantine activities in the area. Other locations such as Gingera, Mura-West, etc., are used similarly to the mentions above. Archaeometric observations pinpoint the peak of this area's activity in the 2nd and 3rd centuries AD[14].

Near the area of Ilindentsi, Petrovo, with important marble deposits, is located. The material is of white to whitish-grey colour and the grains are of fine to medium size. It is believed that in the pre-Roman era, this area belonged to the local unknown rulers of Thrace. Analysis showed that marble from Petrovo was used for many tombstones, possibly indicating a local workshop at the quarry itself[15].

THE INVESTIGATED ARTEFACTS

The sampling and analysis of 22 funerary monuments were conducted. A quantity of 15 objects (13 tombstones and two *ostothecae*) from the Regional History Museum Blagoevgrad were analysed, while the remaining seven tombstones are now located at the National Archaeological Museum, in Sofia. These monuments were found on the borders of Roman Thrace and Macedonia, providing information about this region's trade network (figs. 2–3; tab. 1).

These artefacts are made of white marble, dating from the Roman period, and were found at various locations in the Struma region. The area is a contact zone between the southwestern parts of the province of Thrace with the territories of Pautalia and Nicopolis ad Nestum, and the northeastern part of the province of Macedonia with the territories of Stobi and Parthicopolis. One of the studied objects is made of local limestone (FWM0237)[16].

THE ICONOGRAPHIC THEMES AND DISTRIBUTION OF FUNERARY MONUMENTS

The stelae from the Middle Struma Valley are chance finds and have no clear archaeological context[17], but they share certain common stylistic and technical features indicating the activity of local stonemasons' workshops.

The largest share is held by the stelae with frontal half-figure reliefs representing the head, neck and upper body limited by a straight line. They are attested in the province of Macedonia since the 1st century AD[18], perhaps reflecting Roman influence[19]. Regarding the Middle Struma Valley area, the funerary art is characterised by a lack of portrait images between the 2nd century BC and the 1st century AD[20], being adopted no earlier than the turn of the 1st/2nd centuries AD and employed

13 Petrova 2017.

14 Petrova 2017.

15 Petrova 2017.

16 The samples FWM0232, FWM0237, and FWM0238 are currently under archaeological study. Information on these objects is currently not available.

17 A grave in the 3rd-cent. necropolis in the St. Todor locality near the village of Piperitsa, Blagoevgrad region, was covered by FWM0209 in secondary use, see Kuzmanov 1979, 107.

18 A stele from Beroia and a medallion-type tombstone from Thessaloniki dated to the 2nd quarter of the 1st cent. AD are the earliest examples relating to the funerary half-figure portraits in Roman Macedonia. Their adoption in a funerary context in Thessaly is assigned to Macedonian influence, see Spiliopoulou-Donderer 2002, 32 f.

19 It has been conjectured that the spread of half-figure representation of the deceased began from the Augustan age onwards, starting from Rome and reaching the Danubian provinces and Macedonia through Italy and Upper Italy, see Spiliopoulou-Donderer 2002, 32.

20 The date in the early 1st cent. AD has been suggested for the stele of a young man found in the village of Tsarlinishte, Prilep region, North Macedonia (FWM0356), on the basis of stylistic analysis, see Dimitrov 1941, 59 fig. 81.

2 The studied artefacts, part I (photos: OeAW-OeAI/V. Anevlavi)

3 The studied artefacts, part II (photos: OeAW-OeAI/V. Anevlavi)

by the mid-3rd century AD[21]. Thracian family names are mostly engraved on stelae with half-figure reliefs[22]. The images of three family members arranged in two rows with the child shown at a lower level between the parents represents a common iconographic scheme[23]. The stelae from the Sorakevo locality, Melnik region (FWM0206. FWM0212), most probably products of the same workshop following similar relief patterns over the years[24], could be considered as characteristic examples.

However, the portrait features exhibit a different style compared to the reliefs from the Middle Struma Valley and thus indicate the activity of a workshop situated at some distance from the valley.

21 Milcheva 2015, 297.

22 Slavova 2010, 46.

23 Cf. IGBulg IV 2277 = Manov 2008, cat. 69; IGBulg V 5916 = Manov 2008, cat. 81; IGBulg V 5921 = Manov 2008, cat. 140; IGBulg IV 2331 = Manov 2008, cat. 147. See also Dremsizova-Nelchinova 1987, 135 tab. 2; Gerasimova-Tomova 1989, 166. 169 nos. 7–8; Gerasimova-Tomova 1989, 166 no. 6 = Manov 2008, cat. 165; Manov 2008, cat. 128. 179. 202. The iconographic scheme is also included in the relief repertoire of the funerary altars in the province of Macedonia, see Spiliopoulou-Donderer 2002, cat. B37. B46.

24 The close dating of both stelae supports this assumption: FWM0206 stylistically indicates a Hadrianic date and

Lab no.	Project no.	Object	Archaeological description	Marble description
9399	FWM0188	Funerary medallion	Upper half of a round plate with a relief showing a horseman riding to the right and holding a spear in his right hand: he is wearing a knee-length tunic girded up at the waist and a mantle fastened over the left shoulder; a snake wrapped around a tree is depicted in front of the horseman and a servant holding a shield is carved behind the horse; the edge of the medallion is decorated with Ionic cyma crowned by a bead-and-reel decoration; foliated vine tendrils fill the narrow outer border (Reho 1993)	Marble; calcite; white colour; medium-grained
9400	FWM0202	Funerary urn	Rectangular chest decorated in the high relief technique: one side is ornamented with a heavy garland laid on the shoulders of an Eros in the centre and hung on bulls' heads at the corners; there are two six-petalled rosettes above the garland; the garland on the opposite side is mounted on a bull's head in the centre and hung on bulls' heads at the corners; the other three sides are decorated with garlands hung on bulls' heads at the corners (Mitova-Džonova 1981; Georgieva 2015; Petrova 2016; Milcheva 2017b; Georgieva 2018)	Marble; calcite; white colour; medium- to coarse-grained
9401	FWM0203	Funerary urn	Rectangular chest decorated in the high relief technique: the preserved three sides are ornamented with a heavy garland laid on bulls' heads at the corners; a bunch of grapes is hanging from the garland on each side; four-petalled rosettes are shown above the garland on each side; the lid is shaped as a gabled roof with acroteria and is engraved with a four-line inscription in Greek (Gerov 1961; IGBulg IV 2297; Mitova-Džonova 1981; Petrova 2006; Manov 2008; Georgieva 2015; Petrova 2016; Milcheva 2017b; Georgieva 2018)	Marble; calcite; white to greyish colour; medium-grained
9404	FWM0206	Funerary stele	Rectangular plate with a narrow convex frame with an arched top: frontal half-figures of a man, a veiled woman and a girl, arranged in two rows with the girl shown at a lower level between them, are represented in the concave field; no inscription (unpublished)	Marble; calcite; white colour; coarse-grained
9406	FWM0208	Funerary stele	Two-register funerary stele: horseman to the right; a snake wrapped around a tree in front of him and a dog and boar beside the horse next to its forelegs are shown in the upper register; four full-length frontal figures of two women and two men between them are represented in the lower register; pupils engraved; a four-line inscription in Greek is engraved on the lower frame (Bozhinova – Rusinov 1987; Manov 2008)	Marble; calcite; white colour; medium- to coarse-grained
9409	FWM0211	Funerary stele	Rectangular plate with a triangular pediment outlined with a frame and decorated with floral pattern in relief: two full-length frontal figures of a woman and a boy holding a bird in his left hand are shown in the central relief; a three-line inscription in Greek is engraved on the lower frame (Bozhinova – Rusinov 1987; Manov 2008)	Marble; calcite; white colour; medium-grained; dark-grey specks
9410	FWM0212	Funerary stele	Rectangular plate with a narrow convex frame: frontal half-figures of a man, a veiled woman and a boy, arranged in two rows with the boy shown at a lower level between them, are represented in the concave field; irises and pupils engraved; no inscription (Dremsizova-Nelchinova 1987; Gerasimova-Tomova 1989)	Marble; calcite; white colour; coarse-grained; dolomite
9411	FWM0213	Funerary stele	Rectangular plate with a narrow convex frame: three full-length frontal figures of two men and a veiled woman between them are represented in the concave field; the men are holding a spear in one hand and an axe in the other; they are wearing short-sleeved, knee-length tunics and a cloak fastened with a big round buckle on the chest; the woman is wearing a chiton and himation; no inscription (Gerasimova-Tomova 1989; Milcheva 2017a)	Marble; calcite; white colour; medium-grained
9414	FWM0216	Funerary medallion	Round plate with a narrow convex frame in the upper part and kept on one level with the relief in the lower part: five frontal half-figures arranged in two rows are represented, a man occupying the central position on the top row with a woman on each side and a boy (left) and a girl (right) on the lower row; no inscription (Dimitrov 1941; Dimitrov 1946)	Marble; calcite; white colour; coarse-grained
9427	FWM0231	Funerary stele	Rectangular plate with a narrow convex frame: a frontal half-figure of a veiled woman is represented in the concave field; irises and pupils engraved; one-line Greek inscription on the upper frame and two-line Greek inscription on the lower frame (Manov 2008)	Marble; calcite; white colour; coarse-grained
9428	FWM0232	Funerary stele	Rectangular plate with a relief of a horseman to the right; a six-line inscription in Greek engraved below the relief (unpublished)	Marble; calcite; greyish colour; very coarse-grained

Table 1 The sampled artefacts with description of the marble (graphics: OeAW-OeAI/V. Anevlavi, P. Andreeva, W. Prochaska)

Lab no.	Project no.	Object	Archaeological description	Marble description
9440	FWM0236	Funerary stele	Two-register funerary stele: two frontal half-figures of a man (right) and a woman (left) are presented in the upper register; four full-length frontal figures of four women are carved in the lower register; no inscription (unpublished)	Marble; calcite; white colour; medium-grained
9432	FWM0238	Funerary stele	Rectangular plate with a triangular pediment with acroteria and a central field outlined with a frame and engraved with a four-line inscription (unpublished)	Marble; calcite; white colour; coarse-grained
9405	FWM0207	Funerary stele	Two-register rectangular plate with a narrow convex frame arched on top: a funerary banquet scene with four men half-reclining on a couch and a veiled woman seated on a high-back chair to the right of the couch is shown in the upper register; only the upper right corner of the lower register is preserved, showing two heads of frontal full-figure women; no inscription (unpublished)	Marble; calcite; white colour; fine-grained
9407	FWM0209	Funerary stele	A half of a two-register rectangular plate with a narrow convex frame: a funerary banquet scene with a man half-reclining on a couch and a veiled woman seated on a high-back chair to the right of the couch is shown in the lower register; a veiled woman seated on a high-back chair to the right of the couch (?) is represented in the upper register (unpublished)	Marble; calcite; white colour; fine-grained
9412	FWM0214	Funerary stele	Rectangular plate with a triangular pediment decorated with a crescent and floral pattern, and acroteria in relief: the rectangular field below is framed with two garlands shaped as columns mounted by bulls' heads; another heavy garland laid on the bulls' heads and a bunch of grapes is hanging in the centre; a six-petalled rosette is carved between the bulls' heads; a three-line inscription in Greek is engraved below the bunch of grapes (Gerov 1961; IGBulg IV 2294; Petrova 2006; Manov 2008)	Marble; calcite; white colour; fine-grained
9431	FWM0237	Funerary stele	n/a	Limestone
9716	FWM0354	Funerary stele	Two-register rectangular plate: frontal half-figures of a man (right) and a woman (left) are shown in the lower relief; the man is wearing a chiton and sagum fastened on the right shoulder with a round brooch; the hilt of a sword is visible on the left side; the woman is unveiled; two (?) frontal half-figures are barely distinguishable in the upper register, now missing (Dimitrov 1941)	Marble; dolomitic; white colour; fine-grained
9718	FWM0355	Funerary stele	Rectangular plate with a triangular pediment decorated with a six-petalled rosette in the centre: two frontal half-figures of a woman (right) and a man (left) in the central field; three-line inscription in Greek below the figures (Dimitrov 1941; Gerov 1961; IGBulg IV 2286; Manov 2008)	Marble; calcite; white colour; fine-grained
9720	FWM0356	Funerary stele	Rectangular plate with a concave field bearing relief of a frontal half-figure of a man: the head is carved in high relief; the upper part of the body is carved in low relief; no inscription (Dimitrov 1941)	Marble; dolomitic; white colour; fine-grained
9722	FWM0357	Funerary stele	Fragment of a plate representing a funerary banquet scene with a man half-reclining on a couch and turning to the left: a veiled woman seated on a cushioned chair to the left of the couch; a frontal full-figure of a girl standing to the right of the woman; smaller figures of servants next to the chair of the woman and in front of a krater (now missing) placed to the right of the table; one-line inscription in Greek engraved on the lower frame (Dimitrov 1941; Gerov 1961; IGBulg IV 2292; Manov 2008)	Marble; calcite; white; medium-grained
9724	FWM0358	Funerary stele	Rectangular plate with a relief of a funerary banquet scene representing a man half-reclining on a couch to the right: a veiled woman is seated frontally on a chair to the right of the couch; the frontal full-figure of Hekate-Bendida holding a torch on her right is presented on the left side of the scene; a frontal half-figure of a boy is carved in low relief to the right of the goddess; two-line Greek inscription above the scene and three-line Greek inscription on the lower frame (Dimitrov 1941; Gerov 1961; IGBulg IV 2311; Manov 2008)	Marble; calcite; white colour; coarse-grained
9726	FWM0359	Funerary stele	Rectangular plate with a triangular pediment decorated with a floral pattern and a five-petalled rosette in the centre: the central field is occupied by a relief of a funerary banquet scene representing two men half-reclining on a couch to the right; a veiled woman seated on a chair to the right of the couch is hugging a little girl in her lap with her left arm; two-line inscription in Greek engraved on the lower frame (Dimitrov 1941; Gerov 1961; IGBulg IV 2315; Manov 2008)	Marble; calcite; white colour; coarse-grained

Table 1 continued

Married couples are usually portrayed with a man on the left and a veiled woman on the right[25]. The deviation from this pattern is explained by the mother and son motif[26], but the stele from Piperitsa (FWM0211) from the mid-2nd/early 3rd century AD provides an example of a woman carved on the right with her son presented on the left. On the other hand, the half-figure formats of a man and an unveiled woman on a stele dated AD 159 from Debrene (FWM0355) represent the woman on the left, probably being a product of a workshop following another tradition in the iconographic scheme.

The stele from the village of Katuntsi bearing only one half-figure portrait of a woman represented fully frontal (FWM0231) is dated to the late 2nd/early 3rd century AD[27]. According to the inscription, it was erected by Harmosyne in memory of her sister. Another stele was most probably commissioned by the same woman in memory of her brother[28].

Funerary medallions bearing relief half-figures of family members were widespread grave markers in the northeastern part of Roman Macedonia[29] and their relative chronological distribution is assigned to the period between the late 1st century AD and the beginning of the 4th century AD[30]. The medallion from Piperitsa (FWM0216)[31] features an excellent composition and high-quality craftsmanship[32] indicating stylistic similarity with a stele from Thessaloniki[33], which

FWM0212 is assigned to the 2nd half of the 2nd/early 3rd cent. AD. The presumed ›serial production‹ might gain support if use of the same iconographical scheme is taken into consideration. Funerary portrait reliefs were probably produced in series in the Struma Valley after AD 144, see Alexandrescu-Vianu 1975, 185. Therefore, the stelae might have been finished by the craftsmen in advance, which is further implied by the lack of inscriptions on both stelae, i.e. their grave context seems highly unlikely, despite the fact that they were accidental finds. This, in turn, entails the probability of a stonemason's workshop operating in the Sorakevo locality in the 2nd and the 3rd cent. AD.

25 Milcheva 2015, 295; Milcheva 2017a, 196. This iconographic scheme is seen in FWM0206, FWM0212, FWM0354 and probably also in FWM0236 of the late 2nd/early 3rd cent. AD, bearing the frontal half-figures of a man (left) and a woman (right) in the upper register, now missing, indicated only by the traces of relief clothing in the lowest section. The same iconographic pattern is depicted on funerary altars, see Spiliopoulou-Donderer 2002, cat. B4. B11. B16. B21. B37. B44. B46. B54. ThN12.

26 Milcheva 2015, 295.

27 The iconography of the round, full face and prominent cheekbones of the female portraits was adopted in the area of the Middle Struma Valley by the mid-2nd cent. AD, see Alexandrescu-Vianu 1975, 186.

28 Manov 2008, cat. 154, early 3rd cent. AD. The upper half of the stele is now missing, but the preserved relief in the lower section indicates an image of a male half-figure shown frontally. The identical iconographic pattern of both reliefs is discernible. The assumption that these are products of the same workshop could also be supported by the close dating of the stelae. The inscriptions, engraved at a later date, were clearly not made by the same hand, given the misspelling of Harmosyne's name in the latter inscription.

29 It is assumed that the round shape of funerary medallions might have followed the Italo-Roman tradition, although its origin should be traced back to Late Hellenistic art in connection with *imago clipeata* on the round shields. The spread of funerary medallions is usually traced from northern Italy to the east and across Noricum to the Black Sea area, and then to northern Greece, see Pilipović 2012, 108. However, the relationship between this type of grave marker and *imago clipeata* has not yet been fully clarified, see Stefanidou-Tiveriou 2001, 116. It is worth noting that funerary medallions appear not to have been very popular in the neighbouring provinces of Lower Moesia and Thracia. So far, one mid-1st-cent. limestone medallion is known from Oescus (Dimitrov 1946, 52 fig. 39; Conrad 2004, 248 cat. 459 pl. 139) and another fragment of unknown provenance is kept in the depot of the National Archaeological Museum in Sofia (Dimitrov 1946, 23 no. 12 fig. 19; Slawisch 2007, 150 n. 971; 160 n. 1054).

30 Pilipović 2012, 110 f.

31 Taking the stylistic and compositional features into consideration, the medallion possibly belongs to the time of Constantine the Great, see Dimitrov 1941, 51 fig. 74; Dimitrov 1946, 20–22 fig. 17.

32 It is argued that the funerary medallions in the province of Upper Moesia were commissioned by members of wealthy families, which is inferred not only by the quality of the marble but also by a set of iconographic and stylistic features, see Pilipović 2012, 113. Such a hypothesis should not be ruled out for the Middle Struma medallions, considering the epigraphically attested high social status and wealth of individuals bearing Roman names and not directly connected with military service. Whether or not they were of Italic origin still remains only conjecture, see Slavova 2010, 44. In this regard, the observation that the appearance of funerary medallions with portrait reliefs in Thessaloniki was synchronous with the development of the Roman community in the city into a *conventus civium Romanorum* (Stefanidou-Tiveriou 2001, 116 f.) also needs to be addressed.

33 The stele from Thessaloniki was initially assumed to belong to the Severan period (Rüsch 1969, 174 f. [R84]

may advance the discussion about the exact location of the workshop by bringing up the question of the import of funerary medallions in the Middle Struma Valley[34].

The sampled stelae with banquet scenes are found in the villages of Laskarevo (FWM0357, second half of the 2nd cent. AD)[35], Petrovo (FWM0207, 2nd/3rd cent. AD), Piperitsa (FWM0209, first half of the 2nd cent. AD[36]; FWM0359, Hadrianic[37]), and Vranya (FWM0358, June, AD 198[38]). In general, the iconographic theme of the funerary banquet accounts for a smaller share compared to the half-figure images, as the impetus for its distribution in the 2nd–3rd centuries AD in the area of the Struma Valley is attributed to Hellenistic influence of an earlier date[39]. It is therefore important to note that the scene was usually depicted on stelae commissioned by individuals appearing with combined Roman and Greek names[40].

The image of Heros Equitans was included in the repertoire of the Middle Struma funerary reliefs by the middle and second half of the 2nd century AD[41]. Interestingly enough, its earliest appearance on stelae was closely connected with the funerary banquet scene[42], and only later was it depicted together with figures and half-figures on two-register reliefs with the horseman being carved in the upper register[43], as shown in the iconographic scheme of the stele from Piperitsa (FWM0208)[44]. The late 2nd/early 3rd century AD is the dating assigned to the stele and the funerary medallion from Neine (FWM0188)[45], corresponding to the increased distribution of the Heros Equitans images in the valley,

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fig. 89), then to the time of Gallienus (Alexandrescu-Vianu 1975, 187. 194 cat. 24), and later it was redated to the 1st half of the 4th cent. AD (Lagogianni-Georgakarakos 1998, 85 f. cat. 98 pl. 42), i.e. it corresponds chronologically to the medallion from Piperitsa.

34 It has already been argued that the funerary medallions could be considered products of a serial production based on the remarkable similarity of the male and female faces and the lack of individual features, respectively. The typification of examples featuring the relief portraits in the Struma and Mesta valleys has been assigned to particular characteristics of the 4th cent. AD, see Dimitrov 1941, 52 f. However, there are also earlier indications of application of the same types of portraits by the workshops in the Middle Struma Valley, see n. 22.

35 The relief scene is crafted in a classical manner revealed in the body posture and the particular attention paid to the details of clothing and furniture, see Alexandrescu-Vianu 1975, 189.

36 See n. 16.

37 The stele is dated to the early 2nd cent. AD (Dimitrov 1941, 12) or is considered of Hadrianic date (Gerov 1961, 187). Given the schematic and austere style of the figures, it is regarded as an example of a new stylistic tendency in the banquet scene from the mid-2nd cent. AD onwards, see Alexandrescu-Vianu 1975, 189.

38 D. Dimitrov considered the stele as belonging to the Flavian period, assuming that the inscription below the relief should be dated according to the Macedonian era (Dimitrov 1941, 10 f.), but B. Gerov redated it to AD 198, arguing an Actium-era date (Gerov 1961, 187. 345 no. 40) and even generalising that no inscription from the Middle Struma Valley is dated to the Macedonian reckoning because of the events related to the campaigns of the Macedonian proconsul M. Crassus (Gerov 1961, 188). It was later concluded that the use of the two eras in the province of Macedonia should be determined not chronologically, but rather relative to different regions, see Spiliopoulou-Donderer 2002, 85.

39 Mitrev 2011, 28. The funerary banquet scene was given iconographic form in the Late Hellenistic period and its distribution in the Roman period is mainly attested in regions greatly influenced by the Hellenistic tradition. Its representation on grave markers in Roman Macedonia is relatively common, probably adopted from the regions of Byzantium and Cyzicus, see Alexandrescu-Vianu, 1975, 189. The banquet is also included in the relief repertoire of the funerary altars, see Spiliopoulou-Donderer 2002, cat. B30. B32–B33. B67–B68.

40 Slavova 2010, 46.

41 Reliefs of Heros Equitans in a funerary context are evidenced in the Greek cities along the Aegean coast in the 1st cent. AD, as the earliest examples come from Perinthos, Maroneia and even Thasos. The horseman is represented in the funerary art of areas close to the Macedonian-Thracian border, such as Nicopolis ad Nestum, mainly from the last quarter of the 2nd cent. AD onwards, see Ivanov 2006, 82.

42 The earliest stelae bearing the horseman relief are arranged in two registers representing the horseman above the banquet scene, see Mitrev 1996, 493. Both iconographic themes are also depicted together on funerary stelae, see Toncheva 1961, 21 f. fig. 3; Andrianou – Lazzarini 2020, 126 relief 54 fig. 11. The banquet scene has been interpreted as the Greek iconography of the heroised dead alongside the Thracian iconographic ›language‹ of heroisation through the Thracian Horseman, see Toncheva 1961, 22 f.

43 Mitrev 1996, 498; Mitrev 2011, 28.

44 Cf. Dimitrov 1941, 39 f. figs. 53–55; Sharankov 2004, 198 f.; Manov 2008, cat. 172. 197.

45 The fragment is a rare example of Heros Equitans carved on a funerary medallion, see Reho 1993, 237.

reaching its peak in the 3rd century AD[46]. It should be pointed out that the horseman reliefs were relatively widespread in the funerary art of the province of Macedonia, including on the altars[47].

Stelae with relief figures of soldiers belong to a specific group of grave markers in the Middle Struma Valley. On the one hand, these full-figure images were influenced by the Western iconographic type of a full-frontal standing soldier, but on the other hand, they reveal some key characteristics by presenting the figures among the family members[48]. The stele from the Sorakevo locality dated to the first half of the 3rd century AD (FWM0213) displays the family-oriented iconographic scheme[49] of standing, full-frontal figures of a woman and two soldiers[50]. In addition to the epigraphic data, the funerary reliefs indicate that several generations of the local families have chosen to undergo military service[51] and return home after receiving *missio honesta*[52].

Another group of stelae is characterised by centrally displayed wreaths or garlands[53] in high relief, which is mainly observed in ancient Macedonia[54]. This type of relief decoration was included in the Roman funerary art of the valley as early as the 1st century AD[55]. The stele from Laskarevo (FWM0214), dated to the second half of the 2nd century AD, is inscribed between two relief garlands shaped as columns mounted by bulls' heads, and the pediment is decorated with a centrally carved moon sickle[56]. The execution of the elaborate details of the iconographic scheme in high relief indicates a good level of craftsmanship[57].

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46 Mitrev 1996, 494.

47 Cf. Spiliopoulou-Donderer 2002, cat. B17 (Hadrianic). B19 (3rd quarter of the 2nd cent. AD). B29 (1st quarter of the 3rd cent. AD). ThN9 (late 2nd/1st quarter of the 3rd cent. AD). ThN13 (2nd quarter of the 2nd cent. AD).

48 Milcheva 2017a, 200.

49 The chronological distribution of stelae with soldier images points to the conclusion that they entered the funerary art of the Middle Struma Valley after the 2nd decade of the 3rd cent. AD, see Alexandrescu-Vianu 1975, 185; Milcheva 2017a, 198.

50 There are more examples of stelae from the Sorakevo locality representing soldier figures dressed in similar clothing (Gerasimova-Tomova 1989, 170 f. nos. 16. 18). The cloak of animal pelt fastened at the chest by a large round buckle is only attested in the Middle Struma Valley in relation to the funerary reliefs. It has been interpreted as everyday Thracian clothing (Gerasimova-Tomova 1981, 34), but since then, its significance as the military attire of the local population has been plausibly argued (Milcheva 2017a, 194 f.), and therefore it cannot be considered a *sagum* fastened at the front by a fibula (Alexandrescu-Vianu 1975, 185). A chiton and a *sagum* clasped with a round brooch on the right shoulder is worn by the man represented on a stele from the village of Tsarnilishte, North Macedonia (FWM0354), which reveals a distinctly different style compared to the military stelae in the Middle Struma Valley. Furthermore, its Flavian date is much earlier than the chronological distribution of the other stelae.

51 Scupi, the only Flavian colony in the province of Macedonia, appeared to be one of the major sources of recruitment for the Moesian legions (Mann 1983, 37. 55), though other settlements in the province must also have been involved in the Roman recruitment policy for the defence of the limes. A stele from Parthicopolis dated AD 121 (IGBulg IV 2270) was set up in memory of a veteran of *legio I Italica*, who probably was among the first recruited to the legion, see Gerov 1961, 203; Slavova 2010, 43; Boyanov 2017, 138. More than a hundred years later, a stele for a veteran dated AD 238 was commissioned by his son, an *optio* of the *legio I Italica* and the *legio VIII Augusta*, see IGBulg V 5891; Manov 2008, cat. 3.

52 Slavova 2010, 43 f.; Boyanov 2017, 137 f.

53 Garlands were typical Hellenistic decorative patterns and widespread ornaments in the Roman period, see Mitrev 2011, 20; Georgieva 2015, 4; Georgieva 2018, 387.

54 Mitrev 2011, 20 f.

55 A garland with a bunch of grapes hanging below is carved in high relief on a tombstone dated AD 71 from the necropolis of Heraclea Sintica, see Mitrev 2011, 40 f. cat. 17 fig. 15.

56 A moon sickle is depicted centrally on the pediment of another stele from the Sorakevo locality bearing half-figure portrait reliefs of a man, a woman and a child arranged in two rows, see Gerasimova-Tomova 1989, 166 no. 6 = Manov 2008, cat. 165. The inscription engraved on the lower frame is dated to AD 154.

57 Stelae of the Roman period decorated with relief garlands have been discovered in Neine (Angelov 2003, 139; Sharankov 2004, 198; Manov 2008, cat. 82), Ilindentsi (IGBulg IV 2254; IGBulg V 5881; Manov 2008, cat. 19), Sandanski (IGBulg IV 2271 = Manov 2008, cat. 63; IGBulg IV 2272 = Manov 2008, cat. 64; IGBulg IV 2273 = Manov 2008, cat. 65; IGBulg IV 2274 = Manov 2008, cat. 66), Laskarevo (FWM0214), Rupite (Manov 2008, cat. 126; Mitrev 2011, cat. 16–18 figs. 14–16) and the locality of Sorakevo (Gerasimova-Tomova 1989, 172 no. 19).

The garland decoration is characteristic of the rectangular and round[58] funerary urns[59] from the Middle Struma Valley. It has been noted that the leaf design is stylistically identical to the garland stelae[60]. The decoration pattern carved on the walls of the urns is assumed to follow prototypes from Asia Minor[61], and therefore it is commonly ascribed to craftsmen from Asia Minor, settled in the area[62], who are also considered to have imported the small-scale containers into the region[63]. However, the detailed stylistic analysis of the garland decoration of the earliest urns dated to the 130s/140s reveals an Attic influence[64], as evidenced by the example from Katuntsi of Hadrianic date (FWM0202)[65]. The relief pattern of the Laskarevo urn (FWM0203) exhibits an apparent reduction of plasticity, pointing to a later date, which is also supported by the date of the inscription[66] engraved on the gabled roof-shaped lid with acroteria[67]. The urns from the valley are usually uninscribed[68].

It is worth noting that they feature not only high-quality craftsmanship but also inscriptions revealing poetic commemorative elements, see Sharankov 2017, 19.

58 The relative chronology of the funerary urns from the Struma Valley is limited between the late Hadrianic and the middle Severan periods, see Milcheva 2017b, 67. The round shape of the urns is attested from the 3rd quarter of the 2nd cent. AD onwards, when the overall number of urns with garland decoration increased significantly in the region, see Milcheva 2017b, 65.

59 The term »funerary urn« is imposed instead of »ossuary« or »ostothek« due to the absence of any epigraphic evidence and a lack of tradition in the use of this particular form of burial repository for the remains in the area under consideration, see Georgieva 2015, 3 f.; Petrova 2016, 101; Georgieva 2018, 354 f.

60 Milcheva 2017b, 61.

61 Cf. the shape and the garland decoration of ostothekes from Pamphylia and Cilicia, see Korkut 2006. The decoration scheme of the garland sarcophagi from Aphrodisias is also a very good parallel, see Işık 2007. The garland pattern of elaborately carved sarcophagi from Thessaloniki is assumed to derive from northwestern Asia Minor and divided into two groups: imported sarcophagi from workshops in Asia Minor and local sarcophagi following the patterns imported from Asia Minor, see Stefanidou-Tiveriou 2001, 121.

62 It is worth noting that except for a large group from Asia Minor, the funerary urns with garland patterns are mainly attested in the province of Macedonia, and particularly in the capital city of Thessaloniki and the Struma Valley. It is further estimated that the find-spot of about 80 % of the urns found in Bulgaria is the Middle Struma Valley, see Georgieva 2015, 3; Petrova 2016, 102; Milcheva 2017b, 63; Georgieva 2018, 383 f.

63 Petrova 2016, 109; Milcheva 2017b, 59. 61. 67.

64 Cf. the garland decoration of the stele of Gaius Valerius Pudens of AD 131 which was found in the vicinity of Neine, see Angelov 2003, 139; Sharankov 2004, 198; Manov 2008, cat. 82 fig. 82; Petrova 2016, 109 f.; Milcheva 2017b, 62 f. The Attic sarcophagi were imported to Thessaloniki before the mid-2nd cent. AD, becoming highly appreciated by the prosperous citizens in the 1st half of the 3rd cent. AD, and copied by local workshops, see Stefanidou-Tiveriou 2001, 121 f. It appears that the local imitations of Attic sarcophagi and those from Asia Minor in Thessaloniki were mainly traded in Thrace, Propontis and Bithynia (Stefanidou-Tiveriou 2001, 121), implying that Attic influences and those from Asia Minor discerned in the relief decoration patterns of the funerary urns in the Struma Valley would mostly have come through the capital of the province of Macedonia. These influences must have also been promoted to a large extent by the settlers from the Aegean region, as evidenced by the Ionic Greek forms appearing in inscriptions from Neine and Parthicopolis, see Slavova 2010, 42.

65 Petrova 2016, 110; Milcheva 2017b, 74.

66 It is dated to the 1st half of the 3rd cent. AD, see Gerov 1961, 342 no. 21a; IGBulg IV 2297; Manov 2008, 102 cat. 94 fig. 94 a–b. The date could be further refined to after AD 212 due to the onomastic data.

67 The place chosen for the inscription brings up the discussion about the exact arrangement of the funerary urns in the *necropoleis*. Given that the precise archaeological context of all finds is unclear, the accurate reconstruction of their *in situ* position is highly contested. The technical features of the chests provide some clues about their attachment to plinths (Petrova 2016, 112; Milcheva 2017b, 57), probably in an open-air area, if the hypothesis about the disposition of garland ostothekes from *necropoleis* in Pamphylia and Cilicia is taken into consideration (Korkut 2006, 77–79). The uneven degree of carving of relief decoration on the outer walls of the urns (an example is the above-mentioned funerary urn from the village of Katuntsi), as well as the representation of portrait images in high relief on walls (Petrova 2016, 117 figs. 9–10; 118 fig. 17 a–c; Milcheva 2017b, 79 cat. 11 pl. 6 figs. 3–6) probably imply their position in niches (Petrova 2016, 112; Milcheva 2017b, 57). It could be further assumed that at least some of the urns were placed at a lower level, as evidenced by the inscription on the lid of the Laskarevo urn.

68 Except for the Laskarevo urn, Greek inscriptions are engraved on urns from Sandanski (Georgieva 2015, 4; Georgieva 2018, 387 fig. 6) and Dolna Gradeshnitsa (IGBulg IV 2249).

Technical, stylistic and iconographic similarities between the funerary reliefs bearing full-figure and half-figure images, scenes or garland patterns could be referred to in support of the hypothesis that the stelae and the urns from the Middle Struma Valley were produced in the same workshops, of unknown location due to the lack of archaeological context of the artefacts. So far, different arguments have been given in favour of the leading role of Heraclea Sintica[69] and Parthicopolis[70] in the stonework of the region. The letter by Antoninus Pius of AD 157/158 testifies to the rivalry between the two cities, apparently rooted in territorial claims[71] and most likely also related to the location of the marble quarries in their territories[72]. The largest share of stelae with soldiers' reliefs is dated to the Antonine and Severan periods, which has so far been explained by the presumed presence of small military detachments in the area of Ilindentsi[73] for the vital defence of the quarries and the transport network[74] connecting the valley with the Via Egnatia[75]. However, there is no certain evidence that regular Roman military units were stationed in the area[76]. The analysis further reveals that the stelae with soldier images have mostly been discovered, although not *in situ*, in the southern part of the Middle Struma Valley, and particularly in the territory of Heraclea Sintica, while only two stelae with such an iconographic theme come from the area of Ilindentsi[77]. It is also Heraclea Sintica that indicates a long-standing tradition of stonemasonry since Hellenistic times[78]. Even if the city lost part of the territory and influence it held in the 2nd and 3rd centuries AD, its workshops probably continued to set the tone for sculptural production in the valley and to be a conduit for cultural influences from the south.

The stylistic similarity of certain groups of stelae also suggests the existence of small-scale local workshops in the Sokarevo locality, the villages of Laskarevo, Piperitsa, Petrovo, Vranya, Katuntsi, etc.[79]. Despite the assumed popularity of stonemasonry in the region, only two names of

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69 For the archaeological investigations and finds in Heraclea Sintica, see Vagalinski 2002; for the stonemasons' workshops in Heraclea Sintica in the Roman period, see Milcheva 2015; Milcheva 2017a.

70 For the archaeological investigations and urban development of Parthicopolis, see Dimitrova-Milcheva 2002; Kolev 2015. The existence of stonemasons' workshops in the territory of Parthicopolis is argued on the basis of archaeological data, giving further indications of a workshop in the northern part producing sculpture in the round, see Petrova 2017, 161.

71 For the full text and commentary on the letter, see Sharankov 2016, 58–61.

72 The foundation of Parthicopolis in the time of Emperor Trajan must have been accompanied by attribution of an urban area, most probably hived off from the urban territory of Heraclea Sintica, see Mitrev – Tarakov 2002, 30; Mitrev 2003, 270; Sharankov 2016, 61. The marble quarries located in the territory inevitably gave a strong impetus to the economic development of the city in the 2nd and 3rd cent. AD (Petrova 2017, 153–160), and they were most likely the reason for the imperial favour to the city in resolving disputes in this part of the province of Macedonia, as the above-mentioned letter of the Emperor Antoninus Pius suggests.

73 It has already been conjectured that Neine was a settlement performing military functions on the Macedonian border, see Gerov 1961, 205; Velkov 1963, 142. According to later assumptions, the military unit was stationed in Neine up to the foundation of the province of Thrace, and then the military functions were suspended, turning the settlement into a *kome*, see Mitrev 1997, 68 f. However, the 3rd-cent. stelae with soldiers' reliefs (Gerasimova-Tomova 1981, 30) indicate a military presence in this area on a certain scale. Moreover, if the epigraphically argued polis status of Neine is taken into account (Sharankov 2016, 60 n. 14), the discussion about the key defence role of Neine in guarding the adjacent marble quarries at Ilindentsi could go further.

74 For the current data on the development of road networks in the Middle Struma Valley in the Roman period and Late Antiquity, see Kolev 2017.

75 Petrova 2017, 156.

76 Slavova 2010, 43; Boyanov 2017, 136.

77 Milcheva 2017a, 199.

78 The assumption of the existence of a workshop of Hellenistic date in Heraclea Sintica is based on Hellenistic stelae with wreaths and garlands carved in low relief or bearing a depiction of a funerary banquet found in the city and its territory, see Mitrev 2011, 24. 26.

79 Milcheva 2017b, 66 f.; Petrova 2017, 162. The unclear archaeological context of the sculptural monuments found so far makes the existence and the dating of a quarry-based workshop only a hypothesis, which should also include the discussion about a head of a man from a statuette of the early 3rd cent. AD (Nikolov 1970, 292 fig. 14), as well as an unfinished head of a tetrarch identified as Licinius I (Popova 2016, 167 f. pl. 8 figs. 7–8), both found close to

stonemasons are known so far[80]. The commissioning of ready-made stelae could be proposed not only based on the same iconographic scheme employed over the years[81], but also on the basis of inscriptions engraved between and around the relief figures, some of them not even corresponding to the images[82]. Last but not least, the lack of inscriptions on some stelae may also be taken as evidence of finished reliefs stockpiled in the workshops[83].

RESEARCH QUESTIONS AND APPLIED METHODS

This paper aims to investigate the origin of tombstones, the material choice linked to the provincial borders, and the construction of the monuments. A stylistic and chronological description of each artefact assists the study and enriches the information concerning the variation in raw materials, their use in different periods, the specific function, and the commercial power and interconnection of the area between the provinces.

The analytical methods applied to these samples included macroscopic observations, chemical analysis with a large range of elements using the inductively coupled plasma mass spectrometry (ICP-MS) method (investigated elements: manganese [Mn], magnesium [Mg], iron [Fe], strontium [Sr], yttrium [Y], vanadium [V], cadmium [Cd], lanthanum [La], cerium [Ce], ytterbium [Yb], uranium [U]) and stable isotopic analysis ($\delta^{18}O$ ‰, $\delta^{13}C$‰)[84]. The samples have been subjected to statistical analysis (STATISTICA and SPSS). The data of the sampled objects have been compared to a large dataset of geological samples, collected from various areas of ancient and modern quarries and outcrops (ca. 5,500 samples). The primary interest is in the local quarries of these areas, northern Greece, North Macedonia and Bulgaria. However, the supraregional quarries include Aphrodisias, Prokonnesos, Dokimeion, Pentelikon, Paros, Miletos/Herakleia, etc.

RESULTS

The analysis of the calcite objects revealed provenance from different sources. The following elements were used for the multivariate evaluation and the numerical statistical approach (STATISTICA and SPSS): magnesium (Mg), chromium (Cr), cadmium (Cd), barium (Ba), iron (Fe), manganese (Mn), strontium (Sr), lanthanum (La), cerium (Ce), ytterbium (Yb), uranium (U), $\delta^{18}O$ and $\delta^{13}C$ (fig. 4; tabs. 2–3)[85]. Pletvar, Asenovgrad, and Petrovo quarries were the sources for the largest number of objects at five and four samples respectively (Pletvar: FWM0202.

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the marble quarries at Ilindentsi.

80 The stonemasons Διοσκουρίδης (IGBulg IV 2269) and Γελασεῖνος (IGBulg IV 2304; AD 162), probably slaves or libertines, are supposed to have been settled from Asia Minor or the Aegean coast, see Slavova 2010, 42. A stonemason's name was also engraved below the relief of a stele from the village of Debrene (FWM0355; AD 159), but unfortunately, it has not been preserved, see IGBulg IV 2286; Manov 2008, cat. 83.

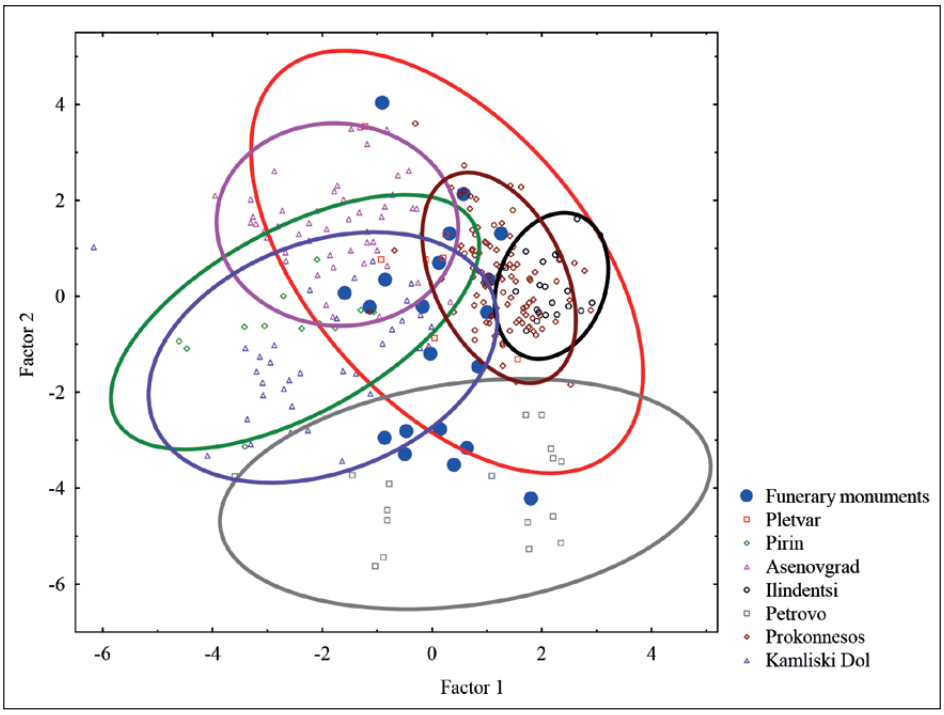
81 Stelae of the same artistic quality bearing the same portrait features repeated by the local craftsmen over the years have already been discussed, see Milcheva 2017a, 198.

82 Sharankov 2004, 200 n. 9. Importantly, in addition to the aforementioned observation, the complete lack of individual facial features of men and women (Milcheva 2015, 294–296; Milcheva 2017a, 198) brings up the question of whether these reliefs should be interpreted as portrait images or if they might be considered conventional relief figures following a certain aesthetic spirit of the epoch, the skills of the craftsmen and the traditions of the workshops in the Struma Valley. For the assumption of individual portrait features carved on the funerary altar reliefs, see Spiliopoulou-Donderer 2002, 33.

83 For the commentary on FWM0206 and FWM0212, see n. 23.

84 Prochaska – Attanasio 2021.

85 Tab. 3: the supplementary material provides the data with the lab and sample number including the stable isotopic values of carbon and oxygen and the chemical values from the ICP-MS analysis (magnesium, manganese, iron, strontium, chromium, vanadium, yttrium, cadmium, boron, lanthanum, cerium, praseodymium, dysprosium, holmium, ytterbium, lead, and uranium, data in ppm).



4 The multivariate diagram of the calcite samples. The variables used are: Mg, Cr, Cd, Ba, Fe, Mn, Sr, La, Ce, Yb, U, $\delta^{18}O$ ‰ and $\delta^{13}C$ ‰ (graphics: OeAW-OeAI/V. Anevlavi, W. Prochaska)

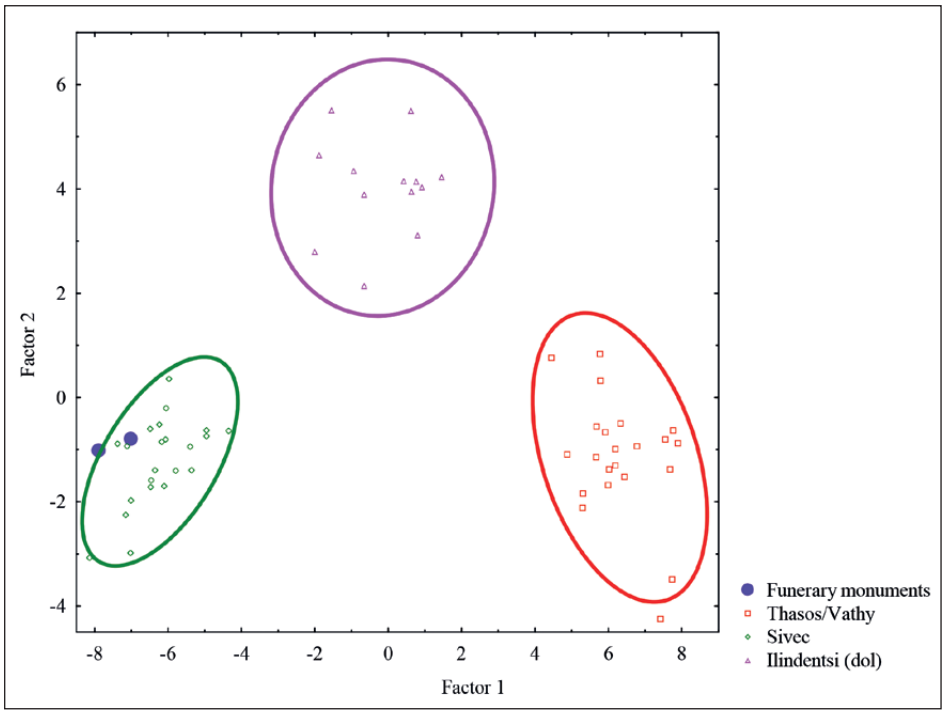
FWM0203. FWM0231. FWM0208. FWM0211; Asenovgrad: FWM0212. FWM0232. FWM0355. FWM0359; Petrovo: FWM0188. FWM0213. FWM0214. FWM0206). The source of Kamilski Dol from the eastern part of the province can also be found among the used materials (FWM0357. FWM0358. FWM0236). One object made from Pirin marble was also detected (FWM0207). Finally, imported marble from Prokonnesos was detected in three objects (FWM0216. FWM0238. FWM0209).

The dolomitic samples both showed the origin of Sivec marble. The following elements were used for the multivariate evaluation and the numerical statistical approach (STATISTICA and SPSS): Mn, Mg, Cr, Cd, V, Fe, Sr, La, Ce, Yb, U, $\delta^{18}O$ and $\delta^{13}C$ (fig. 5; tab. 3).

DISCUSSION

The results show that the majority of the objects are made of Pletvar marble. This quarry is located in the territory of the province of Macedonia and provides high-quality raw materials. One of the other big antique marble sources is also represented – Prokonnesos, by three samples. An interesting mix of local sources is demonstrated: sources in direct proximity to the Struma Valley (Petrovo, Pirin) and one that is more distant from the province of Thrace, namely Asenovgrad (hinterland of Philippopolis). This combination of large quarries and local production establishes a strong level of economic integration and development of the exploitation of the local raw material sources in the region. Based on the stylistic and iconographic studies, it occurs that the sampled elements come from the same workshop(s) in the area. As was mentioned above, the importance of the area and the existence of local workshops was related to military units (possibly temporary), controlling the trade routes.

The studies of tombstones in the vicinity of Petrovo and Sandanski reveal possible stone workshops in the area near the river Struma, based on stylistic and iconographic research. However, objects with common characteristics such as those from the Thessaloniki workshop can also be



5 The multivariate diagram of the dolomite samples. The variables used are: Mn, Mg, Cr, Cd, V, Fe, Sr, La, Ce, Yb, U, $\delta^{18}O$ ‰ and $\delta^{13}C$ ‰ (photos: OeAW-OeAI/V. Anevlavi, W. Prochaska)

found as imports around the Middle and Lower Struma Valley. It is assumed that prefabricated materials (such as medallion types) arrived in the valley together with artisans from Macedonia, Greece, Asia Minor, etc., settling in the area[86].

The chronological distribution of the artefacts shows the marble preferences in different periods. The majority of the objects are dated between the 2nd and the 3rd century AD. During this period, the major local material concentration can be seen with Pletvar being the marble most used in the 2nd century. During that period, we also observed local imports from the central and eastern parts of the province, e.g. Asenovgrad and Kamilski Dol. The two early objects, which came from imported sources, are of special interest, with the earlier one being of Sivec marble and the second of Proconnesian. In the 4th century, we see again a preference for Proconnesian marble (fig. 6).

Other studies of similar groups of artefacts showed quite different results in comparison to the current analysed group. The work of P. Niewöhner and colleagues in the area of Macedonia II or Salutaris presents a wide range of archaeometrical analyses and objects, including tombstones[87]. Their investigations are focused on objects from the Classical period through to Late Antiquity, observing the timeline of the marble trade and the trade connections of local and imported samples. Specifically, Classical and Late Hellenistic tombstones showed that imported marble was used. In the case of the Classical object, the marble source is Penteli, in Attica, Greece. It is believed that finished products arrived in Thessaloniki and then were sent on via various transportation routes (such as the river Axios) to northern areas. The later example, on the other hand, is made of local limestone. Finally, a later Roman example of a grave medallion, dated in the early Hadrianic period, is made of Thasian dolomitic marble[88]. Despite the imported provenance of the medallion, the

86 Petrova 2017.
87 Niewöhner – Audley-Miller – Prochaska 2013.
88 Niewöhner – Audley-Miller – Prochaska 2013.

Lab. no.	Sample	Distance	Abs. Prob.	Rel. Prob.	Provenance	Rel. Prob.	Provenance
		1. Choice				2. Choice	
9400	FWM0202	6.3	28.1	99.1	Pletvar	0.9	Petrovo
9401	FWM0203	2.2	66.3	100.0	Pletvar	0.0	Philippi
9405	FWM0207	8.3	17.2	97.3	Pirin	2.7	Asenovgrad
9427	FWM0231	14.1	1.5	93.8	Pletvar	6.2	Petrovo
9406	FWM0208	10.8	5.6	100.0	Pletvar	0.0	Petrovo
9409	FWM0211	47.3	0.0	100.0	Pletvar	0.0	Prokonnesos
9399	FWM0188	2.4	78.4	100.0	Petrovo	0.0	Prokonnesos
9410	FWM0212	6.2	28.5	83.4	Asenovgrad	16.0	Prokonnesos
9411	FWM0213	5.2	39.1	100.0	Petrovo	0.0	Prokonnesos
9414	FWM0216	7.8	16.5	59.1	Prokonnesos	39.2	Asenovgrad
9428	FWM0232	5.8	32.6	99.9	Asenovgrad	0.1	Prokonnesos
9432	FWM0238	9.5	9.2	50.8	Prokonnesos	47.7	Petrovo
9407	FWM0209	2.4	78.9	99.6	Prokonnesos	0.4	Asenovgrad
9412	FWM0214	8.6	12.4	88.7	Petrovo	10.5	Prokonnesos
9404	FWM0206	8.0	15.6	99.2	Petrovo	0.8	Prokonnesos
9718	FWM0355	2.0	73.5	87.6	Asenovgrad	10.0	Pirin
9722	FWM0357	7.6	10.7	99.9	Kamilski Dol	0.1	Kamilski Dol II
9724	FWM0358	10.8	2.9	61.5	Kamilski Dol	21.5	Asenovgrad
9726	FWM0359	3.6	45.4	95.9	Asenovgrad	3.3	Pirin
9440	FWM0236	8.5	7.4	84.0	Kamilski Dol	12.4	Kamilski Dol II

Table 2 The numerical probability showed the different sources of calcite marble used for the funerary objects, including Pletvar, Prokonnesos, Asenovgrad, Petrovo, Pirin and Kamilski Dol (graphics: OeAW-OeAI/V. Anevlavi, W. Prochaska)

Related commentary on table 2:
Distance: Distance of the sample under consideration from the centre of the ellipse that represents the quarry probability field. The central point of the ellipse expresses the average and hence most characteristic values of a quarry. The closer a point is to the centre of an ellipse, the more likely the provenance from that marble site.
Relative (posterior) probability: Probability of the sample belonging to some group within the assumption that it originates in any case from one of the groups in the selection. The threshold is 60 %. Low values indicate that the sample's assignment is dubious and could fall in two or more groups.
Absolute (typical) probability: This is a distance-dependent parameter measuring the absolute probability that the sample belongs to the chosen group or, in other words, is a typical representative of the group properties. The threshold is 10 %, corresponding to samples on the edge of the 90 % probability ellipse. Low values indicate anomalous samples (outliers) or samples possibly not belonging to any group in the selection.

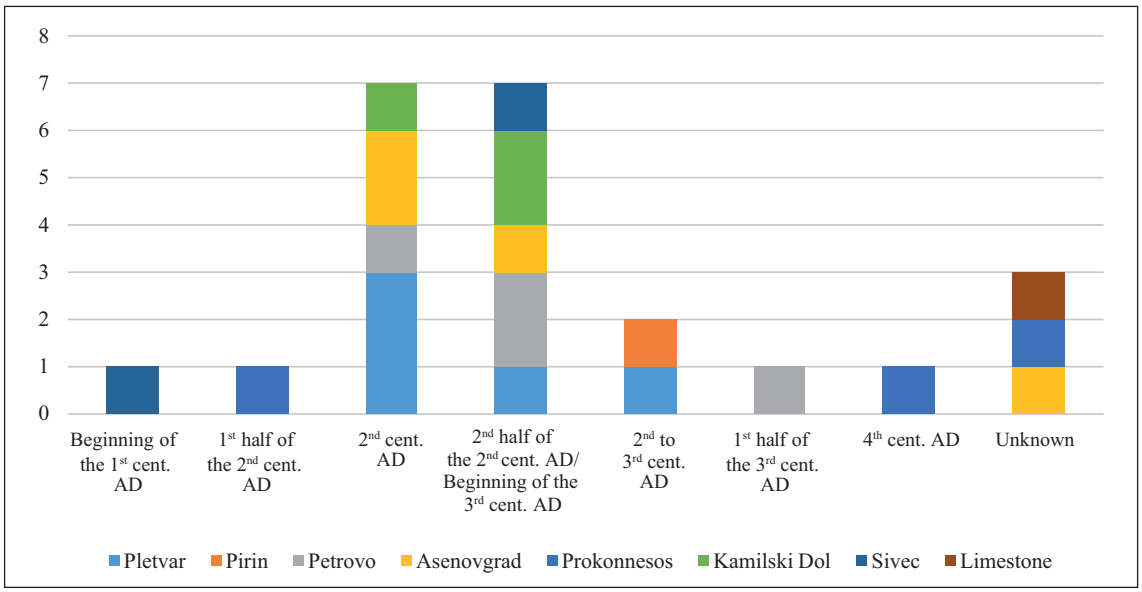
stylistic characteristics appear to be local and indicate a local craftsmanship/workshop[89]. No Thasian dolomitic marble was detected for the funerary monuments in the Struma Valley.

In addition, D. Andrianou's and L. Lazzarini's extended investigations in Greek Thrace and Macedonia revealed new opportunities for exploring marble trade relations and discussions of trade and interprovincial connections. The analysis of local quarries and a wide group of tomb monuments illustrated the use of local sources, Thasian (dolomite), Pentelic, Parian and Proconnesian marble[90]. This study includes more than 70 funerary monuments. Important elements of their studies are the fact that local Thracian onomastic characteristics appear carved in local materials[91]. A special focus is given to the choice of Thasian dolomite, underlining the importance of the source during Roman times, and sharing repeated characteristics among the reliefs, such

89 Niewöhner – Audley-Miller – Prochaska 2013.
90 Andrianou – Lazzarini 2013; Lazzarini 2017; Andrianou – Lazzarini 2020.
91 Andrianou – Lazzarini 2020.

Lab no.	Sample	Marble	$\delta^{18}O$ (PDB)	$\delta^{13}C$ (PDB)	Mg	Mn	Fe	Sr	Cr	V	Y	Cd	Ba	La	Ce	Pr	Dy	Ho	Yb	Pb	U
9718	FWM0355	Calcite	–3.16	2.02	1.80	11.72	46.57	–	0.81	0.43	2.49	0.22	1.30	0.79	0.54	0.15	0.20	0.05	0.10	1.57	0.04
9722	FWM0357	Calcite	–4.71	4.65	4.21	18.84	–	–	0.89	0.33	0.33	0.20	1.98	0.20	0.22	0.03	0.03	0.01	0.02	0.62	0.02
9724	FWM0358	Calcite	–6.25	3.77	1.66	23.30	–	–	0.92	0.29	2.70	0.32	1.91	0.79	0.40	0.13	0.20	0.05	0.12	1.01	0.02
9726	FWM0359	Calcite	–4.44	2.44	1.35	10.22	–	–	1.14	1.10	0.11	0.21	1.78	0.08	0.09	0.01	0.01	0.00	0.01	0.33	0.08
9440	FWM0236	Calcite	–5.60	3.50	2.14	51.23	–	–	1.08	0.17	0.50	0.09	1.08	0.22	0.18	0.04	0.04	0.01	0.03	0.69	0.05
9400	FWM0202	Calcite	–4.03	2.55	2.41	20.06	–	–	1.15	0.33	2.55	0.33	1.28	0.64	0.53	0.12	0.19	0.04	0.11	0.70	0.03
9401	FWM0203	Calcite	–2.73	1.53	1.07	11.82	91.19	–	1.77	2.31	1.79	0.16	2.99	0.69	1.00	0.14	0.15	0.03	0.10	1.19	0.26
9405	FWM0207	Calcite	–2.95	2.41	0.81	15.24	70.79	–	1.13	0.28	4.28	0.27	2.03	2.56	0.83	0.27	0.25	0.06	0.13	0.61	0.04
9427	FWM0231	Calcite	–5.64	3.19	1.75	35.93	–	–	1.13	0.18	4.54	0.28	1.25	1.64	1.16	0.35	0.40	0.09	0.22	0.74	0.01
9406	FWM0208	Calcite	–5.66	1.64	1.50	35.27	–	–	1.27	0.37	5.23	0.48	2.15	2.03	1.40	0.38	0.42	0.10	0.24	0.65	0.07
9409	FWM0211	Calcite	–4.70	1.49	1.18	21.93	–	–	1.82	0.72	1.80	0.75	1.24	1.79	3.18	0.35	0.21	0.04	0.11	0.97	0.38
9399	FWM0188	Calcite	–9.22	3.52	4.54	23.05	–	–	1.17	0.32	1.54	0.27	0.98	0.67	0.61	0.12	0.12	0.03	0.07	0.45	0.04
9410	FWM0212	Calcite	–6.88	2.23	2.13	31.16	–	–	1.20	0.30	0.87	0.17	1.00	0.36	0.31	0.06	0.07	0.02	0.05	0.54	0.05
9411	FWM0213	Calcite	–9.78	3.69	5.32	13.71	–	–	1.34	0.34	1.10	0.16	2.17	0.58	0.46	0.09	0.09	0.02	0.04	0.47	0.04
9414	FWM0216	Calcite	–5.64	2.41	1.45	15.27	98.89	–	1.55	0.29	1.09	0.18	1.35	0.40	0.36	0.07	0.09	0.02	0.05	0.43	0.02
9428	FWM0232	Calcite	–3.38	0.90	2.37	7.61	–	–	1.34	1.50	0.19	0.06	4.23	0.14	0.23	0.03	0.02	0.00	0.01	0.98	0.16
9432	FWM0238	Calcite	–3.76	3.25	1.39	7.93	61.34	–	1.17	0.18	1.10	0.10	1.28	0.41	0.30	0.08	0.09	0.02	0.05	0.59	0.01
9407	FWM0209	Calcite	–2.92	2.53	1.15	3.45	23.23	–	1.48	0.26	0.54	0.17	0.69	0.23	0.25	0.04	0.04	0.01	0.02	0.41	0.04
9412	FWM0214	Calcite	–7.74	3.08	12.50	16.71	–	–	1.25	0.30	0.70	0.20	0.81	0.28	0.30	0.05	0.06	0.01	0.03	0.28	0.02
9404	FWM0206	Calcite	–5.70	3.90	3.51	32.07	–	–	1.18	0.34	0.23	0.15	1.39	0.16	0.24	0.02	0.02	0.00	0.02	0.35	0.06
9716	FWM0354	Dolomite	–0.91	2.79	37.99	7.67	92.56	48.81	1.10	8.19	0.09	0.13	1.73	0.11	0.16	0.02	0.02	0.00	0.01	3.33	0.16
9720	FWM0356	Dolomite	–1.41	2.59	37.44	6.00	75.57	51.01	1.21	5.12	0.10	0.12	1.16	0.12	0.16	0.02	0.02	0.00	0.01	0.22	0.14

Table 3 The analytical data of the sampled artefacts (graphics: OeAW-OeAI/V. Anevlavi, W. Prochaska)



6 The chronological distribution of the artefacts and their provenance (graphics: OeAW-OeAI/V. Anevlavi, P. Andreeva)

as the common carving from large blocks and the similar iconographic patterns, which led to a possible conclusion of the existence of one workshop[92]. In addition, Thasian marble has been found in Ainos and Kyzikos[93]. It is clear that different regional Greek sources were used for the funerary monuments of Greek Macedonia and Thrace, underlining the importance of the local marble sources of the Upper Struma Valley and their role in the local production and economy.

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MARBLE PRODUCTION IN RATIARIA

Abstract
New excavations of Ratiaria began ten years ago. As a result, large parts of the Late Antique capital of the province of Dacia ripensis were discovered – the so-called Residence Complex, public bathroom and Residential Building A, which covers the whole *insula*. A number of other finds have been uncovered in other areas of the ancient city, among them what is possibly a temple of the goddess Diana from Ratiaria's period as a Roman colony. The most important excavations were carried out in the last two years. During the years 2020 and 2021, the excavation study of the largest architectural complex in the city began – the great public baths of the so-called imperial type. They have an area of almost nine decares.

New excavations of Ratiaria began ten years ago. During all these excavations, a large number of architectural details and interior elements were found which are made of marble. Even just describing the finds and registering them in the find documentation, many different marble types stand out.

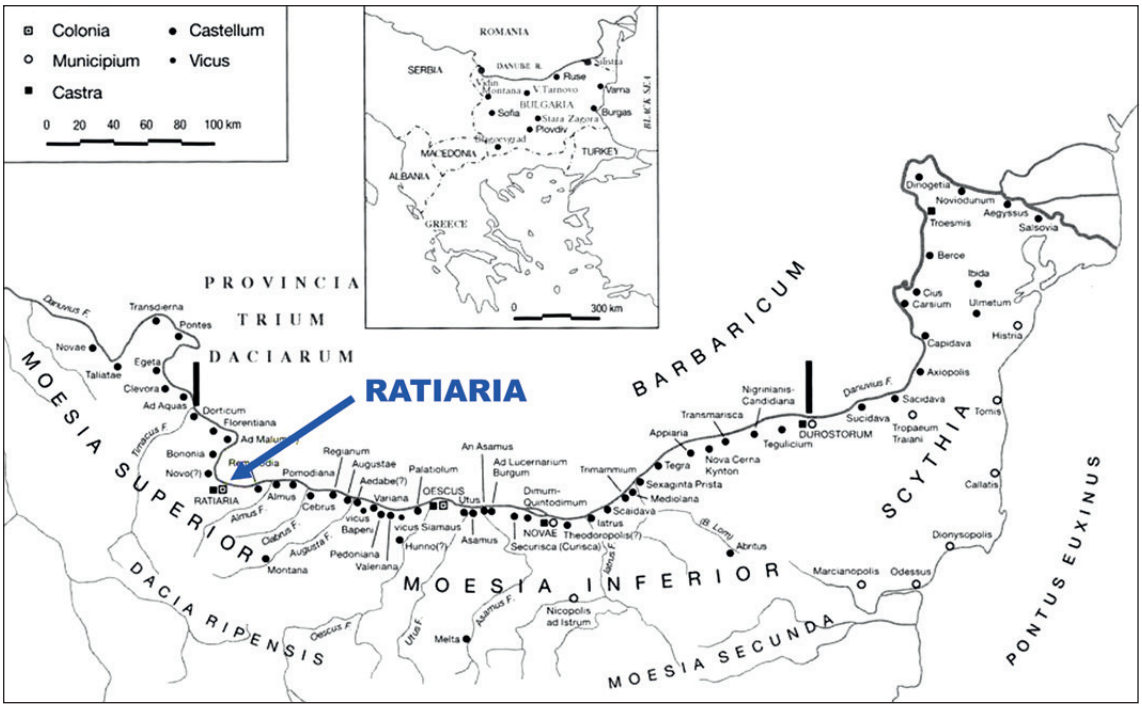
With the following research we aim to raise the scientific question of the study of marbles in Ratiaria. This important building material has never before been studied in terms of the origin, purpose of use, type determination and analysis of individual details – architectural, stone slabs, grave stones, and other interior elements. The study of marble materials in Ratiaria has a great future and serious scientific prospects.

The remains of Ratiaria are situated at the beginning of the Lower Danube area, the main and most dangerous part of the limes in the Roman Empire during the Early Imperial era and throughout Late Antiquity (fig. 1). Historical development of this important Roman settlement began as a military fort in the beginning of the 1st century AD[1]. The evidence from the latest excavations (2013–2023) also contribute to our understanding of the early military life of Ratiaria. We have plenty of finds from the first half of the 1st century AD (mostly from the Tiberian-Claudian period, 30s–50s of the 1st century AD) like terra sigillata from Italian manufacturers (Arezzo, etc.), »Rippenschalen«, pieces of armour, coins, little fragments of *lorica segmentata* and *lorica hamata*, etc.

Later, in the Trajanic period (1st decades of the 2nd cent. AD), Ratiaria became a colony of Rome[2]. At this stage of development, the settlement grew into a flourishing city on an area of over 800 decares, together with necropolises, suburbs and satellite settlements nearby. Thus, Ratiaria became one of the largest cities along the Lower Danube, along with Oescus, Novae and Durostorum. The earliest inscription from Ratiaria's time as a Roman colony is from AD 125[3].

After the cataclysms in the Roman Empire from the 3rd century AD (especially strong and dramatic in the Balkans), the city again became part of the border. By AD 272–275 (the time of Aurelian), the 13th legion (*legio XIII Gemina*) returned here from Apulum (Alba Iulia) and Ratiaria was declared the capital of the new province of Dacia ripensis. It was during this period – the

1 Filow 1906, 36–46. 89; Ritterling 1925, 1267–1279; Ivanov 1999, 91 f.
2 Gerov 1953, 331; Velkov 1965; Velkov 1966.
3 CIL III 14499; Gerov 1953, 331.



1 Map of the Lower Danube Limes with the position of Ratiaria (after Ivanov 1999, map cover; graphics: R. Ivanov)

end of the 3rd century AD until the end of the 6th century AD – that the city grew to its maximum size, as many of the citizens withdrawing from the former Roman Dacian provinces settled here[4].

The history of Ratiaria comes to a close at the end of the 6th century AD, when after long and destructive invasions by Huns, Avars and Slavs, the city was completely destroyed and abandoned[5]. During all these historical eras and separate stages of the life of the great Roman centre in Ratiaria, monumental constructions were undertaken and a number of private buildings erected.

The use of building materials, especially stones, is significant. It is these lasting architectural complexes – streets, fortress walls, huge buildings erected from construction ceramics, limestone and marble details – that constitute the distinctive difference between the archaeological sites of the Roman era and the preceding periods of prehistory and Thracian antiquity.

That is why interdisciplinary approaches in research into architectural complexes made of marble and other stones (all kind of building materials) are of key importance today. The research on the architectural environment of Ratiaria should pursue three directions:

1. The archaeological context of the complexes that make up the Roman city – field data concerning the stratigraphy, chronology and functions of each archaeological sub-site of the city infrastructure (baths, streets, parts of buildings, public complexes, etc.)
2. Architectural analysis of structures and their decoration
3. Interdisciplinary study of each complex – the origin of and data on building materials, content of materials from the individual stages in the life of the buildings (ceramics, glass, other material remains)

The territory of Ratiaria is the most northwestern part of present-day Bulgaria and was of crucial importance for the defence of the Lower Danube Limes of the Roman Empire (fig. 1). Here the Danube turns due east. In addition to Ratiaria, the Romans also created many mili-

4 Not. dign. or. 42, 38; Filow 1906, 82; Ritterling 1925, 1346.
5 Velkov 1966; Giorgetti 1980.

tary forts, fortresses, road stations and small settlements. Large military centres were established at a distance of 30 km from one another – examples are Bononia (present-day Vidin), Ratiaria (present-day Archar) and Almus (present-day Lom).

A great advantage of our future research is that to date, none of these great Roman military centres has been well studied, unlike the state of similar archaeological sites in other areas of the European limes – in Germany, Austria, Hungary and Serbia. For example, only few sub-sites of the entire area of the city, which is over 800 decares, have been localised in Ratiaria.

In 2013 when the excavations were resumed, we started exploring five of these sites:

- The Great Roman Thermae, described by Dario Giorgetti in the 1980s, but never excavated before[6]
- The Late Antique Thermae, located next to the so-called Residence Complex[7]
- The Temple of Diana, east of the well-known centre of Late Antique town structures[8]
- The so-called Residence, but in the part that was not excavated in the 1980s (western end of the complex and northern ridge) and in some places in depth[9]
- A private complex, the whole *insula* building next to the northern site of the Residence[10]

Given the slow progress of excavations at the site, there are tremendous prospects for all kinds of future research relating to the stone materials – the origin of and data on marbles and other stones in antiquity. For example, the biggest and the best-preserved of the original high structures were explored and exposed by the Bulgarian-Italian team working in the 1970s and 1980s[11]. These are the structures of the western fortification wall of Ratiaria, where many towers and the western gate of the city were studied archaeologically, but they have never been used in the research into stone materials.

The most rewarding in that direction of general studies is this, which will get the ball rolling and raises the main question of the marble production in the Roman city of Ratiaria, the origin, supply, trade and use of various marble raw materials in Ratiaria never having been studied before.

Many new surveys and excavations of villas, settlements and necropolises were also carried out in the region of Ratiaria. There are marble details among the finds from these locations. In 2019–2021, two large, completely unknown villas were discovered – near Gramada and the village of

2 Marble head of a bearded man, part of a little sculptural figure discovered in the Roman villa near Sinagovtsi (2021) (photo: Z. Dimitrov)

6 Giorgetti 1987, pl. A 7.

7 The Residence was excavated in the 1980s, see Kuzmanov 2000. On the Late Antique Thermae in the last few years, see Dimitrov 2021.

8 Topalilov – Bru 2016; Topalilov 2017.

9 Dimitrov – Topalilov – Tzvetkov 2019.

10 Dimitrov (forthcoming).

11 Atanasova 1995.

3 Ionic-type base from the anta constructions in the door passageway in the Late Antique Thermae in Ratiaria (photo: Z. Dimitrov)

4 Corinthian cornice from the lapidarium in Archar village (photo: Z. Dimitrov)

5 a–c: Pediment detail from the lapidarium in Archar village (photo: Z. Dimitrov)

Sinagovtsi. They are located in the agricultural lands between Ratiaria and Bononia. The most diverse finds were found in these complexes. For example, in 2021, a small head of a sculptural figure of a bearded man, which was made of marble, was discovered in the Roman villa near Sinagovtsi (fig. 2)[12].

Many new marble and limestone details are also being discovered in the Roman colony of Ratiaria itself, for example: architectural details, burial slabs and materials from the interior of the baths. One of these complexes are the Late Antique Thermae, which we localised in 2013–2014. This is a complex that is designated as Complex B in the general plan of the whole city and on the map of thermal complexes in Ratiaria. In it we found the first details made of marble that we want to study in the coming years.

The best examples of marble production at this complex are:

- One enormous Ionic-type base from the anta constructions in the door passageway. It was found in the baths and was probably part of the decoration of the thermae (fig. 3).
- Another classic marble detail with very important information is a huge slab from the floor of the baths, which was found fallen in the *suspensura* of the thermae.

Particularly important monuments were found at the eastern end of Ratiaria, where a sanctuary of the goddess Diana was found outside the fortified territory of the site. This area is under the

[12] Find from the Sinagovtsi excavations (no. 831/17.08.21).

6 Great Roman Thermae in Ratiaria (photo: Z. Dimitrov)

present-day village of Archar and lies on a terrace over the Danube. In 2014, two inscriptions dedicated to the goddess Diana were found here[13]. They are official inscriptions placed there by the provincial governors of Upper Moesia province from the time of the emperors Hadrian and Antoninus Pius.

Excavations were carried out in the area, where these inscriptions were found. Among the remains of the temple building there were some architectural details in marble and limestone – upper part of the columns, an Ionic cornice without decoration and fragments of interior details and thresholds. All collected details are small in their dimensions – for example cornices, parts of columns and several Corinthian pilaster capitals from the interior of the temple. Here, the study of the marble details is of particular importance, as we also have the relative chronology of the cult complex – dating to the middle and second half of the 2nd century.

Among the most important details from the site of Ratiaria are also other large architectural details in limestone and marble which were reused in late antiquity. These are a huge Corinthian corner cornice from a large public building and an entire upper edge of a pediment of a temple building (for sure), which also contains the ridge of the temple and a pedestal for a statue over the top of the roof (figs. 4–5).

The largest complex in the territory of the ancient city of Ratiaria is the complex of the Great Roman Thermae. Their area is almost 10 decares, which makes them the largest Roman thermae within the territory of present-day Bulgaria (fig. 6). It is in this complex that the most numerous and most diverse marble details can be found, which must be studied. In 2020–2021, we began excavations in the eastern wing of the Great Roman Thermae. Our team localised a number of rooms there and a complex architectural situation. According to the results of the studies, here, the thermae have three construction periods. In the first construction period, dating back to the 3rd–4th centuries, these were the premises of the largest baths of Ratiaria – dressing rooms (*apodyteria*), a little frigidarium, some shops and vestibules. In the second period, in the 5th century,

13 Topalilov – Bru 2016.

7 a–b: Architectural details from other stone materials (marble and limestone) from the interior of the Great Roman Thermae in Ratiaria (photo: Z. Dimitrov)

an early Christian basilica was erected on the ruins of the abandoned thermae. Finally, in the third period, the second half of the 5th century and in the 6th century, after the Hunic invasions, the premises throughout this area were partitioned into smaller rooms. In this last period of antiquity, these were ordinary and very small residential buildings for the citizens of Ratiaria.

A tentative overall reconstruction of the thermae in Ratiaria shows that they were very high and the interior space was quite large. Over 30 architectural details found in the east wing of the baths provide the most important data concerning the studies of marbles. These are huge stone details like bases, columns, capitals and slabs (fig. 7) and very interesting pier and pilaster capitals and cornices. All these marble elements were collected in the archaeological base on the site and in depots of the village of Archar. Many of them were brought here in Late Antiquity for the construction of the early Christian church, built on the ruins of the thermae at the beginning of

8 a–b: Marble details (slabs, cornices, etc.) from the interior of the Great Roman Thermae in Ratiaria (photo: Z. Dimitrov)

the 5th century AD, and were later reused again (for the second time) as tables and benches in the 6th-century AD premises.

So far, this complex of architectural details – probably brought from the forum of Ratiaria – is the largest source of data on marble production in the great Roman city. Inside the thermae we also found numerous pieces of interior decoration in different types of white marble, like wall facing plates and slabs with mouldings, a few well-decorated capitals and cornices and other types of details. The constructions are very fine and well made. For example, the wall facing slabs are only 3–4 cm wide. They are made from pure white marble containing some internal grey elements. In the 6th-century dwellings, whole complexes of these earlier details were found, some of them reused close to the hearths.

At this stage of the modern studies in Ratiaria we have over 40 details in marble. They can be studied in a future project on the marbles along the Lower Danubian Limes and, more precisely, from the Roman military centre of Ratiaria; however, the main models are those that we found during the recent excavations in the interior of the baths.

Now in the depots of the village of Archar, pieces of facing slabs, capitals, bases, other profiled parts and some whole columns have been collected, and also many details from the balustrades that decorated the pools in the baths (fig. 8). There is also a whole cornice detail in a very pale white, yellowish marble, which does not match any of the elements from the interior listed here.

Two of the details – marble columns – were part of the altar decoration of the early Christian building. The basilica itself was paved with small pebbles, yet large parts of the floor were also covered with marble slabs taken from the previous, antique complexes.

It should be kept in mind here that the chronology of the details found in the Great Roman Thermae is slightly confusing, as many of them are from the Roman period of the 2nd–3rd centuries, but were reused in later times, first, as decoration in the early Christian complex of the first half of the 5th century AD, and the second time, in the late 5th and whole of the 6th century in the reconstructed dwellings in Late Antiquity. So far, we have no direct data on the import or use of local marble in Ratiaria from Late Antiquity – as is the case in another episcopal centre on the Danubian Limes, Novae.

The last large fragments of marble details in Ratiaria to be studied in the future are the epigraphic monuments – tombstones or official inscriptions. They are kept in the museum in Vidin and in the village of Archar. Hitherto, no marble sarcophagi have been found in Ratiaria, but there are a few well-known marble tombstones and official monuments from the city territory.

At the end of this short contribution, I would like to mention that a future project to explore the origin of marbles in Ratiaria is very much needed, and the materials for it are already available. Future studies will also enrich the fund and the collection, which should and can be explored in the same way as the already successful project on the study of the white marbles and their provenance in the Roman province of Thrace.

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MARBLE AND OTHER STONES IN COLONIA AELIA MURSA (OSIJEK, CROATIA)

Abstract
Hadrian's colony Mursa (modern-day Osijek, Croatia) was situated in the centre of Pannonia, in the marshland on the right bank of the Drava River not far from its confluence with the Danube, near the Roman limes. Its nearest possible stone resources lie in the Bansko brdo Hill to the north, the Mecsek Mountains some 90 km to the north in the area of the Roman town Sopianae (Pécs, Hungary) and the Slavonian Mountains (Krndija, Papuk) some 60–80 km to the west-southwest. In all these cases, rivers (Drava, Danube) were the preferred route for transporting heavy loads. The architectural remains of the colony, as well as the sepulchral and votive monuments found in and around it show a predominant use of different limestone rocks, mostly Budakalász travertine imported from Aquincum, but also Badenian limestone, most probably from Bansko brdo. Eastern Alpine marbles (Gummern, Pohorje) were used for sepulchral and votive monuments, as well as sculpture. White Mediterranean marbles were occasionally used for cult statues, while coloured Mediterranean marbles (Africano, Portasanta, Cipollino verde, Pavonazzetto, Greco scritto) were only used for *opus sectile* floors. The Roman bridge over the Drava River was constructed of blocks of Badenian limestone and Budakalász travertine, the town walls of Badenian limestone, most probably from Bansko brdo.

INTRODUCTION

Roman cities met their needs for stone used in monuments and other constructions, as well as for decorative and other purposes predominantly from local and regional sources[1]. Distant sources only provided prestigious stones, which were transported primarily along waterways and mostly in the form of half-finished products from the large Mediterranean quarries[2]. Cities located on or near the coast were privileged in this sense, as were those on large and small navigable rivers. Standing out in terms of the stone supply were the cities that either had no suitable rocks in the vicinity or where these rocks were of an inferior quality. There are not many such examples in the Roman Empire, but some can be found in Pannonia, established on the floor of the former Pannonian Sea. For such cities, the patterns of stone supply for construction and other purposes have been studied using the example of Colonia Aelia Mursa[3] (modern-day Osijek, Croatia).

Mursa was constructed on the right bank of the Drava, at an important crossing/bridge over the river on the route leading along the limes between Singidunum[4] and Aquincum[5]. Before the construction of the town, which was given the status of a (veteran) colony under Hadrian (most likely in AD 133), it was a unit of the Roman army that controlled the river crossing and was stationed in an as yet unidentified fortress, presumably associated with a civilian settlement, of which the cemetery has been investigated. The earlier, La Tène settlement in the area of the colony was destroyed in Augustan times[6].

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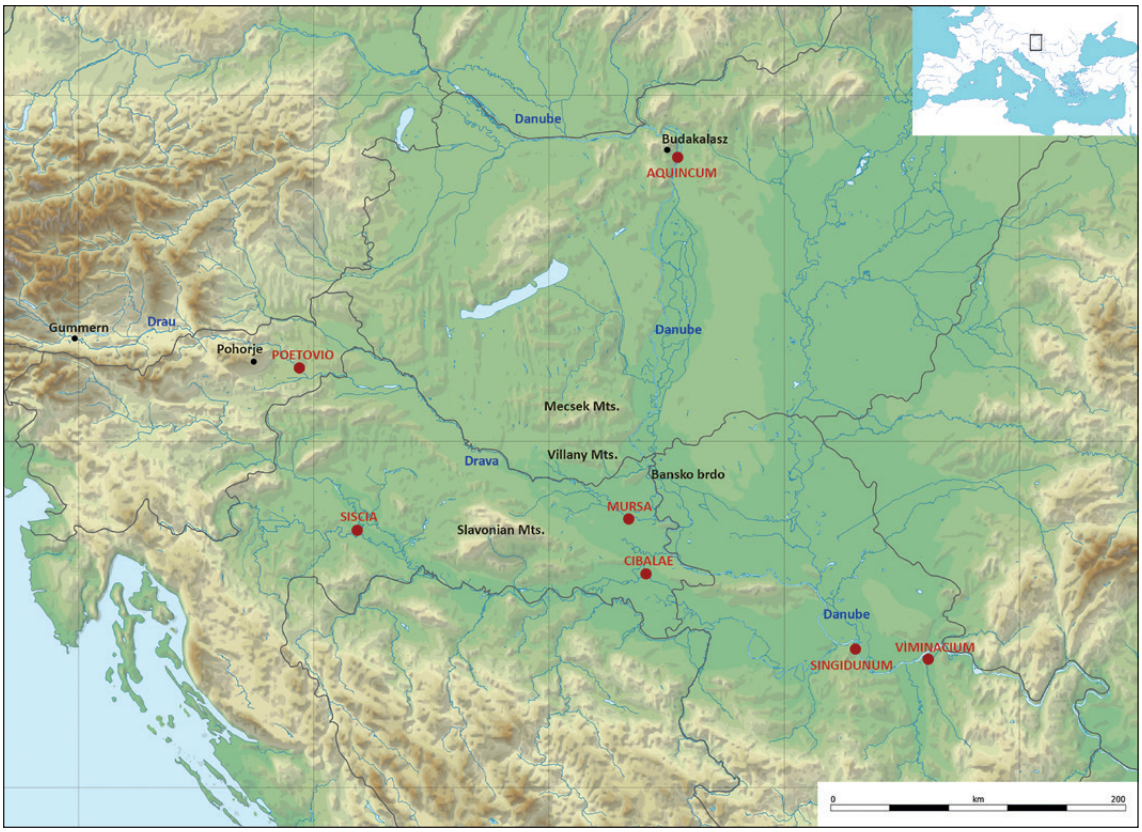
1 E.g. Previato 2015; Djurić – Rižnar 2017.
2 Russel 2013.
3 Pinterović 1978; Filipović 2004a.
4 Korać et al. 2014; Vukmanić 2021.
5 Visy 2003.
6 For a new topographic interpretation of the Mursa area, see Leleković 2020.



1 Map of Pannonia showing the Roman cities (red), mountains and confirmed quarries (black) mentioned in the text (© DARE [CC BY 4.0])

The town was erected on the southern, higher (92 m asl) loess terrace along the Drava, in the eastern part of the Drava depression between the Villany and Mecsek Mountains[7] in the north and the Slavonian Mountains[8] in the west (fig. 1). Located northeast and east of the town was an extensive marshland at the confluence of the Drava and Danube, today known as Kopački rit, while other marshes were located to the southwest, probably known as Hiulca Palus in Roman times[9]. The peaks of the Slavonian Mountains[10] closest to the town were Krndija (ca. 60 km) and Papuk (ca. 90 km), with several small rivers such as the Karašica and Vučica that discharge into the Drava[11]. Roughly at the same distance from Mursa were the Villany (ca. 60 km) and Mecsek Mountains (ca. 90 km), accessible along the Pécsi-víz and Fekete-víz as the left tributaries of the Drava. The closest, however, was the Bansko brdo Hill[12] (244 m asl) at a distance of ca. 30 km, which was a tectonic block (horst) stretching 20 km in the northeast-southwesterly direction and reaching the banks of the Danube. The hill was excellently connected with the town via the rivers Karašica and Danube.

7 Császár – Szinger – Piros 2013.
8 Pavelić 2001.
9 Šašel-Kos et al. 2019.
10 Pavelić et al. 2003.
11 Nadilo 2014.
12 Bognar 1974/1975; Banak et al. 2010.

MONUMENTS

Over the past two decades, the extensive preventive[13] and small-scale targeted investigations that took place in advance of constructing the university centre on the grounds of the former army barracks in Osijek have revealed considerable sections of the Roman town[14], which includes parts of its defensive walls[15]. The recently unearthed architectural elements are published here for the first time, whereas the stone monuments previously found in the Mursa area have been published on several occasions[16] and are, almost without exception, accessible in the online database[17].

The dating of the unearthed architectural remains is based on the stratigraphy and brick stamps[18], and reveals several phases spanning from the Hadrianic and Antonine to and including Severan times, i.e. the 2nd and 3rd centuries[19]. The town walls were presumably constructed under Hadrian, while stratigraphic evidence shows that other buildings only began to be made of durable materials in the Antonine period. The architectural elements and road structures in the western suburbs date to the second half of the 2nd and the 3rd century. Construction mainly used brick with the odd stone element (architraves, tympana, columns). Brick was produced in the imperial brickworks in Mursa, but also imported from Poetovio, Aquincum, Lugio and Viminacium[20]; these import routes also define the waterway transport routes for heavy loads.

The sepulchral, votive and other stone monuments also mainly date to the 2nd and 3rd centuries, partly even later, with the exception of four sepulchral stelae[21] from pre-colony times.

STONES

The range of stones used in Mursa is limited to limestones (light Neogene limestones of Badenian and Sarmatian age, dark brown-grey Mesozoic limestone, light-grey tectonic limestone breccia, travertine), white and coloured marbles, as well as andesitic-basaltic breccia.

White Marble

Marble is in most cases medium- to coarse-grained Eastern Alpine marble. The analyses by the late Harald W. Müller (tabs. 1–2, fig. 2)[22] revealed that it mainly came from the Gummern (Carinthia, Austria) and Pohorje (Slovenia) quarries, while two monuments were made of Mediterranean marbles from the Dokimeion[23] and Carrara quarries[24]. There is a total of 53 known marble monuments, of which 32 (60 %) were analysed[25]. The latter include 21 (70 %) made of Gummern and nine (28 %) of Pohorje marble, which is a representative ratio also recorded in other Pannonian centres.

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13 Filipović 2004b; Filipović 2005; Filipović – Katavić 2005; Filipović 2007a; Filipović 2007b; Filipović 2008; Filipović 2009; Filipović 2011; Crnković – Filipović 2013.

14 Filipović – Kusik 2019.

15 The results of the unpublished excavations are partly summarised in Leleković 2020.

16 Pinterović 1978; Dautova Ruševljan 1983.

17 <https://www.ubi-erat-lupa.org> (15.02.2023).

18 Filipović – Kusik 2019.

19 Leleković 2020.

20 Filipović – Kusik 2019.

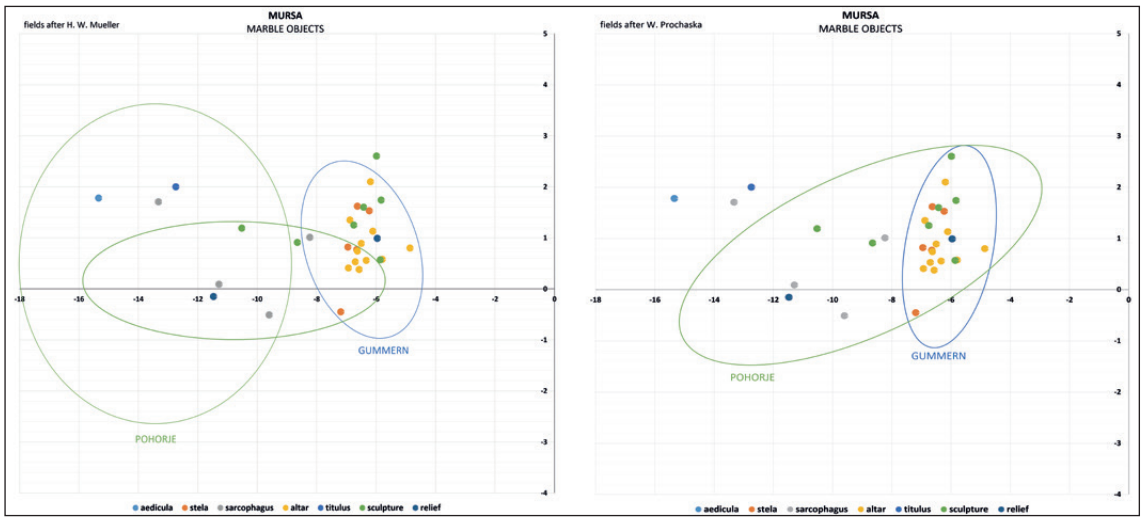
21 Stelae for Niger Sveitrius (lupa 3074), Velagenus Ulattius (lupa 3071), Urbana and Gaetulus (lupa 4294) and Iulia Primilla (lupa 3084).

22 Djurić – Müller – Filipović 2009.

23 Statue of Cybele: Pinterović 1967, 67 f.; Dautova Ruševljan 1983, 27 tab. 36, 1.

24 An unpublished statuette of Venus and two Erotes was found during the 2005 excavations that Slavica Filipović led at the Poljoprivredni fakultet site.

25 Twelve inscription fragments, five statues, two reliefs and two altars remain unanalysed.



2 Diagrams showing the $\delta^{18}O$ and $\delta^{13}C$ values according to monument type (graphics: H. W. Müller, W. Prochaska)

Sample	$\delta^{18}O$	$\delta^{13}C$	Object	Provenance	lupa
mOSJ 14	–15.34	1.78	Aedicula relief, AMO inv. 19627	Pohorje	2810
mOSJ 15	–6.93	0.41	Altar Hercules, AMO inv. 7600	Gummern	26316
mOSJ 16	–6.19	2.10	Altar Terater Mater, AMO inv. 7731	Gummern	11476
mOSJ 17	–4.86	0.80	Altar Mithra, AMO inv. 642	Gummern	26317
mOSJ 18	–6.88	1.35	Altar Iuppiter, AMO inv. 18403	Gummern	5690
mOSJ 19	–6.33	0.56	Altar Iuppiter, Iuno, Minerva, AMO inv. 767	Gummern	26312
mOSJ 20	–6.57	0.38	Altar Iuppiter, AMO inv. 2598	Gummern	26310
mOSJ 21	–6.75	1.25	Sculpture Hercules, AMO inv. 650	Gummern	5257
mOSJ 22	–5.96	0.99	Relief Menade, AMO inv. 686	Gummern	–
mOSJ 23	–5.83	1.74	Portrait young man, AMO inv. 19622	Gummern	26433
mOSJ 24	–10.52	1.19	Sculpture woman, AMO inv. 355	Pohorje	26441
mOSJ 25	–6.42	1.60	Male head with beard, AMO inv. 19636	Gummern	26436
mOSJ 26	–5.86	0.57	Sculpture Hercules, AMO inv. 753	Gummern	–
mOSJ 28	–11.29	0.09	Sarcophagus lid, AMO inv. 20112	Pohorje	26304
mOSJ 29	–9.60	–0.51	Sarcophagus chest, AMO inv. 20112	Pohorje	26304
mOSJ 30	–8.23	1.01	Sarcophagus correction, AMO inv. 20112	Pohorje	26304
mOSJ 31	–6.70	0.53	Altar top, AMO inv. (?)	Gummern	–
mOSJ 33	–2.67	2.90	Sculpture Venus and two Erotes, AMO inv. (?)	Carrara	–
mZAG 14	–8.65	0.91	Sculpture boar and dog, AMZ inv. 193	Pohorje	6019
mZAG 41	–7.91	–0.45	Stele, AMZ inv. (?)	Gummern (?)	22810
mZAG 58	–5.79	0.58	Altar Mars, AMZ (?)	Gummern	22719

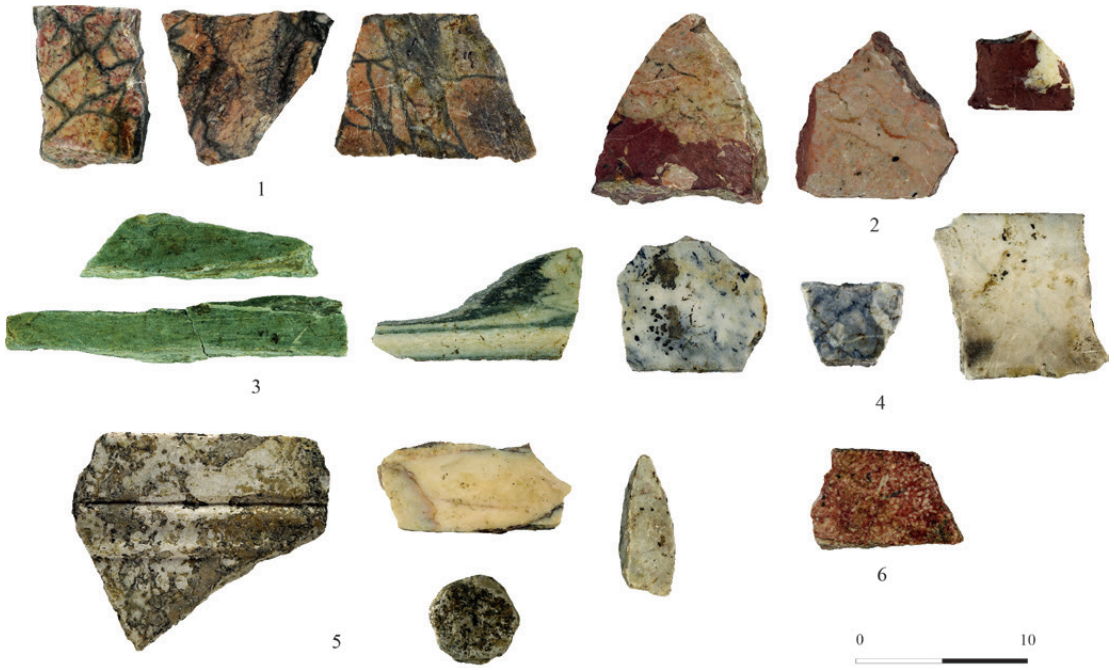
Table 1 Analysed marble samples and their stable isotope values. AMO = Archaeological Museum Osijek; AMZ = Arheološki Muzej Zagreb

Sample	Na	Mg	Al	K	Sc	V	Cr	Fe	Mn	Co	Cu	Zn	Rb	Sr	Y	Cd	Ba	La	Ce	Eu	Hf	Th	U
	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
mOSJ01	787	0.30	4654	2387	2.0	10	9	0.38	531	4.7	2.9	16	5.5	241	6.0	0.1	49	4.4	8.6	0.26	0.10	1.1	0.28
mOSJ02	102	0.24	463	295	2.0	10	6	0.09	38	3.7	0.6	12	0.6	200	0.3	0.1	77	0.5	0.6	0.16	0.10	0.5	0.09
mOSJ03	133	0.41	150	232	2.0	10	7	0.05	72	3.7	0.7	12	0.3	201	1.6	0.1	1	0.9	1.2	0.03	0.10	0.5	0.05
mOSJ04	142	0.28	504	386	2.0	10	10	0.06	10	3.8	0.5	9	0.6	198	0.4	0.1	15	0.4	0.6	0.05	0.10	0.5	0.05
mOSJ05	103	0.24	350	289	2.0	10	8	0.06	13	4.0	0.4	12	0.3	174	0.3	0.1	6	0.4	0.5	0.03	0.10	0.5	0.05
mOSJ06	105	0.10	119	261	2.0	10	8	0.06	43	3.9	0.4	10	0.2	2678	0.7	0.1	5	0.4	0.6	0.03	0.10	0.5	1.48
mOSJ07	1030	0.44	2216	523	2.0	10	10	0.25	78	3.8	0.7	10	1.4	281	1.0	0.1	69	1.2	2.3	0.20	0.10	0.5	0.20
mOSJ08	401	0.24	670	443	2.0	10	9	0.11	176	3.9	0.7	13	0.8	292	1.1	0.1	27	0.4	0.7	0.08	0.10	0.5	0.08
mOSJ09	193	0.33	527	531	2.0	10	9	0.08	43	4.1	0.8	12	0.9	174	0.3	0.1	11	0.4	0.6	0.04	0.10	0.5	0.09
mOSJ10	142	0.38	395	393	2.0	10	9	0.08	21	3.9	0.4	13	0.6	158	0.7	0.1	3	0.6	0.6	0.03	0.10	0.5	0.08
mOSJ11	251	0.23	277	312	2.0	10	7	0.08	32	4.0	0.4	9	0.1	241	0.6	0.1	15	0.3	0.5	0.04	0.10	0.5	0.05
mOSJ12	167	0.36	1758	1191	2.0	10	11	0.14	43	4.0	0.9	11	4.3	200	0.8	0.1	18	0.6	1.2	0.06	0.10	0.5	0.08
mOSJ13	142	0.23	484	305	2.0	10	8	0.08	29	4.1	0.6	14	1.0	176	0.2	0.1	10	0.3	0.4	0.04	0.10	0.5	0.07
mOSJ14	238	0.50	685	298	2.0	10	7	0.10	38	3.8	0.8	19	1.3	186	0.6	0.1	7	0.6	0.8	0.03	0.10	0.7	0.13
mOSJ15	1209	0.20	3082	659	2.0	10	6	0.10	59	3.7	1.0	11	5.1	180	0.5	0.1	44	0.5	0.7	0.11	0.10	0.7	0.46
mOSJ16	135	0.32	851	399	2.0	10	7	0.07	17	3.9	0.8	20	1.7	173	0.4	0.1	14	0.5	0.7	0.05	0.10	0.5	0.10
mOSJ17	110	0.22	473	391	2.0	10	8	0.04	7	4.0	0.7	11	0.9	168	0.2	0.1	6	0.3	0.3	0.03	0.10	0.5	0.11
mOSJ18	254	1.27	1462	1232	2.0	10	9	0.17	47	4.5	1.2	16	4.4	200	0.6	0.1	13	0.7	1.2	0.06	0.10	0.5	0.06
mOSJ19	181	0.25	2029	857	2.0	10	9	0.19	58	4.1	1.2	14	2.7	178	0.8	0.1	85	1.2	2.3	0.23	0.10	0.8	0.47

Table 2 Chemical element values in the marble samples

Sample	Na	Mg	Al	K	Sc	V	Cr	Fe	Mn	Co	Cu	Zn	Rb	Sr	Y	Cd	Ba	La	Ce	Eu	Hf	Th	U
mOSJ20	142	0.30	1373	777	2.0	10	9	0.19	80	4.3	1.7	12	2.7	249	1.2	0.1	62	1.3	2.5	0.18	0.10	0.5	0.23
mOSJ21	182	0.42	850	362	2.0	10	9	0.08	21	4.1	0.9	12	0.7	191	0.4	0.1	6	0.6	0.8	0.03	0.10	0.5	0.13
mOSJ22	196	0.29	836	659	2.0	10	10	0.08	12	4.1	0.6	16	1.7	200	0.5	0.1	19	0.5	0.8	0.06	0.10	0.5	0.12
mOSJ23	225	0.25	623	297	2.0	10	9	0.06	21	4.3	0.6	16	0.6	197	1.1	0.1	5	0.5	0.5	0.03	0.10	0.5	0.06
mOSJ24	239	0.68	971	849	2.0	10	10	0.08	18	4.4	0.7	15	2.4	231	0.3	0.1	14	0.3	0.5	0.05	0.10	0.5	0.05
mOSJ25	106	0.30	276	357	2.0	10	9	0.08	28	4.2	0.7	11	0.4	150	0.6	0.1	3	0.4	0.5	0.03	0.10	0.5	0.12
mOSJ26	303	0.32	1886	917	2.0	10	11	0.16	50	4.4	0.9	16	3.2	215	0.7	0.1	15	0.9	1.7	0.06	0.10	0.5	0.18
mOSJ27	145	0.20	289	314	2.0	10	10	0.09	57	4.3	0.6	11	0.1	181	1.1	0.1	4	0.9	1.3	0.05	0.10	0.5	0.16
mOSJ28	164	1.81	373	495	2.0	10	10	0.16	46	4.3	0.8	17	0.7	338	0.9	0.1	10	0.8	1.2	0.06	0.10	0.5	0.29
mOSJ29	136	0.68	298	512	2.0	10	10	0.12	76	4.5	0.5	14	0.9	199	1.1	0.1	6	0.6	0.9	0.05	0.10	0.5	0.14
mOSJ30	145	0.54	224	423	2.0	10	10	0.15	34	4.6	0.5	14	0.3	231	0.3	0.1	7	0.4	0.4	0.03	0.10	0.5	0.24
mOSJ31	159	0.29	1528	994	2.0	10	12	0.14	63	4.5	0.9	18	2.5	202	0.6	0.1	109	0.8	1.4	0.27	0.10	0.5	0.25
mOSJ32	119	0.31	209	484	2.0	10	10	0.13	109	4.6	0.6	13	0.3	284	0.2	0.1	9	0.4	0.3	0.03	0.10	0.5	0.09

Table 2 continued



3 *Opus sectile* tiles and their fragments: 1 Africano; 2 Portasanta; 3 Cipollino verde; 4 Greco scritto; 5 Pavonazzetto; 6 Red limestone (photo: B. Djurić)

Monuments

The largest group of marble monuments from Mursa is that of sculptures and reliefs of different sizes (17), followed by altars (13) and inscription slabs (13). There are unusually few sepulchral monuments, only comprising six stelae, two sarcophagi and two pieces of aedicula tombs. These monuments date to the 2nd and 3rd centuries, with the exception of one stele predating the establishment of the colony, put up for Iulia Primilla in the Flavian period.

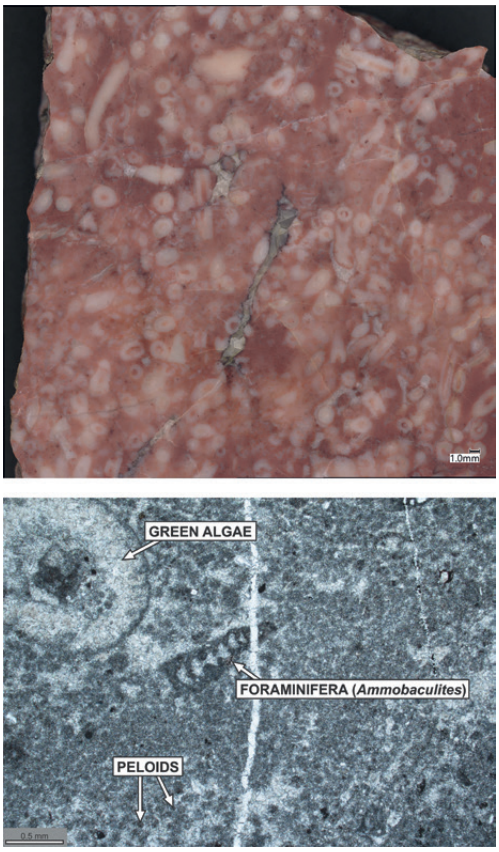
Completely absent at Mursa are architectural elements of marble. Albeit in small numbers, these were found in the neighbouring colonies of Cibalae[26] and Viminacium[27] and prove the import of such products to Pannonia. The main source of marble for the monuments of Mursa is the Gummern quarry, and in a small measure, the Pohorje quarry. Marble sculpture imported from the Mediterranean is exceptionally rare.

Coloured Marbles

In Mursa, coloured marbles were used for *opus sectile* floors, with most of the surviving pieces unearthed as refuse at the edge of the town's west fossa[28]. The refuse assemblage comprised 15 fragments and two complete tiles, more precisely three of Africano, three of Portasanta, three of Cipollino verde, three of Greco scritto, four of Pavonazzetto and one of red limestone (fig. 3). These marbles are well known and macroscopically readily identifiable, with the exception of a red limestone (fig. 4) that shows a multitude of fossils and is of unknown origin, hence its analysis is given in full below.

The red limestone is dasycladacean floatstone and rudstone, with approx. 30–50 % of the surface area occupied by a few-millimetres-large neomorphically altered geniculi of dasycladacean

26 Half-finished Corinthian capital (lupa 26455).
27 Unpublished half-finished column shaft.
28 Excavations that Slavica Filipović conducted at the Pravni fakultet site in 2014–2015.



4 Macro- and microphotograph of a red limestone tile (photo: L. Gale)

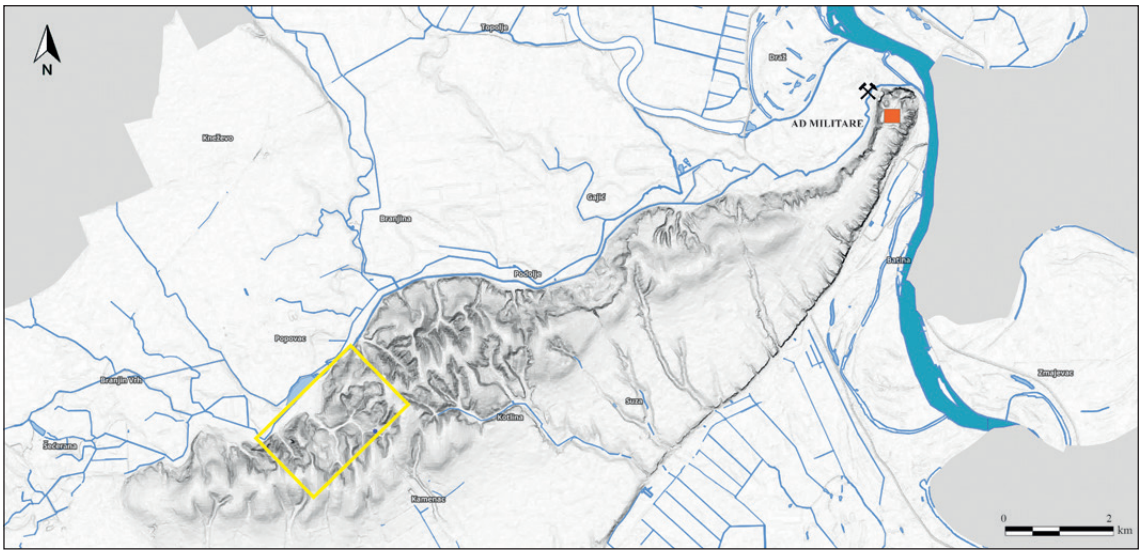
algae. Geniculi are slightly abraded and have micritised outer margins. Subordinate among the larger particles are echinoderm plates and intraclasts of microbialite. The space between the larger particles is filled with peloid packstone with rare bioclasts (ostracods, agglutinated uniserial benthic foraminifera, mollusc fragments, terebellid tubes). Irregular vugs represent a small part of the rock; they are filled with fibrous/acicular rim calcite cement, followed by mosaic spar. These vugs are perhaps early diagenetic. Also present are larger vugs filled with clear blocky spar; they are late diagenetic features.

The abundance of peloids, the type of foraminifers and the presence of terebellid tubes suggest a Triassic (Middle Triassic [?]) age. The photographs of dasycladacean algae were sent for identification to Filippo Baratolo[29], who could not identify the species but noted that the morphological features suggested its affinity with Late Triassic taxa[30]. Bulgarian geologists were also unable to identify the rock[31]. Upon further investigation, Hans-Jürgen Gawlick[32] suggested an affinity with Upper Triassic – Lower Jurassic limestone from the quarries at Adnet (Austria) based on the similar colour of the rock and the long history of mining in that area[33]. Florian Böhm[34] and Priska Schäfer[35] both confirmed that dasycladacean algae may occur in mass accumulations in the Upper Triassic part of the red Adnet limestone. However, they also pointed out that such limestone occurs in many places in the Alps, Apennines, Carpathians, Dinarids and Hellenids[36].

Andesitic-basaltic Breccia

This stone was detected in the core of the foundations of the northern town walls[37]. In the vicinity of Mursa, a deposit of andesitic-basaltic breccia is known at the northernmost edge of the Bansko brdo Hill (i.e. northern and western fringes of the settlement of Batina, or Kiskőszeg in Hungarian), below the Ad Militare limes fortress (fig. 5). A quarry was opened here in 1892[38], remaining active until recently. We presume that a Roman quarry also existed here, the material from which was transported down the rivers Karašica and Danube to Mursa.

29 Università degli Studi di Napoli Federico II, Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse.
30 Pers. comm. with Luka Gale in 2021.
31 Pers. comm. between Luka Gale and Athanas Chatalov from the Sofia University St. Kliment Ohridski, Bulgaria in 2021.
32 Montanuniversität Leoben, Department of Applied Geosciences and Geophysics, Petroleum Geology.
33 Bernecker – Weidlich – Flügel 1999; Moshammer et al. 2015.
34 Helmholtz-Zentrum für Ozeanforschung, Kiel.
35 Kiel University, Institute of Geosciences.
36 Pers. comm. with Luka Gale in 2021.
37 We thank Tino Leleković for these and other samples taken in the town walls and the Park kraljice Katarine Kosača.
38 Schafarzik 1909, 113.



5 Bansko brdo with the quarry of andesitic-basaltic breccia in the north and the area of modern quarries marked within a yellow frame in the south (© <Geoportal.dgu.hr> [25.01.2023])

The breccia is mainly built of porphyrophytic and hypocrystalline andesite fragments with the matrix of crystal-vitrophyric tuff. Igneous rocks are of Badenian age (13.4 Ma) and intruded into sedimentary rocks during the Upper Badenian magmatic events in the Pannonian Basin[39].

Limestone

The most prominent limestone used in Mursa in both quantity and function is Pleistocene travertine. It is followed by Middle Miocene Badenian limestone (in one example also Sarmatian limestone), dark-grey Mesozoic (Triassic [?]) limestone and, with a single example, also light-grey tectonic limestone breccia.

Travertine

Of the 67 known monuments of travertine, 28 were initially analysed followed by an additional 24 architectural elements, two samples taken from the wall and foundations of a public building in the Park kraljice Katarine Kosača[40] and one sample taken from the foundations of the northern town walls.

The results of the stable isotope analyses confirm that the stone for these monuments came from the Budakálasz quarry in the Buda Hills (tab. 3)[41]. The two deviant samples (nos. 23. 90) with a low $\delta^{13}C$ value most likely belong to Felső-Pannon (Upper-Pannonian) limestones[42] from the Buda Hills (fig. 6), less likely to travertine from the Roman quarry at Dunaalmás in the western Gerecse Hills[43].

39 Pamić – Pikija 1987; Banak et al. 2010; Pikija – Šikić – Trifunović 2015, 38.
40 Leleković 2020, 136 f. fig. 22.
41 Kele et al. 2003; Kele 2009; Djurić – Kele – Rižnar 2018; Claes et al. 2017.
42 Kele 2009, fig. 6, 6-3.
43 Kele 2009, fig. 6, 6-2.

Sample	$\delta^{18}O$ (VPDB)	$\delta^{18}O$ (VSMOW)	$\delta^{13}C$ (VPDB)	Object	lupa
aOSJ 01	–12.4	18.1	1.6	Aedicula part from Bilje, AMO inv. 6145	4291
aOSJ 05	–11.0	19.6	0.8	Sarcophagus lid, AMO inv. 671	26303
aOSJ 06	–13.7	16.8	1.0	Altar pyramidal top, AMO inv. 659	4302
aOSJ 07	–10.52	20.1	2.2	Building inscription, AMO inv. 638	5702
aOSJ 08	–11.6	19.0	1.8	Sarcophagus chest, AMO inv. 14189	4301
aOSJ 09	–12.5	18.0	1.0	Sarcophagus chest, AMO inv. 667	26305
aOSJ 10	–10.9	19.7	0.8	Architrave (?), AMO inv. 19628	5697
aOSJ 11	–13.4	17.1	1.9	Altar Silvanus Domesticus, AMO inv. 1962.1	26318
aOSJ 12	–12.0	18.6	2.1	Sarcophagus chest, AMO inv. (?)	–
aOSJ 13	–10.5	20.1	–0.9	Sarcophagus lid, AMO inv. 6151	26306
aOSJ 14	–12.6	17.9	1.0	Sarcophagus chest, AMO inv. 6151	26306
aOSJ 15	–12.1	18.5	2.6	Stele, AMO inv. 662	5262
aOSJ 16	–13.2	17.3	1.6	Sarcophagus chest, AMO inv. 6113	4299
aOSJ 17	–12.2	18.3	2.2	Plate with relief, AMO inv. (?)	5698
aOSJ 18	–10.6	20.0	1.9	Altar Danuvius and Dravus, AMO inv. 643	5260
aOSJ 19	–11.8	18.8	1.9	Altar Iuppiter, AMO inv. 644	26311
aOSJ 20	–5.6	25.2	1.6	Altar of Quintus Corvinius Severianus, AMO inv. 6147	4306
aOSJ 21	–12.0	18.5	2.1	Column base, AMO inv. 219000	–
aOSJ 22	–11.5	19.0	2.0	Semipilaster base, AMO inv. 219001	–
aOSJ 23	–9.5	21.1	–2.3	Column base, AMO inv. 219002	–
aOSJ 24	–13.4	17.1	1.8	Column base, AMO inv. 219003	–
aOSJ 25	–10.8	19.7	2.0	Tuscan capital, AMO inv. 219004	–
aOSJ 26	–13.1	17.4	2.0	Semipilaster capital, AMO inv. 219005	–
aOSJ 28	–13.2	17.3	1.4	Column base, AMO inv. 219009	–
aOSJ 29	–11.7	18.8	2.2	Column shaft, AMO inv. 219012	–
aOSJ 31	–12.4	18.1	1.8	Column base, AMO inv. 219014	–
aOSJ 35	–12.9	17.7	1.7	Tuscan capital, AMO inv. 219036	–
aOSJ 36	–12.5	18.0	2.0	Column base, AMO inv. 219037	–
aOSJ 37	–12.4	18.1	2.2	Column base, AMO inv. 219038	–
aOSJ 38	–11.9	18.6	1.6	Column base, AMO inv. 219039	–
aOSJ 41	–11.7	18.8	2.4	Road curb (?), AMO inv. 218976	–
aOSJ 47	–11.4	19.2	2.3	Column shaft, AMO inv. 218983	–
aOSJ 51	–12.0	18.6	2.2	Column shaft, AMO inv. 218987	–
aOSJ 52	–11.5	19.1	2.2	Column shaft, AMO inv. 218988	–
aOSJ 53	–11.1	19.5	2.2	Column shaft, AMO inv. 218989	–
aOSJ 61	–10.5	20.1	2.2	Column shaft, AMO inv. 218997	–
aOSJ 63	–12.3	18.2	1.5	Lorica from Drava bridge, AMO no inv.	–
aOSJ 64	–12.6	17.9	2.5	Altar Silvanus, AMO inv. 225994	–
aOSJ 68	–12.3	18.3	2.0	Corinthian capital, AMO inv. 218973	26326
aOSJ 74	–12.6	17.9	1.2	Stele Lucius Fidiclanius Fresianus, Bijelo brdo, AMO inv. 631	4289
aOSJ 75	–6.2	24.5	1.8	Stele with Triton, AMO inv. 6146	4290
aOSJ 76	–10.8	19.8	2.2	Stele with lions on top, AMO inv. 7316	4303
aOSJ 78	–11.9	18.6	2.1	Frieze, AMO inv. 224657	5699
aOSJ 79	–17.3	13.1	1.8	Stele with lions on top, AMO inv. 663	5703
aOSJ 80	–12.1	18.4	2.1	Altar Iuppiter, AMO inv. 647	26314
aOSJ 81	–12.2	18.3	2.4	Milestone (?) of AD 361, AMO inv. 664	26319
aOSJ 82	–10.8	19.8	0.4	Sarcophagus, small, AMO inv. (?)	26449

Table 3 Analysed samples of travertine and their stable isotope values

Sample	$\delta^{18}O$ (VPDB)	$\delta^{18}O$ (VSMOW)	$\delta^{13}C$ (VPDB)	Object	lupa
aOSJ 83	–11.6	19.0	2.2	Aedicula relief with Ariadne, AMO inv. (?)	26323
aOSJ 84	–13.5	17.0	1.6	Altar Mithra (?), AMO inv. 17149	26421
aOSJ 85	–13.2	17.3	1.7	Altar Silvanus Domesticus, AMO inv. 7243	26298
aOSJ 86	–11.4	19.1	2.4	Stele with lions on top, AMO inv. (?)	–
aOSJ 89	–16.5	13.9	1.8	Stone from the foundation of the town wall	–
aOSJ 90	–7.5	23.2	–4.6	Wall stone from a building, park Kraljice Katarine Kosača	–
aOSJ 96	–11.8	18.7	2.0	Stone from the foundation of a building, Park Kraljice Katarine Kosača	–
aZAG 107	–12.6	18.0	0.8	Stele C. Iulius Verecundus, AMZ inv. 6150	4294
aZAG 109	–12.8	17.7	1.9	Stele Valerius Martialis, AMZ inv. (?)	5741

Table 3 continued

6 Diagram of the $\delta^{18}O$ and $\delta^{13}C$ values of the analysed monuments (graphics: S. Kele)

Monuments

The earliest travertine monuments from Mursa are the Hadrianic building inscription from AD 133[44], which probably relates to the construction of the town walls[45], and a stele for Caius Iulius Verecundus, a soldier of the *legio X Gemina pia fidelis*[46] dated to the early 2nd century. All other monuments span from the Antonine period to the early 4th century. They consist of predominantly votive and some sepulchral altars (20), different inscriptions (15), sarcophagi (9) – which are among the most common products of the Budakálasz quarry in Pannonia –, stelae (8), aedicula

44 CIL III 3280 = 10261; lupa 26297.
45 Mráv 2003, 127–129.
46 Migotti 2016, 176; <https://edh.ub.uni-heidelberg.de/edh/inschrift/HD023806> (17.01.2023); lupa 4304.

tombs (2), statues (15) and milestones (3). There are also architectural elements (24), most of which are different parts of columns, and some pieces that belong to relief-decorated architraves and largely date to the Antonine and Severan periods.

The travertine stelae include that erected for Valerius Martialis[47] with the inscription relating a *lapidarius subaedanus* and *collegae lapidari*, which are most probably cutters of *crustae*[48] rather than stonemasons.

Middle Miocene Limestones

These limestones of Badenian and Sarmatian ages[49] in Pannonia are rocks that the Romans greatly exploited as they are common, solid and easy to extract and work. Their deposits in the vicinity of Mursa can be found in the Slavonian Mountains (Krndija, Papuk)[50], Mecsek Mountains[51] and closest in Bansko brdo (only Badenian limestone)[52]. The rock crops out on the northern slopes of Bansko brdo, where several quarries were active in the recent past (now closed). We presume that a Roman quarry was also located here to meet Mursa's demand for stone.

19 artefact samples (tab. 4) were analysed for their biostratigraphic age in order to establish potential differences that could lead to the identification of different quarries. Three distinct groups emerged from the results of the analysis.

1. The yellowish-white Lithotamnian packstone to rudstone with poorly to medium-sorted, up to 5 mm-large, more or less abundant red algae fragments, briozoans and more or less frequent benthic foraminifers is the most frequent lithotype among the analysed artefacts. The foraminiferal assemblage in samples aOSJ 04, aOSJ 27, aOSJ 33, aOSJ 34, aOSJ 65, aOSJ 69, aOSJ 71, aOSJ 73, aOSJ 92 and aOSJ 93 belong to the Middle Badenian.
2. Samples aOSJ 70, aOSJ 72 and aOSJ 77 represent yellowish-white well-sorted and fine-grained (up to 0.5 mm) packstone with red algae fragments, benthic and planktonic foraminifers and other detritic grains. The foraminiferal assemblage in these samples is Late Badenian.
3. The third group is foraminiferal wackestone to packstone with benthic foraminifers, mostly miliolids up to 0.5 mm-large and sub-rounded pelloid grains, probably also micritic intraclasts, red algae fragments and some ostracod shells. The matrix is partly washed micrite. The sample aOSJ 2 shows a uniform foraminiferal association characteristic of the Sarmatian age.

There is also sample aOSJ 91, which is fine micritic mudstone, classified as mudstone with individual calcispheres without internal structure and devoid of any sedimentary structure (at the sample level). This limestone is clearly of Neogene age based on its appearance, but a lack of recognisable biota prevents a more precise identification.

Monuments

The earliest, pre-colony sepulchral stelae from the 1st century AD were made of Badenian limestone, one of them more precisely of Middle Badenian (stele for Velagenus Ulattius) and one from the Upper Badenian limestone (stele for Urbana and Gaetulus). Although it is possible for

47 Hoffiller 1912, 5 f.; <https://edh.ub.uni-heidelberg.de/edh/inschrift/HD027213> (17.01.2023); lupa 5741.
48 Cinque – Lazzeri 2012, 182.
49 Piller – Mandic – Harzhauser 2007.
50 Kovačić – Pavelić 2017.
51 Sebe et al. 2015.
52 Pikija – Šikić – Trifunović 2015, 24. 35.

Sample	Object	lupa
aOSJ 02	Aedicula part, AMO inv. (?)	5920
aOSJ 04	Block of Drava bridge, AMO inv. (?)	–
aOSJ 27	Architrave, AMO inv. 219006	–
aOSJ 33	Architrave, AMO inv. 219016	–
aOSJ 34	Tympanum, AMO inv. 219035	–
aOSJ 39	Architrave, AMO inv. 219040	–
aOSJ 65	Altar Silvanus Domesticus, AMO inv. 225994	–
aOSJ 66	Altar Silvanus, AMO inv. 225995	–
aOSJ 67	Altar Silvanus, AMO inv. PU 354	–
aOSJ 69	Tympanum, AMO inv. 6151	26325
aOSJ 70	Stele Urbana and Gaetulus, AMO inv. 6150	4294
aOSJ 71	Altar, AMO inv. 849	26432
aOSJ 72	Altar, AMO inv. 768	26431
aOSJ 73	Stele Velagenus Ulattius, AMO inv. 656	3071
aOSJ 77	Architrave with relief, AMO inv. 19748	5267
aOSJ 91	Floor plate near the town wall	–
aOSJ 92	Block from the town wall	–
aOSJ 93	Architrave	–
aNSD	Stele Niger Sveitrius, Muzej Vojvodine inv. (?)	3074

Table 4 Analysed samples of Neogene limestone

Middle and Late Badenian limestones to occur in the same quarry, the monuments differ in form to a degree that does not allow us to attribute them to the same workshop, probably also not the same quarry (fig. 7).

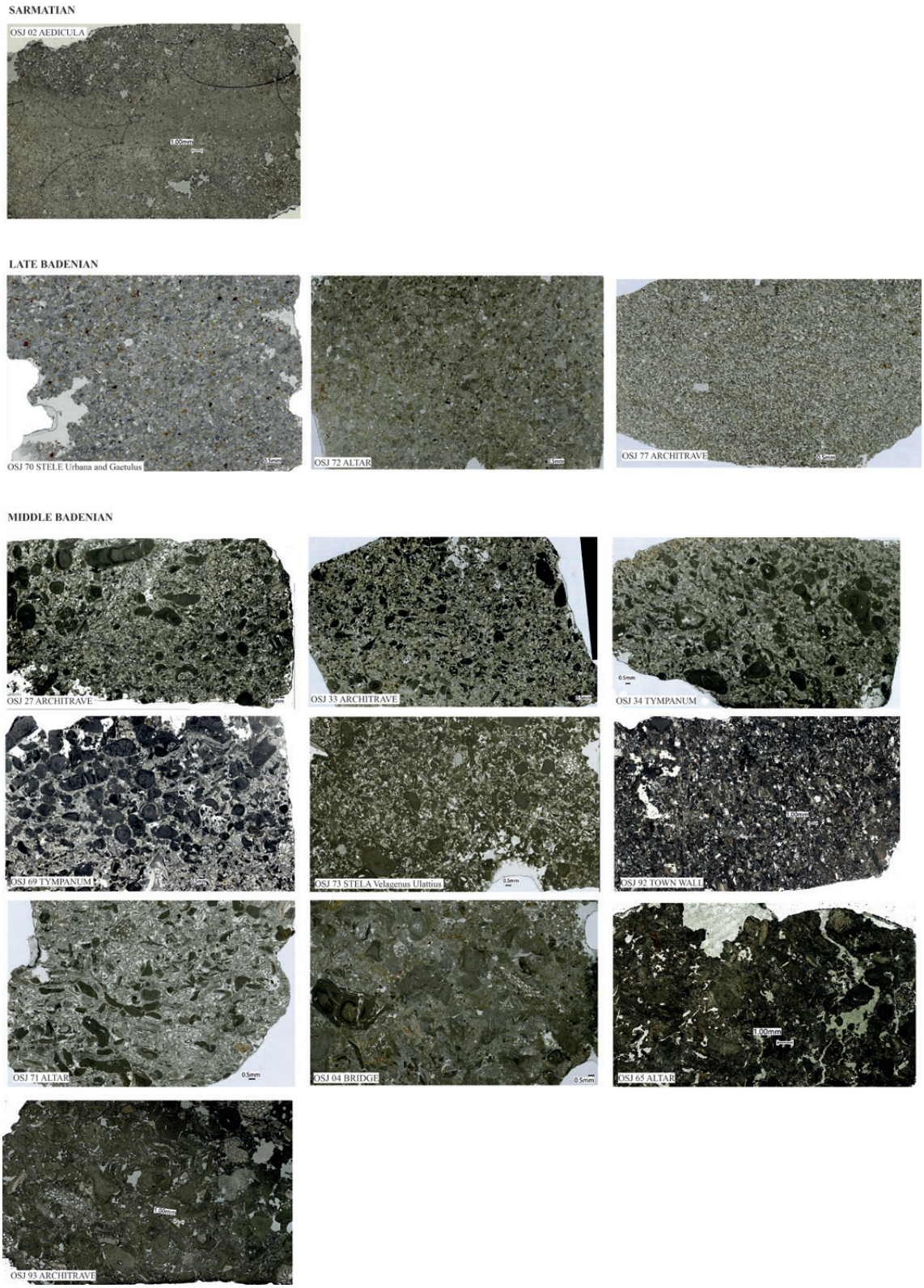
Blocks of Middle Badenian limestone from the same source were also used to build the town walls of Mursa and its bridge across the Drava. The stone was frequently used for the entablature parts (architraves, tympana), but never for load-bearing elements – columns. Small votive altars were also made of it, but not sepulchral monuments of any form. This limestone was most likely sourced at Bansko brdo.

Late Badenian limestone was used in the production of small votive altars, in one case also relief-decorated architrave. Although it is very likely, the origin in the same quarry as the Middle Badenian limestone cannot be confirmed due to the absence of definitive evidence.

High-quality Sarmatian limestone used to make the surviving part of an aedicula tomb is of unknown origin.

Brownish-grey Limestone

The rock used for the curb stones (19 blocks) is mostly yellowish-brown to brownish-grey (10 YR 4–6/2 to 5 YR 4–6/1–2) mudstone with occasional sparitised small, mostly radial or subradial unrecognisable forms. Low-amplitude bedding-parallel and irregular solution seams are frequently present and have a thin brownish infill. Poorly expressed lamination is observed in one of the 19 samples. Peloidal packstone is observed in one sample, but also without any useful fossil record. Fossils (*Glomospira sp.*, *Tolypammina sp.*, *Nodosaria sp.*) observed in another sample are facies-related fossils suggesting shallow-water platform limestone, but not conclusive as to the age of the limestone; it is probably Triassic, though Jurassic and Cretaceous ages cannot be excluded (fig. 8).



7 Thin sections of the Middle Miocene limestone samples (photos: I. Rižnar)

8 Curb stone of dark limestone and its thin section (photos: I. Rižnar)

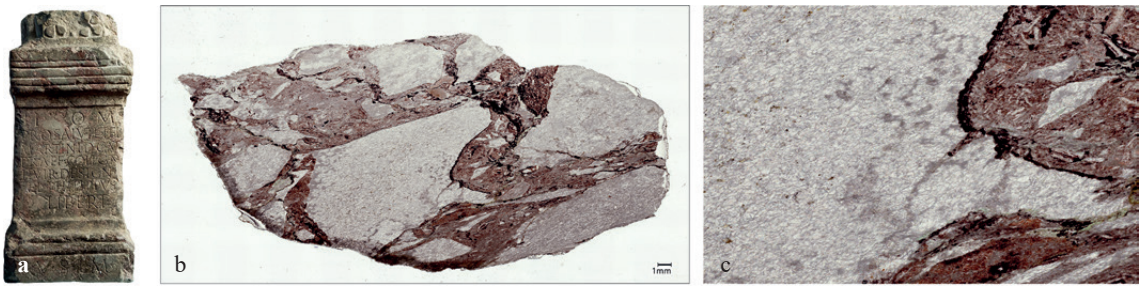
Light-grey Tectonic Limestone Breccia

This rock has only been identified in a medium-sized altar dedicated to Jupiter and erected for Titus Flavius Martinus[53], *decurio* and *duumvir* of Mursa, dated to the 3rd century (sample OSJ 100). The altar (fig. 9 a) is made of tectonic limestone breccia with up to 30 cm-large limestone tectoclasts. The sample (fig. 9 b) is actually a miniature image of the rock the artefact is made of. The parent rock is light-grey neomorphised recrystallised limestone. Medium-sorted elongated spar grains with irregular grain boundaries are imbricated and measure 0.1–0.3 mm. Darker patches are the remnants of a micrite matrix, while the spar grains are supposedly sparitised detritus. Up to 20 % of grains show twinning lamellae (perhaps echinoderms) and some of them are (tectonically) deformed. As all the tectoclasts in the sample show imbrication in the same direction, parallel to the imbrication in the dark-red cataclasite, it is inferred that the imbrication and deformation of the twinning lamellae is tectonically induced. The red cataclasite is predominantly calcitic and contains a micrite matrix with elongated angular limestone clasts and red and blackish iron oxides with greenish chlorite (fig. 9 c). As far as the age and stratigraphic position of the rock are concerned, it is clear that the limestone is of Mesozoic age or older with regard to its diagenesis. The absence of fossils in the sample prevents us from hypothesising its provenance.

DISCUSSION

Mursa is believed to have been constructed several years before being granted the status of a colonia in AD 133. In the initial stages, the construction presumably employed perishable materials

[53] Cvetko 2022, 333 no. 636; lupa 5259.



9 a: Altar. b: Sample. c: Thin section (photos: I. Rižnar)

and stone came to be used from the Antonine phase onwards. The only known stone construction from the Hadrianic times is the town walls that utilised worked blocks of Middle Badenian limestone. It is reasonable to hypothesise that the closest quarry was sourced for such a huge undertaking and that this quarry may be sought on the northern slopes of the Bansko brdo Hill. Supporting such a hypothesis is the use of andesitic-basaltic breccia in the wall foundations that has been positively identified as quarried on the northernmost part of the said hill. The limestone quarry there was likely already opened in the 1st century AD, as suggested by the stele for Velagenus Ulattius[54] from the 1st century AD that is made of limestone of the same lithotype[55]. Middle Badenian limestone was also used to make the blocks for the bridge across the Drava[56].

Upper Badenian limestone used in the 1st century for the stele for Urbana in Gaetulus[57], later also for the architrave with the relief depiction of the Dioscuri, Victoria and Jupiter[58] and a small altar[59], probably comes from a different, as yet unidentified quarry.

Standing out among the sepulchral monuments in terms of stone is the corner block of an aedicula tomb made of high-quality Sarmatian limestone. Thus far, products of this material have not been recorded either in the area between Poetovio and Mursa[60] or between Aquincum and Mursa[61].

The Hadrianic building inscription from AD 133 associated with the construction of the town walls is, in contrast, made of Budakálasz travertine. Together with the stele for Caius Iulius Verecundus[62], soldier of the *legio X Gemina pia fidelis*, they are the earliest monuments made of this stone and indicate that the use of travertine in Mursa began under Trajan[63] and continued under Hadrian. The results of the most recent archaeological excavations indicate that in Mursa travertine was mainly used for columns, though we also know several architraves of this stone[64]. Entablature parts were otherwise primarily made of Badenian Lithotamnian limestone. An exception in the currently incomplete knowledge of the architecture in Mursa is a public building constructed of worked travertine blocks that came to light in the Park kraljice Katarine Kosača, which also revealed waste pieces of travertine incorporated in the foundations. There are, as yet, no known architectural

54 Dautova Ruševljan 1983, 23 no. 133; lupa 3071.
55 The same limestone was also used for two architraves, two pediments and a small altar kept in the Museum of Slavonia, see Cvetko 2022, 348 no. 670; lupa 26432.
56 Also an architrave (OSJ 93) and a small altar (OSJ 65).
57 Dautova Ruševljan 1983, 23 no. 132; lupa 4294.
58 lupa 5267.
59 Cvetko 2022, 348 no. 671; lupa 26431.
60 See Migotti – Šašel Kos – Radman-Livaja 2018.
61 See e.g. Jevtuhova 2009.
62 Klemenc 1928.
63 Between 102 and (at the latest) 108, the *legio X Gemina pia fidelis* was stationed in Aquincum where Budakálasz travertine predominated among the used stones. For the legion, see Endres 2020. We believe the stele for Verecundus was made at Aquincum.
64 lupa 5697. 5699 (?).

	Alpine marble	Mediterranean marble	Neogene limestone	Travertine	Grey limestone	Sum	%
Aedicula	2	0	1	1	0	4	3.1
Stele	6	0	0	8	0	14	11
Sarcophagus	2	0	0	8	0	10	7.9
Altar	14	0	4	20	1	39	30.7
Sculpture	14	2	0	10	0	26	20.5
Titulus	15	1	0	15	0	31	24.4
Milestone	0	0	0	3	0	3	2.4
Sum	53	3	5	65	1	127	
%	41.7	2.4	3.9	51.2	0.8		100

Table 5 Monuments from the time of the colony according to monument type and stone given in numbers and percent

elements made of marble[65], while the discarded remains of *opus sectile* floors made of a classic array of coloured Mediterranean marbles prove the existence of splendidly decorated interiors.

Compared with the architecture, the use of different stones for the sepulchral, votive and other monuments in Mursa shows a fairly different picture (tab. 5). In the pre-colony times, only a few sepulchral stelae are known and those are predominantly made of limestones of Badenian age[66], joined in the Late Flavian and Trajanic periods by Gummern marble[67] and Budakálasz travetine[68]. At least 127 monuments survive in the span from the foundation of the colony to the late 4th century.

Just over half of them are made of travertine, and just over 40 % of Eastern Alpine marble. This general ratio, however, varies according to the category of monument. It is most apparent in sarcophagi, almost all of which are made of travertine, but also with altars, with more than half made of travertine and just under 40 % of Eastern Alpine marble. The only category that shows a greater share of Eastern Alpine marble products compared to those in travertine is sculpture, which would indicate a preferential use of marble for such products.

The product analysis reveals that the Colonia Aelia Mursa was compelled to meet its needs for stone almost exclusively from distant sources, with which it was well-connected via waterway routes. Only for construction purposes did it make more use of regional limestone, (most likely) quarried in the Bansko brdo Hill, though this stone was only suitable for horizontal, but not vertical, load-bearing elements. In terms of using accessible stones, Mursa is very much an exception among Roman towns, which is due to its geographic location in the centre of the Pannonian Basin.

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65 The fragment of a coffered ceiling (lupa 26327) probably belongs to an aedicula tomb.
66 Stelae for Niger Sveitrius, Velagenus Ulattius, as well as Urbana and Gaetulus.
67 Stele for Iulia Primilla.
68 Stele for Caius Iulius Verecundus.

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THE POHORJE MARBLE QUARRY COMPLEX OF ŠMARTNO/FRAJHAJM

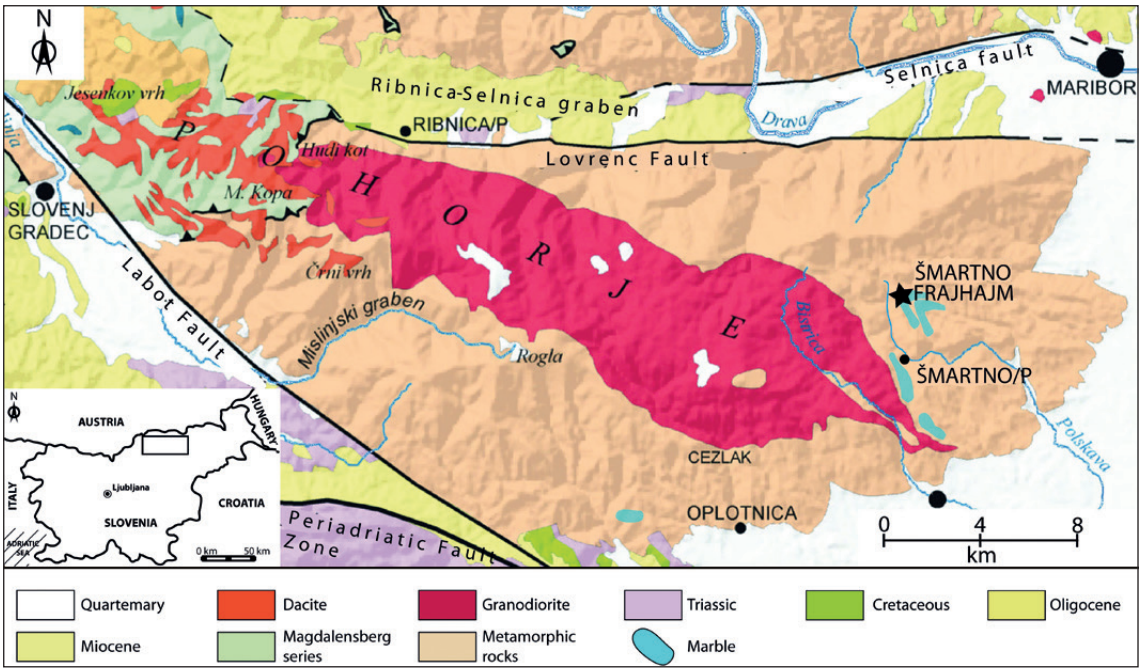
Abstract
The Šmartno/Frajhajm quarry complex in the Pohorje Mountains is one of the few centres of marble production (besides the quarries in Gummern and Kainach) that exported its products to the Roman provinces in Pannonia. It is a large complex on the slopes above the Velika Polskava stream, investigated in recent years using airborne laser scanning technology (LiDAR) and geological/archaeological research. The valley of this stream hosted the main route for transporting marble blocks to the workshop responsible for further processing (*officina*) at Velenik, a site located on the main Roman road (*via publica*) connecting Celeia (Celje) with Poetovio (Ptuj). The quarry complex consists of several quarrying areas, of which only a few were previously known, obscured by the dense spruce forests. These areas are named after the nearest mountain farms. One of them – the Videc quarry – was thoroughly investigated in 2020–2021 in order to understand better the characteristics of the marble, the dynamics and the method of extraction, as well as the internal organisation of the quarry. The investigation showed that spoil mounds were sourced in modern times for burning lime in the lime-kilns set up within the quarry. The archaeological excavation of one of the kilns confirmed its use in the 19th century.

INTRODUCTION

The Pohorje Mountains (northeastern Slovenia) form the southeastern part of the Alps, i.e. the Austroalpine units of the Eastern Alps (fig. 1). A system of large nappes formed here during the Eoalpine orogeny[1]. The lowest is the Pohorje nappe[2], which mainly consists of medium- to high-grade metamorphic rocks, especially mica schists and gneisses with numerous lenses and bodies of marble, amphibolite, quartzite and eclogite[3]. In addition, small ultramafic bodies of garnet peridotites and serpentinised harzburgites occur on the southeastern margin[4]. The rocks were subjected to (ultra-)high-pressure metamorphism[5] in the Upper Cretaceous[6] and later to Tertiary metamorphism[7].

A nappe of weakly metamorphosed rocks such as slates and phyllites overlies the rocks of the Pohorje nappe[8]. The upper nappe is composed of clastic rocks of a Permo-Triassic age[9], followed by Miocene sediments of the syn-rift basin fill of the Pannonian Basin[10]. In the central part of the Pohorje Massif, there is a large granodiorite body with dacite of a Miocene age[11].

1 Frank 1987; Schmidt et al. 2004; Fodor et al. 2008.
2 Janák et al. 2006.
3 Mioč – Žnidarčič 1977; Mioč 1978; Mioč 1983; Mioč – Žnidarčič 1989; Fodor et al. 2008.
4 Hinterlechner-Ravnik 1987; Janák et al. 2006; De Hoog et al. 2009.
5 Janák et al. 2004.
6 Thöni 2002; Miller et al. 2005; Janák et al. 2009.
7 Fodor et al. 2002; Li et al. 2021.
8 Hinterlechner-Ravnik 1971; Hinterlechner-Ravnik 1973; Vrabec 2010.
9 Hinterlechner-Ravnik 1971; Hinterlechner-Ravnik 1973; Janák et al. 2004; Vrabec 2010.
10 Fodor et al. 2003.
11 Dolar Mantuani 1935; Faninger 1970; Trajanova – Pecskay – Itaya 2008; Poli et al. 2020.



1 Geological map of the Pohorje area (graphics: P. Miklavc, modified after Mioč – Žnidarčič 1977)

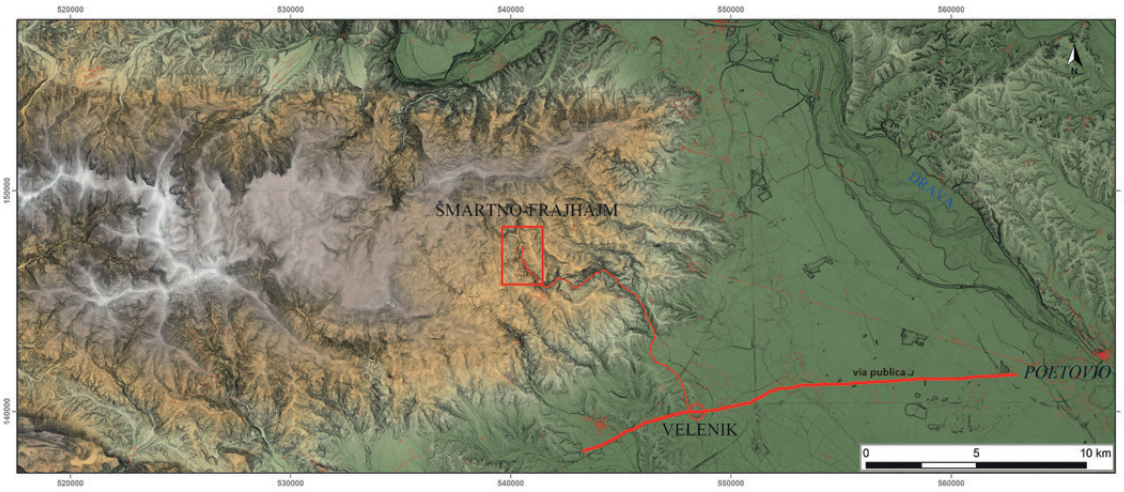
Marble lenses and bodies mainly occur in the southern and eastern parts of the Pohorje Massif in gneisses, mica schists and amphibolites[12]. Pohorje marble is a relatively pure carbonate with up to 95 % calcite and some dolomite[13]. The main accessory minerals are quartz, mica (muscovite and phlogopite), clinopyroxenes, amphiboles, titanite, epidote/clinozoisite, feldspars, ferric oxides and sulphides[14]. The marble is white, sometimes coloured by accessory minerals such as graphite, pyrite, amphibolite and biotite[15]. It is very heterogeneous, predominantly medium- to coarse-grained with a homoeoblastic to heteroblastic texture.

THE ŠMARTNO/FRAJHAJM QUARRY COMPLEX

The quarry complex lies in the southeastern Pohorje Mountains (fig. 2). More precisely, it is located in the middle of the inclined eastern Pohorje plateau, to the north of the Šmartno na Pohorju village and on the west and partly east slopes above the Velika Polskava, a boundary river between the cadastral municipalities of Šmartno and Frajhajm. In this section, the Velika Polskava runs almost perpendicularly to the predominant sloping of the Pohorje, along a fault[16]. The complex is composed of individual quarries, traditionally named after nearby mountain farms: Bojčnik, Kresnik (VI), Trmota (IV), Motaln (I) and Puderšnik (I) on the west, and Lunežnik and Videc (VII) on the east side. The recent investigations using airborne laser scanning technology (LiDAR) have enabled an insight into the whole interconnected quarry complex, now overgrown with dense spruce forests (fig. 3).

Most quarries are located on the west slope with its upper edge at approx. 800 m asl and the valley floor at approx. 700 m asl, with an average gradient of 22° or 40 %. Marble extraction took place at several levels in a 250 m-wide and 1,700 m-long strip. There are six large quarries

12 Hinterlechner-Ravnik – Moine 1977.
13 Jarc – Zupančič 2009.
14 Jarc – Zupančič 2009.
15 Hinterlechner-Ravnik 1971.
16 Gams 2008, 202.



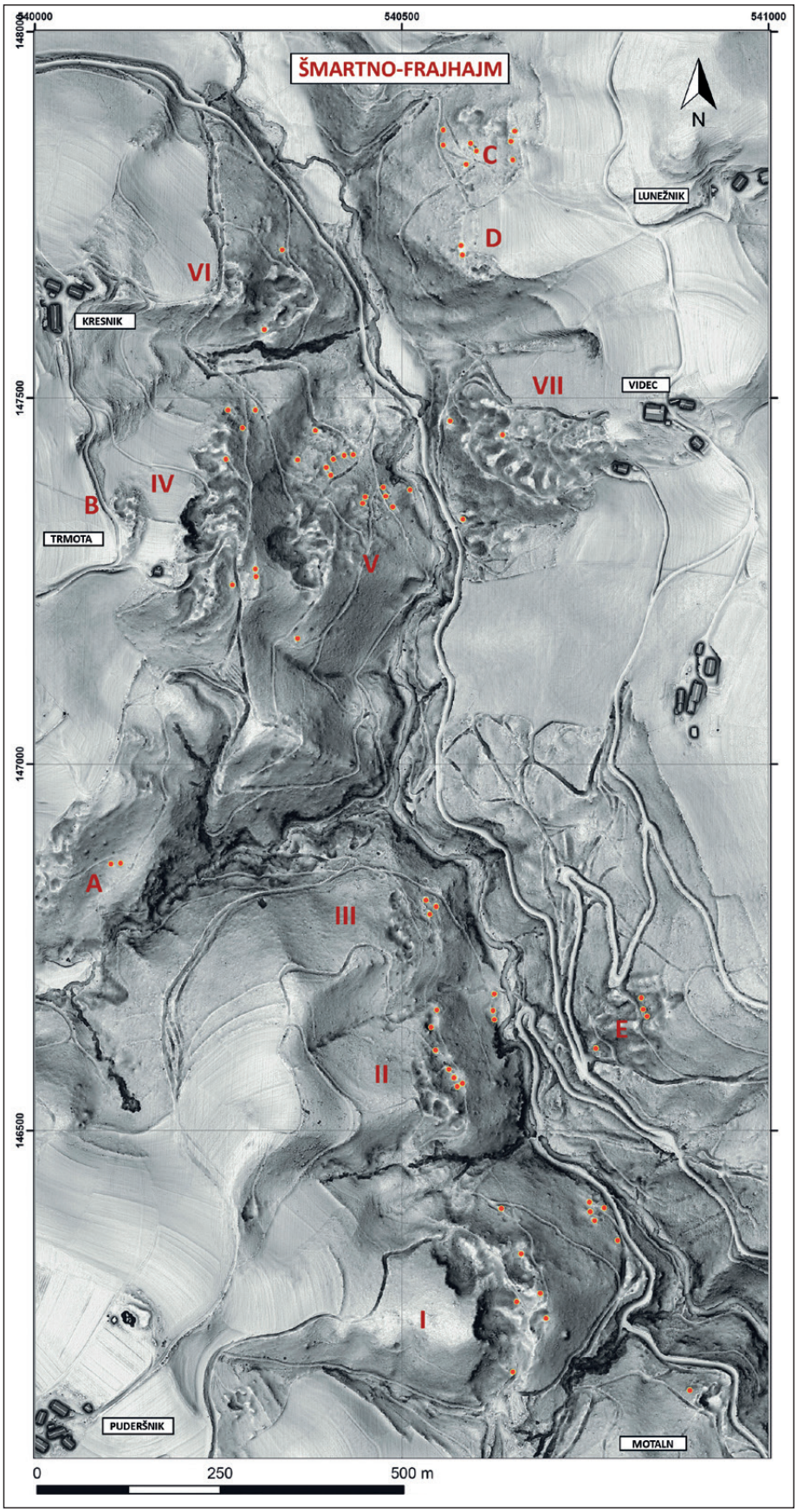
2 The Šmartno/Frajhajm quarry complex in relation to the road network, the colony of Poetovio and the workshop at Velenik (graphics: E. Lozić)

(I–VI) and two pits where marble was sourced for lime production and construction purposes (A–B). A similar situation has been observed on the east slopes, where the average gradient is 20–21° or 35–36 %. One large quarry has been identified here (VII) and three marble pits (C–E). Both sides of the valley host deep beds of torrential streams, running perpendicularly to the valley and dividing the complex into individual areas. These are connected with pathways, partly still in use today, which lead to the valley floor. The latter also holds a road towards Zgornja Polskava in the southeast, where it joins the road network on the plain below the Pohorje.

Marble cropping out on the steep slopes was, according to the local inhabitants and brief notes in the literature of that time[17], used for a variety of purposes at least to the middle of the 20th century. The most readily visible traces of the modern, possibly even earlier marble extraction are the remains of 66 topographically recorded round lime-kilns of different sizes that were dug deep into the ground. They typically concentrate along the pathways within the vast spoil mounds of individual quarries, but also in the immediate vicinity of pits where marble was extracted to be used for lime production. Oral reports mention that stonemasons were active in the Videc quarry (»pri vici«) in the 18th and 19th centuries[18], while the use of a handheld drill shows modern-day activities also in the upper part of the Trmota quarry. Despite the clear evidence that at least some of the quarries (Trmota, Videc) were exploited in the 18th and 19th centuries, this is not recorded on the first cadastre from the 19th century[19], which only shows forests in these areas.

Traces of Roman quarrying activities are rare. The visible outcrops (quarry walls) thus far revealed no tool-marks. These were observed, in the shape of parallel grooves made by a pick, on a block found in the bed of a torrential stream below the Motaln quarry. Recovered on the pathway that leads diagonally across the spoil material on the slope below this quarry was a fragment of a half-finished marble vessel – mortar (fig. 4)[20] – which is similar to a mortar unearthed in the Spitzelofen quarry[21]. A marble block with characteristic grooved pick-marks (fig. 5) was found in front of the entrance to one of the loci of the Kresnik quarry[22]. A Roman

17 Pogatschnigg 1890, 71; Koprivnik 1913, 113; Kieslinger 1963.
18 Pahič 1990, 41–43.
19 Franciscan cadastre for the cadastral municipalities of St. Martin and Freyheim from 1824.
20 PM Maribor, no inv.
21 Karl 2021, 102 tab. 50.
22 Size 140 × 50 × 35 cm.



3 The Šmartno/Frajhajm quarry complex with its quarry areas (I–VII) and marble pits (A–E) (graphics: B. Djurić, E. Lozić)

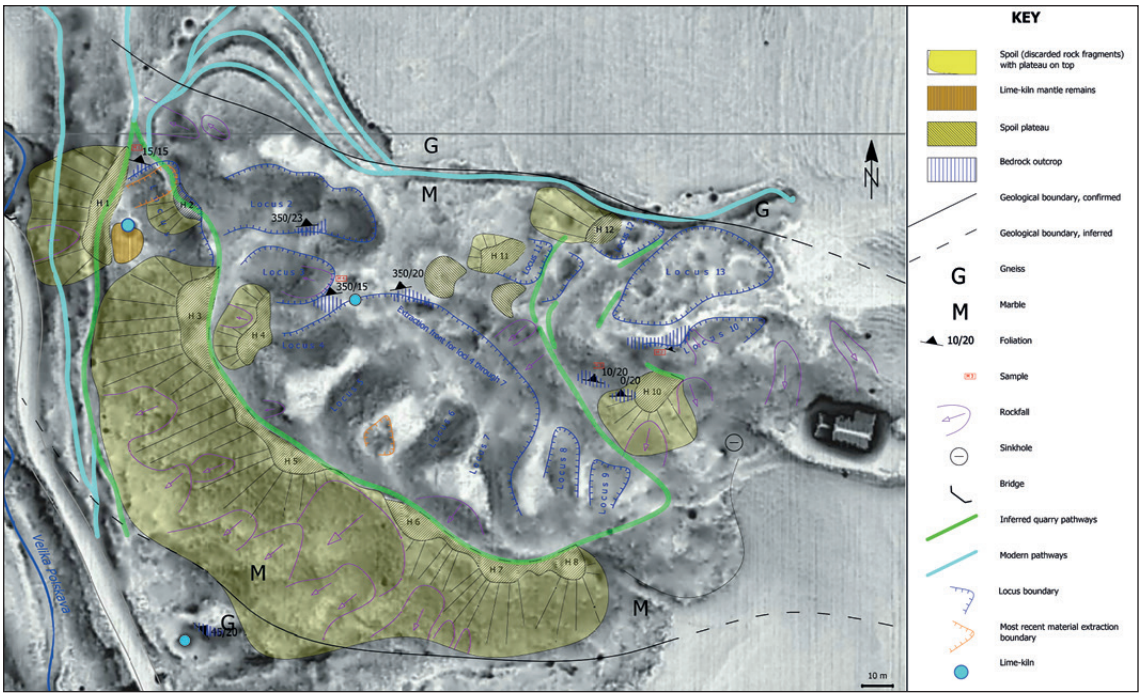
4 Fragment of a marble mortar and the relief with Saxanus from the Motaln quarry (photos: B. Djurić, B. Farič)

votive altar that bears a relief depiction of a stonemason, identified as Saxanus (fig. 4), came to light in the area of the Motaln quarry[23]. The construction of the church of St. Martin in Šmartno (13th cent.)[24] reused funerary and votive monuments, but also several half-finished products[25] that were most likely collected in the quarries. In addition, remains of a presumed stonemasons' settlement were found and registered as protected cultural heritage (EŠD 22585) in the valley of the Velika Polskava below the quarry complex[26].

5 Marble block in the Kresnik quarry (photo: B. Djurić)

Acknowledging the different opinions[27] and the complete absence of material evidence on the transport route, we nevertheless posit that the route in the length of some 18 km and of an approx. 3 % gradient led from the quarry complex (700 m asl) down the valley of the Velika Polskava through the modern-day village of Gornja Polskava (296 m asl) to connect with the Roman *via publica* from Celeia to Poetovio at the foot of the Velenik Hill near Slovenska Bistrica (fig. 2). The archaeological habitation and sepulchral remains at Velenik, which include

23 PM Ptuj, inv. 308; Skrabar 1924.
24 Höfler 2016, 320.
25 Pahič 1977, 58 f.
26 The Official Gazette of the Republic of Slovenia 23, 2013, 2996.
27 Pahič 1990, 9 f.



6 The Videc quarry (graphics: B. Djurić, E. Lozić, I. Rižnar)

7 Chips from the working platform of Locus 1 (photo: B. Djurić)

blocks, cores and semi-products, suggest that a roadside stonemasons' settlement existed here in association with the local workshop[28].

28 Djurić 2001; Djurić 2004.

THE VIDEC QUARRY

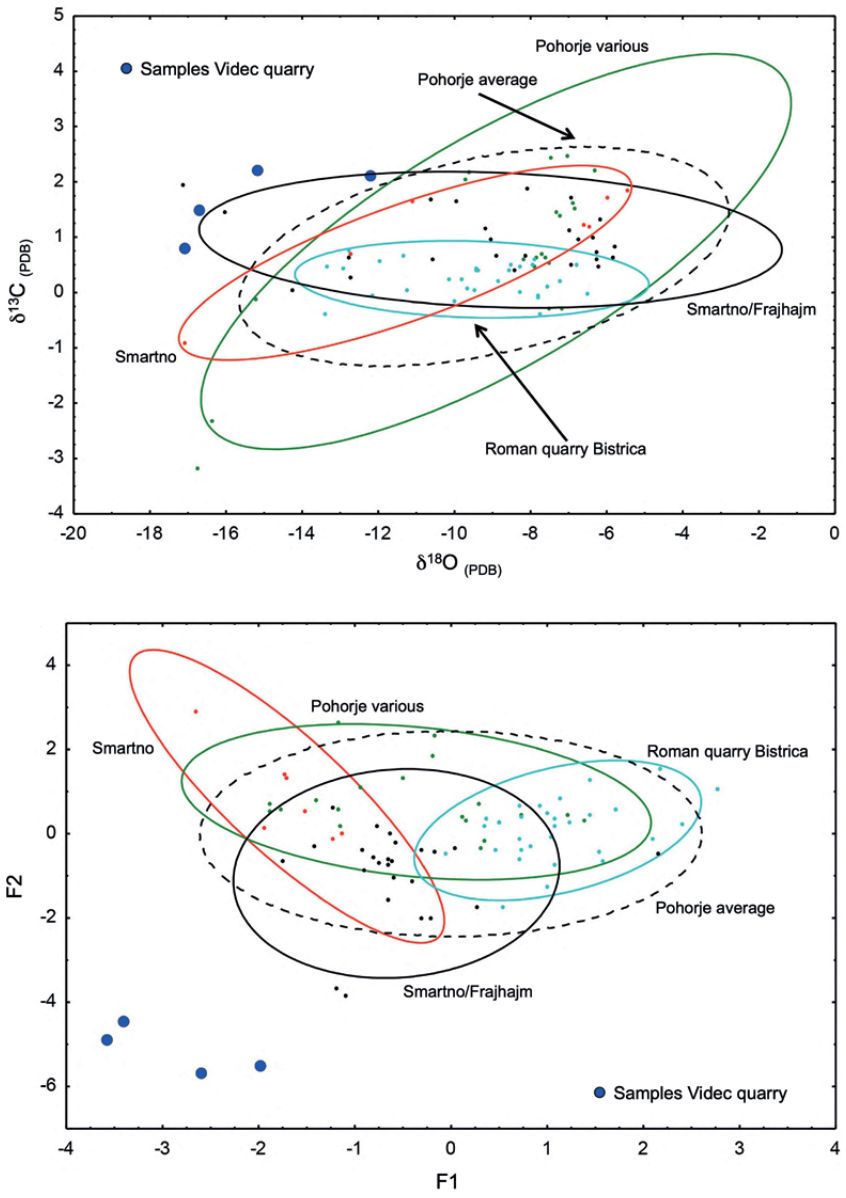
The only quarry to be topographically investigated in the vast area of the Šmartno/Frajhajm complex is the Videc quarry (fig. 6)[29]. Besides the one below the Trmota farm on the west slope of the Velika Polskava Valley, it is most frequently mentioned in archaeological literature. The first to write about it was Balduin Saria[30], later also Stanko Pahič[31], though without offering more precise information. The two authors note several modern-day products found in the quarry, kept at the Videc farm. Pahič also mentions the year 1854 carved into a marble block in the quarry and the local tradition of »štancarji« or stonemasons. This is evidence of more or less intense activities that took place in the quarry in modern times.

The quarry was opened on the south-southwestern slope of a marble lens that dips northwards (350°) at an angle of 20°, and is overlain and underlain by gneiss. The lens measures 250 × 200 m and has a ridge that extends from east to west with a slight northward deviation of 13° and gradually descends westwards at an angle of 20°. The slope on which the quarry developed has a gradient of 62 %.

The marble lens in the quarry is exposed, i.e. not overlain by gneiss or other rocks, and shows cleavage characterised by horizontal schistosity and vertical fissures that enabled opencast extraction using the levering technique. The extraction of marble with such characteristics produced great amounts of spoil. In this quarry, there are extensive spoil heaps on the slopes, but also spoil concentrations in the shape of differently sized platforms created at the rear of individual loci. Twelve loci (1–12) have been established, most of them in a characteristically elongated tongue shape and arranged one next to the other along the ridge. They are 25 to 30 m long and 10 to 15 m wide, with the exception of loci 1 and 2 that are larger; three loci (10–12) on the north side of the ridge are in the formative phase. The front and side walls of loci are largely hidden behind the spoil material. They bear no tool-marks. Each of the nine loci on the south side below the ridge is connected with a path that leads below them and was used to transport the extracted material. The path has a gradient of 14–15 % in the upper part and 12–13 % in the lower part down to the valley floor. The first and earliest locus (1), in the shape of a semicircular niche, was opened in the west part of the marble lens, at the lowest point on the slope at an altitude of 720 m asl, 20 m above the valley floor. It is largely filled with the spoil material from the higher-lying loci 2 and 3. The vast spoil heap in Locus 1 was levelled to serve as a working platform. The layer of working chips (fig. 7) unearthed here during the archaeological excavations (2020–2021) and several marble blocks with tool-marks found in the vicinity suggest that

8 Remains of a modern lime-kiln on the platform of Locus 1 (photo: B. Djurić)

29 Known in literature as »pri vici«.
30 Saria 1939, 63.
31 Pahič 1990, 41–43.



9 a: Isotope diagram (graphics: W. Prochaska). b: The bivariate diagram with the two most powerful canonical factors of the multivariate calculation (graphics: W. Prochaska)

the platform was used, probably in modern times, for roughly dressing different (semi-finished) products. Probably in the 19th century, one of the largest lime-kilns of the complex was dug in the middle of this platform (fig. 8)[32], the remains of which are well preserved as a sunken drystone construction and vast heaps of earth used to coat the kiln[33]. The remains of another kiln survived at the south edge of the quarry, in immediate proximity to the pathway and the spoil material on the slope. A third kiln came to light on the ridge of the marble lens just above the front wall of Locus 3 and associated with shallow pits made to obtain the marble stones to be burned.

The Videc quarry thus far yielded no traces of marble extraction and dressing that could date to the Roman period. Having said that, its Roman age is indicated by the size and layout, and even more so, the shape of the individual extraction areas or loci, which differ from later ones

32 Measuring almost 6 m in diameter and dug more than 2 m deep.
33 Vinko Dovnik Sr from Šmartno recalls burning lime in this kiln immediately after World War II.

Lab no. Sample	10222 FRA4	10223 FRA3	10224 FRA2	10225 FRA1
$\delta^{18}O$ (PDB)	–15.17	–16.70	–17.06	–12.22
$\delta^{13}C$ (PDB)	2.22	1.48	0.80	2.11
$MgCO_3$	1.00	0.87	1.60	1.06
Fe	361.40	1060.30	620.40	415.70
Mn	22.80	115.80	52.30	24.30
Sr	178.80	138.00	186.70	166.80
Cr	0.15	0.13	0.09	0.11
V	0.232	0.251	0.221	0.218
Y	0.515	0.467	0.31	0.478
Cd	0.084	0.134	0.12	0.095
Ba	3.831	1.61	7.06	4.37
La	0.412	0.247	0.256	0.306
Ce	0.792	0.408	0.475	0.516
Pr	0.097	0.056	0.056	0.071
Dy	0.072	0.056	0.044	0.057
Ho	0.015	0.012	0.009	0.012
Yb	0.039	0.024	0.023	0.028
Pb	1.143	11.616	7.072	1.713
U	0.012	0.033	0.015	0.022

Table 1 Median contents of the analysed variables. Stable isotopes are presented in the usual δ notation. Trace element contents are given in ppm

in their shape and method of marble block extraction. The elongated, tongue-shaped loci are set perpendicularly to the slope and separated from one another by the remaining slope up to a height of 6 m, next to and on top of which the spoil material was deposited. When a front wall exceeded the height of 6 m, the extraction process moved to a higher level, as visible in the joint front walls of loci 4 to 7 and the front parts of loci 1 and 2. In contrast, the undoubtedly modern-day parts of quarries, such as the upper level of the Trmota quarry, are shaped as shallow rectangular niches in plan, with their front walls much wider and over 10 m high.

The marble in this quarry is coarse-grained and white. Four samples were examined and compared with other well-defined and already investigated locations from the Pohorje area. The samples were subjected to stable isotope and chemical analyses using inductively coupled plasma mass spectrometry (ICP-MS). The results were compared with the databank for the published Alpine marbles[34].

The stable isotope analysis as the standard method of marble provenance investigation (fig. 9 a) is not viable for the Pohorje marble, because the different marble sets from various locations almost completely overlap and cannot be separated. The four samples from the Videc quarry are characterised by a comparatively light oxygen (O) isotope composition (12–17 ‰) and similar carbon (C) isotopes compared to the bulk Pohorje marbles. The isotope diagram shows that the plot of the samples falls on the edge of the general Pohorje composition and outside all the 90 % probability ellipses of the Pohorje area known so far.

A very good separation of the Videc samples from the bulk Pohorje marbles can be achieved by using a larger number of variables ($\delta^{18}O$ ‰, $\delta^{13}C$ ‰, magnesium [Mg], manganese [Mn], iron [Fe], strontium [Sr], chromium [Cr], vanadium [V], yttrium [Y], cadmium [Cd], barium [Ba],

[34] Prochaska 2021.

lanthanum [La], cerium [Ce], ytterbium [Yb] and uranium [U]; see tab. 1). Figure 9 b suggests that the four samples from the Videc quarry represent a distinct group among Pohorje marbles, though their number is rather small and hence their statistical significance low.

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Benjamin Frerix

TRANSPORT AND LOGISTICS OF WHITE MARBLE IN THRACE

ASSESSMENT OF THE ACCESSIBILITY OF THE KAMILSKI DOL WHITE MARBLE QUARRIES IN ANTIQUITY

Abstract
In southeast Bulgaria, near the municipality of Ivaylovgrad the discovery of a *villa rustica*, lavishly decorated with white marble architectural decoration, led to recent investigations into the provenance of the white marble. Establishing the local/regional origin from the quarries in the west of the villa and the nearby Kamilski Dol quarries, the analysis of the transport routes is not without hindrance, as the construction of the Ivaylovgrad Dam prevents the simulation of past paths. The geographical information system-based (GIS) case study of a forthcoming PhD thesis focuses on the reconstruction of the pre-modern landscape and the accessibility of the quarries.

INTRODUCTION

The study of the white marble quarries of Roman Thrace and the utilisation of their products in the cities and *villae rusticae* of the province, would not be complete without an analysis of the distribution and supply network. Mapping and connecting the dots provides new insights into the scale and scope of these networks and the Thracian marble trade in general. By applying a geographical information system-based (GIS) analysis to determine the routes from the quarries to the land and riverine transport infrastructure, the economic advantages of a quarry can be assessed.

This is the focus of an ongoing PhD project that is investigating the transport routes from the white marble quarries in Thrace to the subsequent place of use in the 1st–3rd centuries AD. Embedded in the Austrian Science Fund (FWF) project[1] »Fingerprinting White Marbles«, a joint venture between the National Archaeological Institute with Museum of the Bulgarian Academy of Sciences (NAIM-BAS) and the Austrian Archaeological Institute of the Austrian Academy of Sciences (OeAI-OeAW), the dissertation project aims to use the insights from the geochemical-petrographic provenance analysis to map the white marble landscape on the basis of nine Thracian cities and three *villae rusticae* (fig. 1).

STATE OF RESEARCH AND STATEMENT OF THE ISSUE

While the road network of Thrace in the Roman Imperial and the Byzantine periods has been the subject of several studies[2], Roman river transport along potentially navigable rivers in Thrace has almost exclusively been the subject of numismatic studies[3]. For the analysis and understanding of the Thracian marble trade, the inclusion of the river networks as modes of transportation is

[1] FWF project no. 33042.
[2] Soustal 1991; Wendel 2005; Madzharov 2009; Ivanov 2012; Kolb 2018.
[3] Tsontchev 1957; Tsontchev 1962; Kolev 1968; Michailov 1972, 38 f.; Cahn 1988; Peter 2005; Manov 2016; Vassilev 2021.

1 Roman Thrace, middle of the 2nd century AD (graphics: B. Frerix)

imperative. Within the dissertation project, therefore, the reconstruction of pre-modern river landscapes is needed, as the second half of the 20th century saw an ongoing increase in hydraulic engineering along the catchments of the rivers Hebros/Maritza, Tonzos/Tundscha, Arteskos/Arda, Strymon/Struma and Nestos/Mesta[4]. With the advent of the railway, river transport on the Hebros became uneconomical and perished henceforth[5]. Navigation channels in the beds of the rivers were no longer kept clear and maintained. However, in the early Roman Imperial age, the natural prerequisites for river transport were favourable[6]. Studies on climate proxies and records for the Roman Climate Optimum (RCO) hint that the climate between 100 BC and AD 200 was generally warm, wet and stable[7]. In a particular climate record from southeastern Thrace, the Uzuntarla cave, the stable isotope profiles of $\delta^{18}O$ indicate a temperature increase in the RCO with enhanced winter precipitation[8]. Being dynamic over time, the climate system »leads to certain differences in the spatial extent of different climate zones«[9]. With reservations, the flow rates of the Thracian rivers in the Roman Imperial age are comparable to the modern discharge rates[10]; their length is not.

4 On the impact of anthropogenic hydraulic activities on the Hebros and its delta, see Artinyan et al. 2008, 23; Karditsa – Tsapanou – Poulos 2020, 292.

5 Moschopoulos 1926, 770 f.

6 McCormick 2013, 70. Inland navigation was favoured by stable climatic conditions and even precipitation. The Levant and the Iberian Peninsula were wetter, see Manning 2013, 163. 169.

7 McCormick et al. 2012, 203; Harper 2017, 44.

8 Göktürk 2011, 77.

9 Nojarov 2017, 60.

10 A study on river navigation in central Europe in Roman times showed that the modern discharge rates from the turn of time up to AD 900 must be multiplied by the factor 0.95, see Eckoldt 1980, 42–44. M. Eckoldt's scientific approach to determining historical navigability by using modern flow rates as parameters for antiquity is not undisputed, see Kröger 2022, 18.

The straightening and dyking of the rivers, combined with anthropogenic factors such as agriculture, forestry, climate change and the high number of dams in the catchments of the river tributaries, have, for example, not only increased the flood events in the lower reaches of the Hebros/Maritza[11], but also significantly decreased the river's length. In order to map the potential marble routes on the water in GIS, and in a further step to elaborate the transport distance, time, cost and economic implications, the pre-modern river lengths are needed[12].

Beginning with the study of historical maps, during the Russian-Ottoman-War of 1877/1878 Russian military cartographers created the first geodetic maps for the territory of Bulgaria, as under Ottoman rule, the creation of maps based on accurate surveying techniques had been neglected[13]. Although based on the pre-metric Russian surveying system, georeferenced in GIS, they highlight the significant changes in the river courses and provide valuable insight into the river landscape of areas that are now drowned by modern reservoirs[14]. Even though the rivers of the Thracian plain have meandered over the centuries, the pre-modern river courses tend to be closer to the ancient ones than the modern ones[15].

VILLA ARMIRA

On 20 April 1964, during the construction of a reservoir about 5 km southwest of Ivaylovgrad, excavators unearthed architectural marble decoration[16]. Subsequent archaeological excavations near the Armira River led to the discovery of the eponymous *villa rustica* and the cancellation of the dam project. The *pars urbana* is built around a deep impluvium surrounded by a peristyle. During the second building phase in Hadrianic times, the bottom of the impluvium was raised and clad with marble veneer. The columns and capitals of the peristyle, as well as the white marble veneer and pilaster capitals of the surrounding walls were also added, replacing the original stucco plaster[17]. In general, the exuberant decoration with marble architectural decorations and mosaics would justify it being referred to as a »marble palace«[18].

To the west of the *pars urbana*, in the adjacent *pars rustica*, finds of marble chippings in the eastern portico led to the assumption of a marble workshop[19]. It is believed that the villa was abandoned in the second half of the 4th century AD. It was buried by a landslide caused by an earthquake at the end of the 4th century AD, which preserved the site until the construction of the reservoir in 1964[20].

The white marble architectural decoration of the Villa Armira and several white marble quarries in the southeastern Rhodope Mountains have been investigated in two joint Bulgarian-Austrian research campaigns in 2018 and 2019. Through the study of historical maps and freely available satellite images and cross-referencing them with a geological map of the region, potential ancient and modern quarry sites have been located and sampled. The provenance analysis of the marble artefacts from the Villa Armira determined the local and regional origin of the white marble architectural decoration[21]. Specifically, it originated from the quarries a few kilometres west of the villa and from the Kamilski Dol quarries about 12 km north-northwest as the crow flies (fig. 2).

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11 Angelidis – Kotsikas – Kotsovinos 2010.
12 Arauner 2020; Werther et al. 2021.
13 Kotseva 2015, 119 f.
14 <https://kade.si/#bgt1878=8/> (24.05.2021).
15 Werther et al. 2021, 52. The case study for southeast Germany showed that the difference in length between the pre-modern and modern river courses resulted in up to 24 % longer travel times.
16 Mladenova 1991, 9.
17 Kabakchieva 2011, 222 f.
18 Kabakchieva 2011, 223.
19 Kabakchieva 2007, 474.
20 Kabakchieva 2011, 229.
21 Anevlavi et al. 2022.

2 The Ivaylovgrad region in southeastern Bulgaria (graphics: B. Frerix)

Data	Resolution	Source
DEM		
European Digital Elevation Model, v. 1.01	25 m	European Environment Agency[a]
DTM		
DTM Armira (22 km²)	0.5 m	NAIM-BAS/OeAI-OeAW
DTM Kamilski Dol (8.8 km²)	0.5 m	NAIM-BAS/OeAI-OeAW
Orthophoto		
Armira (22 km²)	0.08 m	NAIM-BAS/OeAI-OeAW
Kamilski Dol (8.8 km²)	0.08 m	NAIM-BAS/OeAI-OeAW
Land use/Hydrology		
OpenStreetMap		OpenStreetMap (Geofabrik)[b]
Geology		
Geological map of PR Bulgaria, K-35-089, Ivaylovgrad	1:100 000	Committee of Geology, Department of Geophysical Prospecting and Geological Mapping, 1989
Historic maps		
Map of the Balkan Peninsula encompassing the whole theatre of war 1877–1878, section VIII, sheet 7	1:126 000	Russian General Staff, 1884–1877/1878[c]
Corrected and completed map of Bulgaria, 1899–1911, section XVII, sheets 13–18	1:40 000	Military Cartographic Institute, 1899–1940[d]
Bulgaria 1 : 50 000, sheet 345, Ivaylovgrad	1:50 000	State Geographic Institute, Ministry of War, 1937[e]

Table 1 Geodata used

[a] <https://land.copernicus.eu/imagery-in-situ/eu-dem/eu-dem-v1.1> (08.09.2022)
[b] <https://download.geofabrik.de/europe/bulgaria.html> (23.11.2022)
[c] <http://digilib.nationallibrary.bg/karti/public/evro?id=26> (24.05.2023)
[d] <http://digilib.nationallibrary.bg/karti/public/evroua?id=33> (31.05.2023). The name of the institute changed several times during this period, see Kotseva 2015, 154
[e] Many thanks to Mr. Vedrin Jeliazkov for providing a GeoTIFF, his tireless help and effort; <https://kade.si/#bgt1933=13/2906967.31/5092653.5/0> (06.06.2023)

Archaeological evidence for the Roman road layout in the region is scarce. It is believed that a road that connected the Via Egnatia and the Via Diagonalis ran in a north-south direction in close proximity to the villa[22]. South of the modern city of Ivaylovgrad, in the area of Ladzha, a Roman road junction was located, where roads to the regional centres of Hadrianopolis and Plotinopolis met the north-south road[23]. Ladzha lies approx. 1.5 km north of the Villa Armira as the crow flies[24]. The potential of GIS-based predictive modelling to enhance the knowledge of the Roman road infrastructure in the area is high[25].

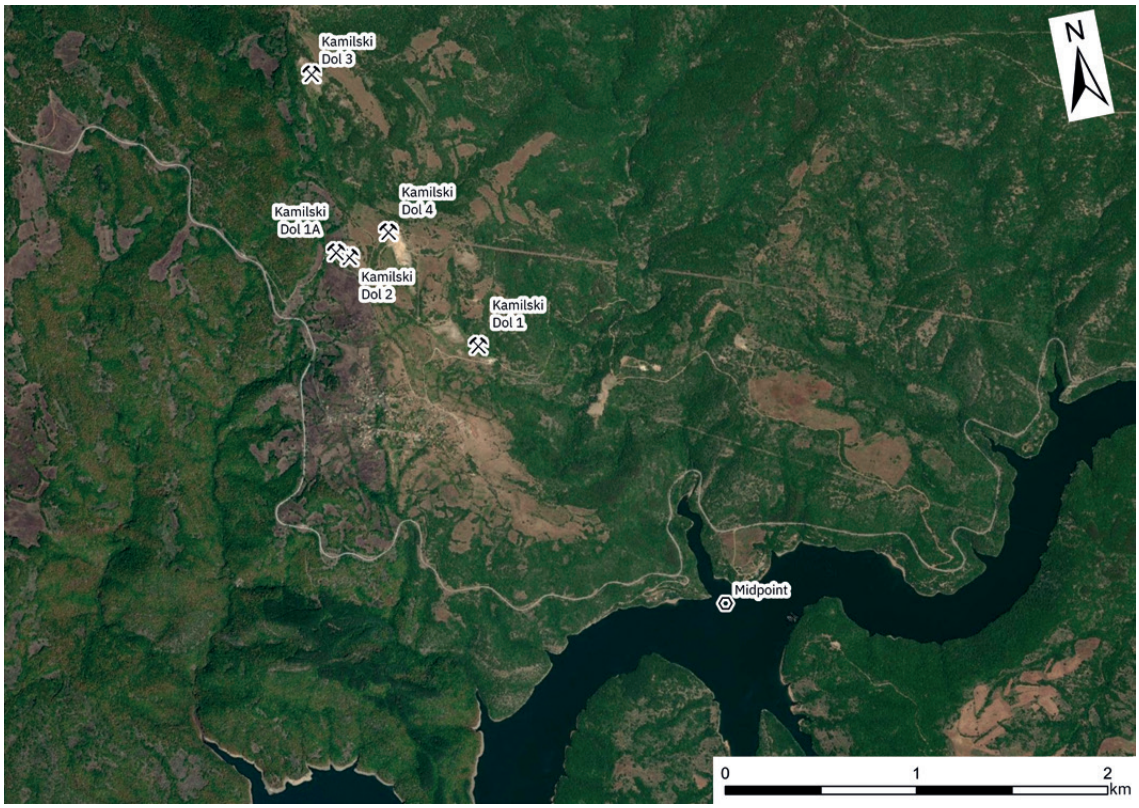
METHODOLOGY

Focusing on the analysis of transport routes from the Kamilski Dol quarries to the Arteskos/Arda River, a dataset representing the three-dimensional digital terrain was needed for mapping the mountainous landscape in GIS[26]. Due to the limited availability of digital terrain models (DTM) derived from high-resolution airborne laser scan data for small areas of the Armira and Kamilski Dol quarry regions, a digital elevation model (DEM) with a resolution of 25 m was used to map the regional marble transport (tab. 1). The now partially submerged riverbed of the Arda before the construction of the Ivaylovgrad Dam was reconstructed using historic maps[27], as the white marble quarries of Kamilski Dol and the Villa Armira are on opposite sides of the reservoir. The steep river valley was modelled by manually converting elevation lines into contour lines, rasterising and interpolating to produce a continuous pre-modern DEM[28]. This was then merged with the 25 m DEM and used to create a slope map. As rivers occur as smooth pathways in DTMs and DEMs and will be preferred routes for the GIS pathfinding algorithm, a cost surface based on the slope map was created. By rasterising and reclassifying vector data on hydrology[29], the regional rivers were given high values and reclassified as zones that hinder movement[30]. Two slope-based cost functions were used to generate the least cost path (LCP) between the quarries and the villa on the basis of the DEM.

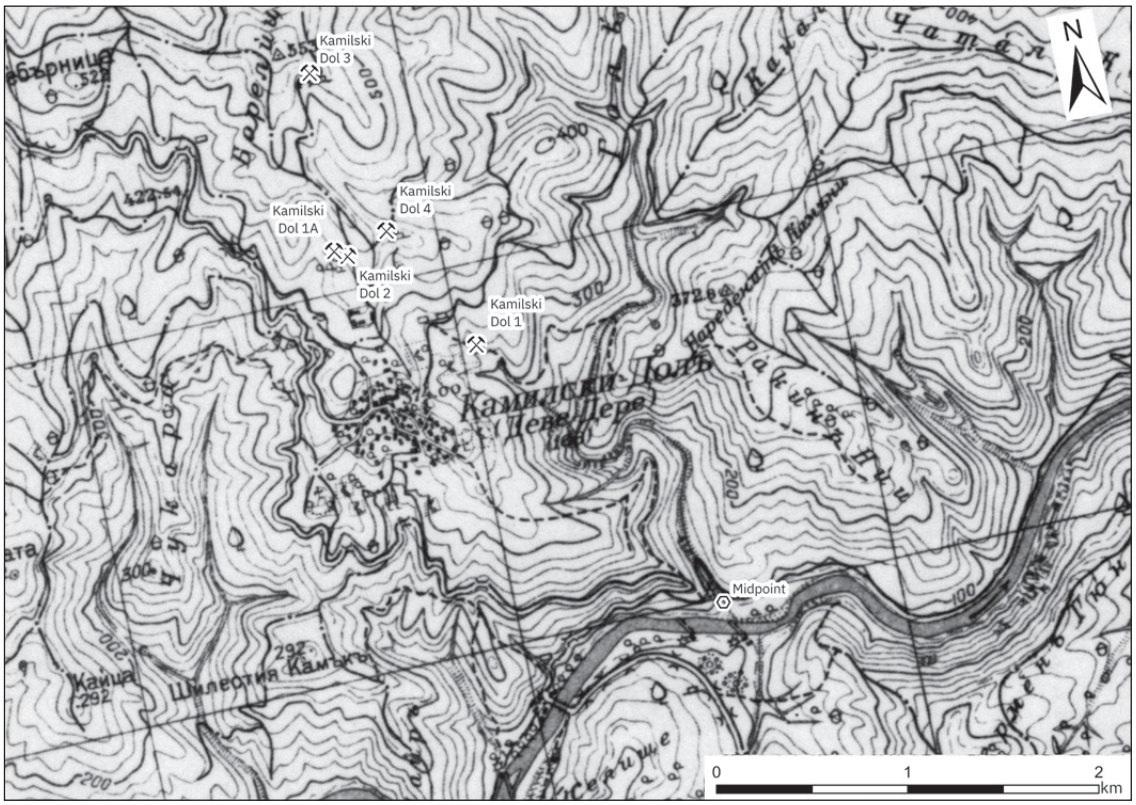
The generated LCPs were split into 100 m parts to identify sections with high gradients in order to determine passages that could not be travelled by ox cart, as a GIS study in Gallia Belgica has shown that Roman roads rarely, if ever, have gradients of more than 15 % and often no more than 8 %[31].

To determine the LCPs between the quarries of Kamilski Dol 1 and Kamilski Dol 3 and the Villa Armira, a hiking function[32] and a vehicle cost function[33] have been employed using a slope-based cost surface where rivers have been regarded as barriers. The reasons are twofold. First,

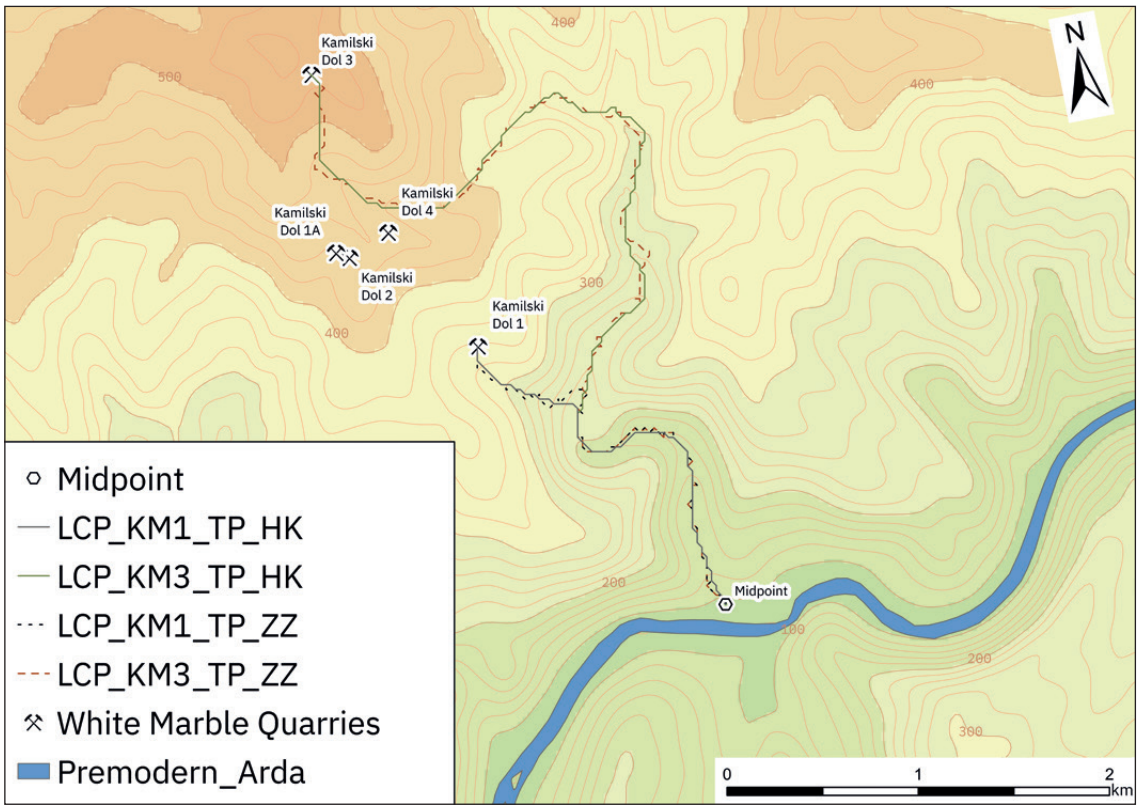
22 Kabakchieva 2010, 280.
23 Deliradev 1953, 22 f.
24 Mladenova 1991, 12.
25 Parcero-Oubiña et al. 2019, 293–296.
26 Dima 2021, 192–195.
27 Sincere thanks to Marina Kalchishkova, Sofia University St. Kliment Ohridski, for her help and support in obtaining the map material.
28 Wheatley – Gillings 2002, 113–118; Conolly – Lake 2006, 103–107; Herzog – Yépez 2016, 11. 16. The visualisation by applying a shaded relief did not reveal any spikes or other errors. On the role of manually corrected DEMs, see Verhagen – Nuninger – Groenhuijzen 2019, 227. The lack of accuracy of a DEM based on a Prussian map was demonstrated in a case study in northwest Germany, see Lechterbeck 2008.
29 The vector data was buffered with a 20 m radius before rasterising to prevent the riverbeds from being used as routes, see Conolly – Lake 2010, 209–211.
30 Güimil-Fariña – Parcero-Oubiña 2015, 34; Herzog – Schröer 2019, 10 f. Watercourses have been given the value that is equivalent to a slope of 15°.
31 Verhagen – Janeson 2012, 125.
32 Tobler 1993. For the potential and limits of the hiking function, see Herzog 2013, 376; Verhagen – Nuninger – Groenhuijzen 2019, 226 f.
33 Herzog 2013 based on Llobera – Sluckin 2007; Herzog – Schröer 2019, 6 tab. 2. A critical slope of 8 % (4.574°) was selected.



3 Satellite image of the Kamilski Dol quarries (graphics: B. Frerix)



4 Extract from the Bulgarian 1 : 50 000 map from 1937 (State Geographic Institute, Ministry of War, 1937)



5 Pre-modern DEM showing the LCPs from the quarries to the midpoint on the bank of the Arda River. HK = hiking function, ZZ = vehicle cost function (graphics: B. Frerix)

water is not an ideal terrain for walkers or vehicles. Secondly, in the majority of cases, watercourses can only be crossed at a limited number of points[34].

Due to the nature of the terrain, all paths created from the quarries of Kamilski Dol 1 and Kamilski Dol 3 to the Villa Armira initially led downhill through the erosion channels towards the Arda Valley. As the lowest point of the generated paths is on the bank of the pre-modern Arda before crossing the river, a midpoint (TP, 95 m asl) has been inserted for enhanced analysis of the steep descents before the paths exit the erosion channel into the Arda Valley. In this case study, only the LCPs to the midpoint are presented as a predictive modelling approach[35]. The forthcoming PhD thesis will further elaborate the transport connections by river and road to the Villa Armira (figs. 3–5).

CONCLUSIONS

It was determined that the gradients of the paths generated on the 25 m DEM to the midpoint were not suitable for transport by oxen (tab. 2)[36]. The calculated routes along the erosion channels

34 Güimil-Fariña – Parcero-Oubiña 2015, 34; the watercourses were assigned a 15° slope to prevent the rivers from being considered as suitable movement routes by the path-finding algorithm of the GIS software used, ESRI ArcGIS Pro.

35 The subsequent marble routes to the Villa Armira will be part of the forthcoming PhD thesis.

36 The fine-grained DTM generated from the LiDAR data did not cover the reservoir bank area and could not be used for a more detailed analysis.

suggest that the marble was transported on sleds[37]. Gradients that are too steep for transport on carts and/or wagons and physically demanding for hikers can be used for downhill sled transport. Evaluation of the LCPs from Kamilski Dol 1 (KM1, 336 m asl) to the midpoint was undertaken by cognitive analysis by comparing the paths with the high resolution DTM and orthophotos. Both generated LCPs using the hiking and vehicle cost functions take a southern route after leaving the quarry. Around 100 m south of the Kamilski Dol 1 quarry, an approx. 150 m-long and around 3 m-broad straight linear terrain feature, an inclined plane, led from the quarry plateau to an erosion channel (fig. 6). In total, the simulated transport route using the hiking function reached the midpoint on the river bank with an average incline of approx. 10° over a distance of around 2.4 km, overcoming a height difference of 242 m.

The path simulated for the Kamilski Dol 3 quarry (KM3, 530 m asl) using the hiking function follows the erosion channels towards the Arda's bank. The path is less steep, with an average gradient of 7° over a distance of 6.1 km (tab. 2). The vehicle function was less suitable for the predictive modelling in the mountainous terrain, because it avoided steep gradients by zigzagging along the slopes of the gully edges, which is the result of the DEM with 25 × 25 m raster pixels and cannot be considered as an accurate simulation of past paths.

The discovery of the inclined plane at Kamilski Dol (fig. 6) led to the hypothesis that this may be the first antique marble slipway found in Bulgaria. Sledge transport has been employed from antiquity to the introduction of internal combustion engines in quarrying, and is now best known by the Italian term »lizzatura«. As quarries were often located on mountain ridges, which made it easier to prospect and remove the debris, gravity could be used to carefully lower the stone using sledges, ropes and holding posts[38]. After passing the debris field, in the quarries of Carrara/Luna in Tuscany inclined planes for marble sledge transport followed the side of the mountain rather than the direct slope of the mountain (fig. 5). Dry erosion channels were also used as transport paths in Carrara but were the preferred choice for stone logistics at the Mons Porphyrites and Mons Claudianus in the eastern Egyptian desert[39].

Path	Height (max.) m asl	Height (min.) m asl	Length (m)	Slope (max.)	Slope (avg.)	Slope (max.) %	Slope (avg.) %
KM3_TP_ZZ	530	94	6922	20	7	36	12
KM3_TP_HK	530	94	6121	21	7	38	13
KM1_TP_ZZ	336	94	3062	23	8	42	14
KM1_TP_HK	336	94	2444	29	10	54	18

Table 2 Data of the generated LCPs from the quarries Kamilski Dol 1 (KM1) and Kamilski Dol 3 (KM3) to the Arda River Valley point (TP) employing the hiking cost function (HK) and the vehicle cost function (ZZ); all values rounded

[37] At the quarries of Mons Claudianus in the Egyptian Desert, the slipways for the sleds were 2–3 m wide and followed the easiest routes downhill that were created by heavy rainfall events, see Peacock – Maxfield 1997, 177. 259–261. At the quarries of Carrara, up until modern times, downhill marble transport was undertaken using sleds that were lowered via ropes and pollards. A minimum slope of 6° (~11 %) was needed, but a slope of 10°–20° (~18–35 %) was preferred, with extremes of up to 50° (~119 %), see Salmojraghi 1892, 278.

[38] The holding posts were made of wooden stakes, known in Italian as *piro*, and were fixed in rectangular holes hewed out of the rock. These rectangular holes are an indication of the ancient sledge transport, as the *piri* were cut in an octagonal shape for the utilisation of steel ropes, which in the 2nd half of 19th cent. allowed greater transport loads, Bradley – Medda 1995, 18. In general, it can be stated that the postholes are usually the longest-lasting indication of a »lizza« route when the terracing is no longer preserved and the slipways are obscured.

[39] Peacock – Maxfield 1997, 259; »(…), the quarries at Mons Claudianus are connected to the wadis by systems of slipways. These generally took the easiest route down the hill-side which would normally equate with erosion gullies formed by storm water.«; Toma 2020, 120–122. 125 f.

6 Comparison of the DTM of the Kamilski Dol 1 quarry and the orthophoto. While the inclined plane is clearly visible in the DTM, its course is only schematic in the orthophoto (graphics: B. Frerix)

However, upon an on-site visit and ground truthing in Bulgaria in November 2023, it was determined that the previously hypothesised sledge ramp was, in fact, a cover for a drainage pipe. What looks like a trough-shaped ramp on the DTM was a linear layer of roughly hewn stones that had been extracted from DEM and non-recognisable on orthophotos (fig. 6). Nonetheless, further investigation into the lower dry erosion channels revealed that approx. 3 m wide ramps were cut into the sandstone of the gully, forming ideal slipways with slopes of approx. 30–45 %. Assumed anthropogenic in shape and conformity, no tool marks could be identified. Additionally, no potholes could be identified, but the general assumption that the erosion channels were used to transport the marble became compelling as the documentation of the channel progressed. Hindrances like a dry cataract with a 5 m drop that have not been identifiable by means of remote sensing were encountered. As examples from the quarries of Carrara and Lasa in South Tyrol account for wooden bridges being used to span gaps in the slipways in modern times[40], bridging a 5 m drop with a wooden ramp in Roman times does seem plausible, given the general technical knowledge in the field of wood construction and bridge building[41]. It is assumed that the obstacle could have been overcome without insurmountable difficulty.

The case study of Kamilski Dol shows the potential of the least cost path analysis for predictive modelling of marble transport routes. With the widespread availability of digitalised historic maps, freely available satellite pictures as well as LiDAR scans and orthophotos, the generated LCPs can be evaluated and thus provide valuable insight into the historic landscape. Predictive modelling can be used to assess the accessibility of the quarry, as the simulation of LCPs can be used to show the potential for good transport links, which would have been an economic advantage[42]. In the case of the Kamilski Dol quarry group, the topography of the steep terrain creates clear corridors of movement that help in identifying the transport routes[43]. The nearby navigable lower reaches of the Arda River provide easy access to downstream markets. For now, this remains hypothetical, as more research into the use of the white marbles of Kamilski Dol in Thrace is needed[44]. The presence of regional to medium-distance roads and the postulated crossroads close to the Villa Armira would also have favoured the transport of marble artefacts by road, thus increasing the economic potential. So far, it can be concluded that the marble trade contributed to the wealth of the inhabitants of the Villa Armira and its lavish marble architectural decoration.

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40 Bradley – Medda 1995, 91. 100; Waldner 2008, 81.

41 Caes. Gall. 6, 9; the construction of the wooden Rhine bridge is given in detail; Adam 2005, 156–190; Ulrich 2007, 1–5; Ulrich 2008, 453–459; Cech 2017, 88–90.

42 On the accessibility of quarries in the Roman Empire, see Russell 2013, 78–81.

43 Herzog – Yépez 2016, 16. The same pattern has been observed in a case study in Ecuador.

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EASTERN AND LOCAL MARBLES IN WESTERN CISALPINE

THE EXAMPLE OF DECORATED SARCOPHAGI

Abstract
Through new data obtained from petrographic analyses, the paper intends to re-consider the question of the presence in Piedmont (Regio XI) of sarcophagi produced in Ravenna or, instead, worked *in situ* on models from Ravenna or, even, completed for local clients on semi-finished products coming from the Adriatic. The group that will be analysed includes nine specimens, i.e. (1) an example with erotes and *tabula ansata* (Turin Museum); (2) a fragment of a shingled lid reused in the early Christian church of Santa Maria (under the present Cathedral of San Giovanni, Turin); (3) the sarcophagus of Didia Cratia (Vercelli, Museo Leone); (4) the sarcophagus of Lollia Procla (Vercelli, Museo Leone); (5) a fragment of an acroterium with lid (Vercelli, Museo Leone); (6) a fragment of a front, *tabula ansata*, with two erotes and inscription of the deceased, Metia Valeriana (now in the church of Santa Maria in Lucedio); (7) a fragment of a sarcophagus from Pollentia, with the inscription of the deceased Lollia (now in the Civic Museum of Bra); (8) the front of Acutia Sabina's sarcophagus (now reused in the facade of San Pietro in Cherasco); and (9) a fragment of a sarcophagus from Centallo with inscriptions mentioning Salvia Verina and Sextius Catesius Verus (now in the Civic Museum of San Francesco in Cuneo). The petrographic analyses allow us to assess new elements in order to reconstruct the stages of the arrival of the Ravenna-type sarcophagi in Piedmont and to highlight imports and imitations in local stones. The result will be a better understanding of the connectivity of the cities and areas of Regio XI which imported products from Ravenna and the possible existence of local workshops.

INTRODUCTION

This contribution aims to present work on the sarcophagi of the Regio XI Transpadana and (part of) Regio IX Liguria, corresponding to the present-day region of Piedmont, and the results of a recent petrological analysis. This is part of a broader study of the sarcophagi of the western Cisalpine area: the site of numerous sarcophagi and simple chests, without any architectonic or figurative decorations, which are made of diverse materials, namely gneiss and granites[1].

There are a few examples from the Piedmontese area of pieces which were imported (from Ravenna, and to a lesser extent, from Aquileia[2]) and/or which imitate imports. We have identified a total of 15 pieces.

The specimina under investigation are discussed in terms of:

1) the typology and style of the sarcophagus chests and figurative scenes, relating them to the lithotypes;
2) the routes of the lithotypes, through a topographical analysis of their distribution; and finally,
3) some considerations on the »chaîne de production«.

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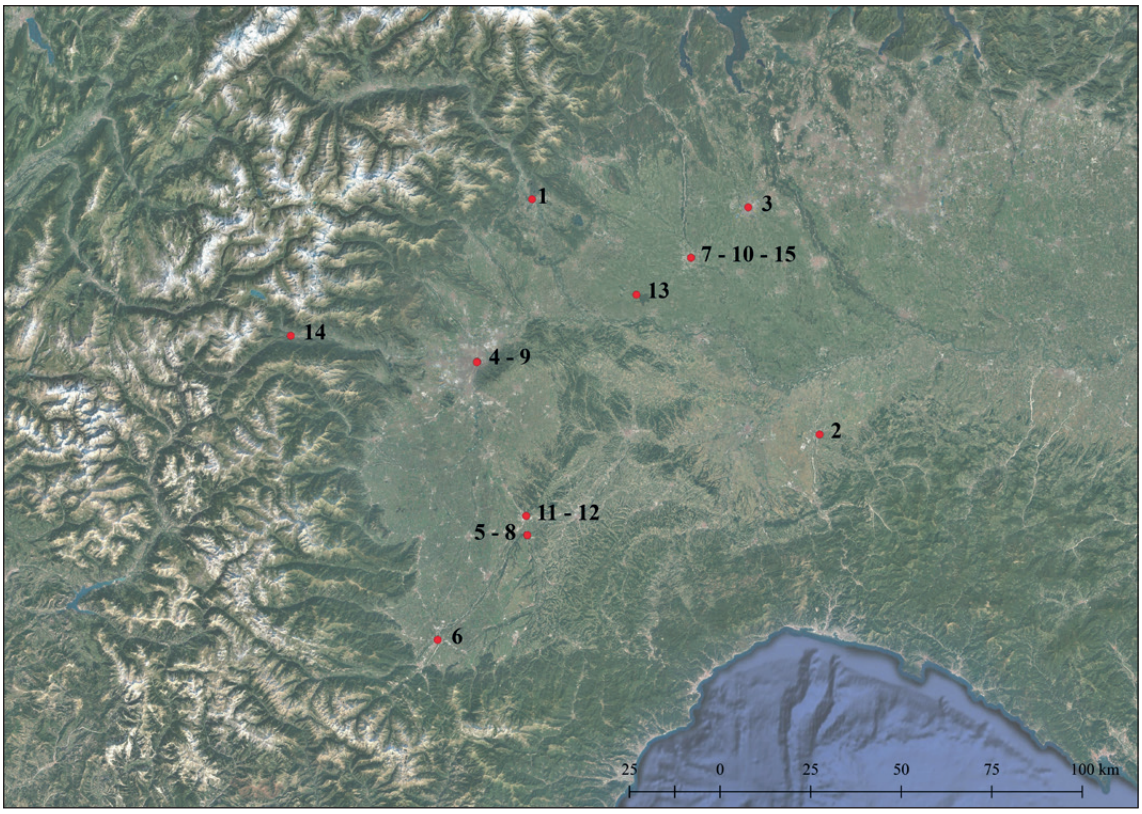
1 On decorated sarcophagi from Cisalpine, see Gabelmann 1973; Rebecchi 1977; Rebecchi 1978a; Rebecchi 1978b; Rebecchi 1978c; Kollwitz – Herdejürgen 1979; Koch – Sichtermann 1982, 281–287; Rebecchi 1990; Sapelli Ragni 2006; Ciliberto 2008; Ciliberto 2015; Gorrini – Robino 2015; Gorrini – Robino 2019; Gorrini – Robino – Prochaska 2024. On sarcophagi with simple chests, see Roda 1985 (Vercellae); Mennella 1999 (Novaria); Zoia 2018 (Milan region); see also the volumes of Supplementa Italica (Suppl. It.).

2 Rebecchi 1978b; Rebecchi 1978c; Canciani 1987; Pensabene 1987; Ciliberto 2005; Ciliberto 2007; Ciliberto 2008; Ciliberto 2012.



1 Distribution map of the analysed sarcophagi (© M. Robino)

We present here new analyses of four pieces; two are from Alpine quarries, one is in Thasian marble and one in Proconnesian marble. A fifth piece, which was too small to subject to isotopic analyses, has been provisionally identified as limestone[3]. In 2004, M. Gomez Serito published an autoptic analysis of two other pieces, both used as spolia in the façade of the church of San Pietro in Cherasco, in which he concluded that the front of the sarcophagus was Proconnesian marble and that the Eros was in Val Varaita marble[4]. We have also analysed the lid and the *tabula ansata* of an example from Turin, which has allowed us to identify stone from another local quarry, Valle Strona marble[5]. Eight pieces, out of 15, have been analysed and one is clearly limestone. This covers just above half of the corpus. We hope to continue this work on the remaining sarcophagi, previously identified as some form of marble, exclusively via autopsy. In the light of this, we will pursue the double approach (typology in relation to the lithotype) and, where this is not possible, make considerations based on typology (fig. 1; tab. 1).

M. E. Gorrini – F. Garanzini

THE SARCOPHAGI IN EASTERN MARBLES

The sarcophagi from Eporedia, Dertona, Novaria, Augusta Taurinorum, Centallo, Lucedio and the front from Cherasco have entered the literature as Proconnesian marble artefacts, but have not been subjected to microscope analysis, isotopic analysis, or analysis of the rare elements in trace amounts. The only confirmed example in Thasian marble is a sarcophagus from Pollentia (see below).

3 See W. Prochaska, below.

4 Gomez Serito 2004. On the Val Varaita quarry, see Gomez Serito 2011: this quarry has been exploited since the 1st cent. AD.

5 M. Robino in: Gorrini – Robino 2019, 77–80.

No.	Provenance and where preserved	Material and dimensions	Inscription	Typology	Description	Bibliography and date
1	Eporedia, Cathedral Church of Ivrea, crypt (reused as sarcophagus for the body of Saint Bessus)	Greek marble (?) or quartzite (?) H: 1.65 m L: 2.25 m D: 1.10 m	CIL V 6788 = InscrIt XI 4, 13	»Tabernakelsarkophag« Gabelmann 1973, B1	The deceased is portrayed twice on the front of the chest, under the arches which flank the epigraphic text. The two images follow the same pattern and present a man standing on a low podium, wearing a toga and holding a scroll in his left hand. Back side: Eros carrying a wreath. Short right side: Atecius Valerius is portrayed on a *sella curulis*, facing a *lictor*, in the exercise of his public offices. Short left side: damaged. The busts of the seasons appear in the acroteria of the lid	Controversial date: Gabelmann 1973, 94 no. 61: late Antonine-Severan; Rebecchi 1977, 118: late Antonine; Kranz 1984, 281 cat. 561 pl. 118, 1. 4: Antonine; Sapelli Ragni 2006, 96: *sine data*; Maritano 2008, 11 f.: *sine data*; Legrottaglie 2014, 81: 2nd half 2nd–3rd cent. AD
2	Dertona, Museo Civico Archeologico di Tortona (Alessandria)	Proconnesian marble (?) H: 1.82 m L: 2.39 m D: 1.09 m	CIL V 7380 and IG XIV 2277	Mythological sarcophagus (Aquileia-Grado group)	On the front, figures of Castor and Pollux frame a scene of the myth of Phaethon, the young hero falling from his chariot into the river Eridanus, watched by a shepherd (Cycnus [?]) with a ram. An inscription on the narrow band above this central scene explains that this was the monument of the otherwise unknown Antonia Tisipho for her son Publius Aelius Sabinus, who lived »for twenty-four years and forty-five days«. Above the heads of the Dioscuri Greek inscriptions (IG XIV 2277). On the short sides, erotes are watching a cockfight and playing dice. On the back, the central field is left empty, and the side fields are filled by two shepherds	Gabelmann 1973, 213: 2nd half 3rd cent. AD; Canciani 1987: Gallienic; Sapelli Ragni 2006, 95 f.: AD 270–290; Maritano 2008, 61: *sine data*; Ghedini – Salvo 2017: 2nd half 3rd cent. AD
3	Novaria, found in a secondary context in the Basilica of San Gaudenzio. Museo Lapidario, Novara	Thasian or Proconnesian marble (?) H: 1.05 m L: 0.87 m D (slab): 0.12 m	–	Mythological (?) daily life scene (?)	The subject, due to its fragmentary nature, could refer to a genre scene linked to the world of navigation	Sapelli Ragni 2006, 94 f.: last quarter 3rd cent. AD; Maritano 2008, 48: 2nd half 3rd cent. AD
4	Unknown provenance. Museo di Antichità di Torino	Proconnesian marble (Sapelli Ragni 2006) H: 0.57/0.60 m L: 1.45 m D: 0.65 m	–	»Truhensarkophag« Gabelmann 1973, A	Winged erotes in the act of supporting the *tabula ansata*. On the left, a fabric shop, on the right, a scene of the toilette of a woman	Koch – Sichtermann 1982, 287 n. 55: *sine data*; Mercando 2004, 60: AD 96–192 (Antonine period); Sapelli Ragni 2006, 97: *sine data*

Table 1 Decorated sarcophagi from Piedmont

No.	Provenance and where preserved	Material and dimensions	Inscription	Typology	Description	Bibliography and date
5	From Augusta Bagiennorum (?). Cherasco, reused in the front of the church of San Pietro	Proconnesian marble (?) (autopsy Gomez Serito 2004) L: 2.42 m H: 1.0 m	CIL V 7680; InscrIt IX 1, 33, cf. Suppl. It. 19, 2002, 211	»Truhensarkophag« Gabelmann 1973, A	Rectangular *tabula ansata*, framed by a simple cornice, sloping down towards the internal field. At the sides of the tabula are two erotes which are resting on a thin base	Mercando 2004, 60: AD 210–240
6	Centallo, or Pollentia, San Rocco. Museo di Cuneo	Proconnesian marble (Sapelli Ragni 2006, 99 [no analyses]); Bardiglio marble (InscrIt IX 1, 196) H: 0.52 m L: 1.26 m D: 0.32 m	CIL V 7655; InscrIt IX 1, 196, cf. Suppl. It. 19, 2002, 157	»Truhensarkophag«	The spaces at the sides of the tabula destined for the erotes have remained at a draft level and the text is inscribed directly on the chest, which has a moulded cornice running along its entire profile	Museum file: 2nd cent. AD
7	Vercellae, from the necropolis in the cathedral area. Vercelli, Museo Leone	Thasian marble H: 0.58 m L: 2.1 m D: 0.70 m	CIL V 6685	»Truhensarkophag« Gabelmann 1973, A	On the sides of the *tabula ansata* are two winged torch bearing Dolentes Cupidines (Mercando 2004, 61 f.), who are holding the tabula with one hand and, with the other, an extinguished torch, turned to the ground. On the short sides, two peacocks (?)	Mercando 2004, 61 f.: mid-3rd cent. AD; Sapelli Ragni 2006, 97: beginning of the 3rd cent. AD
8	Provenance not available. Reused in the façade of the church of San Pietro in Cherasco	Venasca or Brossasco marble, Bassa Val Varaita; (autopsy Gomez Serito 2004, 210. 217 n. 29) H: 0.3 m (Eros)	–	Likely from a »Truhensarkophag«	Eros carrying a torch	Betori 2004, 69: »between mid 1st cent. CE and mid 2nd cent. CE« (not acceptable); Sapelli Ragni 2006, 97: *sine data*, but 3rd cent. AD on the grounds of comparanda
9	Provenance not available. Reused as a floor slab in Santa Maria (present Cathedral of San Giovanni) in Turin	Val Varaita marble (analyses by M. Oddone)	–	Lid	Shingle lid and *tabula ansata* (not possible to establish if they belong to the same sarcophagus)	Gorrini – Robino 2019, 182–192: mid-3rd cent. AD
10	From Vercellae. Vercelli, Museo Leone	Alpine marble H: 0.615 m L: 1.5 m D: 0.665 m	CIL V 6693 (= CLE 610)	»Truhensarkophag« Gabelmann 1973, A	Two winged erotes on a tiny base at the sides holding *tabula ansata* with staples. Short sides: two garlands and ribbons; back unworked	Mercando 2004, 59 f.: »un po' più tardi del precedente«, i.e. mid–2nd half 3rd cent. AD; Sapelli Ragni 2006, 97: late 3rd cent. AD

Table 1 continued

No.	Provenance and where preserved	Material and dimensions	Inscription	Typology	Description	Bibliography and date
11	From Cascina Pedaggera (area of Pollentia). Bra, Museo Archeologico	Thasian marble H: 0.884 m L: 1.66 m D: 0.94 m *Tabula ansata*: 112 × 48 cm	–	*hapax*	The front is framed by a frame with strips and groove. The *tabula ansata* is framed by a strip frame and double rods	Unpublished. Mid-2nd half 3rd cent. AD
12	From Pollentia. Bra, Museo Archeologico	Proconnesian marble H: 0.44 m L: 0.8 m D: 0.08 m	G. Mennella in: Micheletto et al. 2004, 190 f.	Fragment probably from a »Truhensarkophag«	Top right fragment of the rounded corner of the *tabula ansata*	Sapelli Ragni 2006, 97 f.: early 3rd cent. AD
13	Provenance not available. Reused in the church of Santa Maria in Lucedio, Vercelli	Material n.d. H: 0.81 m L: 2.07 m	CIL V 6759 (Bruzza 1874, 82; Viale 1971, 60; Roda 1985, 172 f. n. 102)	»Truhensarkophag«	The front is framed by an undercut listel. The erotes are resting their feet on two bases. The double-framed *tabula ansata* has an unusual profile: the corners are rounded and a rounded extroversion is present at the mid-height of the short sides	Mercando 2004, 60 fig. 39: 2nd half 3rd cent. AD on the grounds of comparanda; Sapelli Ragni 2006, 97: *sine data*
14	From Segusium. Susa, Seminario Vescovile	Limestone H: 0.69 m L: 1.09 m D: 0.66 m	CIL V 7257; ILS 2138 p. 222–224)	sarcophagus-osteothek	*Tabula ansata* with two staples. On the back side, a pastoral scene	Sapelli Ragni 2006, 101: late 2nd cent. AD – beginning of the 3rd cent. AD
15	From Vercellae. Vercelli, Museo Leone	Limestone H: 0.175 m	–	Part of an acroterium of a lid	Male head pertaining to the right acroterium of a sarcophagus lid	Mercando 2004, 60: mid-3rd cent. AD; Sapelli Ragni 2006, 97 follows Mercando 2004

Table 1 continued

2 Front of the sarcophagus of Atecius Valerius, Eporedia, cathedral, crypt (© M. Robino)

Among the productions in local lithotypes, it is necessary to distinguish marble from Val Varaita (the eros from Cherasco) and Valle Strona (the lid reused in Turin Cathedral) from the generically Alpine marbles in the cases where it was not possible to identify the quarries (the sarcophagus of Lollia Procla from Vercellae and the sarcophagus of Didia Cratia from Vercellae, all analysed below). Lastly, there are two limestone specimens, the sarcophagus from Segusium/Susa[6] and the acroterium from Vercellae (tab. 1, nos. 14–15).

In terms of typology, one of the examples in Proconnesian marble is a »Tabernakelsarkophag«[7] in Eporedia[8] (tab. 1, no. 1). The deceased, a high-ranking municipal magistrate, is depicted twice on the front of the chest, under the arches flanking the epigraphic text. The two images follow the same pattern and feature a character standing on a low podium, wearing a toga and carrying a scroll in his left hand. Atecius Valerius himself is portrayed on the *sella curulis* on the right side, faced by a *lictor*, in the exercise of his public offices. A garland-holding eros occupies the entire rear side, while the busts of the seasons appear in the acroteria of the roof to show the continuous flow and renewal of time[9] (fig. 2). The layout and the workmanship on the four sides seem to echo the Ravenna productions, even though M. Sapelli Ragni prefers to attribute this piece to the Aquileia-Grado group[10].

6 On the sarcophagus of Segusium, see CIL V 7257; Ferrua 1967, 46 f.; Debergh 1978/1979, I 21 f.; II 54 f.; III 83 f.; Sapelli Ragni 2006, 94; Cimarosti 2008, 222–224 no. 59. The typological, lithological and iconographical specificity of the piece will be the object of a separate analysis.

7 Gabelmann 1973, 215 no. 61; Rebecchi 1978a; Rebecchi 1978b; Rebecchi 1978c.

8 On Eporedia, see Perinetti 1964; Brecciaroli Taborelli 1987; Cavaglià 1998; Gabucci – Pejrani Baricco – Ratto 2014. On the sarcophagus of Atecius, from Eporedia, see CIL V 6788; Gabelmann 1973, 112 no. 61; Rebecchi 1977, 118 f. 122–124; Koch – Sichtermann 1982, 287; Mercando 1990; Franzoni – Pagella 2002, 30 figs. 29–31; Sapelli Ragni 2006, 96 (with further literature at n. 20) pl. 18; Legrottaglie 2014, 81 fig. 90.

9 See n. 8.

10 Gabelmann 1973, 215; Rebecchi 1977, 122–124; Sapelli Ragni 2006, 96 (Aquileia-Grado); Legrottaglie 2014, 81 (Ravenna).

3 Front of the sarcophagus of Publius Aelius Sabinus, Dertona, Museo di Tortona (© M. Robino)

4 Fragment of a sarcophagus front from Novaria, Novara, Seminario Vescovile (© SABAP Novara)

There are also two special commissions. One with mythological scenes is the Dertona sarcophagus, from the second half of the 3rd century AD[11] (tab. 1, no. 2; fig. 3). On the front, the figures of Castor and Pollux frame a scene of the myth of Phaethon, the young hero falling from his chariot into the river Eridanus, watched by a shepherd (Cycnus [?]) with a ram. An inscription on the narrow band above this central scene explains that this was the monument of the otherwise unknown Antonia Tisipho for her son Publius Aelius Sabinus, who lived »for twenty-four years and forty-five days«[12]. Above the heads of the Dioscuri, two Greek inscriptions are lightly engraved: on the left, »to noble courage« (?); and, on the right, the commonplace consolatory phrase, »no one [is] immortal«. On the short sides, erotes are watching a cockfight and playing dice. On the rear, the central field is left empty and the side fields are filled by two shepherds. F. Ghedini, echoing H. Gabelmann, G. Koch, H. Sichtermann, and F. Canciani[13], included the Dertona piece among the Aquileia-Grado group on the grounds of the iconographical motif on the chest construction and on prosopographical evidence (arguing that both mother and son are from the Venetia area, and the piece from the workshop in that area). We agree that this is an isolated case, with a close parallel only with a specimen from Grado[14], and notice motifs from the Aquileia-Grado workshops, beside others of a different origin.

11 On Dertona, see Finocchi 2002; Maggi 2006. On the Dertona sarcophagus, see Rebecchi 1978a, 207 f. n. 11; Koch – Sichtermann 1982, 180–183; Canciani 1987, 415; Sapelli Ragni 2006, 95 n. 19; Ghedini – Salvo 2017 (with discussion of earlier literature). On the inscription, see CIL V 7580 = ILS 8169.

12 Ghedini – Salvo 2017, esp. 128 f., hypothesise, on epigraphical-prosopographical grounds, that the dedicants were originally from Aquileia or northeastern Italy, and they called on a workshop from that area to sculpt the sarcophagus of Aelius Sabinus. H. Gabelmann (1973, 90) proposed recognising a workshop of urban origin, which subsequently moved to Aquileia and, from there, to Dertona (whilst the material would have arrived at Dertona via the Po, from the port of Ravenna); F. Rebecchi (1978a, 207 f. n. 11) finds Gabelmann's hypothesis cumbersome and considered the sarcophagus the work of two workshops: local, northwestern, for the rear, and oriental for the front; S. Finocchi (2002, 182 f.) prefers assigning the work to a local atelier in Dertona.

13 Thomas 2012, 144 f. M. Sapelli Ragni (2006, 95 f.) leaves open the hypothesis of considering the inscription later than the monument.

14 F. Canciani (1987, 413–416) has highlighted the isolation of the two Grado slabs possibly belonging to the same sarcophagus, and concluded, on p. 416: »Resta comunque irrisolto il problema della definizione della bottega del gruppo Aquileia Grado, in cui confluiscono tante e così diverse tradizioni: urbana, attica, microasiatica, provinciale. La partizione architettonica ed alcuni particolari fanno pensare ad una bottega di provenienza orientale, che si sia adeguata nei temi alle esigenze della committenza locale.«

The second is a fragment of a sarcophagus slab from Novaria[15], with a navigation scene, which is dated in the second half of the 3rd century AD[16] (tab. 1, no. 3; fig. 4). The subject, due to its fragmentary nature, could be a genre scene linked to the world of navigation or an allegorical presentation of new Christian motifs[17]. For the Novaria piece, an urban production can be assumed on the basis of comparanda[18] and as indicated by the high stylistic rendering.

The other Proconnesian marble sarcophagi are »Truhensarkophage« and are from Turin, Cherasco, Centallo, Pollentia and Lucedio (tab. 1, nos. 4. 6. 8. 12–13)[19].

The Turin[20] sarcophagus (tab. 1, no. 4; fig. 5), dated to the Antonine age[21] is smaller than other examples decorated in Proconnesian marble (even though the typology is closely aligned with comparanda from both the Aquileia and Ravenna groups[22]). Secondly, the scenes on the short sides refer to subjects attested on stelae from western Cisalpine[23]. This suggests that this was an unfinished product, possibly completed in loco by a local workshop.

The front of the sarcophagus, reused in the church of San Pietro in Cherasco[24], is in Proconnesian marble (?) (tab. 1, no. 5; fig. 6). The erotes rest directly on the tabula without handles and this piece can be dated to the end of the 2nd century AD on account of the hardness of the rendering of the wings, the drapery and a profound use of the drill in the hair[25]. Unfortunately, nothing is known of the deceased, Acutia Sabina, although we may note that her husband has a very Celtic name, Q(uintus) Vequasius Fortunatus[26]. In its current location, the sarcophagus cannot be properly examined, and consequently, it is difficult for us to comment on the production chain or on the origin of this model. There are comparanda in Aquileia and Ravenna[27], although the height of the erotes seems to differ from the Ravenna models (following F. Rebecchi[28]) and to be closer to Aquileian specimens, based on the rendering of the erotes of Canius Restitutus in Grado from the Antoninine period[29].

15 On Novaria, see Spagnolo Garzoli – Gambari 2004.

16 Slavazzi 1999, 123 no. 10.

17 Uglietti 1985; Slavazzi 1999, 123 fig. 10; Sapelli Ragni 2006, 95.

18 The closest comparandum is the sarcophagus of the Nereids from the catacombs of Praetextatus, see Gütschow 1938, 57–65; Rumpf 1939, 34; Grabar 1980, 102.

19 None of them has been analysed: establishing that they are in Proconnesian marble is exclusively based on autoptic examination by M. Gomez Serito, whilst it is totally hypothetical to consider the other two Proconnesian (Centallo and the ›inaccessible‹ Lucedio fragment).

20 On Roman Augusta Taurinorum, see Grazzi 1981; Mercando 1998; Mercando 2003.

21 On this sarcophagus, see Rodenwaldt 1942, 225 tab. 17, 2; Koch – Sichtermann 1982, 287 n. 55; Mercando 2004, 53–65 figs. 36–37; Sapelli Ragni 2006, 97.

22 Comparanda (according to Rebecchi 1977, 132–142, with plates and further literature): Ravenna, Santa Maria Maggiore, sarcophagus Rasponi, late Hadrianic (head of the series); Ravenna, San Francesco church, sarcophagus of the Del Sale family; Ravenna, sarcophagus of Martinus Strozzi; Ariminum, front of the sarcophagus of Claudia; Adria, Terentia Capitolina; Vicentia, sarcophagus of the Seasons; Mutina, sarcophagus from the Piazza Matteotti; Mantua, sarcophagus of Pompeia Celerin.

23 Mercando – Paci 1998, 114–116 no. 51–52.

24 Micheletto – Moro 2004, 53–65 figs. 30–31; Maritano 2008, 77–102; for the material, see Gomez Serito 2004, 218 (Proconnesian).

25 F. Rebecchi (1984, 56 n. 2) dates it to the 2nd decade of the 3rd cent. AD, based on comparison with the sarcophagus of Marcus Aurelius Prosenes in Rome; L. Mercando (2004, 53) prefers a date at the beginning of the Severan age, based on the structure of the tabula and the formula of the inscription. Rebecchi (1977, 114 pl. 54, 2) compares it with a fragment of a sarcophagus from Argenta, Pieve di San Giorgio; with the sarcophagus of Vettonius Maximus (Sant'Eulalia, Asolo; see also Rebecchi 1978a, 244); and with the sarcophagi of Titus Canius Restitutus (Grado) and Prosenes (the so-called Nero's tomb); see also Sapelli Ragni 2006, 98.

26 CIL V 7680; InscrIt IX 1, 33; Suppl. It. 19, 2002, 211.

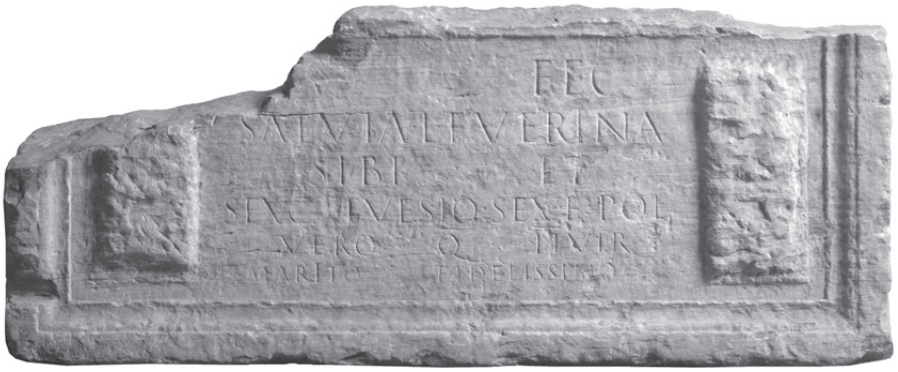
27 See above n. 25.

28 Rebecchi 1984, 43 n. 2.

29 Rebecchi 1977, 117; Canciani 1987, 410.

5 Sarcophagus from Turin, Museo di Antichità 625 (© SABAP Torino)

6 Front of the sarcophagus of Acutia Sabina, Cherasco, Cuneo, Chiesa di San Pietro (© M. E. Gorrini)



7 Front of a sarcophagus from San Rocco, Centallo, now in Cuneo, Museo Civico (© SABAP Cuneo)

The sarcophagus from Centallo[30] (tab. 1, no. 6; fig. 7) has also been identified as Proconnesian marble[31]. In this case, however, the spaces at the sides of the tabula destined for the erotes have remained at a draft level and the text is inscribed directly on the chest, which has a moulded cornice running along its entire profile. This clearly indicates that this piece arrived half-finished and had to be completed on-site. The deceased are Salvia Luci filia Verina and her husband, Sextius Catesius of the tribe Pollia, *quaestor* and *duovir* at a time between the end of the 2nd and the beginning of the 3rd century AD[32].

The fragment (tab. 1, no. 12; fig. 10) from Pollentia of a sarcophagus for another Lollia is comparable with the fragment from Lucedio, also a »Truhensarkophag«. This is clear from the rounded corner of the tabula, but the state of preservation of the fragment does not allow us to identify its typology.

In the church of Lucedio[33] (tab. 1, no. 13) there is a slab which was reworked in the Middle Ages. Unfortunately, it was not possible to conduct an autoptic examination, the piece having been packed away in a church, privately owned, for over a decade. The morphology of the tabula, the pedestals on which the erotes stand and the apparently coarse stylistic treatment all suggest that at least part of the workmanship was executed *in situ* (assuming it is Proconnesian)[34]. This artefact can be dated, on stylistic grounds, to the second half of the 3rd century AD and reflects models from Ravenna[35]. Unfortunately, the name of the deceased, Metia Valeriana, is otherwise unknown.

The only example of a sarcophagus in Thasos marble (tab. 1, no. 11) is the unpublished specimen recently recovered in the vicinity of Pollentia[36]: it is a *hapax*, as is indicated by the presence of the staple motif inverted towards the inside of the tabula, a mark, probably, of a local workshop. The sarcophagus was identified following seizure by the Nucleo Carabinieri Tutela Patrimonio Culturale of Turin, within the context of a broader investigation of archaeological looting within the province of Cuneo. The sarcophagus almost certainly comes from the necropolis area of Pollentia, known since the 19th century and partially investigated in the 20th century, and, more precisely, from Cascina Pedaggera, on the road between Pollenzo and Cherasco[37]. Other Thasian marble sarcophagi in western Cisalpine are from Lambrate[38] and the chest from Sant'Aquilino, analysed by W. Prochaska[39].

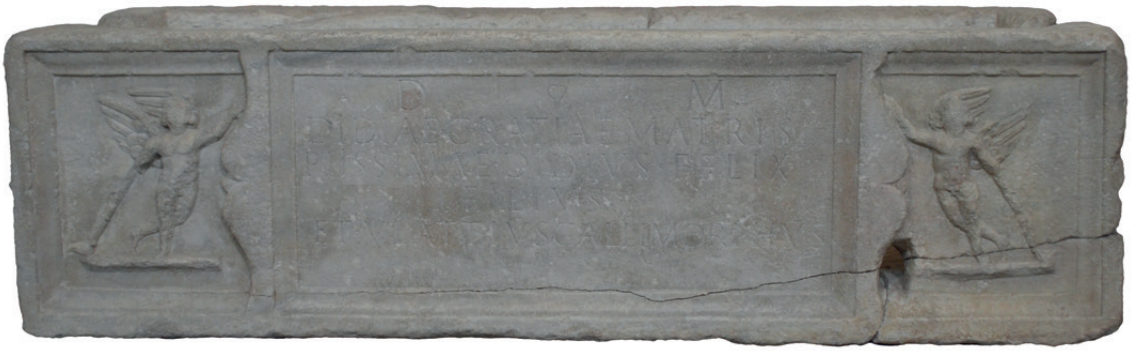
F. Garanzini – S. G. Lerma

THE SARCOPHAGI IN LOCAL MARBLES

The second macro-category of lithotypes includes marble artefacts from Val Varaita and generic Alpine marbles[40].

The Val Varaita cases include the mourning Eros, reused in the façade of San Pietro in Cherasco (tab. 1, no. 8). This is a variant of a well-known Adriatic type: the legs are not crossed but are parallel. It has been dated to the Antonine age, but we could suggest the Severan age, for stylistic

30 Sapelli Ragni 2006, 99.
31 Sapelli Ragni 2006, 99, but the museum file reports »Marmo di Bardiglio di Valdieri«.
32 CIL V 7655; InscrIt IX 1, 196; Suppl. It. 19, 2002, 157.
33 Destefanis 2007, 76. 96 f.
34 Sapelli Ragni 2006, 97.
35 The typology and the position of the erotes allow us to cite, as comparanda, the sarcophagus of Martino Strozzi, Ravenna, and the sarcophagus of Pompeia Celerina, Mantua (Rebecchi 1977, pls. 63, 1; 64, 1); the tabula's shape echoes the relief on the sarcophagus of Mindia Procilla, Museo Nazionale Ravenna, 3rd quarter of the 3rd cent. AD, see Kollwitz – Herdejürgen 1979, 45 f. A55; Bencivenni 2020, 407 figs. 1. 2 b.
36 On Pollentia, see Panero 2000, 131–144; Filippi 2006.
37 Filippi 1991; Filippi 2006, with literature.
38 Herrmann – Tykot – van den Hoek 2018; Gorrini – Robino 2019, 183; Gorrini – Robino – Prochaska 2024.
39 Sena Chiesa 2018, 169; Gorrini – Robino – Prochaska 2024.
40 W. Prochaska's database is not specific for the Western Alpine areas.



8 Front of the sarcophagus of Didia Cratia from Vercellae, Vercelli, Museo Leone (© M. E. Gorrini)

9 Front of the sarcophagus of Lollia Procla from Vercellae, Vercelli, Museo Leone (© M. E. Gorrini)

reasons[41]. The shingle lid, reused in the floor of Santa Maria (under the present Cathedral of San Giovanni) in Turin, is in Valle Strona marble (tab. 1, no. 9). The comparanda are numerous and indicate that it is a reproduction of excellent models from Ravenna or Aquileia, to be dated to the middle of the 3rd century AD[42].

The generic local marble artefacts include the Lollia Procla sarcophagus from Vercellae[43] (tab. 1, no. 10; fig. 9) and the piece[44] for Didia Cratia, likewise from Vercellae (tab. 1, no. 7; fig. 8), dated to the beginning of the 3rd century AD, also a »Truhensarkophag« with a tabula framed by a staple motif with torch-bearing erotes. If the layout of Didia Cratia's sarcophagus is fully in line with the Ravenna models, as shown by the comparanda[45], the birds, probably peacocks, carved on the short sides, as well as the torch-bearing erotes, unique in their posture, allow

41 See Gabelmann 1973, 209 no. 24 (fragment of a sarcophagus from Brescia, Museo Romano); Rebecchi 1977, pl. 65, 1 (sarcophagus of M. Aufidio Fronto, Pesaro); Kollwitz – Herdejürgen 1979, 40 f. A44 (sarcophagus of M. Aurelius Macedo, Ravenna); Pilutti Namer 2012; Calvelli 2014 (sarcophagus of Barbula, Murano).

42 Sapelli Ragni 2006, 97; Gorrini – Robino 2019, 183. Comparanda: from Rimini: sarcophagus lid, Musei Civici (Rebecchi 1977, pl. 74, 2); from Ravenna: sarcophagus of Victorinus, lid, Museo Arcivescovile; sarcophagus of Vibius Protus; sarcophagus of Giardino di San Vitale (Kollwitz – Herdejürgen 1979, 45 f. A53; 47 A59; 47 f. A60; 32 f. A27).

43 Gabelmann 1973, 221 no. 87; Mercando 2004, 59 f.; Sapelli Ragni 2006, 97.

44 Gabelmann 1973, 221 no. 86; Sapelli Ragni 2006, 97; Sommo 2008, 36 f.

45 Rebecchi 1978a, 243 pl. 3, 2. See sarcophagus of Acculeius, from Acelum (Luciani 2012, 25) and sarcophagus from the Piazza Matteotti, Mutina (Giordani – Paolozzi Strozzi 2005, 134 f.).

us to hypothesise that local workshops completed the piece. Nothing is known about the deceased lady, whose sarcophagus was dedicated by her son Didius Felix and her freedman, Ulattius Callimorphus[46]. The sarcophagus of Lollia Procla, a young woman whose parents also dedicated a metric composition, is a »Truhensarkophag« with *tabula ansata* in staples, with the placement of the two erotes, somewhat coarsely rendered stylistically, following the models from Ravenna and Aquileia[47]. On both short sides, garlands and ribbons fill the space.

The limestone examples include the Susa specimen (tab. 1, no. 14), which will be analysed elsewhere, and the acroterium from Vercellae (tab. 1, no. 15), which is part of the very long series of comparisons of shingle lids with acroteria but which are made of a local material[48].

M. E. Gorrini

PROVENANCE ANALYSES OF MARBLES OF SELECTED ARTEFACTS

From four of the investigated sarcophagi, samples could be obtained in order to carry out scientific analyses to investigate the provenance of the marbles. These are the samples Pollentia nos. 11 and 12 and Vercellae nos. 7 and 10. Both Pollentia samples are medium- to fine-grained calcitic marbles, while the Vercellae samples are fine-grained marbles with dolomitic contents. The calcite marble samples from Pollentia were matched with comparable marbles in the databank. For the fine-grained dolomitic samples, we do not have any comparable examples in our databank, thus it is assumed that these marbles are of local origin from the Western Alps.

For the purpose of provenance analysis, the samples were thoroughly cleaned and powdered in an agate mortar. An aliquot of 0.1 g was used for the chemical analysis by inductively coupled plasma mass spectrometry (ICP-MS) of a large number of main and trace elements. Furthermore, stable isotope analysis (carbon and oxygen isotopes) was performed on the powdered material.

For the Pollentia calcite marbles, the analytically obtained variables were evaluated by means of a multivariate statistical analysis and compared to their most probable source area. Therefore, on account of the chemical, isotopic and petrographic characteristics of the samples, probable source areas were chosen for comparison from medium- to coarse-grained marbles, while fine-grained marbles were excluded a priori. The white medium- to coarse-grained calcite marbles from the island of Thasos were chosen for comparison because of the obvious isotopic and chemical similarity of this famous marble site with the sample Pollentia no. 11. For sample Pollentia no. 12, two types of Proconnesian marble were chosen as the reference material because of their outstanding importance for the production of sarcophagi and again because of the isotopic and chemical similarity. The marbles from the island of Paros, Herakleia Miletos or other medium-grained marbles were excluded a priori because of their evidently different isotopic or chemical properties. Because of their special chemical features, the marbles from the Harmantaş and Aksoy quarries were separated as Prokonnesos III from the bulk of the Proconnesian marbles. The analytical data obtained were compared with our databank of more than 4,500 quarry samples[49].

Pollentia nos. 11 and 12

Unfortunately, the samples available were too small to allow the preparation of petrographic thin sections. Macroscopically, Pollentia no. 11 is coarse-grained with a maximum grain size of about 3 mm.

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46 CIL V 6685; Roda 1985, 52. On the gens Ulattia in Piedmont, see Antico Gallina 1980/1981, 142.

47 CIL V 6693; Roda 1985, 58–63. Comparanda: Ravenna, fragment of a sarcophagus for Iulia (Kollwitz – Herdejürgen 1979, 46 A56); Ariminum, sarcophagus of Martinus dux (Rebecchi 1977, pl. 66, 3); Ferrara, sarcophagus of Neon (Rebecchi 1977, pl. 74, 1); Monza, sarcophagus of Audasia Cales (Rebecchi 1990; Zoia 2018, 167. 170 f. fig. 48).

48 Gorrini – Robino 2019; Gorrini – Robino – Prochaska 2024.

49 Prochaska – Attanasio 2021.

10 Fragment of the sarcophagus of Lollia from Pollentia, Bra, Museo Civico (© M. E. Gorrini)

	Distance	Absolute probability	Relative probability	Provenance	Relative probability	Provenance
	1st Choice				2nd Choice	
Pollentia 11	0.89	64.3	100.0	Thasos	–	–
Pollentia 12	1.62	44.4	100.0	Prokonnesos	–	–

Table 2 The calculated numerical probabilities for the assignment of the investigated samples to their source region

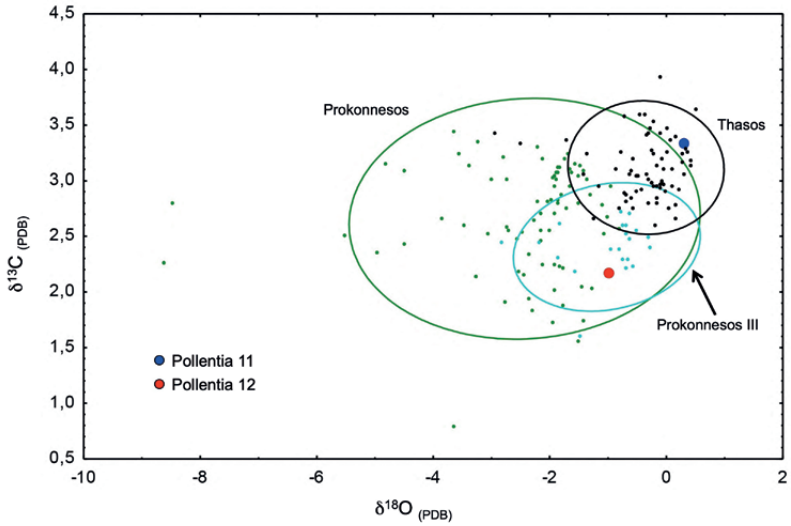
In the isotope diagram, the selected data fields overlap considerably. Thus, a clear and safe assignment on this basis is not possible, as can be seen in figure 11.

A much better separation of the data fields and a better assignment of the investigated samples can be achieved through a statistical discriminant analysis using a much larger set of analysed variables ($\delta^{18}O$ ‰, $\delta^{13}C$ ‰, manganese [Mn], iron [Fe], chromium [Cr], strontium [Sr], vanadium [V], barium [Ba], cadmium [Cd], yttrium [Y], lanthanum [La], cerium [Ce], ytterbium [Yb] and uranium [U]). The graphic display of the results is shown in figure 12. The calculated probability of the corresponding assignments is given in table 2. Accordingly, the absolute probability for an origin of sample Pollentia no. 11 from the quarries of the island of Thasos is 64 %, the marble of the sarcophagus Pollentia no. 12 comes from Prokonnesos Island with a relative probability of 44 %. In both cases the absolute probability is 100 %, which means that there is no serious alternative available for another provenance instead of the calculated Thasos and Prokonnesos.

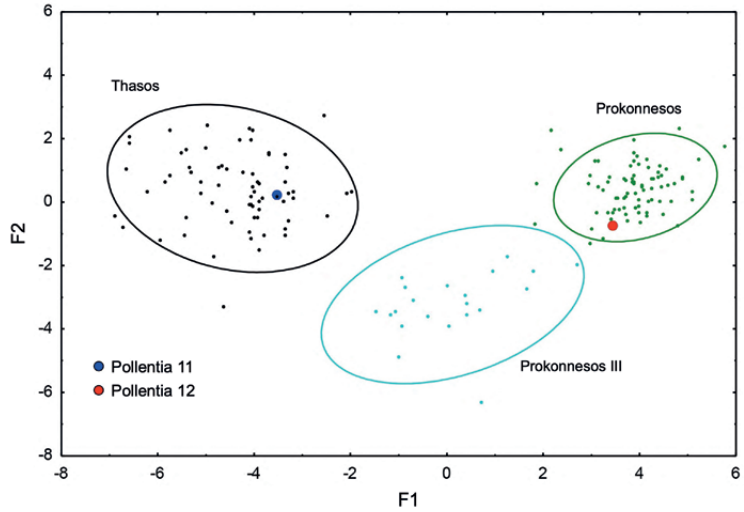
Vercellae nos. 7 and 10

As previously mentioned, these samples are fine-grained marbles with different dolomitic contents. The calculated dolomite content of sample no. 7 is approx. 80–90 % and 10–15 % for sample no. 10.

None of the dolomitic marbles in our databank correlate with these two samples. This suggests that these marbles originate from local sources in the Western Alps. The dolomitic marbles from Domodossola/Piedmont (modern brand name is Palisandro) can be excluded for chemical



11 Isotope diagram of the investigated samples. Also on display are the data fields for Thasos, Prokonnesos and Prokonnesos III (© W. Prochaska)



12 Bivariate diagram of the two canonical factors of the discriminant analysis (© W. Prochaska)

reasons. Marbles from the Penninic units of Piedmont also do not fit with the oxygen-isotope composition[50]. The best fit in the isotopic composition of the investigated dolomitic marbles is with the Piedmont marbles of Crevola[51]. However, more data from quarry samples have to be acquired for a sound provenance analysis.

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CONCLUSIONS

Considering the lithotypes and types of production, it appears that river systems were exploited whenever possible.

In fact, we may say that all of the sarcophagi which are known, or suspected, to be made from imported marble are located along waterways: Vercellae and Lucedio (Sesia, a left tributary of the

[50] Vola et al. 2022.
[51] Barbin et al. 1991; Borghi et al. 2009.

Po), Eporedia (Dora, also a left tributary of the Po), Novaria (Agogna, again a left tributary of the Po), Turin (on the Po), Cherasco and Centallo (on the Stura di Demonte, a right sub-tributary of the Po via Tanaro). We can assume the presence of an integrated transport system by ship along the Po, as far as it was navigable, and then by barge, limiting land transport as much as possible[52].

As far as local marbles are concerned, the only quarries determined by petrological analyses are those in Val Varaita. In this case too, it is possible to reconstruct part of the river transport system, via the Varaita itself, which ends as the first right tributary of the Po in Turin, while for Valle Strona, the Sesia would most likely have been used[53].

In terms of the »chaîne de production«, with the exception of Novaria[54], it seems reasonable to hypothesise local workshops able to translate or adapt the models from Ravenna and Aquileia to the tastes of the patrons, both in imported marbles and in local lithotypes, and so to satisfy the often particular requests (e.g. Dertona and Eporedia) of a local élite.

Our work, however, is only at a preliminary stage, as a number of pieces have not yet been subjected to petrographic analyses, a necessary phase to dispel any lingering doubts. This work, alongside fieldwork exploration for unrecorded sarcophagi and the study of non-marble sarcophagi, starting with their dimensions, and concluding with lab analyses as well as the prosopography of the patrons, will complete the picture sketched so far.

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[52] In general, on river navigation in Roman Cisalpine, see Uggeri 1978; Uggeri 1990; Medas 2017; Gabucci 2018, 42–46.

[53] Frisa Morandini – Gomez Serito 1998; Frisa Morandini – Gomez Serito – Zanda 2002; Frisa Morandini – Gomez Serito 2003; Borghi et al. 2009; Gomez Serito 2019.

[54] Slavazzi 1999, 123.

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›ROCKY MOUNTAINS‹ IN NORTHERN NORICUM

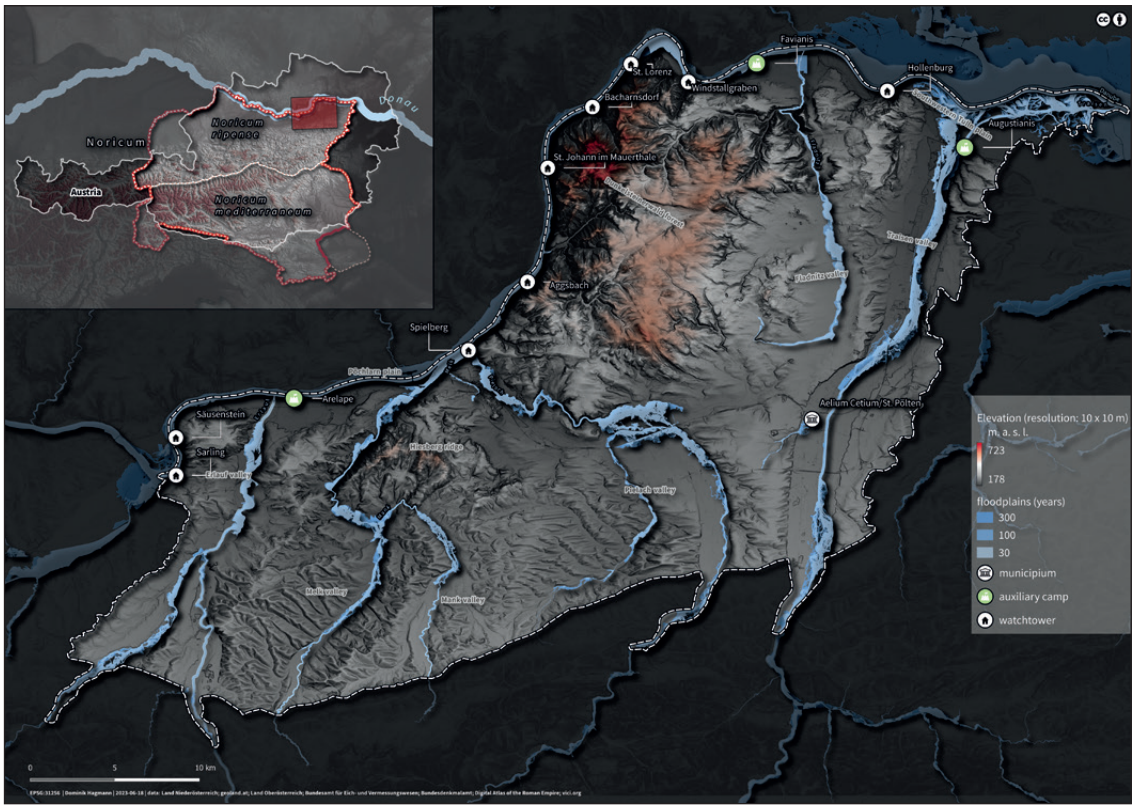
NEW INSIGHTS INTO THE INTRA-REGIONAL AND SUPRA-REGIONAL ORGANISATION OF THE ECONOMY OF STONES

Abstract
Building on a poster presentation for the ASMOSIA XIII conference, this paper offers fresh insights into ancient Roman mining, processing, and distribution of extracted materials on an inter- and supraregional scale. The focus area is situated in the northern part of the province of Noricum, in the hinterland of the former Roman border, along the so-called Danube Limes between the rivers Erlauf and Traisen in present-day Lower Austria (Austria). This study was a component of the author's PhD project, »Roman Rural Landscapes in Noricum«. The area, a portion of the southern Bohemian Massif located south of the Danube, functioned as a regional-scale mining domain for conglomerate rocks and, on occasion, marbles (such as the well-known Hiesberg, Häusling, Lunzen, and Großweichselbach marbles) during Roman times. The immediate vicinity of the mining areas, currently known as the Dunkelsteinerwald forest and Hiesberg mountain, was sparsely populated in ancient times. Even today, it remains heavily forested and, in parts, impassable. Drawing from previous scientific, petrographic, and cultural studies on this area, a new economic model for stone processing enterprises in a Roman micro-region on the outermost periphery of the Roman Empire will be proposed. Considering current datasets on existing natural geological resources, all archaeologically relevant information regarding the economical use of local stones during the Roman Imperial period and Late Antiquity has been incorporated into a geographical information system (GIS). The goal was to evaluate this information with new GIS-based data on rural settlement locations and ancient transportation paths, as informed by tailored least cost analyses. This approach sought to uncover the local, intra- and supraregional dynamics of economic activity in stone quarrying and related products in the area under investigation. Based on an archaeological assessment of the finds and features, the GIS-based analysis indicates an increase in findings within zones favourably located for transport along reconstructed paths, as determined by least cost analyses. The abundance of stone monuments in the same area, along with evidence of a local Roman stonemason's workshop, suggests a rural settlement/vicus in the vicinity of present-day St. Leonhard am Forst/Ruprechtshofen. This centre likely supplied adjacent settlement sites (villas, auxiliary forts, towns) with its products.

INTRODUCTION

The rural settlement of northern Noricum, i.e. roughly the region along the Danube in the southern Upper Danube River Basin (sUDRB)[1], must be characterised as rather understudied, especially concerning non-military settlement between the rivers Erlauf and Traisen, and especially in comparison to northwestern Noricum[2]. In order to address the gap in research and gain fresh insights into local, intra- and supraregional dynamics of economic activity in the lapidary field and related products in the investigated area, a novel model is presented. This model outlines the economic operations of lapidary businesses in a Roman micro-region, located on the farthest periphery of the Roman Empire. Prior scientific, petrographic, and cultural studies of the area have been integrated with new GIS-based data on rural settlement locations and ancient transportation paths, as informed by tailored least cost analyses. This study formed part of the author's PhD project titled »Roman Rural Landscapes in Noricum«[3].

1 Fehér – Muerth 2015; Stagl – Hattermann 2015; Zoboli et al. 2015; Sommerwerk et al. 2022.
2 Hagmann 2019.
3 Hagmann 2022.



1 AOI in present-day Lower Austria (Austria) encompassing the region between the rivers Erlauf, Danube, and Traisen, including an indication of its location during ancient Roman times in northern Noricum (graphics: D. Hagmann; data: Province of Lower Austria; geoland.at; Province of Upper Austria; Bundesamt für Eich- und Vermessungswesen; Bundesdenkmalamt; Digital Atlas of the Roman Empire; vici.org)

MATERIALS

Area of Interest (AOI)

The area under investigation is in the north of the province of Noricum in the hinterland of the former Roman borderland, along the so-called Danube Limes[4] between the rivers Erlauf and Traisen in the present-day county of Lower Austria (Austria) (fig. 1). In Roman times, this area was a regional-scale mining domain of conglomerate rocks and, sporadically, also of marbles. The immediate vicinity of these mining areas was hardly populated in ancient times. Even now, it is still relatively scarcely populated, heavily forested and, in places, impassable due to steep slopes.

The paper focuses on the so-called Dunkelsteinerwald forest and Hiesberg mountain, both located in the AOI. They are integral parts of the Bohemian Massif in Lower Austria, south of the Danube. The Dunkelsteinerwald forest is a hilly region situated between the towns of Melk and Mautern an der Donau (ancient *castellum* of Favianis). This landscape, reaching elevations of up to 700 m asl, is currently shaped by forestry and agriculture, reflecting the region's predominantly rural character (fig. 2). The Hiesberg mountain, located to the west of the Dunkelsteinerwald forest, is a ridge running from east to west and reaching its highest point at 558 m asl. This approx. 8 km-long ridge is mostly covered with mixed forest and is separated from the Dunkelsteinerwald forest by the Pielach Valley (fig. 3). Both the Dunkelsteinerwald forest and the Hiesberg mountain are bounded by the Danube Valley to the north; while the former is

4 Schwarcz 2022.

2 Drone-based view of a northern area of the Dunkelsteinerwald forest next to the *burgus* Windstallgraben (01.05.2020) (photo: D. Hagmann, in collaboration with A. Steininger, ArchaeoPerspectives GesbR [operator unmanned aerial vehicle/UAV])

3 View (to north) to the foothills of the Hiesberg mountain (from the south), next to site no. 32 (13.09.2022) (photo: D. Hagmann)

bounded by the Fladnitz Valley to the southeast, the latter is bounded by the Mank and Melk river valleys to the south.

Selected Roman rural sites, which can be interpreted as civil and military settlements (villa-/non-villa settlements and military stations such as camps or watchtowers), were used for the study. A special characteristic of the AOI is the presence of Roman mining districts, which did

not have iron ore deposits or the like for producing the commonly highly valued *ferrum Noricum*, which was already considered typical for Noricum in antiquity[5]. Instead, it was a matter of various construction and worked raw materials, which are also not rare in Noricum. Just think of the marble mining area of Spitzelofen in today's Carinthia, which S. Karl discussed in detail in a volume in 2021[6], while W. Prochaska explicitly dealt with the inland Noric marble quarry areas in 2021[7]. The solid rocks and sediments (mainly various sands) of the study area discussed below served especially as building materials and as architectural elements. Until recently, extensive information on the hinterland of Iuvavum/Salzburg was available via the online information portal »IVVAVUM – Roman Stones in the Bavarian-Austrian Border Area«[8]; in addition, data on natural resources and related aspects continue to be accessible through the web-based, interactive raw material information system »IRIS online«[9].

Petrographic studies directly concerning the ancient raw materials of northern Noricum – and thus the AOI – were also pursued in the 2000s by a group of researchers led by C. F. Uhlir and W. Müller[10]. A general overview of mining areas in the Roman Empire was published in 2013 by B. Russell, who draws mainly on the sources above[11].

Some mining areas in the AOI are overlaid by the post-antique use, which is the main reason why the marbles were not studied based on specific Roman sites, but especially through petrographic analysis of the Noric stone monuments, which allowed them to be linked to the corresponding precincts. The fact that, unsurprisingly, various raw materials were used on-site in *villae* as part of a possibly extensive raw material and production chain is shown, for example, by a lime pit lined with wooden boards from the *pars rustica* of the villa of Petzenkirchen (site-ID 13), which could have related to the slaking of building lime for the local construction activities[12]. Just as in the case of the petrographic analysis of the stone monuments, however, for the AOI, it is mostly only indirect evidence that can point to a raw material extraction – although admittedly, features such as pits could in many cases also be interpreted as quarries or similar installations. Still, there is mostly a lack of valid evidence that could prove a corresponding use.

MATERIALS AND METHODS

Geology and Soils

Lower Austria encompasses several key geological units, each defined by their respective ages and rock properties, contributing to the region's diverse landscape. Particularly noteworthy are the Bohemian Massif, the Molasse Zone, and the Flysch Zone. The Bohemian Massif, an ancient geological unit, forms the northern part of Lower Austria. This significant landform is the remnant of a mountain range from the Late Palaeozoic era (approx. 360–300 million years ago), which has been heavily influenced by erosion. In Lower Austria, the Bohemian Massif belongs to the Moldanubian section, characterised by its hilly yet partly impassable terrain due to steep inclines. The massif is composed of a variety of rocks, including granites and gneisses, granulites, mica schists, and, in some places, marbles, many of which are visible on the surface. Contrasting with the age of the Bohemian Massif is the younger Molasse Zone, which was formed about 40 million years ago during

5 Cf. e.g. Cech 2017. On the written sources mentioning *ferrum Noricum*, cf. e.g. Ov. met. 14, 711–715; Strab. 5, 1, 8; Plin. nat. 34, 144–145. See Hofeneder 2017.

6 Karl 2021.

7 Prochaska 2021.

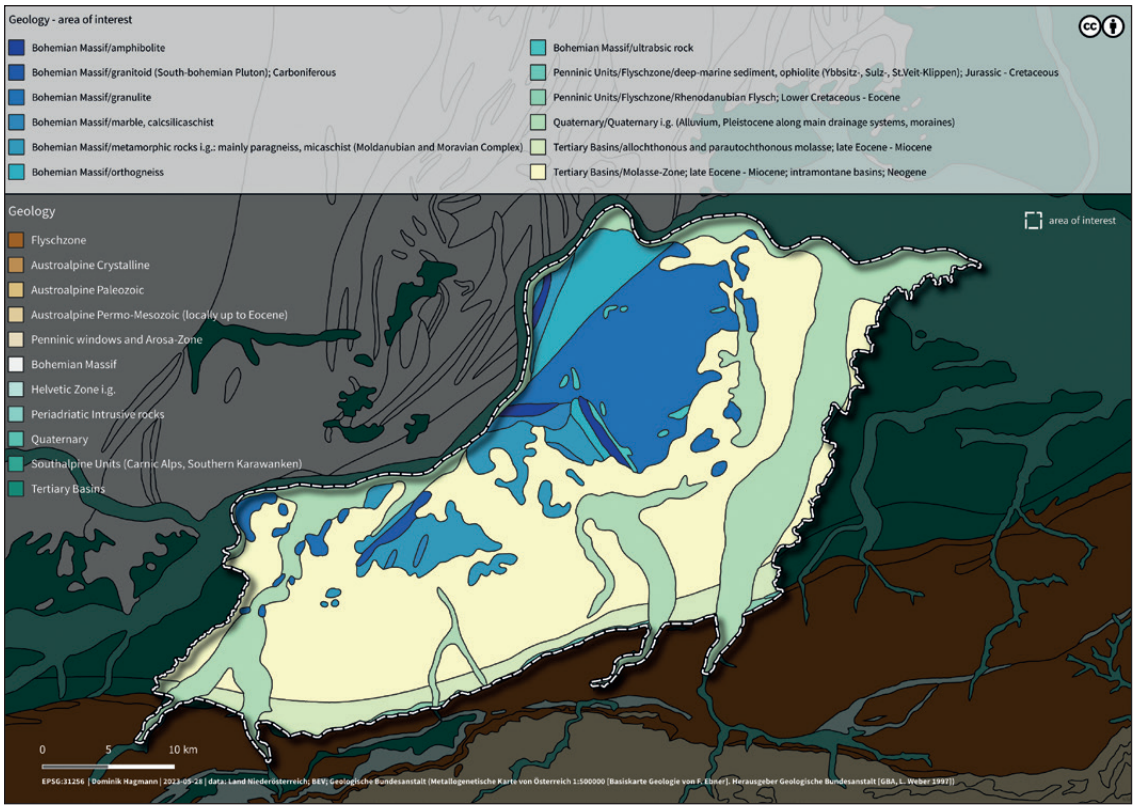
8 The project appears to be offline at the moment – it was originally accessible via the link <http://iuvavum.org/> (01.04.2025).

9 <https://gis.geosphere.at/iris> (01.04.2025). See Weber – Schedl – Lipiarski 2019.

10 Uhlir – Müller 2006. See Müller et al. 2004; Traxler – Uhlir – Hemmers 2008; Cemper-Kiesslich et al. 2010.

11 Russell 2013.

12 Morschhauser 2018, D3472; Hagmann 2019.



4 Geological map of the study area (graphics: D. Hagmann; data: Province of Lower Austria; Bundesamt für Eich- und Vermessungswesen; GeoSphere Austria (Metallogenetic Map of Austria 1:500000 [base map geology by F. Ebner]. Published by GeoSphere Austria [Weber 1997])

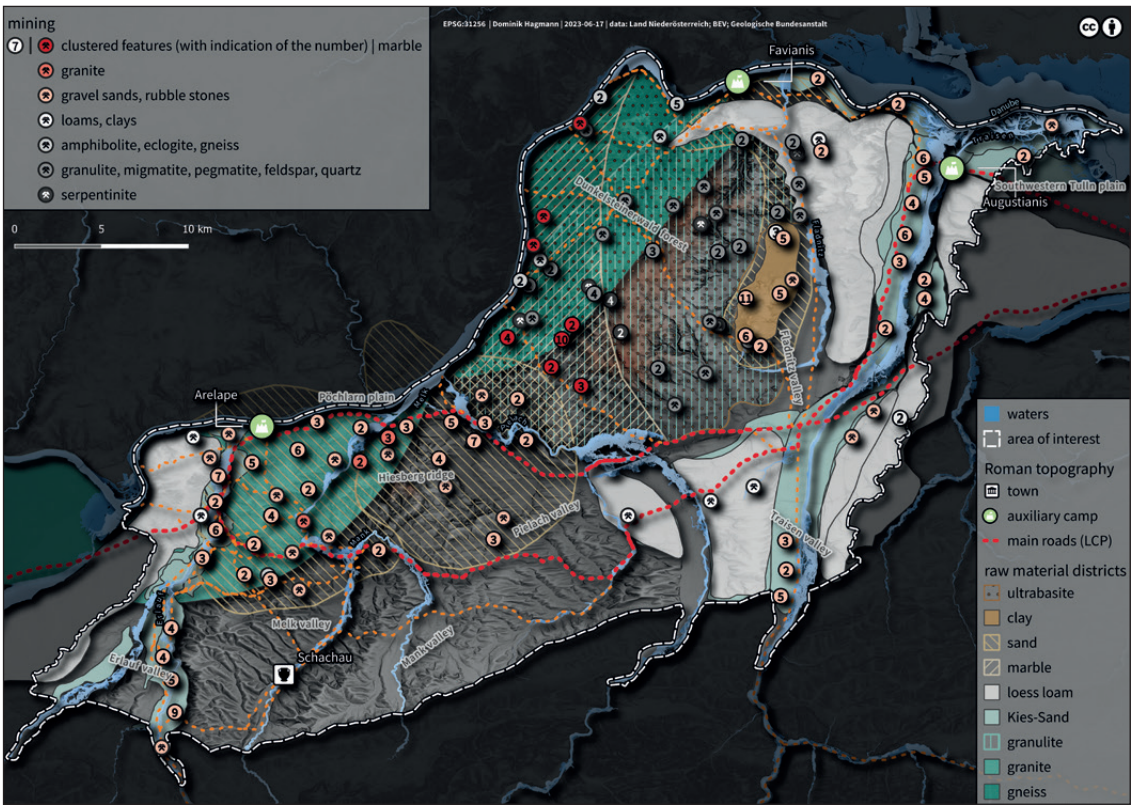
the formation of the Alps. This zone, located to the south of the Bohemian Massif, overlies it with Tertiary sediments. These sediments primarily comprise clays, marls, sands, gravels, limestones, sandstones, rare coals, conglomerates, and schlier (a type of clay-marl rock). The Molasse Zone, situated in the foothills of the Alps, is marked by its gently hilly terrain. In the region's larger water bodies, such as the rivers Erlauf, Melk, Mank, Pielach, Fladnitz, and Traisen, the geological composition is characterised by alluvial sediments from the Quaternary period, which were deposited as alluvial material[13]. The AOI also borders the Rheno-Danubian Flysch Zone to the south. This zone extends from the Rhine to the Wienerwald forest, lying south of the Molasse Zone, and is part of the Penninic nappes. The flysch zone is already considered an Alpine unit, therefore it exhibits a topography distinct from the other geological units in Lower Austria (fig. 4)[14].

Resources in the AOI

In the context of the AOI, there are broadly four primary sources of relevant resources. In the following sections, further details on these raw materials will be provided (fig. 5).

- Construction and industrial raw materials: these include various minerals, aggregates, and other geological resources used for construction and manufacturing industries
- Agricultural and forestry resources: this encompasses the land used for farming, including crops, livestock, and forestry for timber and other wood products

13 Thenius 1974, 15–19. 41.
14 Weber 1997; Schwaighofer 2003, 11. 13 f.; Wagreich 2013; Geologische Bundesanstalt 2015.



5 Raw material districts in the AOI (graphics: D. Hagmann; data: Province of Lower Austria; Bundesamt für Eich- und Vermessungswesen; GeoSphere Austria)

- Animal resources: these refer to livestock farming, as well as wildlife, which may be utilised for food, materials, or as part of the local biodiversity
- Water resources: these include creeks and rivers, ponds and lakes as well as groundwater that are used for drinking, irrigation, power generation, and other purposes[15]

Raw Materials: (Gravel) Sands, Loess Loams, Clays of the Traisen and Fladnitz Valleys, Sandstone, and Conglomerate

In the AOI in Lower Austria, there are diverse raw material districts. These include:

- (Quartz) sands, found in the Traisen and Fladnitz valleys
- Gravel sands, located in the high terrace sediments on both sides of the Traisen Valley
- Loess loam, found on the Older Blanket Gravel
- Clays, especially abundant in the Fladnitz Valley

In the past, such raw materials were primarily extracted from pits, a process that continues today in places like Pottenbrunn near St. Pölten[16]. This method – applied, for example, to clay – could also have been employed in ancient times, given that the material is particularly well-suited for the production of roof tiles.

In the Hollenburg area, west of the confluence of the Traisen River with the Danube, two additional raw materials are found: Hollenburg sandstone and a light-grey to yellow-brown-grey-coloured

15 See for this in general, Fulford et al. 2017.
16 <https://iris.geosphere.at/showText.aspx?TID=9234> (01.04.2025).

sandy conglomerate. Historically, these materials have been used for building construction and for making cippi or small columns, typically used as mile markers or tombstones within a relatively restricted regional radius of approx. 50 km[17].

Raw Materials: Granites, Gneisses, and Marbles on the Southern Margin of the Bohemian Massif near Melk

The southern foothills of the Bohemian Massif, located on the right side of the Danube, are characterised by granites, gneisses, and marbles. These features, including the Dunkelsteinerwald forest and the Hiesberg mountain, are situated in the north of the AOI. It can be assumed that the granites and gneisses, despite being challenging to work with, were used in ancient times, especially in the local area. The marbles, on the other hand, vary in quality. They were partly used throughout northern Noricum and were likely also used for the production of lime, for instance in the construction of buildings[18].

The Dunkelsteinerwald forest is particularly characterised by gneiss and marble, with the marble being of special importance for the study area. The marble, which belongs to the Drosendorf cover system, has been quarried since Roman antiquity in the Häusling area[19]. Other rocks in the Dunkelsteinerwald forest, such as serpentinites from the Gföhler cover system, are well-suited as multi-purpose building materials[20]. East of the Erlauf River and west of the Dunkelsteinerwald forest, in the area of the Hiesberg mountain, granite is predominant. This is mainly attributed to the Weinsberg granite, but it also comprises local granites and can be mined as loose material due to its grusy weathering properties. Today, this material is used as building stone for various purposes. However, the extent to which this applies to antiquity can only be conjectured at this point[21]. The marbles, however, which are essential for the study area, occur in spatially small and compact lenses. These lenses are 10–30 m thick and have a maximum extension of 200 m[22].

In the area of the Dunkelsteinerwald forest and the Hiesberg mountain, several small marble mining areas are known, for which, among other things, Roman mining activity can be attested based on investigations of the stone monuments of northern Noricum. These are the areas near Häusling (light-grey and uniformly coarse-grained »Häuslinger Marmor«) in the Dunkelsteinerwald forest, as well as, in the area of the Hiesberg mountain, the light-grey and medium-grained »Hiesberger Marmor« with yellowish and light-brown banding (quarried on the northeast slope of the Hiesberg mountain) and the light- to medium-grey as well as medium- to coarse-grained »Lunzener Marmor« (near Lunzen on the southwest slope of the Hiesberg mountain). To the latter must apparently be added the »Großweiselbacher Marmor« (from near Großweiselbach in the central area of the Hiesberg mountain), which has yet to be examined in detail through archaeometric analysis. While the Hiesberg and Lunzen (and presumably Großweiselbach) marbles overlap in their isotopic fields, the Häusling marble is different from them, which is also consistent with the geographic location of the precincts on the Hiesberg mountain and the Dunkelsteinerwald forest, respectively[23].

Spatial Archaeology

Considering current datasets on existing natural geological resources, all archaeologically relevant information on economically motivated work with local stones in the broadest sense during

17 Müller et al. 2004, 81.
18 Uhlir – Müller 2006, 39.
19 <https://iris.geosphere.at/showText.aspx?TID=7827> (01.04.2025).
20 <https://iris.geosphere.at/showText.aspx?TID=7826> (01.04.2025).
21 <https://iris.geosphere.at/showText.aspx?TID=7804> (01.04.2025).
22 Müller et al. 2004.
23 Uhlir – Müller 2006, 39.

the Roman Imperial period and Late Antiquity was integrated into a geographic information system (GIS)[24] using QGIS[25] as free and open source software (FOSS). Additionally, for queries and visualisations, data from IRIS online was provided free of charge by the Geological Survey of Austria, GeoSphere Austria. Potential routes within and between regions were determined by calculating least cost paths (LCPs)[26] while considering important archaeological features and discoveries. Data from the Austrian Federal Monuments Authority's (Bundesdenkmalamt) site registry was used to identify and map find-spots of archaeological artefacts and structures using a clustering algorithm called density-based spatial clustering of applications with noise (DBSCAN) in QGIS.

Sites that could be relatively clearly interpreted as rural settlement types (vicus, villa, non-vicus/villa-settlement) were then used as starting and ending points for the LCPs[27]. The resulting network of routes accordingly represents *inter- and intraregional* connections between the residential areas of the region, primarily used for intraregional trade and exchange of information[28]. However, it seems to provide limited representation of *local* route connections, as features used purely for industrial purposes – such as processing sites, including the quarries discussed here – and their links to their respective immediate surroundings are not taken into account.

The database »Ubi erat lupa«[29] served as the source for the data on the stone monuments. These are located in the centre of the respective modern community area where the object was found. Accordingly, the dataset only provides some information about the spatial distribution regarding a cartographically smaller scale of observation.

RESULTS AND DISCUSSION

Building upon existing research, notably provided by researchers such as H. Ubl and C. Farka (see below), the present study enhances our understanding of an economically prosperous region in northern Noricum. Mining operations were prominent in the southern region of the Bohemian Massif, located south of the Danube, during the Roman era. By analysing existing data on geological resources and newly acquired GIS-based information on rural settlements and ancient water- and land-based traffic routes, a favourable logistical area (site-ID 32) was identified in close proximity to known ancient quarries. The research also revealed, based on the dataset used, a high concentration of stone monuments in the AOI (n = 63), particularly in the vicinity of site 32 (n = 14), also considering comparable stylistic and iconographic attributes of corresponding stone monuments. This suggests the possibility of a local Roman stonemason's workshop in the area of a Roman roadside settlement (vicus) at site 32 (fig. 6).

Site 32 is located in the area of today's regional centres St. Leonhard am Forst and Ruprechtshofen; while many significant objects are known from this area (see below), archaeological structures that could provide concrete clues for a clear, structural-functional interpretation are not known. Furthermore, the majority of stone objects in the area of St. Leonhard am Forst and Ruprechtshofen were found to have been used in a secondary manner (indicating reuse activities in the Middle Ages and beyond), although some were also found *in situ* in this area[30]. Therefore, an interpretation of the site can only be derived indirectly on the basis of circumstantial evidence, especially with regard to the analysis of the site factors to be observed.

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24 Wheatley – Gillings 2002; Conolly – Lake 2006; Gillings – Hacigüzeller – Lock 2020.

25 QGIS.ORG Association 2002–ongoing; Ducke 2015; Orengo 2015; Wells – Parr – Yerka 2015; Hagmann et al. 2016; Streatfeild-James 2016; Bibby – Ducke 2017; Homsher et al. 2017; Lock – Pouncett 2017; Jensen 2018.

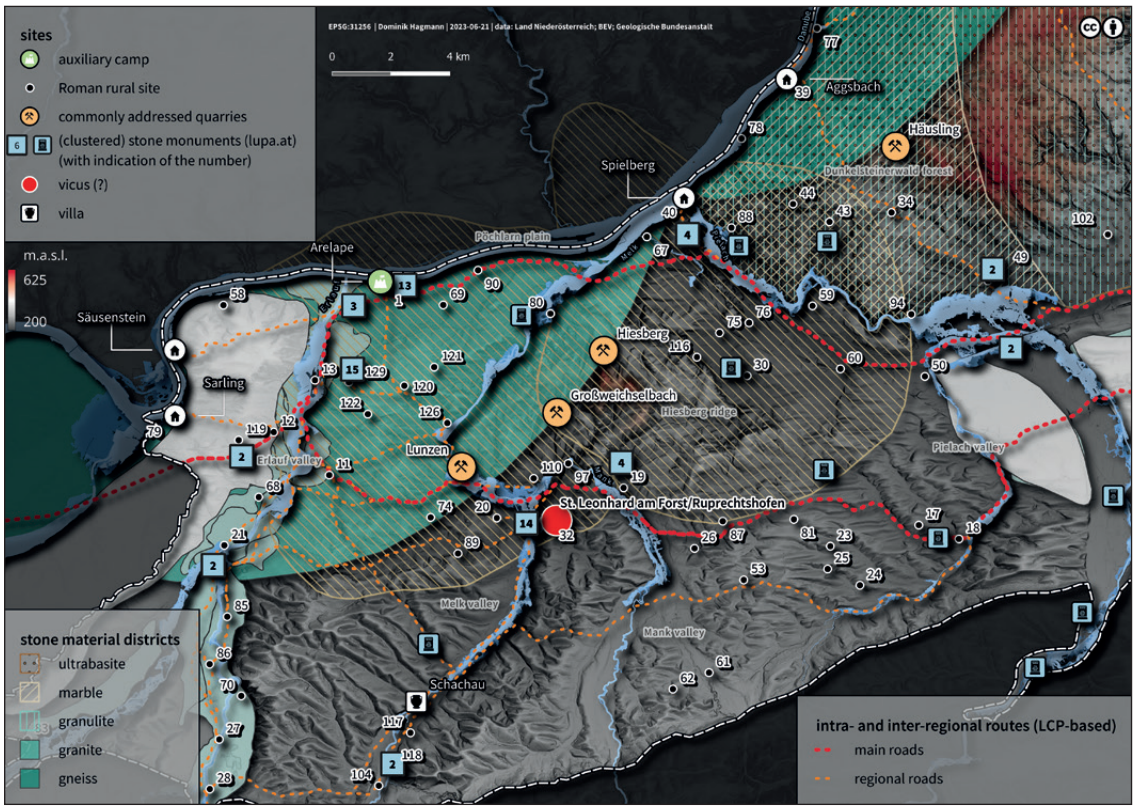
26 Cf. Verhagen – Jeneson 2012, 127.

27 Hagmann 2022; Hagmann 2025.

28 For a detailed breakdown of the 129 archaeological sites within the AOI, see tab. 1 in Hagmann (2025).

29 <https://lupa.at> (01.04.2025).

30 Farka 1990.



6 Approximate location of the marble mining districts and bedrock districts of the southeastern Bohemian Massif in the area of the Hiesberg mountain and the western Dunkelsteinerwald forest of Häusling (Dunkelsteinerwald), Hiesberg, Lunzen, and Großweichselbach (Hiesberg) in alignment with the find sites (graphics: D. Hagmann; data: Province of Lower Austria; Bundesdenkmalamt; Bundesamt für Eich- und Vermessungswesen; GeoSphere Austria)

The site is located precisely at the confluence of the Mank and Melk rivers, as well as at the intersection of several interregional and intraregional routes, based on the LCPs. One such interregional route is the Limes Road, which travels from the urban centre of Aelium Cetium/St. Pölten in an east-west direction and continues towards the legionary base at Lauriacum/Enns. The most significant intraregional route comes from the Melk Valley and intersects with the Limes Road near the site. Additional regional connections from the west and the north, originating from the auxiliary fort Arelape/Pöchlarn, also converge at St. Leonhard am Forst and Ruprechtshofen. Furthermore, this path passes directly by the quarry near Lunzen. There are also paths of purely local significance that connected the quarry regions of Lunzen, Hiesberg, and Großweichselbach – as well as other quarries not previously included in the ›canon‹. It is quite possible that these paths subsequently linked to Site 32, suggesting a wider network of transportation and communication in the region. The site's advantageous location with respect to transportation geography and its relative proximity to the extraction areas strongly support the interpretation of this location as a vicus, or even small town.

Selected stone monuments from the AOI provide support for this hypothesis (fig. 7): a marble gable with relief from a grave building[31] is therefore particularly significant. Measuring 1.31 × 0.66 × 0.32 m, this relief was discovered in 1974 during the mechanical excavation of a cable trench at a depth of approx. 80 cm, in the area of a farmhouse today known as »Gstetten 1« (site-ID 117)[32]. According to H. Ubl's initial description, the relief is adorned with the carving of a naked child in the tympanum of a simply designed triangular gable. The child, in a kneeling

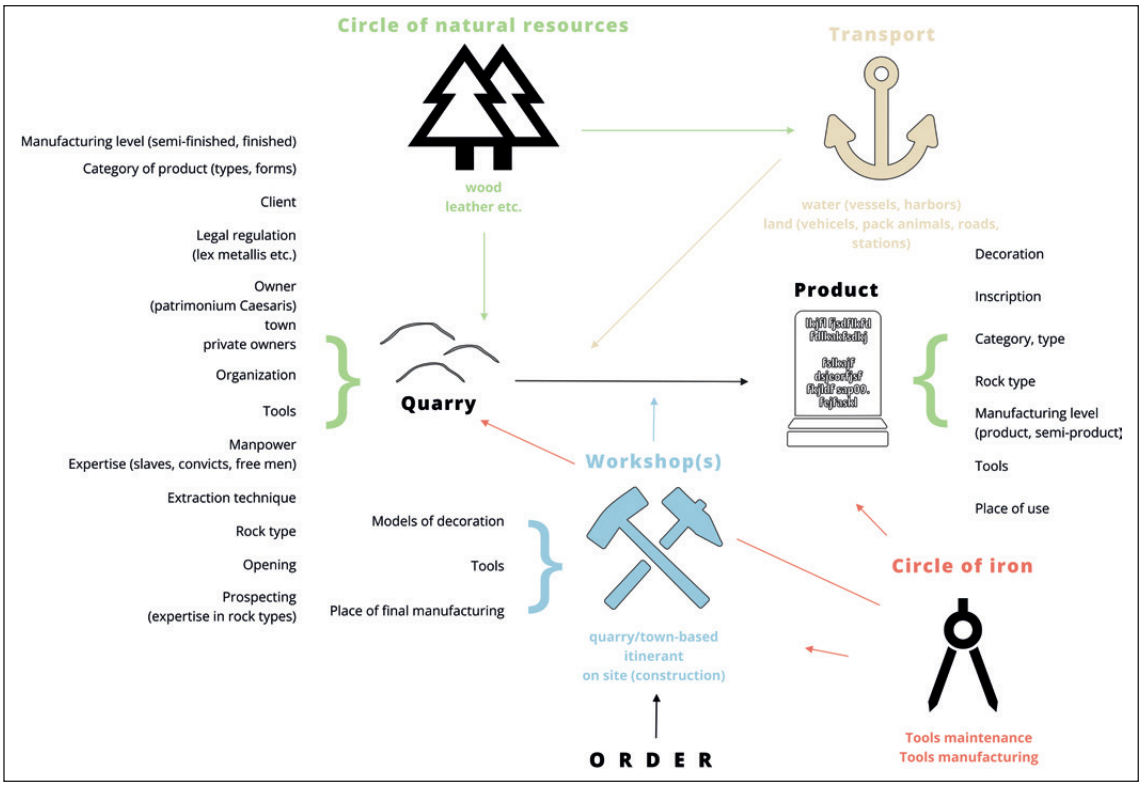
31 <http://lupa.at/372> (01.04.2025).
32 Ubl 1977; Grubner 2000, 21; Harl – Harl – Beszédes 2018.

7 Selected stone monuments. a: Funerary gable with relief from Gstetten, <http://lupa.at/372> (01.04.2025). b: Funerary stele of Aurelius Cupitus from St. Leonhard am Forst, <http://lupa.at/360> (01.04.2025). c: Altar of Maturus with dedication to Mithras from the parish church of St. Leonhard am Forst, <http://lupa.at/9071> (01.04.2025) (photos: D. Hagmann)

position, is depicted as strangling two snakes, each emerging from the left and right corners of the gable. Each corner of the gable also features a sculpted lion with a bushy mane and an elevated head. The zone of the architrave is distinguished by three joints and extensive fluting[33]. It is likely that the object was brought to the farmhouse as a spolia at an unknown point in time and originally came from the nearby villa of Schachau[34]. The relatively heavily weathered pediment relief shows the childlike Herakles as he kills the snakes sent to murder him by his stepmother Hera[35]. According to Ubl, the stone monument likely dates to the beginning of the 3rd century AD.

Ubl compares the object further with another stone fragment of a funerary stele[36] found in the lapidarium of the parish church of St. Leonhard am Forst (site-ID 32), located approx. 8.5 km away. This fragment shares similar motifs and stylistic elements with the piece from Gstetten.

33 Ubl 1975a, 108.
34 Hagmann 2022; Hagmann – Grubner – Lindinger 2024.
35 Harl – Harl – Beszédes 2018, photo: O. Harl 2001, D0372_G1, <http://lupa.at/372/photos/1> (01.04.2025).
36 <http://lupa.at/360> (01.04.2025).



8 Schematic visualisation of the stone production and processing cycle (graphics: D. Hagmann after Djurić 2019, 10 fig. 1)

Additionally, based on macroscopic and descriptive analysis, the fragment from St. Leonhard am Forst may be made of Hiesberg marble. This evidence strongly suggests the presence of an active workshop in the area that utilised locally available rocks to create various forms of funerary sculptures, which were likely traded within the region as well[37]. The fragment from St. Leonhard am Forst can be dated, according to F. Harl and J. Beszédes, to the period between AD 175 and AD 225 due to the mention of the gentile name Aurelius and the use of the formula *dis manibus*[38].

These observations could also be taken as an indication that a possible workshop could have been present in a possible vicus of St. Leonhard am Forst. Such a roadside settlement has already been suggested by P. Scherrer at that place[39]. Also, the regional and local connections postulated by means of LCP would be very good as supply routes of a workshop in St. Leonhard am Forst. Such a vicus could have supplied the adjacent settlement sites of the region with products. However, in the absence of further evidence, this can only be a hypothesis.

The identities of the direct operators of the quarries remain unknown. In ancient times, the areas immediately surrounding the mining sites, now known as the Dunkelsteinerwald forest and its neighbouring regions, were scarcely populated. Even today, these regions maintain a dense forest cover and, in certain areas, remain highly inaccessible. Given the significant lack of settlement evidence in the immediate vicinities of the Dunkelsteinerwald forest and Hiesberg mountain, it is conceivable that these quarries, seen as micro-regions, might have functioned as individual, enclave-like extensions similar to a *patrimonium regni Norici* (PRN), potentially representing

37 Ubl 1975b.
38 Harl – Harl – Beszédes 2020.
39 Scherrer – Kronberger – Szaivert 2002, 220.

imperial property. The ›PRN hypothesis‹, postulated by G. Alföldy, has drawn considerable criticism[40]. However, it is plausible that the actual circumstances might have somewhat echoed his concept, albeit not in the precise form of a large-scale imperial dominion at the core of Noricum, as he suggested. Instead, it might have manifested as significantly smaller, geographically isolated micro-regions scattered throughout Noricum. As Farka and Ubl note, an altar with the dedicatory inscription of the administrative slave Maturus[41], (*actor domini nostri*) from the 3rd century AD, which was found walled up as a spolia in the church of St. Leonhard am Forst in 1973, could also point to an imperial domain[42].

B. Djurić emphasised that the production and processing of rocks is not a straightforward task, but rather a complex network of various, sometimes interconnected processes. These processes also required the use or processing of numerous additional materials and products (such as metal for tools, iron clamps, water, wood, and leather). Often, these additional items were not produced by the stone-processing companies themselves, but were procured from suppliers (fig. 8)[43].

Such considerations would once again confirm that a vicus was located in the area of present-day St. Leonhard am Forst and/or Ruprechtshofen, since this position concerning the location factors of water and land transport, as well as the expected presence of further specialised supplier companies supporting the stone production, would present a very appealing hypothesis overall. However, this is not a justification for the actual existence of such a site: for the AOI, transport – at least downstream – was possibly carried out via the inland waters such as the Erlauf, Melk, Mank, Pielach, Fladnitz, Traisen, and Danube[44]. However, no findings indicative of harbour functions have been discovered at any riverine AOI sites to date. Simultaneously, a relatively extensive local and regional road network is expected within the area of investigation. Thus, it is plausible that the transport of marbles could have been conducted, in addition to river-based transport routes, mostly overland, particularly since these quarries were primarily responsible for supplying the whole of northern Noricum[45]. Regarding the aforementioned quarries in the AOI, the Häusling marble, was primarily used intraregionally. This marble, which exhibited strong signs of weathering after just 50 years, was still considered high-quality and uniform in colour by today's standards. In contrast, the Hiesberger marble, which was of noticeably lower quality and exhibited a banded appearance, was used interregionally[46]. The Häusling marble was utilised for various stone monuments in northern Noricum, primarily within a radius of approx. 20 km around the quarries. Meanwhile, the Hiesberger marble was used – even upstream of the Danube – between Ovilava/Wels, Lauriacum/Enns and, further, regionally in Aelium Cetium/St. Pölten. This pattern also holds true for the Lunzen and Großweichselbach marbles, which were even in widespread use between Iuvavum/Salzburg, Comagena/Tulln, and Carnuntum[47].

CONCLUSION

In conclusion, the study unveiled significant insights into the economic operations of stone-processing enterprises in the remote periphery of the Roman Empire. Incorporating geological resources and archaeological data as well as applying GIS technology along with tailored least cost analyses, the research shed light on the local, intraregional, and interregional dynamics of stone quarrying and related economic activities within the studied region. The findings lend support to

40 Alföldy 1970; Schmall 2011; contra Scherrer 2020.
41 Ubl 1975b, 111 fig. 265; <http://lupa.at/9071> (01.04.2025).
42 AE 1974, 00477: *D*(eo) *I*(nvicto) *My*(thrae) / *sacr*(um) / *Maturus* / *ser*(vus) *act/or d*(omini) *n*(ostri). See also Ubl 1974, 35; Ubl 1975b; Farka 1990, 39 f.; Harl – Harl 2020.
43 Djurić 2019, 9 f.
44 Pochmarski 2012.
45 Djurić – Müller 2009, 115 f.
46 Müller et al. 2004.
47 Uhlir – Müller 2006, 40; Kremer 2010, 165 f. 173; Hemmers – Traxler 2012, 50.

the hypothesis of a rural settlement (vicus) operating as a processing centre in the area of what is now the villages of St. Leonhard am Forst and Ruprechtshofen. This settlement likely played a pivotal role in delivering stone products to proximate settlements, such as villas, auxiliary forts, and towns. The vicinity around the prospective vicus, potentially a domain under direct imperial Roman control, was marked by the extraction of conglomerate rocks on a regional scale, punctuated by occasional mining of marbles, including Hiesberg, Häusling, Lunzen, and Großweichselbach marbles. The presence of stone monuments and probable evidence of a local Roman stonemason's workshop further reinforce the concept of a rural settlement serving as a vital processing hub, assigned with the duty of supplying stone products to neighbouring settlement sites, reaching as far as the neighbouring province of Pannonia.

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Andreja Krašna

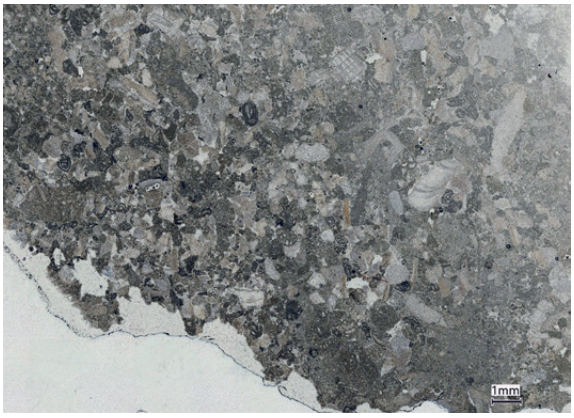
USE OF AURISINA LIMESTONE IN THE TERRITORY OF SLOVENIA (ITALIA, REGIO X)

Abstract
The main quarry of the Latin colony of Aquileia (181/180 BC) since the end of the 2nd century BC was a Cretaceous limestone quarry in Aurisina/Nabrežina. Its products and their distribution in the northern part of Italy are quite well known. Much less known are the products discovered in the area of the western part of Slovenia, including the colony of Iulia Emona (modern Ljubljana), which belonged to the Regio X – Venetia et Histria. A recent analysis of stone products and the characterisation of their material has shown the early presence of Aurisina/Nabrežina products in this area. The results have revealed a connection between the distribution of Aurisina/Nabrežina limestone products and the penetration of the Romans to the east. Aurisina/Nabrežina limestone products are known from the Roman pre-Augustan trading post Nauportus (modern Vrhnika) and slightly later from the colony Emona. Additionally, they have been found in various locations scattered throughout the territory of western Slovenia. So far, various sepulchral and votive monuments have been documented (altars, tombstones, urns), in addition to architectural elements mainly of the Tuscan order (column bases, capitals, and architraves). These have been discovered in Emona, Nauportus, Fluvio Frigido/Castra (modern Ajdovščina), and at coastal sites. The presence of Aurisina/Nabrežina products is primarily documented in the 1st century in Emona and Nauportus. In the western part of Slovenia, they were used until the 4th century inclusive.

INTRODUCTION

Aurisina is located in the municipality of Duino in the Italian part of the Karst region (Kras, Carso). The geological structure of the Karst region is dominated by various types of limestone, which were formed in the Brje, Povirje, Repen, Sežana, Lipica, Liburnija, and Trstelj formations. These limestone formations exhibit a range of colours from grey to black and brown. The Aurisina/Nabrežina limestone is a part of the Lipica Formation. The recognisable composition of the Aurisina/Nabrežina limestone is fragments of usually brownish rudists shells in a grey base[1] (fig. 1). There are several types of Aurisina/Nabrežina limestone, commercially known as: Aurisina chiara, Aurisina fiorita, Aurisina granitello, Roman stone, Fior di mare, Repen classico and Breccia carsica. They differ from each other mainly in the size and roundness of shell fragments[2].

During the period from the 1st century BC until the collapse of the Western Roman Empire in the 5th century AD, several smaller quarries and one large quarry operated in the area of today's village of Aurisina/



1 Sample (no. 1) of the urn from Most na Soči, dated between the 1st and 2nd century AD (from Krašna 2022, 41 fig. 13)

1 Jurkovšek – Cvetko – Kolar-Jurkovšek 2013, 69–74 tab. 11, sl. 1–3; 12; figs. 1–2.
2 Maritan – Mazzoli – Melis 2003, 364.

2 The supposed administrative borders in the early Roman period (1st–2nd cent. AD) in the area of the southeastern Alps. Towns are indicated with red squares, and main Roman roads with red lines (the early Roman roads are added with a dotted red line); thick dotted ochre marks provincial borders, and a thinner ochre dotted line represents borders between different *agri* (from Horvat – Belak 2009, <http://www.dedi.si/dediscina/110> [04.05.2025])

Nabrežina, where a quarry is still operating today under the name Cava Romana. Caterina Previato has located nine quarries, which she believes were in operation in the Roman period[3]. These quarries are located approx. 30 km from Aquileia, 3 km from the river Timavo and about 1 km from the coast.

Aurisina/Nabrežina belonged to the *ager* of Aquileia, which was founded in 181 BC at a geographically strategic point through which important trade routes passed. The main Roman road connecting Trieste and Aurisina/Nabrežina likely followed along the route documented on a 16th-century map[4]. This route led from Trieste through Grignana/Grljan and Santa Croce/Križ all the way to Aurisina/Nabrežina. A section of this historical route today coincides with the regional road Via del Pucino. The pathway to Aquileia runs along the northwest side of Aurisina/Nabrežina. From Aquileia, there were two main roads[5] leading to the east (today Slovenian territory). One crossed the Roman bridge Pons Sontii[6] and then followed the river Vipava/Vipacco, and the other passed Trieste (fig. 2)[7] and proceeded along the coast to the south.

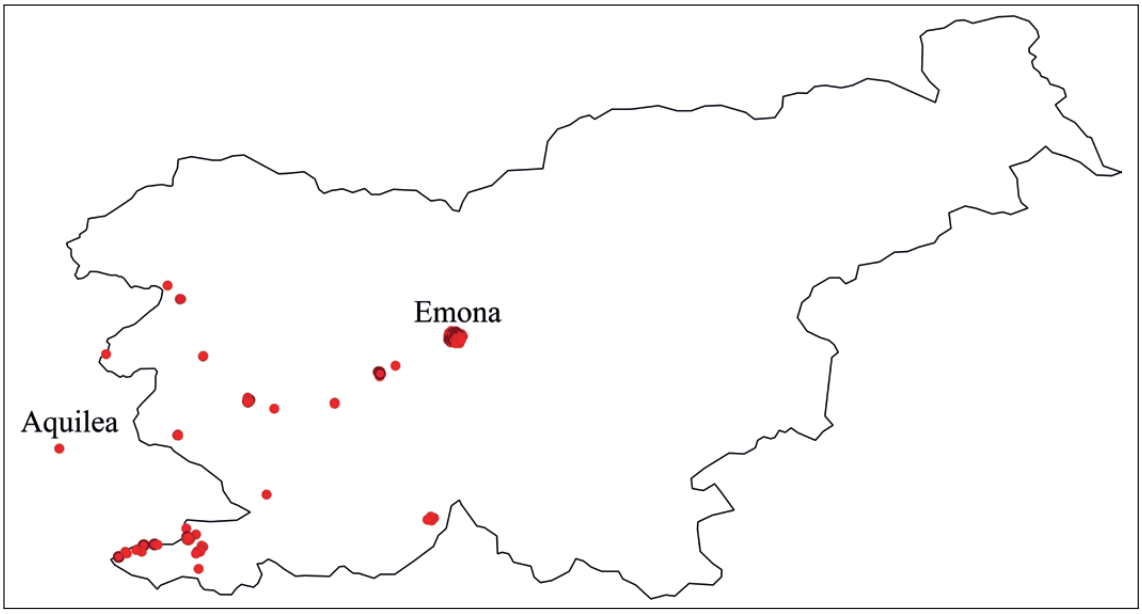
3 Previato 2015. Roman quarries: Cava Romana, Cava Caharija, Bacino Ivere, Cava ferrovia 1, Cava ferrovia 2, Cava ferrovia 3, Cava ferrovia 4, Cava ferrovia 5, Cava Slivia. See also Previato 2018, 935 fig. 3.

4 Ubaldini 1987, 30 f.; 2nd map in Flego – Rupel – Župančič 2001, 159.

5 Via Gemina to Emona and the road to Pola and Tarsatica, see Harej 1972, 14 f.; Horvat – Bavdek 2009.

6 The bridge was located near Majnice/Mainizza, near the watershed between the river Vipava/Vipacco and the river Soča/Isonzo, see Rutar 1899, 27.

7 Rutar 1899; Ciglenečki 1985.



3 Distribution of Aurisina/Nabrežina limestone products on the Slovenian part of Regio X, marked with red dots (graphics: A. Krašna after Krašna 2022)

DISTRIBUTION OF THE AURISINA/NABREŽINA LIMESTONE PRODUCTS IN SLOVENIA

The distribution of the stone products from Aurisina/Nabrežina quarries shows their presence in Regio X (Trieste, Altinum, Padua, Este, Cremona, Brescia), Regio VIII (Ravenna, Rimini, Emilia-Romagna), Regio XI (Milan, Pavia) and along the shores of the Adriatic Sea[8]. In the Slovenian territory, their presence is documented as far as Emona (modern Ljubljana) and its *ager* (fig. 3).

In the centres located near the Aurisina/Nabrežina quarries, their limestone was extensively used as a building material[9]. The distance from the quarry and the weight of the product influenced the transportation cost and consequently the final price of the product. If there were no nearby rivers or seas and the cargo had to travel overland, the final price of the product doubled[10]. In inland towns further away, the Aurisina/Nabrežina limestone was an imported good of a higher status. Based on Giovanni Pegoretti's[11] formulas, Diocletian's edict[12], and Cicero's statement on the price of the marble pillar[13], we can get a rough insight into how luxurious these stone products were. Epigraphic sources further indicate that only civilian and military elites could afford the products made from Aurisina/Nabrežina limestone.

In the Slovenian part of Regio X, we documented 133 products (fig. 3) made from Aurisina/Nabrežina limestone. Based on their functions, they can be divided into six main groups: 1) architectural, 2) sepulchral, 3) votive, 4) statuary, 5) boundary stones and milestones, and 6) everyday items. Macroscopic analyses of 105 of these monuments were conducted by the geologist Igor

8 Previato 2015, 421.

9 At the forum in Aquileia, the colonnade is made out of Aurisina/Nabrežina limestone (Previato 2018, fig. 8); at Rimini, the bridge is made out of Aurisina/Nabrežina limestone; and in Aquileia it was used for paving the streets (Previato 2015, 424 f.).

10 Russell 2013, 139; Russell 2015.

11 The closest approximation for calculating the price of transport in the Roman period is Pegoretti's formula, based on a practice manual for assessing architectural, road, hydraulic, and fortification works from the 19th cent., see Pegoretti 1843/1844, 28.

12 See Russell 2013, 31 f.

13 Cic. Verr. 1, 147, after Russell 2013, 24.

Rižnar, two grave inscriptions were defined by Vladimir Kusik[14], and 26 monuments were defined by the geologists Rok Brajkovič and Luka Gale[15].

ARCHITECTURAL MONUMENTS

Architectural monuments made from Aurisina/Nabrežina limestone found in Slovenia are dated from the 1st century BC to the end of the 3rd century AD. They were found in and around the main settlements[16] situated along the Roman roads. On the sites along the coast, we documented nine parts of architectural elements. The majority of them belonged to Roman villas[17] and sepulchral architecture[18]. In the inland territory of Ajdovščina (Fluvio Frigido, Castra) on the main road to Emona, six parts of architectural elements were documented. These include a part of a Corinthian cornice, four parts of lintels with inscription, and one fluted column shaft, which are interpreted as elements of a sanctuary or some other public building[19]. They are dated in the 1st to early 2nd century AD. Continuing along the same road, the last outpost before Emona was Nauportus (modern Vrhnika). A building inscription was found there, dedicated by two *magistri vici* who took care of the construction of a colonnade[20] between 59 and 30 BC. At the same site, a part of a lintel was discovered[21], decorated with a wide band of acanthus leaves, intertwined with grape tendrils and leaves, dating from the 2nd to 3rd century. A small Tuscan capital[22] with an inscription belonging to a sepulchral monument was also found, dating to the period of Caesar or Augustus.

The majority of all architectural parts and elements made from Aurisina/Nabrežina limestone discovered in Slovenia come from Emona and its vicinity (Nauportus). In Emona, two capitals of a Tuscan order, one building inscription, one fluted pilaster shaft, one column shaft, parts of a capital and a fluted column shaft, one console, and two sepulchral architectural parts were documented[23]. A console in the shape of an Acheloos head is dated to the period of Nero. However, the exact date of the other architectural parts, excluding the fragmented and reconstructed ones[24], could not be determined. The composite capital was found in the *basilica civica* of Emona, and some scholars believe it belongs to the Severan period.

SEPULCHRAL MONUMENTS

The main imported Aurisina/Nabrežina products are 82 sepulchral monuments. Among them there are ten simple quadrangular grave slabs (*tituli*) dated from the 1st century BC to the 1st century AD, 30 stelae from the 1st century BC to the 3rd century AD, four sarcophagi dated between the 2nd and the 3rd century, 24 urns dated from the 1st to the 2nd century, and nine funerary altars dated from the 1st century BC to the 2nd century AD.

Stelae were classified according to the basic division of Hermann Pflug and the typological definition of Lorenzo Cigaina into three types (fig. 4)[25]: basic type of rectangular stelae I (beginning of

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14 Kusik 2015, 72 f. (EDR007632). 89 f. (EDR007643).

15 Brajkovič et al. 2022.

16 Koper (Capris, Aegida): lupa 20807. 20812. 20816; Strunjan: lupa 16326; Ajdovščina (Fluvio Frigido): GM AG 84/1. 85–86. 4149 (pillar); Vrhnika: lupa 9233 (architrave); Ljubljana (Emona): NMS L65. L168.

17 One Corinthian capital was documented in Seča (Krašna 2022, 144); in Simonov zaliv, one column base and one fragment of a Corinthian capital was documented (Stokin – Zanier 2011, 83).

18 lupa 20804. A part of the sepulchral architecture was found in secondary use for an oil press.

19 Svoljšak et al. 2013, 63; Žerjal – Tratnik 2020, 21.

20 lupa 9232; Šašel Kos 1997, no. 1.

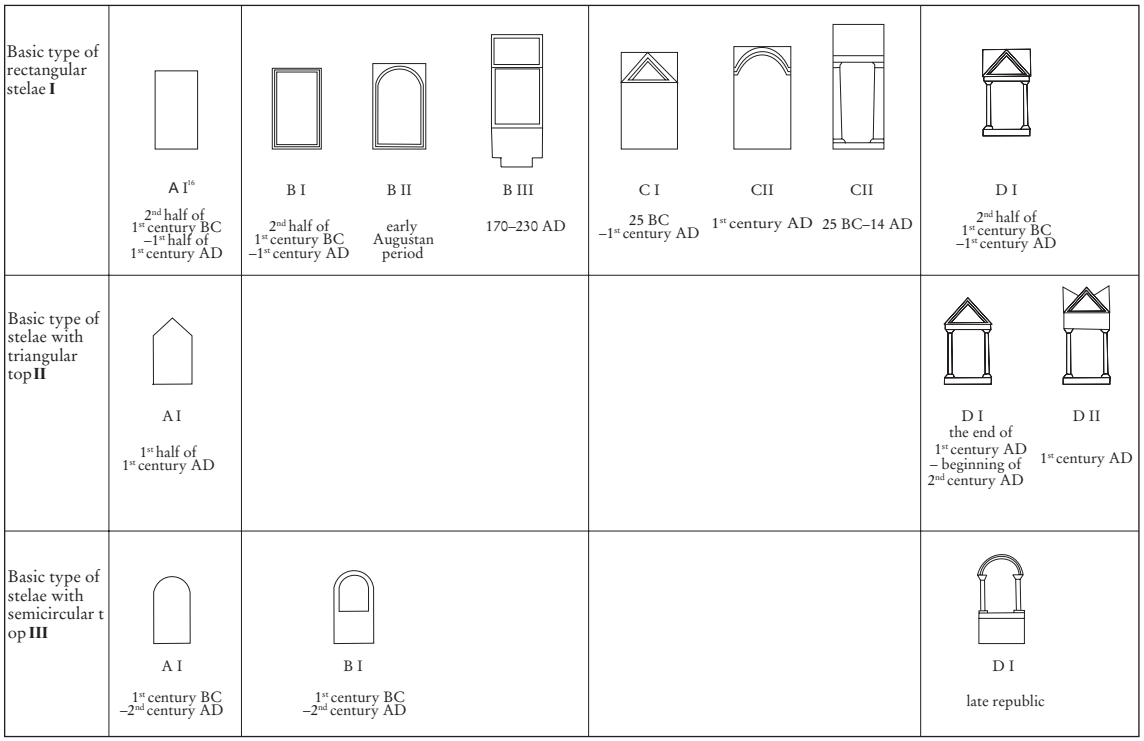
21 Horvat 2020, 103 f.

22 lupa 9233; Šašel Kos 1997, no. 2.

23 These monuments are held in the Mestni Muzej in Ljubljana (inv. MGML 65. 35232. 41117. 48569) and in the Narodni Muzej Slovenije (inv. L 168. 185. 200. 222–223; lupa 9232).

24 Plesničar Gec 2006, 44; Gaspari 2014, 182.

25 Pflug 1989; Cigaina 2016. See also Krašna 2019.



4 Typological division of stelae from Slovenia and their time frame (graphics: A. Krašna after Cigaina 2016; Krašna 2022)

the 1st cent. BC until the end of stelae production); the basic type of stelae with triangular top II (end of the 1st cent. BC to the beginning of the 2nd cent. AD); and the basic type of stelae with a semicircular top III (the beginning of the 1st cent. BC until the end of stelae production).

The quantity of stone products and their distribution documented within the territory of Slovenia in the 1st century BC and 1st century AD can be observed not only in relation to sepulchral stelae but also with regard to urns. The workshops in Aquileia carved urns of cylindrical form with a round lid, square urns with a flat lid, situla-form urns with a base, cylindrical and square urns in the shape of a ›knitted basket‹ and cylindrical pseudo-urns[26]. In Slovenia, 24 urns from the Aurisina/Nabrežina quarry (fig. 5) have been documented.

Although there were working quarries at Podpeč and Medvode/Povirje in the 1st century AD[27], the time frame of distributed stelae and urns from Aurisina/Nabrežina tells us that from the 1st century BC until the end of the 1st century AD, there was no quarry and stonemasonry workshop in the western part of Slovenia that could supply the demand for a high-quality product. This hypothesis could be confirmed by a boundary stone[28] from Bevke, as there would be no need for a boundary stone to be made out of imported rock unless there was no active quarry nearby.

There are two milestones and three boundary stones made from Aurisina/Nabrežina limestone found in Slovenia. Two boundary stones are private and dated to the second half of the 1st century BC and the 1st century AD; one stood as a marker of a private road[29], and the other served as a marker of a grave plot[30]. One boundary stone was discovered in the Ljubljanica River near the village of

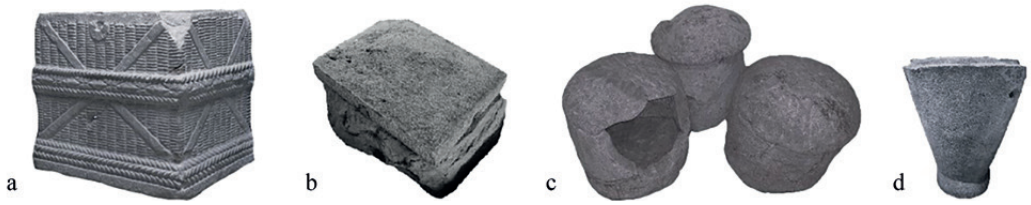
26 Buora 1982.

27 See Djurić – Gale – Brajkovič 2022.

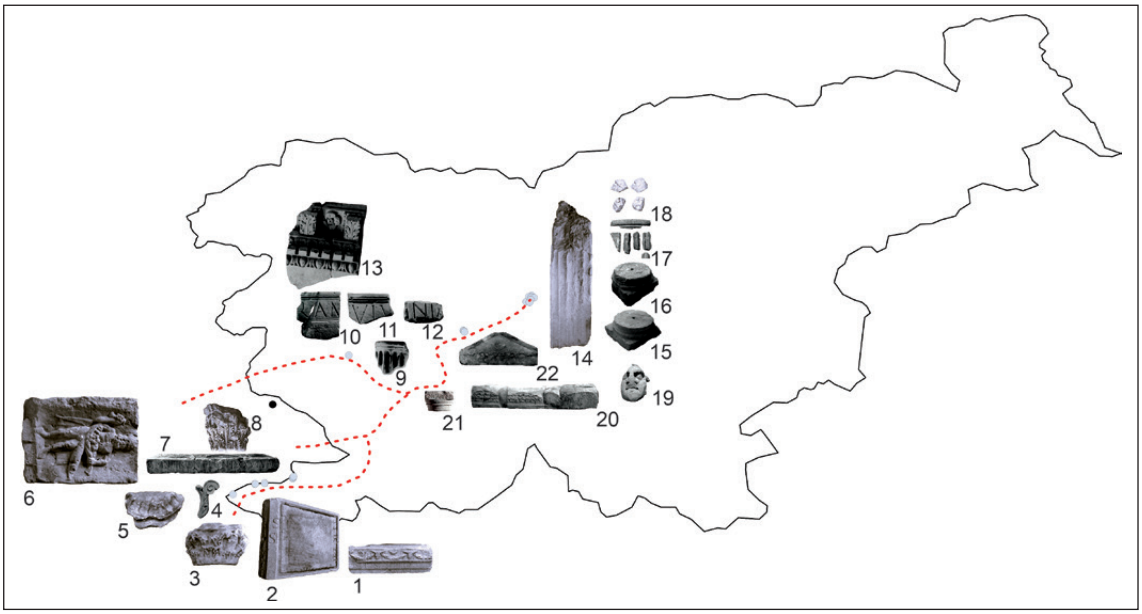
28 lupa 9454. A milestone also demarks the line between the *ager* of Aquileia and Emona (*Finis* // *Aquileien*/*sium* // *Emonen*/*sium*).

29 lupa 16031.

30 EDCS-04500006.



5 Types of Aurisina/Nabrežina limestone urns documented in Slovenia. a: Urn in the shape of a ›knitted basket‹ from Ankaran, dated from the Augustan period to the end of the 1st century AD (inv. A4123, Pokrajinski Muzej Koper) (from Harl 2012, lupa 20810). b: Square flat lid of an urn from Ljubljana (inv. U17b/L265, Narodni Muzej) (from Djurić 2021, personal record, not published). c: Cylindrical urns with round lids from Most na Soči, dated to the 1st and 2nd centuries AD (Tolminski Muzej) (photo: from Krašna 2019, personal record, not published). d: Situla-form urn with a base from Ljubljana, dated to the 1st century AD (inv. MGML 51188, Mestni Muzej) (from Djurič 2021, personal record, not published)



6 The main Roman road marked with a dotted red line; grey dots show the locations of the finds. Monuments from Aurisina/Nabrežina limestone are numbered as follows: 1 – Architrave (Strunjan); 2 – Architectural slab (Strunjan); 3 – Corinthian capital (Seča); 4 – Corinthian capital (Simonov zaliv); 5 – Column base (Simonov zaliv); 6 – Architrave (Koper); 7 – Lintel (Koper); 8 – Corinthian capital (Aquileia/Kanal); 9 – Fluted column shaft (Ajdovščina); 10–12 – Parts of a building inscription (Ajdovščina); 13 – Corinthian architrave (Ajdovščina); 14 – Pilaster shaft (Ljubljana); 15 – Column base (Ljubljana); 16 – Column base (Ljubljana); 17 – Fluted column shaft (Ljubljana); 18 – Part of a capital and fluted column shaft (Ljubljana); 19 – Console (Ljubljana); 20 – Lintel (Vrhnika); 21 – Tuscan capital (Vrhnika); 22 – Gable of a composite sepulchral monument (Vrhnika) (graphics: A. Krašna after Krašna 2022)

Bevke[31]. It served as a marker between the *agri* of Aquileia and Emona, and was set up in the second half of the 1st century BC. Two milestones[32], one found in Ajdovščina and the other 5 km east of it, on the *via publica* leading to Emona, have been dated to the 3rd and 4th centuries AD.

It seems that in the early period from the 1st century BC onwards, at coastal sites Aurisina/Nabrežina limestone was used for private boundary stones, and further inland, for public boundary stones only. Later on, in the 3rd century AD, Aurisina/Nabrežina limestone was a commodity of a higher status, imported only exceptionally.

31 lupa 9454; Šašel Kos 2002, 373; Šašel Kos 2004, 114.
32 lupa 23481; EDR117366.

One hemispherical sundial from the 1st century AD was excavated at a *villa rustica* in Loke near Nova Gorica. According to the calculated latitude of 42.3°, the sundial was made for the town of Aquileia[33]. Four everyday items (two stone containers, one mortar, and one weight) were documented on the coastal side of Slovenia (near Aurisina/Nabrežina). A mortar from the Roman villa at Školarice is dated to the 4th century or the first half of the 5th century AD[34]. This could mean that for small stone products for everyday use, the market in the vicinity of Aurisina/Nabrežina still existed in the 4th century AD.

The number of imported monuments (fig. 6) found along the coast may be deceptive because some of the monuments probably arrived there as merchandise stone blocks at a later date. Two architectural pieces[35], dated to the 1st century AD, which were reused as parts of oil presses, could have come to Strunjan from the vicinity of a Roman *villa rustica* or could have been imported much later as a secondary product (or a stone block). Additionally, there is also no archaeological evidence of any larger Roman public construction in Kanal where the Corinthian capital was found, suggesting that it was most likely imported from Aquileia at a later period. It seems reasonable to see these products as the result of a trade operating in the territory of Aquileia specialised in selling spoiled parts of abandoned constructions. This practice was well established in Late Antiquity, when building material for new buildings was sourced from abandoned ones[36].

THE DIFFERENCE IN DISTRIBUTED MONUMENTS FROM AURISINA/ NABREŽINA LIMESTONE ON THE COAST AND ON THE INLAND

I would like to emphasise the difference in the time frame, distribution, and type of Aurisina/ Nabrežina monuments that were found at the coastal sites, on the one hand, and in inland centres, on the other. As we stressed above, the distance from the quarry and the weight of the product influenced the transportation cost and consequently the final price of the product[37]. Therefore, in the centres further away from the Aurisina/Nabrežina quarry, its products were more expensive and consequently of a higher status.

I divided the territory of Slovenia where monuments from Aurisina/Nabrežina quarry were found, into three categories: coastal and pre-coastal sites[38], inland sites of the western part[39] of Slovenia[40], and Emona with its vicinity[41] (fig. 7).

The distribution of monuments from Aurisina/Nabrežina across the western part of Slovenia extending to central Slovenia could provide us with a time frame for trade and Romanisation (fig. 8). The oldest grave slab belonging to Sextus Brinarius Certus[42], dating between 75 and 25 BC, was discovered near the seashore in Koper. In central Slovenia, specifically in Ljubljana

33 Svoljšak – Žbona-Trkman 1986, 395 f.

34 Žerjal – Novšak 2020, 205. 760.

35 Polygonal architectural slab (Boltin-Tome 1990, 255; Krašna 2019, 114) and architrave (Boltin-Tome 1990, 254; Krašna 2019, 132).

36 Murer 2019, 119.

37 For an experimental formula to attempt to calculate the price of Roman monuments, see Krašna 2019, 34–44.

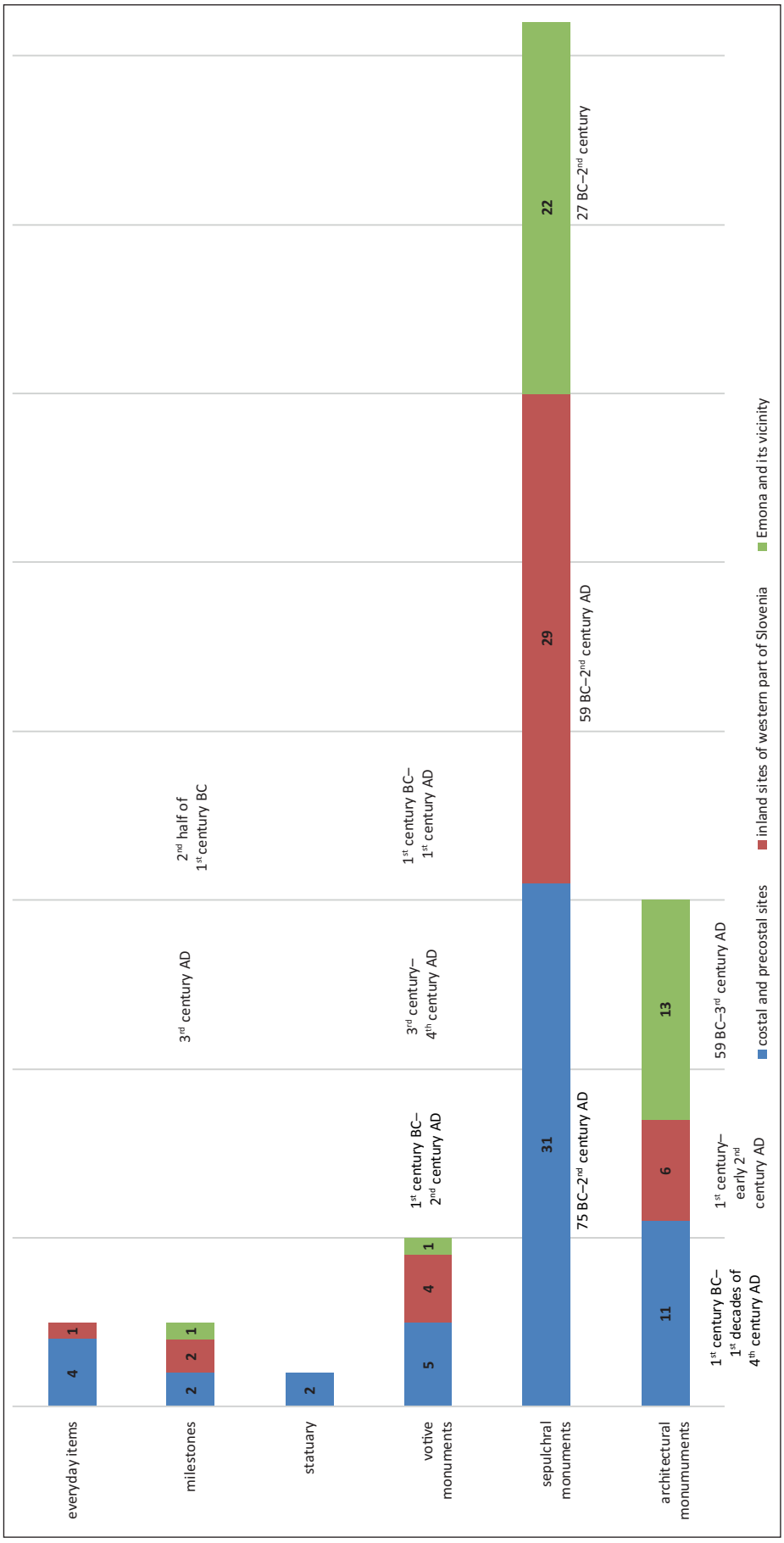
38 Under the group of coastal and pre-coastal sites, I classified the modern settlements and towns: Koper, Piran, Seča, Simonov zaliv, Strunjan, Ankaran, Izola, Beli kamen, Glem near Koper, Grubelce, Loka, Predloka, Šmarje near Koper, Raven near Koper, Črni kal and Školarice near Spodnje Škofije.

39 The definition of the western part of Slovenia in this paper combines the territories of Coastal-Karst, Goriško, and a part of the central Slovenia region.

40 Under the group of inland sites of the western part of Slovenia, I classified the modern cities: Ajdovščina, Col near Ajdovščina, Hrušica, Gorjansko, Volčji grad, Hruševlje, Most na Soči, Ivanji grad, Šmarata, Loke, and Škocjan.

41 Under the group of Emona and its vicinity, I classified the modern cities: Ljubljana, Vrhnika, and Verd near Vrhnika.

42 lupa 23491; InscrIt X 3, 9.



7 Distribution and time frame of Aurisina/Nabrežina limestone in the territory of Slovenia (graphics: A. Krašna after Krašna 2022)

(Emona), the oldest grave slab belonged to Titus Caesernius Diphilus[43] and is dated between 59 and 30 BC. The oldest stela discovered in the western part of Slovenia at Most na Soči belonged to Aulus Vicrius[44] and is dated between 59 and 30 BC. Another stela was unearthed along the coast in Bernardin near Piran, it is a simple stela which belonged to Caius Liburnius[45] and is dated between 25 BC and 25 AD.

On the coastal side of Slovenia, we have documented modest tombstones made of local sandstone[46], dated in the period from 50 BC to 14 AD. On the one hand, there are high-quality, imported Aurisina/Nabrežina limestone products that were used by the elite, and on the other hand, we have low-quality local sandstone products that were most likely more affordable for the poorer population.

Smaller stone products for everyday use were documented only on the coastal side of Slovenia. It makes sense that products such as mortars would be made from local rocks rather than imported ones, as the cost of the product would otherwise be too high.

Only a few monuments carved in Aurisina/Nabrežina limestone dating to the 3rd and 4th centuries have been documented in this area of Slovenia (sepulchral architectural elements, reliefs, sarcophagi, grave and votive altars, milestones, and one commemorative inscription). Therefore, we can conclude that in this period, monuments made from Aurisina/Nabrežina limestone are a case of rare imports, which most likely only the civilian and military elites could afford.

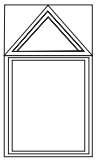
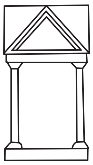
A DECLINE IN THE USE OF AURISINA LIMESTONE IN THE TERRITORY OF SLOVENIA

In Emona and its *ager*, so far 286 stone products made out of local, regional and imported stone have been discovered. In and around Emona, there are four presumably Roman local quarries known to date[47]: Ljubljana-Grajski grič (carboniferous quartz sandstone), Podpeč near Ljubljana (Jurassic limestone), Medvode/Verje (Jurassic limestone) and Ig-Pungrt (Jurassic limestone)[48]. Out of 287 analysed products, 66 % of them are made from Podpeč limestone, 15 % from Aurisina/Nabrežina limestone, 8 % from Medvode/Verje limestone, 7 % are made from Alpine marble, and 4 % from Badenian Moravče (?) limestone[49]. These results show us that Podpeč quarry was the main local stone supplier for Emona and that the main quarry for imported stone was Aurisina/Nabrežina.

For the construction of the town wall and architecture in the 1st century AD in Emona, the Romans used quartz sandstone quarried in the immediate vicinity, on the southwestern slopes of Castle Hill (Grajski grič). Columns, other architectural elements, and decorations were made from limestone extracted from the quarries in Podpeč and Medvode/Verje. During the first half of the 1st century AD, white marble[50] was used only for inscribed slabs, some Corinthian capitals, and a few sculptures[51].

Products made in Podpeč can be divided into three main categories: boundary stones, architectural elements, and sepulchral monuments[52]. So far the presence of three stonemasonry

43 lupa 3691; Šašel Kos 1997, no. 3.
44 EDR156266; Svoljšak – Žbona-Trkman 1986.
45 lupa 16323; Supplementa Italica 10, T, 22.
46 EDR007659. EDR007608. EDR007606; see Krašna 2022, 43.
47 Djurič – Rižnar 2017.
48 Žvab Rožič – Gale – Rožič 2016, 359 f.
49 Djurić – Gale – Brajkovič 2022.
50 In Emona, Eastern Alpine white marble from Gummern, near Villach, and from the Pohorje Hills is documented, see Djurić – Rižnar 2017, 142.
51 Gaspari 2014, 174.
52 Djurić – Gale – Brajkovič 2022.

Typology	Time of production in Aquilea	Imported product from Aurisina/Nabrežina limestone found in Emona	Local products made at Ig
Rectangular type AI (Krašna 2019); Rechteckstele I subtype a (Cigaina 2016); subtype III a (Pflug 1989)	1st century till the end of stelae production	lupa 3691 EDR129719	lupa 4202 lupa 4196 lupa 1158 MGML63840
Profilgerahmte Giebelstele; subtype IIII c (Cigaina 2016)	 1st century till the end of stelae production		lupa 3704 lupa 4190 lupa 3708
Rectangular stelae type of aedicula DI (Krašna 2019); Grundform mit eingefasstem Giebel III, subtype D (Cigaina 2016)	 from the end of the 1st century till the beginning of 2nd century	lupa 3702	lupa 3689 lupa 20797 lupa 4192

8 Local products carved in Podpeč limestone which imitate forms of stelae from Aurisina/Nabrežina (graphics: A. Krašna after Krašna 2022)

workshops located in Ig has been hypothesised[53]. Workshops at Ig and Iška vas existed simultaneously between the 1st and 3rd centuries AD. Within this time frame, residents of Roman Ig possibly supplied their products to Emona[54].

The early Podpeč products show similarities with the products carved in Aurisina/Nabrežina, which are otherwise strongly present in Emona in the 1st century AD. Bojan Djurič and colleagues put forward a solid hypothesis suggesting the arrival of stonemasons from Aurisina/Nabrežina who started working in Podpeč after the foundation of the colony. As a result, imported products were no longer needed[55]. This hypothesis finds support in the declining number of Aurisina/Nabrežina stelae in Emona during the late 1st and early 2nd centuries[56].

SUMMARY

Within the Slovenian territory, a range of products carved in Aurisina/Nabrežina limestone were used; tombstones, stelae, altars, sarcophagi, various tomb constructions, architectural elements, boundary stones, building and honorary inscriptions, statues, and sundials. These products were widespread, reaching as far as Emona. The oldest evidence of Roman trade with Aurisina/Nabrežina products is dated to the pre-Augustan or early Augustan period, and it flourished in the first half of the 1st century AD. By the end of the 1st century AD, a decline in products in the Emona area was documented. It is likely that the Podpeč quarry satisfied the needs of Emona

53 See Lozić 2009.
54 Grahek – Ragolič 2020, 185.
55 Djurić – Gale – Brajkovič 2022.
56 Brajkovič et al. 2022, 15.

inhabitants with its good-quality Jurassic limestone. The shape and iconography of stelae made in Podpeč were similar to those made in Cava Romana, but the quality of products, in terms of the iconography and craftmanship, was lower compared to those from Aurisina/Nabrežina. This suggests that the stone-cutters knew how to carve the same shapes and iconographic elements, to which they added their own decoration[57]. This is supported by the hypothesis proposed by Djurić and colleagues regarding the arrival of stonemasons from Aurisina/Nabrežina who started working in Podpeč after the foundation of the colony Emona[58]. Based on this, we can conclude that Emona and its vicinity were well supplied with quality stone products, and yet we still documented Aurisina/Nabrežina limestone in the 3rd century[59]. This indicates that later products made from Aurisina/Nabrežina limestone were a sign of a higher status, imported only exceptionally[60].

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[57] Dolphin with a triangular tail and/or a round encircled eye and/or a mark in the form of the letter V on the body, additional decorative fields on both sides of the gable or portrait niche, see Lozić 2009.

[58] Djurić – Gale – Brajkovič 2022.

[59] E.g. import of the architectural furnishings of the civil basilica in Emona dated to the Severan period (?!), see Djurić – Rižnar 2017, 140.

[60] Djurić – Rižnar 2017, 140.

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THE MARBLE PROVENANCE OF A GROUP OF SCULPTURES FOUND IN VIRUNUM (AUSTRIA)

FRUITS OF METHODOLOGICAL DEVELOPMENT AND INTER-INSTITUTIONAL COOPERATION

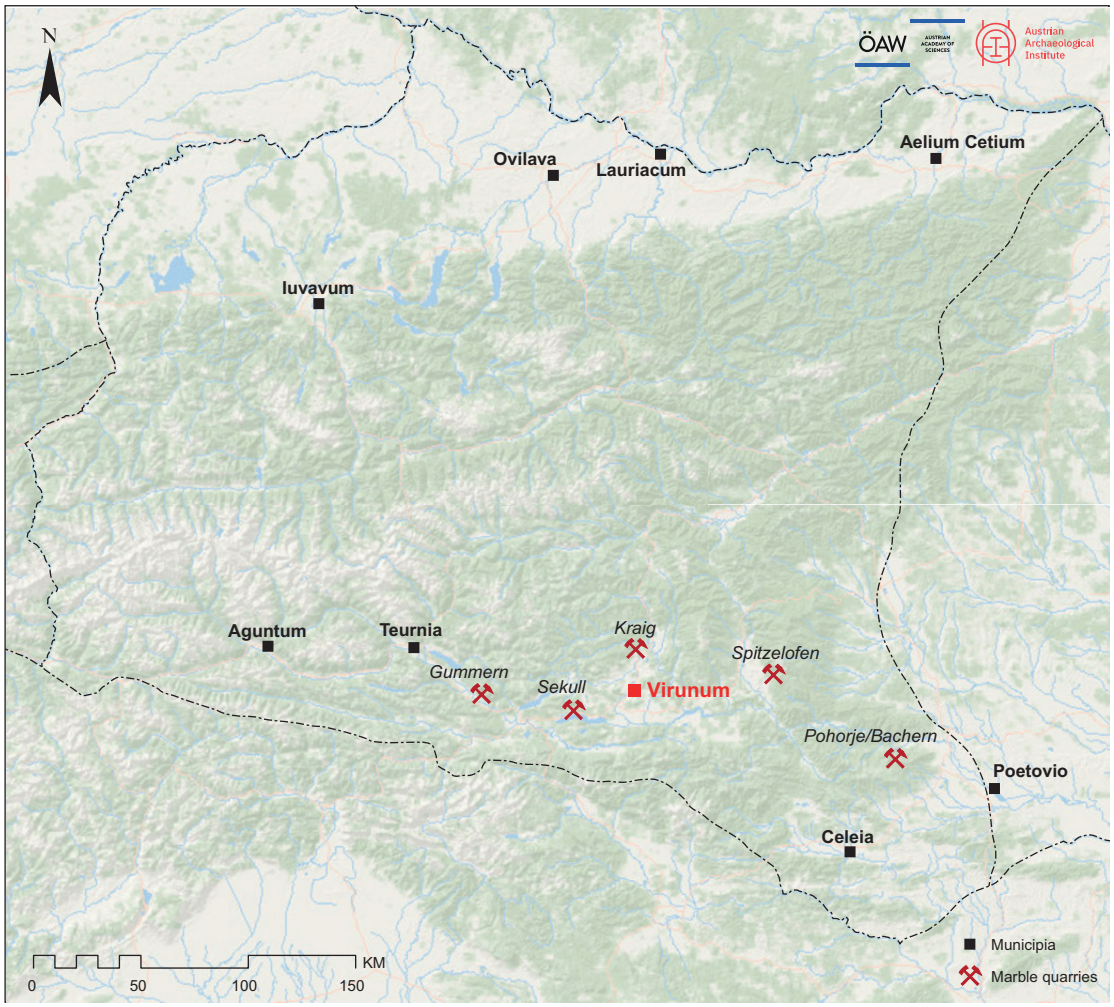
Abstract
The Municipium Claudium Virunum was the capital of the Roman province of Noricum until the Roman retreat from this part of the Alps in the 4th century. Numerous excavations and archaeological investigations already starting in the first half of the 19th century revealed a large number of sculptures and sculptural fragments in different stages of preservation. Over the decades, investigations on the provenance of the marble used for these artefacts were presented with inconsistent results showing substantial differences between the first solely visual examinations and later isotope investigations. Presented here are the results of a multimethod investigation and a subsequent statistical discrimination analysis revealing imported marbles from the island of Prokonnesos and dolomitic marble from Thasos. Two sculptures of identical artistic quality are made of marble from the Gummern quarries, which were the most important and potent marble quarries in Noricum.

The following paper deals with a group of sculptures found in Virunum, the capital of the Roman province of Noricum (fig. 1)[1]. The Municipium Claudium Virunum experienced its heyday in the 2nd century AD, especially in the Hadrianic and Antonine periods, and its material culture shows a high level of craftsmanship with a close connection to Italy, first and foremost to the north Adriatic port city of Aquileia, from which numerous merchant families were already active in the Eastern Alpine region before the province was installed and which remained the most important transshipment point for Mediterranean-Alpine trade during the Roman Empire.

In 1842, the first fragments of marble statues were found in the centre of Virunum on the ›Tempelfeld‹, and half a century later, in 1897, a beautiful floor mosaic measuring 30 m² was discovered in the same area, which finally triggered the excavations of the building complex that took place from 1899 to 1908 (fig. 2)[2]. In the course of these excavations, numerous other sculpture fragments were discovered and provisionally assembled by the excavator Eduard Nowotny and subjected to a first iconographic analysis. Comprehensive publication, however, did not take place until 1947 by Camillo Praschniker and Hedwig Kenner as part of the presentation of the ›Bäderbezirk‹, which is a misleading designation, since it is actually a (double [?]) inner-city insula, as we know today[3].

After World War II, excavations concentrated on the nearby Magdalensberg, and intensified fieldwork in Virunum only resumed in the 1990s, which continues to this day and has led to

1 Excavation reports are published annually in the journal Rudolfinum of the kärnten.museum. For a comprehensive overview, see Dolenz – Ebner-Baur – Schindler Kaudelka 2024, 206–216. We would like to thank Christian Gugl (OeAW-OeAI) for this information.
2 Glaser – Pöschl 2008.
3 Praschniker – Kenner 1947.

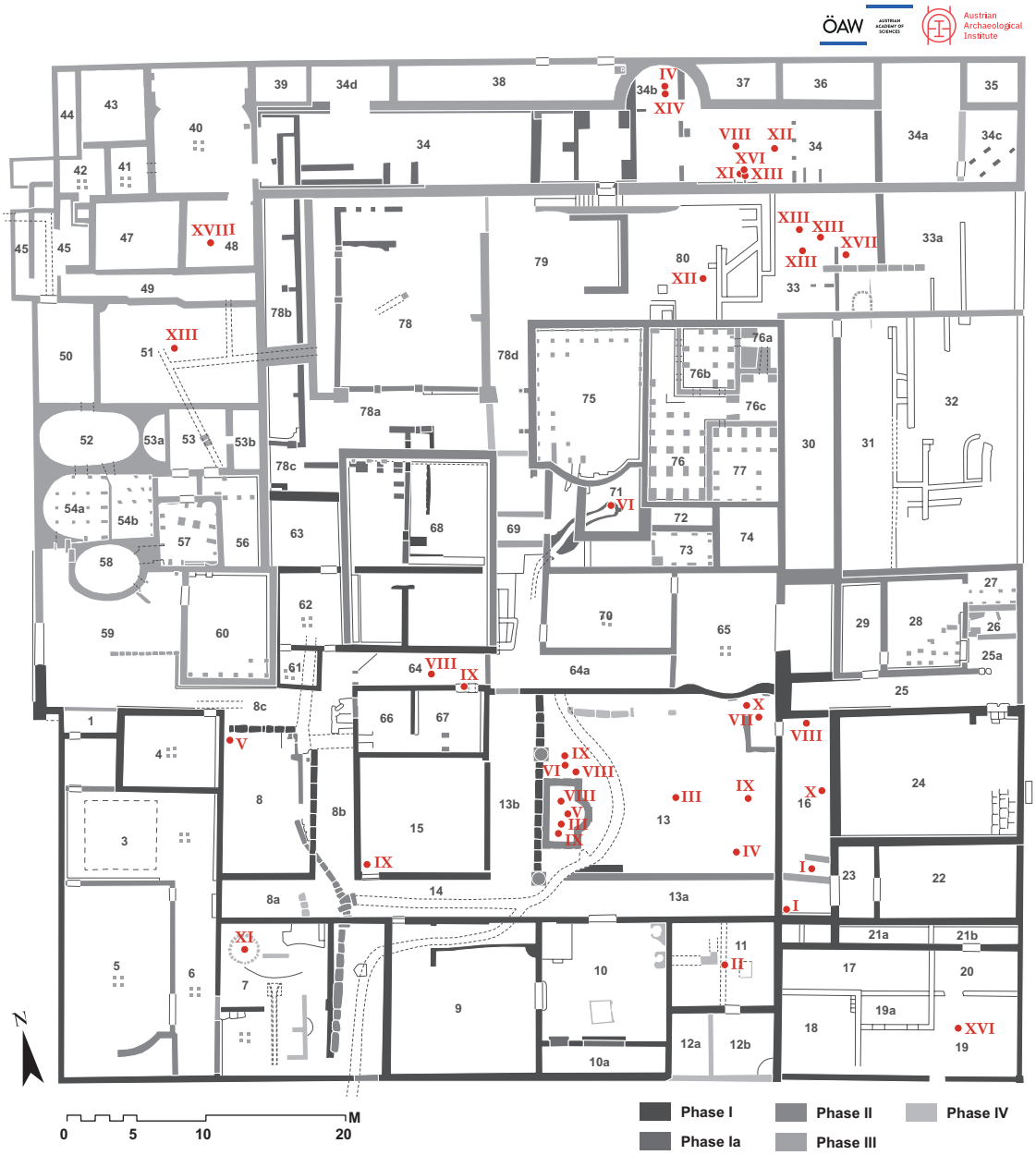


1 Map of the Roman province of Noricum with major cities and marble quarries (© OeAW-OeAI, graphics: N. Math)

sensational discoveries, such as an amphitheatre[4], a military camp[5], a collegium for the Liber Pater cult[6], an early (Caesarian) settlement including a temple district in St. Michael[7], a late antique bishop's church[8] and extensive field research in the *necropoleis*[9]. Furthermore the research team is also dedicated to the restoration and reinterpretation of buildings from old excavations, such as the stage theatre[10].

One of those old excavated objects is the already mentioned luxuriously equipped insula with high-quality wall paintings, mosaic pavements and sculptural decoration in marble. The fragments were partly broken into small pieces all around the insula, but there are obviously two clusters: one around the apsidal hall no. 34 in the north and a second in the open courtyard or garden

4 Gugl 2004.
5 Gugl et al. 2014.
6 Dolenz 2022.
7 Dolenz 2005.
8 Dolenz 2016.
9 Hinker et al. 2018, summarising the state of research.
10 Dolenz – Hinterhöller-Klein 2020.



2 The ›Bäderbezirk‹, an urban insula in Virunum. The find-spots of the statues are marked as dots in red (after Praschniker – Kenner 1947, Beil. 6, © OeAW-OeAI, graphics: N. Math)

no. 13 and adjacent rooms[11]. This is a clear indication that the statues were originally displayed here, probably as part of a »Bildungslandschaft«, as Franz Glaser assumed[12].

Let us take a closer look at the objects: they are at minimum 13 sub-life-size figures in white marble, of which twelve have survived completely or could be largely reconstructed (fig. 3). Their average height is 1–1.25 m, individual figures are somewhat taller at 1.43 and 1.33 m. They are fully carved in the round and stand on plinths, although the backs of some of them have been left rougher. The fronts are finely worked, although measuring points can be observed on some pieces.

11 For a view of courtyard or garden no. 13 after its excavation, see Praschniker – Kenner 1947, 19 fig. 13.
12 Glaser 2011.

3 The statue group: Apollo, Dioscur I, Dioscur II, Ares, Hermes, Dionysus, Satyr, Hermaphrodite, Aphrodite, Isis Fortuna (Noreia) (© kärnten.museum, photos: N. Gail), Wounded Amazon (© Kunsthistorisches Museum, photo: C. Mendez), Nymph, Centaur (© kärnten.museum, photos N. Gail)

While one statue – the Wounded Amazon – was purchased in 1824 by the Kunsthistorisches Museum Vienna[13], the others, together with the many fragments, some of which cannot be assigned to specific statues, remained in the kärnten.museum. Shortly after the excavation, as already mentioned, the scultptures were restored, whereby fractures and missing parts were supplemented in plaster. Unfortunately, most of the figures are missing their heads, and in the case of the added heads, the fractures do not always fit properly, so that it cannot be said with certainty whether the head and torso originally really belonged together.

Our team started to reinvestigate the ensemble to identify the origin of the marble types used and to compare our results with older analyses already available. Previously Camillo Praschniker and Hedwig Kenner attempted a determination of the marble in 1947 on the basis of macroscopic observations[14]. They divided the ensemble into two groups[15]: those made of Carinthian (fig. 3) and those made of »foreign – i.e. Greek and Italic – material« (fig. 4). Only two pieces, the satyr and the centaur were defined as imports, all other figures they attributed to Alpine quarries and here, of course, in particular to that of Carinthia[16]. The work of the so-called Master of Virunum – a workshop operating in the capital with local resources – was deduced from this publication, but for the objects made of imported marble, it was assumed that they reached Virunum as finished works of art[17].

In volume II 1 of the »Corpus Signorum Imperii Romanum« (CSIR), Gernot Piccottini went one step further and declared all the statues, with the exception of the satyr, to be works of art made from local resources[18]. Following Praschniker, he attributed it to the ›Master of Virunum‹ and thus to a sculptor's workshop operating in the Noric capital in the middle of the 2nd century. While Praschniker assumed that it was a sculptor of Italic origin who worked with local material in Virunum[19], Kenner was of the opinion that only the Wounded Amazon was the work of an Italic sculptor[20] due to its high artistic quality, but that all other statues indicated local craftsmen. The prerequisite for these hypotheses was the assumption that the material used was of local, i.e. Carinthian, origin.

This perception was to change abruptly when the statue group was analysed scientifically for the first time in the 1990s by a research group led by Harald Müller[21]. The great advantage of this research was that it focused on Alpine marbles and their significance for the ancient marble trade. For the group of statues, however, it meant the opposite. In contrast to previous works, Harald Müller and Alexandra Steiner identified almost all the statues as made of imported marble, which they thought would even increase the importance of the objects. According to them, only Ares, Dioscur I and the fountain nymph are of Carinthian origin (fig. 4). For all the others, a Thasian provenance has been postulated, both the quarries of Vathy and those of Aliki, by using different methods: thin section, isotopes and trace element analysis with inductively coupled plasma mass spectrometry (ICP-MS). In retrospect, an assessment of the sample series reveals some serious problems. Although the results were published in a diploma thesis by Steiner and in several articles, the analysis data remained unpublished and therefore cannot be used for comparison[22]. Moreover, the individual catalogue entries in the thesis do not explicitly mention the methods applied. It therefore remains unclear for which pieces only isotope analysis or additionally trace

13 Kunsthistorisches Museum, Collection of Greek and Roman Antiquities, inv. I 164.
14 Praschniker – Kenner 1947, 56–99.
15 Praschniker – Kenner 1947, 56.
16 Praschniker – Kenner 1947, 92.
17 Praschniker 1950.
18 Piccottini 1968, 13–19 nos. 4–15.
19 Praschniker – Kenner 1947, 92.
20 Mentioned in Piccottini 1968, 13.
21 Steiner 2006; Müller 2007.
22 Steiner 2005.

4 Nymph, Dioscur I and Ares (Gummern marble) (© kärnten.museum, photos: N. Gail)

5 Aphrodite, Satyr and Isis Fortuna (Noreia) (Thasos Vathy marble) (© kärnten.museum, photos: N. Gail)

6 Apollo, Dioscur II, Hermes, Amazon, Hermaphrodite, Dionysus (Proconnesian marble) (© kärnten.museum, photos: N. Gail Gail, Amazon: © Kunsthistorisches Museum, photo: C. Mendez)

element analysis and thin sections were actually used. And finally, the samples are not available for verification – at least for us – with serious consequences:

In 2022, we had the opportunity to re-examine some of the figures thanks to the generous permission granted by the kärnten.museum and the Kunsthistorisches Museum. The impetus came from restoration work on the statues, in the course of which older additions were removed and fractured surfaces were covered. As usual in ›Team Prochaska‹, a multimethod approach with a combination of different analytical methods was applied:

- Stable isotope analysis, which is the standard method for the provenance analysis of marbles was applied to analyse the isotopes of oxygen and carbon. However, as the compositional fields of many different types of marbles overlap considerably when applying this method alone, trace element analysis was additionally performed.
- Multi-element trace element analysis by ICP-MS was used to analyse a series of 15 trace elements at the ppm and sub-ppm level.
- For the final statistical evaluation of the large number of analytical variables obtained by these combined methods, the program packages STATISTICA and SPSS were used, and the results were evaluated by a multivariate discrimination analysis.
- Microscopic investigations were performed in cases where the sample size allowed for the preparation of a microscopic slide.

The results correspond to those of Müller in the allocation to Alpine deposits as well as Thasos Vathy, but differ clearly in one point from the previous results. All of the figures then attributed to Thasos Aliki in fact come from Prokonnesos. Following our investigations, Ares and Dioscur I are of certain Carinthian origin, Isis Fortuna (Noreia [?]), Aphrodite and the Satyr (fig. 5) come from dolomite deposits in Thasos Vathy, and the remaining statues from Prokonnesos (fig. 6).

The assignment of each investigated sample to the corresponding quarry or quarry region was done by means of statistical multivariate discriminant analyses and the results are presented in table 1. The terms describing the probability are as follows:

- Distance: The distance of the sample under consideration from the centre of the ellipse that represents the quarry probability field. The central point of the ellipse expresses the average and hence most characteristic values of a quarry. The closer a point is to the centre of an ellipse, the more likely is the provenance from that marble site.
- Relative (posterior) probability: The probability of the sample belonging to some group within the assumption that it originates in any case from one of the groups in the selection. The threshold is 60 %. Low values indicate that the sample's assignment is dubious and could fall in two or more groups.
- Absolute (typical) probability: This is a distance-dependent parameter measuring the absolute probability that the sample belongs to the chosen group or, in other words, is a typical representative of the group properties. The threshold is 10 %, corresponding to samples on the edge of the 90 % probability ellipse. Low values indicate anomalous samples (outliers) or samples possibly not belonging to any group in the selection.

After the a priori elimination of several Alpine and international marbles on account of their chemical composition and isotopic ratios, the following marbles were short-listed for the statistical evaluation shown above: Gummern high strontium (Sr), Prokonnesos, Prokonnesos III, Herakleia/Miletos, Paros II (Lakkoi) and Thasos Aliki. It is worthy of note that only two samples could be attributed to Alpine marbles, the Ares and the Dioscur I. Both belong to a special type of Gummern marble characterised by extremely high Sr contents. Marbles from Herakleia/Miletos, Paros II (Lakkoi) and Thasos Aliki could not be identified. The absence of marble from the latter location in particular is noteworthy, as previous investigations argued for prominent Thasos Aliki marbles for the Virunum sculptures. This may be due to the substantial isotopic overlap of Proconnesian marble with those from Thasos Aliki, and the earlier provenance assignment was based

Object	Distance	Absolute probability	Relative probability	Provenance	Relative probability	Provenance
	1st Choice				2nd Choice	
VIR1 Ares	2.01	91.6	100	Gummern high Sr	–	–
VIR2 Apollo	2.89	82.3	98.3	Prokonnesos	1.7	Herakleia/Miletos
Dioscur I	–	–	–	Gummern high Sr	–	–
LMKSc04 Dioscur II	7.04	31.8	99.8	Prokonnesos III	0.2	Prokonnesos
VIR3 Hermes	1.10	98.2	93.8	Prokonnesos	6.2	Herakleia/Miletos
LMKSc11 Hermes head	1.65	94.8	89.4	Prokonnesos	10.6	Herakleia/Miletos
LMKSc12 Hermes sheep	1.99	92.1	96.3	Prokonnesos	3.7	Herakleia/Miletos
LMKSc13 Hermes plinth	0.98	98.6	96.1	Prokonnesos	3.9	Herakleia/Miletos
LMKSc06 Dionysus gluteus	1.13	98.0	83.9	Prokonnesos	16.1	Herakleia/Miletos
LMKSc08 Dionysus	1.93	93.6	78.8	Prokonnesos	21.2	Herakleia/Miletos
LMKSc07 Dionysus foot	7.54	27.4	98.9	Prokonnesos III	1.0	Prokonnesos
Amazon KHM I 164 (torso)	1.21	97.7	92.7	Prokonnesos	7.3	Herakleia/Miletos
Amazon KHM I 164 (leg)	1.58	95.4	96.2	Prokonnesos	3.8	Herakleia/Miletos
VIR4 Isis				Thasos Vathy dolomite		
LMKSc09 Isis				Thasos Vathy dolomite		
VIR5 Aphrodite				Thasos Vathy dolomite		
VIR6 Satyr P1				Thasos Vathy dolomite		
VIR7 Satyr P2				Thasos Vathy dolomite		

Table 1 The statistical parameters for the calculation of the provenance of the investigated sculptures. The multivariate discrimination analysis was performed by the statistical package SPSS. The variables used for the calculation were: $\delta^{18}O$ ‰, $\delta^{13}C$ ‰, magnesium (Mg), manganese (Mn), strontium (Sr), chromium (Cr), yttrium (Y), cadmium (Cd), lanthanum (La), cerium (Ce), praseodymium (Pr), ytterbium (Yb) and uranium (U)

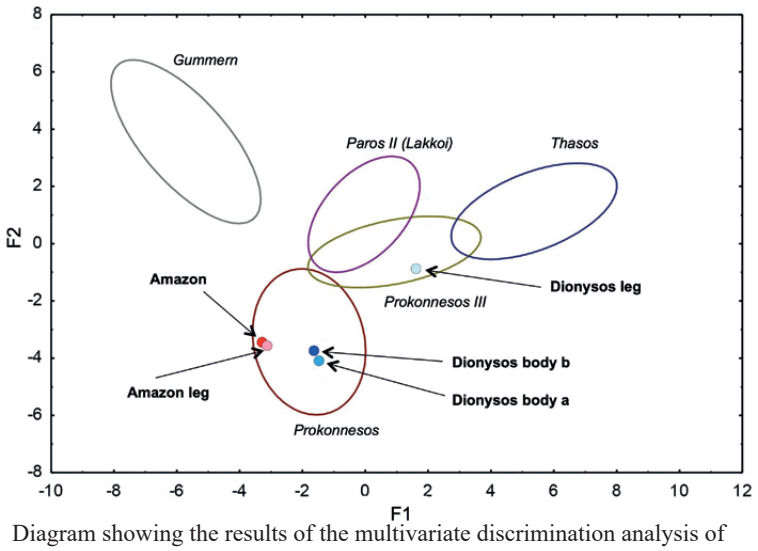
solely on the use of stable isotopes. If the observed source of error in Müller's work is correct, the fountain nymph would indeed be of Carinthian marble as indicated by Müller, but for the hermaphrodite, we would have to assume a Proconnesian origin. Unfortunately, we could not sample these two sculptures. Of particular interest, of course, is the little head of the centaur, which even Praschniker suspected to be an import, but scientific analyses have never been conducted on this piece.

Five samples were indicated as Thasos Vathy dolomitic marble. This assignment is straightforward on visual examination and no further analytical or statistical investigation was performed on these samples. For one sample (Dioscur I), no isotope analysis is available so far, thus a statistical multivariate analysis was not performed. However, the chemical analysis, and especially the extremely high Sr content, definitely argue for a Gummern (high Sr-Gummern) provenance of this sculpture.

Summing up, we have three different marble sources for the statue group in Virunum: two from the Eastern Mediterranean, Thasos Vathy and Prokonnesos; one from Carinthia, Gummern; and none from Italy (fig. 7). A cultural and economic-historical analysis of the archaeometric results would go far beyond the scope of this publication but in any case, the narrative of a »local sculptor working with local material« has been finally refuted. Instead, we want to focus on further discoveries that arose primarily from our collaboration with the conservators.

From the Dionysus, three samples were taken: torso, gluteus and right leg. It turned out that although all three samples were Proconnesian, the leg differed from the other two as it shows the typical Prokonnesos III pattern (fig. 8). An examination by the conservators immediately showed that the leg was indeed not belonging to this statue. The god Dionysus now has one leg less, but the statue ensemble of Virunum has one male figure more (fig. 9). The Dionysus statue clearly shows that mistakes were made during the modern restorations. Actually, one should – if one wants to be methodically correct – not take only one sample per sculpture, but especially those body parts that do not directly fit should be sampled individually. However, this also applies to

7 Map showing the provenance of the marbles used for the statue group in Virunum (© OeAW-OeAI, graphics: N. Math)



8 Diagram showing the results of the multivariate discrimination analysis of Dionysus and the Wounded Amazon (© OeAW-OeAI, graphics: W. Prochaska)

the observed antique repairs. One can assume that ancient additions were made with local marble. A statue could therefore consist of different types of marble. It is therefore all the more important that the exact sampling point is clearly marked.

In the case of the Amazon in the Kunsthistorisches Museum, the question, if leg and torso belong together, has been discussed controversially until now. Here too, archaeometric investigations led to a clear result (fig. 10). The torso was purchased in 1824 without any indication of where it was found; the leg was discovered almost a century later in 1903 during excavations in

9 Dionysus right leg (© kärnten.museum, photo: N. Gail)

10 Wounded Amazon torso (© Kunsthistorisches Museum, photo: C. Mendez)

Virunum. Based on iconographic, stylistic and technical observations, Eduard Nowotny already suspected that they might belong together. Another century later, scientific confirmation is now provided. In figure 8 it is demonstrated that the two fragments fit together perfectly in the Prokonnesos field and may have originally belonged to one block of marble. We are also reminded of Praschniker's wise words at the end of his chapter on the sculptures in the monograph on the ›Bäderbezirk‹, which has already been quoted several times: »Hier kommt es entscheidend auf die Bestimmung des Marmors an […]. Es ist wohl heute [i.e. 1947] der Zeitpunkt für eine derartige Untersuchung noch verfrüht.«[23] *Quod erat demonstrandum!*

[23] Praschniker – Kenner 1947, 56.

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REGIO X – VENETIA ET HISTRIA BETWEEN THE MEDITERRANEAN AND THE ALPS

IMPORTED LITHOTYPES FROM THE ROMAN THEATRE OF VICENZA (VENETO, ITALY)

Abstract
This paper aims at presenting the first results of a research project on marbles and other local and imported stones found in the Teatro di Berga, i.e. the Roman theatre of Vicenza (Veneto, Italy) and their contribution to understanding the trade, use and diffusion of imported marbles and other ornamental stones in northern Adriatic regions during Roman times. In particular, a group of 18,732 fragments, made up of imported coloured marbles used in architecture (structural elements, coating slabs), will be analysed. Results on lithotype characterisation, quantification and functional definition will be reported, in order to increase our knowledge about types and volumes of marbles used in Roman Vicenza and to compare this case with other theatres and public buildings in northeastern Italy. The data collected show the deep integration of Vicenza, like other towns in northern Adriatic Italy, into the marble trade network within the Roman Mediterranean, with particular reference to the Greek/Eastern routes. They also attest to the use of expensive and prestigious materials, thus showing the economical, socio-political and cultural significance of Vicetia. Furthermore, chronological information from the ornamental stones analysed seems to attest to the use of imported lithotypes in the Roman city since the beginning of the Imperial period.

In 2022, the Department of Cultural Heritage of the University of Padua started a collaboration with the Soprintendenza Archeologia, Belle Arti e Paesaggio per le province di Verona, Rovigo e Vicenza and Comune di Vicenza (Musei Civici Vicenza – Museo Naturalistico Archeologico) with the aim of studying local and imported stones used in the city of Vicenza (Veneto, Italy) during the Roman period[1]. This research fits into a wider project dedicated to the study of building materials and techniques used in urban and territorial sites in Roman Cisalpina, which has been carried out by the University of Padua since 2009[2]. In particular, the aim is to investigate the provenance and characteristics of raw materials and ways of manufacturing and installing them, as well as the organisation of construction systems, in order to rebuild the steps of the constructive processes and the reasons behind certain building and architectural choices. This is being undertaken in order to acquire as complete a picture as possible of technical-constructive aspects of northern Italian architecture during the Roman period, which in turn can be useful for reflections on the socio-economic, geopolitical and cultural relationships between Cisalpina, Rome and other territories of the Roman Empire[3].

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1 The project is included in two agreements signed in 2022 between the Department of Cultural Heritage, the Municipality of Vicenza and the Soprintendenza Archeologia Belle Arti Paesaggio for the Provinces of Verona, Vicenza and Rovigo.

2 Bonetto – Previato 2013.

3 First results in Previato 2015; Zara 2018. See also the proceedings Bonetto – Camporeale – Pizzo 2014; Bonetto – Bukowiecki – Volpe 2019; Bonetto – Previato (in print).

1 Vicenza. a: Location map (basemap by Lencer, CC BY-SA 3.0 via Wikimedia Commons; graphics: B. Marchet). b: Plan of the city with Roman structures indicated (from Rigoni 1998, figure on p. 462)

Research on Vicenza, in particular, is currently focused on the identification of marbles and other local and imported stones by examining published data and carrying out detailed petrographic analysis on samples from materials used in architectonic complexes of the Roman Vicetia.

In this paper, we consider the imported coloured lithotypes found in the Roman theatre of Vicenza and used for structural and coating purposes, which were first systematically studied at the end of the last century[4]. Since our research is still very much in the initial stages, our data will be enriched by those previously collected by R. Prandoni in her master thesis, supervised by L. Lazzarini[5]. Those materials are re-elaborated here in order to analyse qualitative and quantitative distribution of the recognised lithotypes in relation to their function, use and provenance.

INTRODUCTION

Vicenza has always been a theatre of passages. In fact, its site is situated in a natural east-west corridor, set between the most eastern offshoots of the Lessini Mountains to the north and the Berici Mountains to the south and crossed by the Astico-Bacchiglione River[6], which, coming from the

4 Prandoni 1997/1998; Basso – Bianco – Legrottaglie 2004.

5 We want to express our sincere thanks to R. Prandoni and L. Lazzarini for their willingness to share and discuss the data with us.

6 In the past, according to palaeohydrographic reconstructions, the Astico River flowed through the northeastern part of the town of Vicenza and then descended toward the southeast following the current path of the Bacchiglione River, see J. Bonetto in: Bonetto 2009, 79.

north, receives the waters of the Retrone River south of the city and then descends southeast towards the Adriatic lagoon (fig. 1 a).

This pattern makes the Vicenza area a crossroads of routes used since the protohistoric age to reach both the southeastern plain and the Adriatic coast, as well as pastures and mineral resources set in the mountains.

Although there is little archaeological evidence, it is now clear that the first settlement dates back to the first half of the 6th century BC[7]. It is also beyond dispute that the Roman Via Postumia, made in 148 BC to connect Genoa to Aquileia, crossed the city in an east-west direction, following the natural path between the Lessini and the Berici Mountains. Nowadays this route is partially retraced by the current Corso Palladio[8].

A few more data are related to the decades between the second half of the 1st century BC and the first half of the 1st century AD, when Vicenza became a Roman municipium (fig. 1 b). It was in this phase that the city began a process of progressive renewal, which aimed at adapting urbanistic and architectural aspects to its new legal status as well as to its role of administrative and management pole of a territorial structure. Brick curtain city walls were built, of which only two sections are known, and also the forum square with its related public and religious buildings, which probably stood between the current Contrà Cavour, Piazza dei Signori and Corso Palladio.

Furthermore, it is probably in this period that two stone bridges were built over the Astico-Bacchiglione (Ponte di Santa Maria degli Angeli) and the Retrone rivers (Ponte di San Paolo)[9].

Little other evidence of the Roman city is known: public baths, whose remains were found between Contrà Pescherie Vecchie and Oratorio dei Proti, some rich domus structures, the theatre south of the Retrone River, a suburban necropolis and an aqueduct coming from the northwest, which brought water to the city[10].

Vicenza retained a certain important role even in Late Antiquity, when many religious buildings for Christian worship were built in the southern and western parts of the city, and in the Early Middle Ages. Between the late 5th and the 6th century AD at least, the city was in fact the seat of an *horreum*, as Gothic sources mentioned. Afterwards, Vicenza became a Lombard duchy and then a Committee during the Carolingian and Ottonian ages[11].

The Roman Theatre

As we have said, the Roman theatre is one of the best-known pieces of evidence in the architectural landscape of Vicetia. The building stood in the southeast suburban block, outside the city walls, but well connected to the centre via the San Paolo bridge. Its structures, still partially visible in the 16th century[12], have been reused by buildings erected in subsequent centuries in the area – called »di Berga« in modern times. Today, the theatre's planimetric articulation is readily perceptible in the design of the block, which is marked by the current Contrà SS. Apostoli, Piazzetta S. Giuseppe, Contrà Porton del Luzo and Piazzetta Gualdi[13] (fig. 1 b).

The theatre was involved in limited excavations and surveys made by several scholars during the 18th century, but the first focused investigation dates back to the mid-19th century (1838–1854), when the architect G. Miglioranza excavated part of the eastern section of the scene building, the

7 See S. Boaro in: Bonetto 2009, 79–83.

8 See Rigoni 1987, 109 f.; Rigoni 1998a, 460; J. Bonetto in: Bonetto 2009, 83.

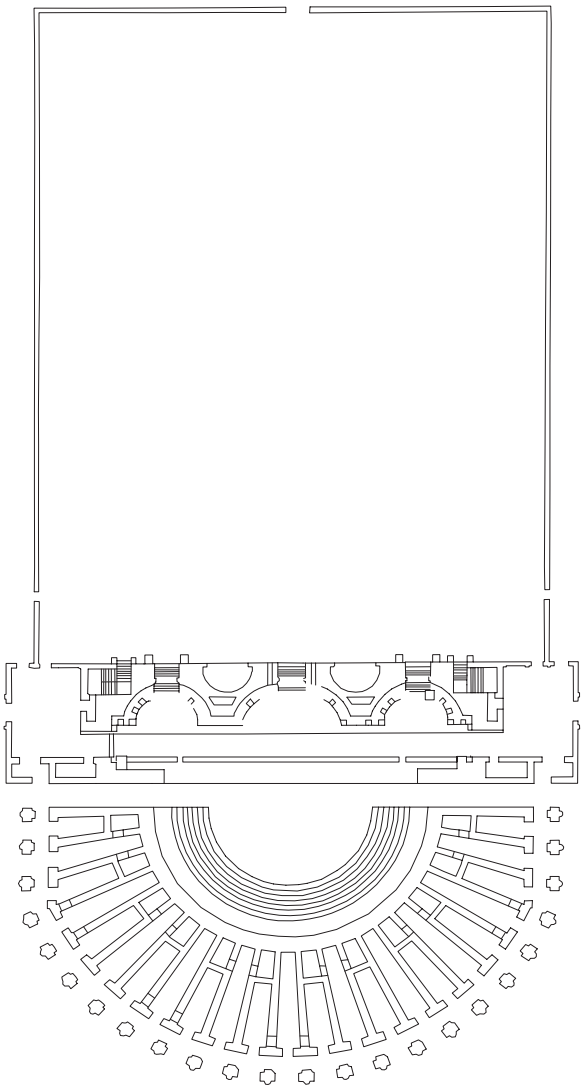
9 These structures are no longer preserved: the Ponte di San Paolo was demolished in 1875 and the Ponte di Santa Maria degli Angeli in 1889, see Bonetto 2009, 88.

10 Rigoni 1987, 110–129; Rigoni 1998a, 460–465; Bonetto 2009, 83–91.

11 Bonetto 2009, 91–94.

12 Two of the niches which decorated the external prospect of the stage building still appear in the »Pianta Angelica« (1580). The same structures were observed by the architect A. Palladio and the humanist D. Barbaro, as noted in the book by the latter, see Rigoni 2004, 239 and other sources mentioned there.

13 Ceretta – Arcaro – Sandri 1978, 29–41; Rigoni 2004, 236 fig. 1.



2 Vicenza. Reconstructive plan of the Roman theatre (drawing: D. Hosking, after Rigoni 2004, 237 fig. 2; graphics: B. Marchet)

ima cavea and the orchestra. Those data he had collected were then reanalysed critically by G. Barichella, who made a new plan of the building[14]. However, it would take about a century for stratigraphic investigations to be carried out.

In 1977 a study carried out by the Archaeological Institute of the University of Padua concerned the lower steps of the *ima cavea* and allowed its structural and planimetric characteristics to be verified as well as its relationship with the orchestra[15]. Finally, a systematic archaeological investigation was carried out in 1991–1993, in order to analyse all of the theatre's structures, which have been reused by the Palazzi Gualdo and other post-antique building complexes[16].

First of all, these excavations have returned an overall understanding of the planimetric and architectural articulation of the theatre[17] (fig. 2). It consisted of a north-facing *cavea*, a semicircular

14 Ceretta – Arcaro – Sandri 1978, 15–28.
15 Polacco – Favaretto 1978, 43–56.
16 Rigoni 2004, 241–249.
17 Rigoni 1998b, 467; Rigoni 2004, 237 f.

orchestra and a scene building, whose front is now under the current complex of the Palazzi Gualdo. The *cavea* was mostly made of concrete, with limestone facing blocks, and it was divided into two *maeniana*, separated from each other by a *praecintio* and supported by two radial groups of chambers covered by a barrel vault. These were in turn marked by 24 radial walls and connected by an annular corridor. The lower *maenianum* was based upon a solid substructure. Six radial rooms provided access to the steps through a complex system of stairways, while the orchestra was reached through the two *aditus*. They developed in parallel to both the straight wall of the cavea and to the front of the stage and were covered by a barrel vault, following the canonical scheme of Roman theatres. The *scaenae frons* had three semicircular niches connected by a rectilinear back wall. Finally, two monumental niches opened behind and overlooked a *porticus post scaenam*, which developed for more than 70 m towards the city centre. Furthermore, past excavations have shown that extensive use was made of marbles and other ornamental stones to decorate the theatre.

Miglioranza observed that the paving of the orchestra was made of coating slabs of white marble[18], as were the *frons pulpiti* wall and steps leading to the stage[19]. Regarding the eastern niche of the *scaenae frons*, he also found part of a floor which was decorated with slabs made of Africano, Cipollino and other coloured marbles[20] and some slabs in Bardiglio lunense preserved on the socle of the niche's wall[21]. Additionally, his excavations have returned a large amount of fragments not *in situ*, which are partially described in his reports[22].

1991–1993 excavations enriched knowledge on the theatre's marble decoration by discovering that at least one of the two framing plinths of the eastern *hospitalia* door was covered by a white marble slab[23]. A similar decoration characterised the steps that descended from the *hospitalia* towards the north[24]. The latter investigations also started the systematic reorder and study of marble materials recovered so far[25]. Finally, research carried out during the biennium 1991–1993 has returned important data related to the chronology of the building[26].

The theatre was in fact created by demolishing an older complex, which dated back to the late Republican age. This provides a terminus post quem for the theatre's construction at the end of the 1st century BC. It was then renewed during the Julio-Claudian period, when the scene building was rebuilt and the marble architectural decoration installed. This is proved in particular by a substantial and homogeneous group of structural and statuary elements, which suggests dating this phase to the reign of the Emperor Claudius (AD 41–54)[27]. Further interventions, made to enrich the decorative apparatus, date back to the 2nd century AD, although only few architectural elements relate to this period[28].

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18 »Il piano semicircolare dell'orchestra, che avanza fino al parapetto del pulpito, era lastricato di marmo bianco«, as observed by G. Miglioranza in his excavation reports, see Ceretta – Arcaro – Sandri 1978, 19.

19 Ceretta – Arcaro – Sandri 1978, 23 f.: »Due muri paralleli alla fronte della scena che devono avere sostenuto il rimanente del pulpito […] di questi due muri il secondo forma il parapetto del pulpito, ed ha traccia di esser stato nel lato esterno incrostato di marmo bianco. Alle estremità di questo muro, a levante, v'è una scaletta, con gradini incrostati di marmo bianco, per la quale montavasi sul pulpito.«

20 Ceretta – Arcaro – Sandri 1978, 23. M. Rigoni (2004, 245) suggests that this »piano di cocciopesto in cui sono inserite crustae di marmi diversi disposti irregolarmente« was the floor preparation, covered by a decoration – possibly made of marble – which is no longer preserved today.

21 Ceretta – Arcaro – Sandri 1978, 23.

22 He noted e.g. »molte piccole membrature di marmo rosso, di giallo antico e d'africano« and many fragments of column shafts made of Africano, see Miglioranza 1838, 13 f. nos. I–II; Miglioranza 1839, 33–35 nos. I. III.

23 Rigoni 2004, 245 f.

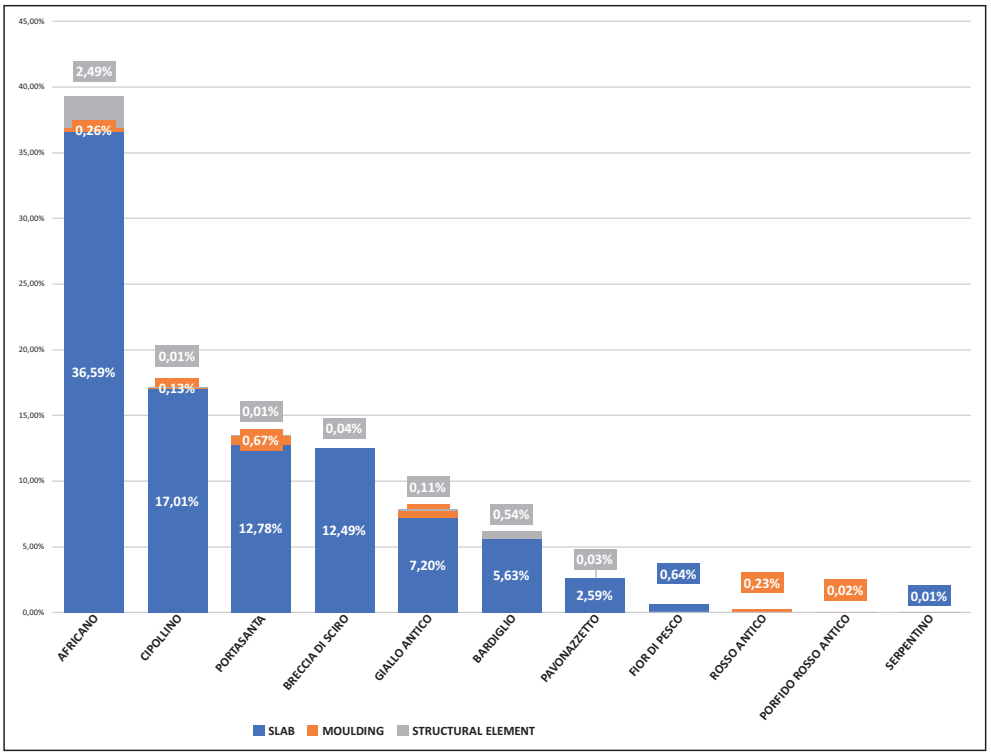
24 Rigoni 2004, 246: »scala […] era originariamente rivestita in marmo bianco, come confermano alcuni frammenti presenti nel primo gradino.«

25 Prandoni 1997/1998; Basso – Bianco – Legrottaglie 2004; Lazzarini 2004.

26 Rigoni 1998b, 467 f.; Rigoni 2004, 238 f.

27 Basso – Bianco – Legrottaglie 2004, 255. 272.

28 Basso – Bianco – Legrottaglie 2004, 272. 278.



3 Bar graph showing the quantity (number) and function of the lithotypes used in the theatre. The quantity is expressed as a percentage of the total number of fragments (100 % = 18,732) (graphics: B. Marchet)

The theatre was used at least until the beginning of the 3rd century AD, when an inscription from Leptis Magna mentioned Vicenza among the cities which honoured the famous *pantomimus* Marco Settimio Aurelio Agrippa for his performances[29].

COLOURED MARBLES FROM THE ROMAN THEATRE

The focus of this paper is a group of 18,732 elements made of imported coloured marbles[30] used for structural functions, architectural decoration and coating surfaces. They have been found in archaeological investigations carried out by both Miglioranza during the 19th century[31] and the Soprintendenza per i Beni Archeologici del Veneto between 1991 and 1993.

The study of these materials was carried out at the end of the 20th century by R. Prandoni, within her master thesis on imported coloured stones. With the supervision of L. Lazzarini, she also undertook the macroscopic identification of lithotypes and registered information on the number of elements, the maximum size and thickness, the shape and profiles, the function and other indicators related to mounting processes and/or reuse activities (e.g. cramp holes, the presence of mortar on one or more surfaces, etc.)[32].

29 IRT 606.

30 The term »marble« is here used in the ancient sense of »marmor« (i.e. polishable stone).

31 The majority of the materials found by Miglioranza have been stored in the Palazzo Chiericati's cellars for decades without providing any detailed information on the context in which they were found. Thus, 20th-cent. scholars – who reordered and studied these fragments (see above) – decided to consider only materials which could be strongly attributed to 19th-cent. investigations because they were typologically and stylistically comparable to Miglioranza's drawings, see Basso – Bianco – Legrottaglie 2004, 253.

32 Prandoni 1997/1998.

Lithotype	Number of elements	Percentage on the number of elements
Africano	6854	38.54 %
Euboean Cipollino verde	3187	17.92 %
Portasanta	2394	13.46 %
Breccia di Sciro	2340	13.16 %
Giallo antico	1349	7.58 %
Bardiglio lunense	1054	5.93 %
Pavonazzetto	486	2.73 %
Fior di pesco	120	0.67 %
Krokean Serpentino	2	0.01 %

Table 1 Quantity (number and percentage) of the coating slabs, divided by lithotype. The quantity is expressed as a percentage of the total number of slabs (100 % = 17,786)

Lithotype	Number of elements	Percentage on the number of elements
Portasanta	125	36.55 %
Giallo antico	98	28.65 %
Africano	48	14.04 %
Rosso antico	44	12.87 %
Euboean Cipollino verde	24	7.02 %
Porfido rosso antico	3	0.88 %

Table 2 Quantity (number and percentage) of the mouldings, divided by lithotype. The quantity is expressed as a percentage of the total number of mouldings (100 % = 342)

Lithotype	Number of elements	Percentage on the number of elements
Africano	466	77.15 %
Bardiglio lunense	102	16.89 %
Giallo antico	20	3.31 %
Breccia di Sciro	7	1.16 %
Pavonazzetto	5	0.83 %
Euboean Cipollino verde	2	0.33 %
Portasanta	2	0.33 %

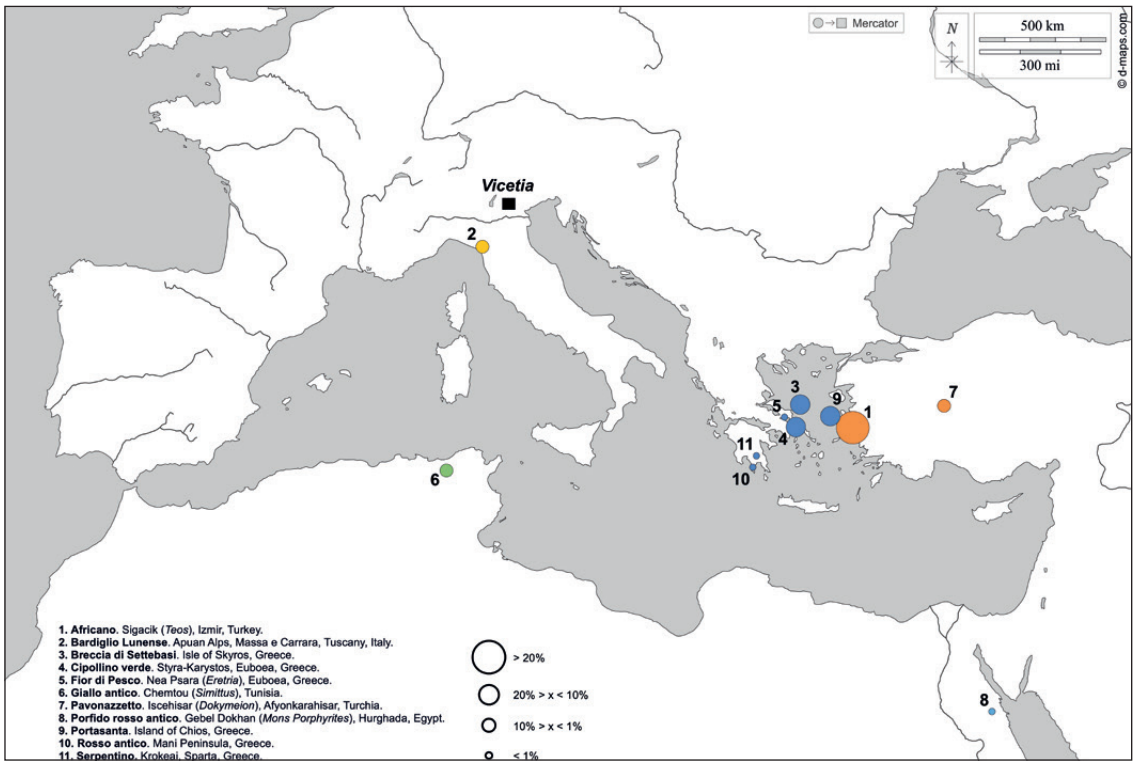
Table 3 Quantity (number and percentage) of the structural elements, divided by lithotype. The quantity is expressed as a percentage of the total number of structural elements (100 % = 604)

Based on these data, enriched by our ongoing study, many tables and graphs have been created and plotted to show the percentage of the different lithotypes identified (figs. 3–5; tabs. 1–3)[33].

It must be noted that all materials were found in secondary contexts. Thus, we cannot assert with certainty that they were used in the theatre. Possibly, this can be suggested only for the majority of the structural elements, whose characteristics are typical of the public architecture[34],

[33] Quantitative calculations presented here are preliminary, based on the number of fragments rather than the weight, which is not yet available.

[34] Basso – Bianco – Legrottaglie 2004.



4 Map of the Mediterranean showing the provenance of the lithotypes found in the theatre of Vicenza (basemap after <https://d-maps.com/m/mediterranean/meditmin/meditmin03.pdf> [21.07.2022]; graphics: B. Marchet)

and for some coating slabs, which can be compared – in terms of their quality – to the few fragments preserved *in situ*[35]. All materials, however, provide a significant amount of important information on the trade, use and distribution of imported lithotypes used in Vicenza during Roman times.

Focusing on the 18,732 fragments, eleven lithotypes have been identified (fig. 3). Foremost among them is Africano, represented by 39.33 % of the total number of elements. Euboean Cipollino verde (17.15 %), Portasanta (13.46 %) and Breccia di Sciro (12.5 %) are also well attested, followed by Giallo antico (7.83 %) and Bardiglio from Carrara (6.17 %). Pavonazzetto too is present (2.62 %), while other stones constitute less than 1 %.

Looking at the function, they can be divided into three groups: floor and/or wall coating slabs, elements with a moulded surface and structural elements.

The majority of fragments (17,786 elements) are coating slabs, characterised by two flat and parallel faces, of which usually at least one is smoothed (tab. 1). Unfortunately, the absence of further indicators (e.g. cramp holes), makes it difficult to determine whether they were used for floor or wall coatings[36]. As regards lithotypes, the majority of the slabs are of Africano (38.54 % of the total number of slabs) followed by Euboean Cipollino verde (17.92 %). Portasanta (13.46 %) and Breccia di Sciro (13.16 %) are also well represented, followed by Giallo antico (7.58 %) and Bardiglio lunense (5.93 %). Pavonazzetto is also quite attested (2.73 %), while Fior di pesco is less common (0.67 %). Finally, there are also two fragments of Krokean Serpentino (0.01 %).

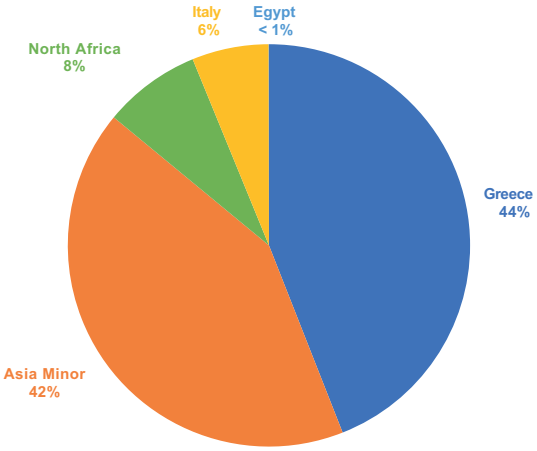
On a small number of fragments (342 elements), the presence of a moulded surface was then identified (tab. 2). With the exception of one fragment of Porfido rosso antico, whose function has

35 E.g. wall coating slabs in Bardiglio lunense, still preserved in the socle of the *scaenae frons*' eastern niche.
36 Guidobaldi 1991, 133 f.

not yet been identified, they are small cornices, fluted pilaster shafts and coating panels: thus elements which marked walls horizontally and vertically.

Cornices, pilasters and panels are made of Portasanta (36.55 % of the total number of mouldings) and Giallo antico (28.65 %). Cornices are also made of Africano (14.04 %), Rosso antico (12.87 %) and Euboean Cipollino verde (7.02 %). Finally, there are two fragments of cornices, plus the one of unknown function, in Porfido rosso antico (0.88 %).

One last group is that of structural elements (604 elements) (tab. 3). They are mostly column shafts (599 elements), but there are also four column bases (two bases made of Africano and two of Giallo antico) and one small column base made of Cipollino verde[37].



5 Pie chart showing the lithotypes' provenance (macro-areas). The quantity is expressed as a percentage of the total number of fragments (100 % = 18,732) (graphics: B. Marchet)

The overwhelming majority of these materials are made of Africano (77.15 % of the total number of structural elements). Bardiglio lunense (16.89 %) and, to a lesser percent, Giallo antico (3.31 %) and Breccia di Sciro (1.16 %) are also well attested. Less than 1 % are Pavonazzetto (0.83 %), Cipollino verde (0.33 %) or Portasanta (0.33 %).

DISCUSSION

Despite the preliminary nature of these data, the group of materials analysed so far allows some interesting reflections.

A first consideration concerns the provenance of marbles. As figures 4 and 5 illustrate, the majority of materials come from the Greek area (44.03 %), in particular from Aegean islands (25.99 %) and Euboea (17.79 %), while only 0.25 % was quarried in the Peloponnese, between Krokea and the Mani Peninsula.

Another considerable proportion is that of materials coming from Asia Minor (41.95 %), particularly from the area of ancient Teos – the modern village of Sıgačık (southwest of Izmir) – near the Turkish Aegean coast (39.33 %). In fact, this is the location of the quarries of Africano, which was massively used in the theatre for both structural and coating functions, as already mentioned. Less attested are other materials – Pavonazzetto in particular – coming from the rest of Türkiye (2.62 %).

North Africa is represented only by Giallo antico from the Tunisian coast (Chemtou) (7.83 %), while the only Italian decorative stone present (among those not quarried locally) is Bardiglio marble coming from the northern Tyrrhenian side (Carrara quarries) (6.17 %).

Finally, only 0.02 % comes from the Eastern Egyptian Desert, while coloured marbles from Gallia and Iberia are completely absent.

As we can see from this first projection, Vicetia seems to have been well-integrated within the Roman Mediterranean marble trade network. Furthermore, the results outline a preferential link to Eastern markets and, in particular, to Greek and Asian Aegean harbours. On the other hand, lithotypes from the western Mediterranean are significantly less attested, with the exception of Giallo antico. This trend is comparable to what has been observed in other *municipia* of the

[37] Most of these structural elements are published in Basso – Bianco – Legrottaglie 2004.

Roman Regio X – Venetia et Histria[38] as well as in many centres of the Adriatic side of central Italy[39].

First data also illustrate the employment of some of the most prestigious and expensive marbles spread in the Roman Mediterranean during the Imperial period and massively exploited in statuary and architecture[40]. Particularly noticeable are column shafts fragments in Africano found in the Roman theatre of Vicenza, which possibly decorated the *scaenae frons*[41]. From a very first analysis of the Roman sites in northeastern Italy, there are in fact only few examples of the use of this lithotype with structural functions in theatrical buildings[42]. In particular, we can mention the big column visible at the entrance of the Santa Giulia Museum[43] and a group of plain column shafts, both belonging to the theatre of Brescia[44] and the great column made of Africano found in the city of Pula (Croatia), which probably came from the major theatre of the Roman city (the Zaro)[45]. On the other hand, the massive use of Africano columns is attested in many theatres throughout Italy and the Roman provinces[46], following the example of the Theatre of Marcello in Rome[47].

Similar considerations can be made in relation to Bardiglio lunense columns, largely used, for example, in the theatres of Volterra and Arles[48].

It is also worth mentioning the targeted use of Rosso antico. Among materials found in the theatre of Vicenza, it is indeed attested, at the moment, only for small cornices: a well-established employment in northern Italy[49] as well as in all Mediterranean[50].

One final remark concerns the chronology. As is known, the majority of the imported lithotypes attested in the theatre were introduced in Rome from the late Republican period and had an early spread even in the rest of the Italian Peninsula[51]. On the other hand, we can observe that many other lithotypes which had a widespread distribution later on during the Imperial period are missing here[52].

Undoubtedly, it is premature to draw systematic chronological conclusions on the coloured marbles described so far, which indeed lack precise references to the primary context of use. However, it can be noticed that this group of material is quite homogeneous and shows that

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38 See e.g. Cipriano 2016, 80 for Altino and Previato 2015, 458 fig. 283 for Aquileia. See also Lazzarini – Van Molle 2015, 709 f. for a synthesis on many sites of the southeastern part of the Regio X.

39 Antonelli – Lazzarini 2013, 302 fig. 7; Taelman – Delpino – Antonelli 2019, 245 f.

40 See e.g. Lazzarini 2009.

41 Basso – Bianco – Legrottaglie 2004, 257.

42 It is worth pointing out, however, that these considerations are affected by the lack of systematic editions of marble materials from those theatres of the Regio X investigated so far. We thus consider here only the few contexts for which an integral study was made on this category of materials.

43 Dell'Acqua 2020, 218 n. 83.

44 Angelelli 2007, 406.

45 Gobić-Bravar – Lazzarini 2011.

46 E.g. Nocera, Herculaneum, Teano, Cassino, Priverno, Arles, Orange, Cherchel/Cesarea (Mauretania), see Pensabene 2020, 125 and works mentioned there. See also Taelman 2018, 41 tab. 2.

47 De Nuccio – Pensabene 2017, 150–153. Columns in Africano were probably also used in the theatre of Pompey, as one fragment from the Via dei Chiavari seems to attest, see Pensabene 2007, 14.

48 Pensabene 2007, 28. 31.

49 Among public buildings see e.g. the theatres of Montegrotto (Destro 2013, 344 tab. 1) and Brescia (Angelelli 2007, 406) and the *capitolia* of Brescia (Angelelli – Dell'Acqua 2014, 386) and Verona (Bocconcello 2008, 249).

50 Lazzarini 2006, 72.

51 Lazzarini 2019, 78–100. In Aquileia e.g. Bardiglio lunense, Breccia di Sciro, Portasanta and Pavonazzetto are attested since the last decades of the 1st cent. BC, while Serpentino, Cipollino verde, Fior di pesco, Rosso antico, Africano, Giallo antico and Porfido rosso antico seem to have been introduced al least in the first Imperial age, see Previato 2015, 461–474.

52 E.g. Breccia corallina and Greco scritto (Previato 2015, 468. 476), but also Proconnesio and Granito della Troade, widely attested in Aquileia (Previato 2015, 469. 471 f.) and Brescia (Dell'Acqua 2020, 213–215) in 2nd-cent. AD contexts.

imported lithotypes arrived in Roman Vicenza from at least the first Imperial period. Furthermore, it does not preclude the hypothesis that these materials were used in the reconstruction phase of the theatre's scene-building, dated back to the first half of the 1st century AD by recent investigations.

CONCLUSIONS

To conclude, we can say that first studies on coloured marmora found in the Roman theatre of Vicenza improved knowledge on the use of imported stones in Vicetia. Macroscopic investigations carried out on a group of 18,732 materials have returned homogeneous and consistent results. Eleven lithotypes have been identified, mostly used for coating surfaces (in particular slabs, but also cornices, pilasters, etc.) but also for structural functions, especially column shafts. The presence of a variety of ornamental stones quarried throughout the Mediterranean, most notably in Greece and Türkiye, shows that Vicenza was well integrated into the wider Roman marble trade network, with a preferential link to Aegean and Asia Minor markets, like many other centres of the northeastern Italy. It is also worth noting the large presence of many expensive and prestigious materials, thus attesting the economical, socio-political and cultural significance of the municipium of Vicetia, which can be compared to other major cities in Italy as well as in Mediterranean and transalpine provinces. Furthermore, chronological information from materials shows a quite early introduction and use of imported lithotypes in the architectural landscape of the Roman Vicenza, thus confirming its relevant role in the Roman Cisalpina since the beginning of the Imperial period.

For the future, it is hoped that new quantitative and qualitative studies will be undertaken combining macroscopic examination with in-depth mineralogical-petrographic and isotopic analyses in order to gain insights on both coloured, but also veined and white stones, and their real volume of use. Further investigations are also expected on the materials' primary and secondary contexts of use. The aim is in fact to return as complete and exhaustive a picture as possible of the quantity, use and function of each type of ornamental stone found in the theatre area, thus understanding their geo-political, socio-economic, cultural and chronological implications.

Ultimately, the aim is to increase knowledge on the Roman city of Vicenza and clarify its role in the Roman Regio X – Venetia et Histria, as well as its relations with the rest of the Italian Peninsula, Mediterranean Basin and Alpine regions during the Roman period.

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Kalina Petkova

A FOREIGNER IN MOESIA

A MARBLE BOXER HEAD FROM NOVAE

Abstract
The paper presents a male head discovered within the territory of Novae. Discovered in the 1930s, it now belongs to the collection of the town museum of Svishtov. Although the head was previously published, an in-depth discussion of its material and the meaning of its iconography is yet to appear. Comparanda of the type of the head come from other representations in different media around the Mediterranean. The Novae exemplar, which represents a boxer, was likely produced from alabaster with a pale-yellow colour in the 1st century AD. Discussion of it can be set in the broader context of imports of Aegyptiaca in the territory of the Danube province of Moesia inferior.

INTRODUCTION

The Roman military camp of Novae lies on the Danubian Limes in central northern Bulgaria, near to the present-day town of Svishtov (fig. 1). The archaeological record such as pottery, terracotta figurines and a portrait of Arsinoe II Philadelphos[1], indicates that a Thracian settlement, located on the right bank of the river, east of Svishtov, existed there. From the middle of the 1st century AD, Novae became a Roman military fortified camp of the first of the eight Augustan legions, replaced after AD 69 by the First Italic Legion. After the division of the province of Moesia into Upper and Lower Moesia in AD 86, it became an important military camp of Moesia inferior[2]. The Roman army and the civilian population that followed it brought with them the official cults of the Roman Empire. A large group of finds from Novae such as monuments of Mithras, Jupiter Dolichenus, the Great Mother, Isis and her circle[3] relates to the so-called Eastern deities. According to some researchers, the spread of Eastern cults in the pre-Roman era was predominantly along the coast, while from the 1st century onwards, they began to penetrate inland as well[4]. The Egyptian cults, in particular, left their mark in some dedications, statuary, amulets, lamps, jewellery, etc.

FIND-SPOT AND DESCRIPTION

The male head, inv. I-243 lacks an archaeological context as it joined the collection of the Svishtov Historical Museum in 1934[5]. The head was discovered accidently at the locality Staklen, where the Roman camp east of Svishtov was located. The remains of the Roman military centre and the Early Byzantine town of Novae have been unearthed there[6], but there are no extant records on the finding context and associated materials.

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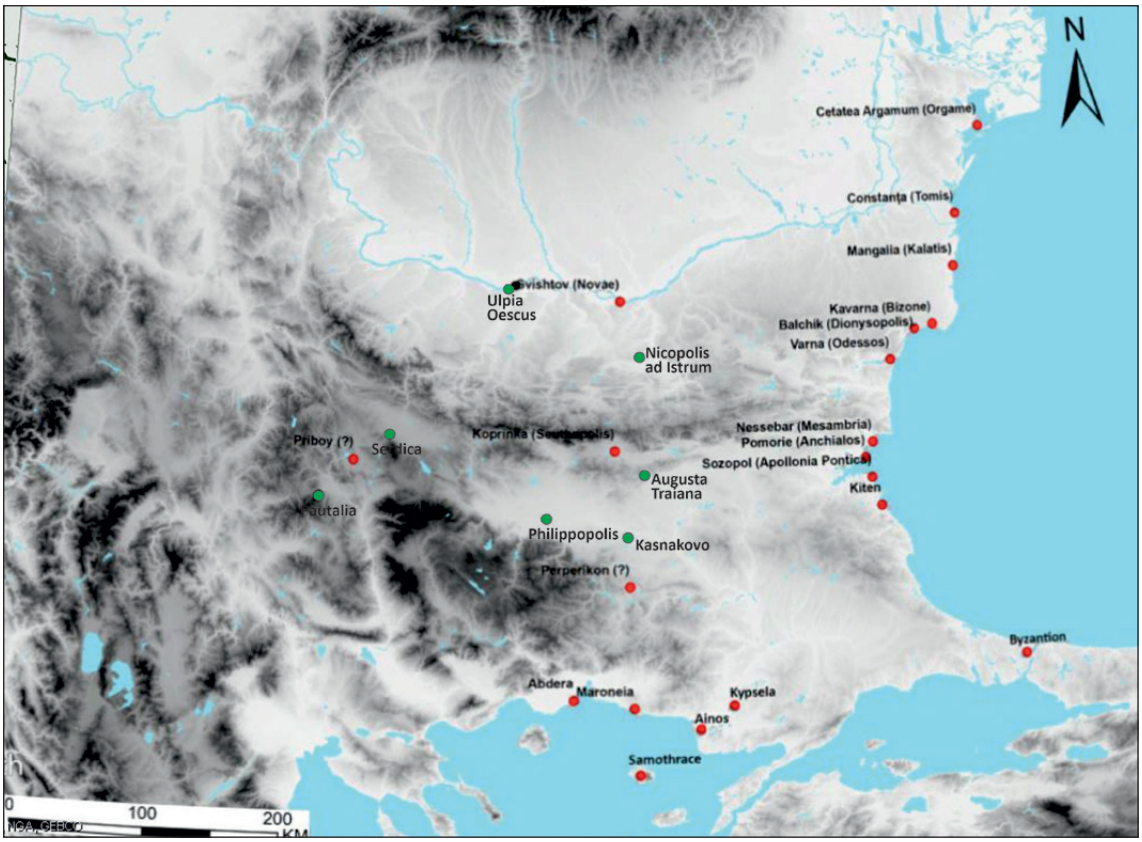
1 Tonkova 2017.
2 Gencheva 2002, 6–12.
3 Naydenova 1982.
4 Bricault 2007, 254.
5 I am extremely grateful to Dr. Marin Marinov, archaeologist at the Historical Museum of Svishtov, for the information and photos provided.
6 Gencheva 2002.



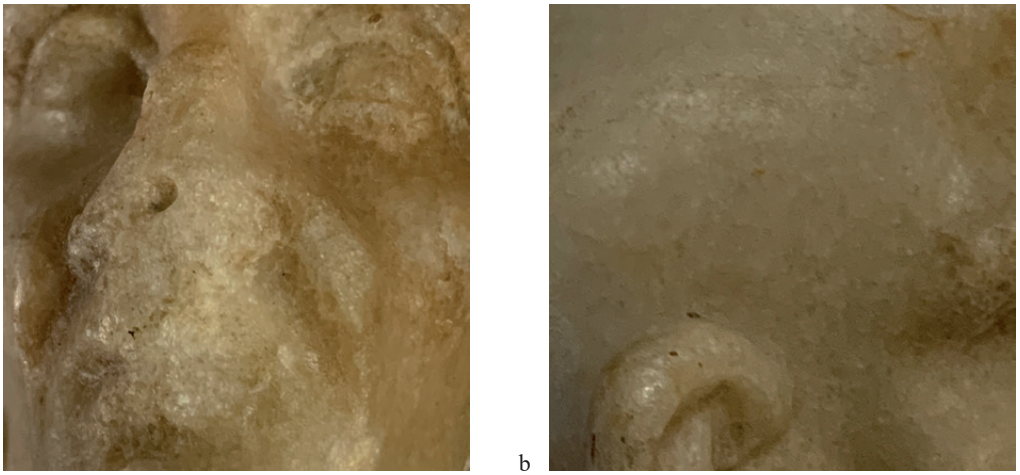
1 A map of distribution of Egyptian and Egyptianising materials in the Hellenistic and Roman ages (graphics: A. Grigorov, K. Petkova)

The head represents a part of a male figurine with a strong cranial deformation (fig. 2 a–d): a sharp point in the middle, etc. It is shaved, with only a long ponytail falling down to the massive neck at the back of the head. The face is long and asymmetrical with a high forehead with a deep horizontal wrinkle in the middle, as well as deep wrinkles along the nose and the lips. The tip of the nose, the enlarged space between the nose and the upper lip and the middle of the narrower upper lip are broken. African features can be recognised in the shape of the eyes, perhaps in the original unbroken nose, the lips, head shape and possibly in the shaved hair, which must have been curly, judging by the ponytail. The head has asymmetrical eyebrows, well-pronounced cheekbones and a sloping jaw-line that leads to a rounded chin below a surly, thick-lipped mouth. Both ears are big and deformed. While the left one is stretched flat across the skull, the soft end of the right one is enlarged and stuck to it. There is a small drilled hole in the left ear, which surely held an earring, now lost. The representation shows a non-Roman of African origin with unquestionable facial components and characteristics. The expression of the face is sad, as if suffering, and pathetic. The deformations of the skull, the eyebrows, eyes, mouth and surely of the nose have changed the original appearance and have affected the almost caricatural but pathetic depiction and facial expression. Nevertheless, the original portrait features can still be identified.

THE MATERIAL

The head was made of material with a dark-beige to pale-yellow colour with dark veins (fig. 3 a–b). The visual characteristics of the material are close to those of yellow marble with a coarse grain structure. The yellow colour could be due to corrosion, but future archaeometric investigations will show the provenance of this object.

2 a–d: A marble boxer head from Novae, late 1st – beginning of the 2nd century AD (H 7.5 cm, W 5.5 cm), Historical Museum Svishtov, inv. I-243 (photos: M. Marinov, P. Penkova)



3 a–b: The material of the boxer head from Novae (photos: P. Penkova)

A FOREIGNER IN MOESIA

The identification of the head as a grotesque dates back to 1967, but an in-depth discussion on the meaning of its iconography is yet to appear[7]. Further down, the problem of its identification either as a caricature and a grotesque or as a portrait, like of a professional boxer of Egyptian origin, together with the question of the provenance of its material will be discussed.

Identifying Features

Cranial Deformation and Boxer-like Features

The cranial deformation is very common for the representations of athletes in Roman art[8]. At the same time, it is also typical for the grotesques and caricature images[9]. But the preserved normal proportions of the head, combined with hyperbolisation of the deformed individual features, do not indicate that the image was a grotesque, but rather emphasize the alien ethnic character of the sitter and his professional occupation. The male head from Novae has the typical, swollen cauliflower ears and broken nose of boxers.

Earring

The earring is also evidence of the foreign origin of the portrait. From that point of view, the mosaic portrait of the owner of the Roman Villa Armira near Ivailovgrad is very similar[10]. Furthermore, the single earring found in many tomb burials from the ancient provinces of Bulgaria witness the existence of the same custom among the late antique barbarian men. The earring worn only in one ear is obviously a non-Roman, Egyptian ethnic habit. It can be seen on several Fayum mummy portraits dated to the 2nd–3rd centuries AD[11]. In the head from Novae, alongside the ›Horus lock‹ and the type of facial components and proportions, this fact can be linked to either his eastern origin and the cult of Isis and Horus, or to his profession and occupation, or to both of these options. The syncretism arose because initially all the Egyptian athletes worshipped Isis and were shown with the ›Horus lock‹. Later on, athletes descended from other ethnic groups were also represented in this way as a professional attribute (the men from the Thermae of Caracalla; the head from Almus, *cirrus in vertice*[12]).

›Horus Lock‹

The long ponytail at the back of the head contrasts with the rest of the hair, which is either clipped short or shaved off. It should be noted that such a long ponytail is rare. Is it an artificial hair-like extension or a natural lock? With small variations, the hair styling appears most commonly on young boys; athletes, grotesques or pygmies from the early 1st century AD onwards. The position of the lock at the back of the head could reveal the syncretism and the assimilation of the goddess Isis to Demeter and Aphrodite[13].

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7 Valov 1967, 12 f.

8 Besques 1972, pl. 189 d (E/D 1039); Thuillier 1998, 355 fig. 2, 15; Süvegh 2014, 150.

9 According to M. Muratov (2012, 56), the heads with acromegaly are certainly not portraits but perhaps generic representations of individuals with this particular condition who »probably exploited their deformity in respect to public amusement«. See Stevenson 1975, 192.

10 Popova (in print).

11 Prag 2002, 57.

12 Popova 2016, 231 pl. 8, 1–4.

13 Smith 2006, 162 no. 7; Backe-Dahmen 2018.

CONCLUSIONS

The Novae male head belongs to an iconographic type developed after the middle of the 1st century in Alexandria and the Dodecanese, which attained popularity slightly later in Asia Minor (Smyrna and Ephesos). These areas share a strong Egyptian influence in the Late Hellenistic period. During the early Imperial period, the Isis cult quickly disseminated in Italy at the time of Caesar and Augustus, the Flavian reign and after Hadrian's travels to Egypt. The process follows the emperors' fascination, the political climate of the period; it penetrated through the army and followed commercial interactions. This same cult likely appears in Novae via a military individual, who worshipped Isis in his private life. The iconography, the style, the comparatively early – for Roman Moesia – date, as well as the material itself point to an import, perhaps from Egypt or the Eastern Mediterranean, where marble quarries existed. The discussed head, which was not a mere humorous curiosity, represents the syncretism characteristic of the Roman period. Alongside the typical features of the boxer genre, the religious-ritual iconography of the worshipper and participant in the festival of Isis is also entwined.

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THE EARLY CHRISTIAN COMPLEX KAMENICA (VINKOVCI, CROATIA)

AN ISLAND OF STONE IN THE SEA OF CLAY

Abstract
The last season of the trial excavations (2013–2015) of the Early Christian complex Kamenica in Vinkovci helped to determine the third phase of the complex, which can be dated to the 5th century AD, and revealed the only *in situ* remains of *opus sectile* at the site. This paper presents numismatic evidence as a basis for a possible dating and puts emphasis on the analysis of marbles found in Trench 9 that belong to the youngest object at the site as circumstantial evidence for the marble trade and transport in 5th-century Pannonia.

INTRODUCTION

The Early Christian site of Kamenica in Vinkovci is the largest Early Christian complex documented so far in continental Croatia. Located one Roman mile outside of Vinkovci, the former Colonia Aurelia Cibalae, it was constructed at the site of the martyrdom of a church scribe from Cibalae, St. Polio/Pulio who was executed after trial on 24 April 304[1].

Excavation has so far documented no remains of earlier buildings[2], thus the terminus ante quem non is the year of the martyrdom. Research so far, both excavations and geophysics, have documented a large basilica with a courtyard surrounded by a wall, with various crypts and mausoleums within and outside of the walled perimeter and a possible martyrium. The complex encompasses some 6,000 m² and with graves and mausoleums outside the wall, more than 18,000 m². There are at least three phases of building activity at the site, the first perhaps in the first quarter of the 4th century AD, the second during the reign of Valentinian I (364–375), and the third one after 378, very likely in the early 5th century. Within the second phase, we have documented the expansion of the basilica with marbles in use that have parallels in the palace in Sirmium, thus connecting it with Valentinian I[3].

The site was ploughed prior to being archaeologically protected, so the marbles collected during excavations come both from the surface of the field and from the excavation trenches. The same applies to Trench 9, which yielded a significant amount of marble from both ploughed and unploughed layers.

The goal of the three-year trial excavation of Kamenica (2013–2015) was to determine the condition of the architecture and to gather data for future systematic excavation of the whole site.

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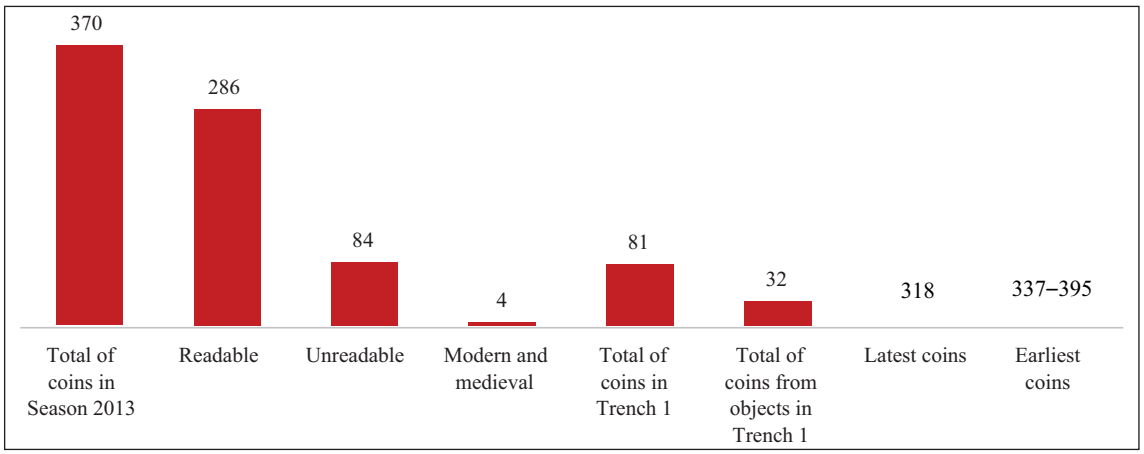
1 See Ruinart 1859, 435 f. (»Passio Sancti Pollionis«).

2 So far, only some 300 m² have been opened, so there is still a possibility that there are some earlier Christian objects on-site.

3 Brunšmid 1902, 150; Šaranović Svetek 1967, 105–108; Dimitrijević 1979, 181; Migotti 1994, 48; Iskra-Janošić 2001, 140; Đurić et al. 2006; Vulić 2016, 138–141.

1 Results of the geophysical survey with an aerial view of Trench 9 (graphics: B. Mušić, A. Papić, H. Vulić)



2 Statistics of numismatic finds from Trench 9 (graphics: H. Vulić)

NUMISMATIC EVIDENCE

Except for the marbles, the other most numerous materials found at Kamenica are coins. In all three seasons of excavations and previous and subsequent surveys, 897 coins were found, some of which helped to date some of the objects to the 6th century[4]. Unfortunately, the objects in Trench 9 were not excavated to the end due to unexpected circumstances[5] and the fact that we did not want to disturb the only fragment of *opus sectile* that was *in situ* at this point of excavations.

Numismatic finds mostly come from ploughed soil and layers below, with only one coin coming from a closed layer.

Coins range from Constantine to Gratian within the presumed use of the object as a church, while coins of Charles I Robert of Anjou are very likely from the phase when the object was robbed or recycled. The only coin coming from an object was one of Constantius II (337–361) with the reverse legend *FEL TEMPORE REPARATIO*, without mintmark and in bad condition, so more precise dating is not possible. Object 111 of 112 is a robbing pit that destroyed part of the wall and the foundation of the main basilica. Thus, we can conclude that numismatic evidence from Trench 9 is not helpful in dating the object and that until further research has been undertaken and the excavation completed, the only reliable chronological points are the stratigraphy and marbles (fig. 2; tab. 1).

Emperors	Coins found	Minted	
Constantine I (306–337)	2	321	335–336
Constans (337–350)	2	337–350	340–348
Constantius II (337–361)	4	333–361	355–361
Valentinian (364–375)	4	364–367	367–375
Valens (364–378)	3	367–375	
Gratian (368–383)	1	367–375	
Charles I Robert Anjou (1308–1342)	2	1338	

Table 1 Coins from Trench 9 (H. Vulić)

4 Vulić 2016, 141; Demo 2018, 166.

5 The archaeological department of the Vinkovci Municipal Museum had to perform an urgent rescue excavation in the town, and by the time it was finished, the weather was unsuitable for continuing the excavations.

THE STRATIGRAPHY OF TRENCH 9 AND THE *OPUS SECTILE* WITHIN IT

At almost 100 m², Trench 9 is the largest trench from the trial excavations at Kamenica. Its importance lies in the objects found within it. The object is clearly visible on a geophysical survey, and before excavations, we presumed it was part of the basilica, possibly a mausoleum.

As the excavations progressed, we had no reason to doubt the hypothesis, but the find of three different *opus sectile* sections within the same object, as well as the quality of the construction cast a doubt about it.

A small probe in the southwestern corner of the trench confirmed that the object in it was younger than the main basilica. The stratigraphy and poor craftsmanship suggest that this phase belongs to the third and possibly the last phase of the Kamenica complex, along with the robbed mausoleum in Trench 8 and the only undisturbed grave on the site, Grave 12 of the Mačvanska Mitrovica type[6].

STONES USED FOR *OPUS SECTILE*

The range of different stone types used for the *opus sectile* floor of the third phase of the central building in Kamenica is quite small. Quantitatively, Giallo antico dominates (23 %), followed in almost equal amounts by recycled white to greyish marble of various provenances[7] (21 %) and banded marble of unknown origin (21 %). Dark stones are represented by black laminite of unknown origin (14 %) and dark-grey limestone of unknown origin (10 %). Egyptian alabaster (Alabastro cottognino) is also represented among the light-coloured rocks (3 %).

For the other discovered coloured marbles of Mediterranean origin, it cannot be said with certainty that their tiles were included in the floor of the third phase. They could have become mixed with its remains during various post-depositional interventions. Among the green marbles, we find Porfido verde antico (2.3 %), Breccia verde di Sparta[8] (1.8 %) and Verde antico (0.3 %). Other marbles are Breccia policroma della Vittoria (1.8 %), Breccia di Sciro (0.4 %), Pavonazzetto (1.2 %) and only one fragment of Red porphyry. The absence of at least Cipollino verde and Breccia corallina, which are common in the range of coloured marbles, is unusual.

The banded marble, black laminite and dark-grey limestone are of unknown origin. Although regional sources cannot be entirely ruled out, an early Christian sepulchral inscription from Savaria[9], made of banded marble, suggests the possibility of an Alpine origin, at least for this type of marble.

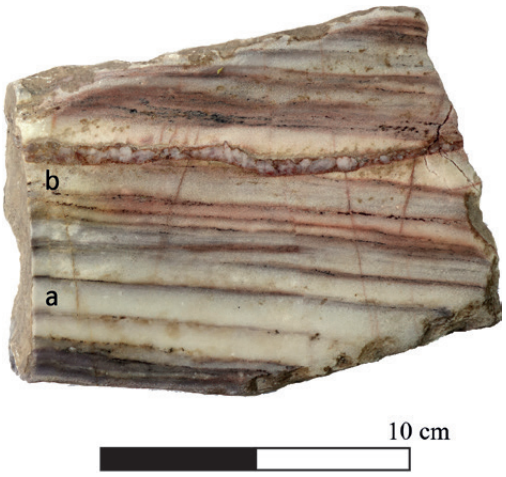
As this is the first publication of these types of stones whose provenance is as yet unknown, we provide a full description.

Banded Marble

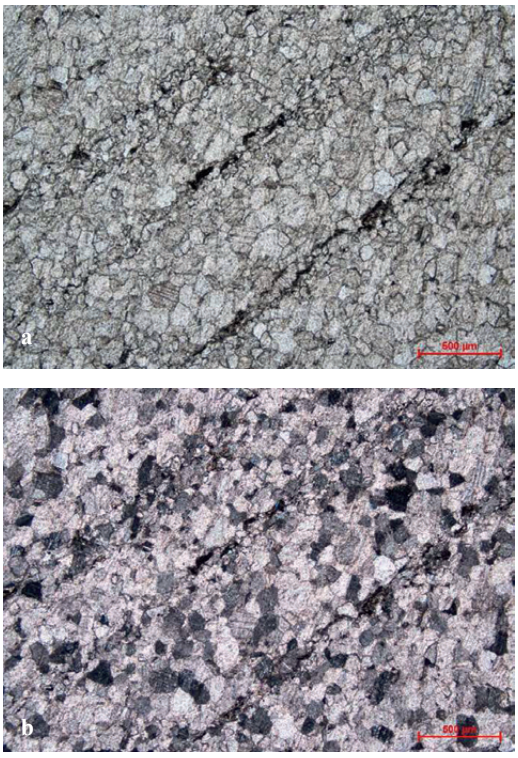
Macroscopic Description

Macroscopically, the marble is fine- and uniformly grained. It is characterised by alternating bands of completely white marble with thinner, darker bands (fig. 3). In the piece examined, the white bands are up to 1 cm thick, and the black bands are up to 1 mm thick, alternating with millimetre-thick layers of white marble in the 1.5 cm-thick bands. On the weathered surface, the bands between the dark layers are pinkish in colour, which cannot be seen in fresh cross-section. The grains in the dark bands have a parallel orientation; some slightly larger ones (0.5 mm) are

6 Ercegović-Pavlović 1980, tab. 24, 1–2; 30, 1.
7 Different types of white to greyish, fine- to coarse-grained marble show that at least this type of marble was recycled.
8 Athanasiadis – Cesare – Lazzarini 2022.
9 Buócz 2003, 118 no. 110.



3 Analysed fragment of banded marble (photo: B. Djurić)



4 Parallel bands of darker minerals (probably magnetite) in marble (plane polarized light [PPL] with parallel and crossed Nicols) (photos: A. Šoster)

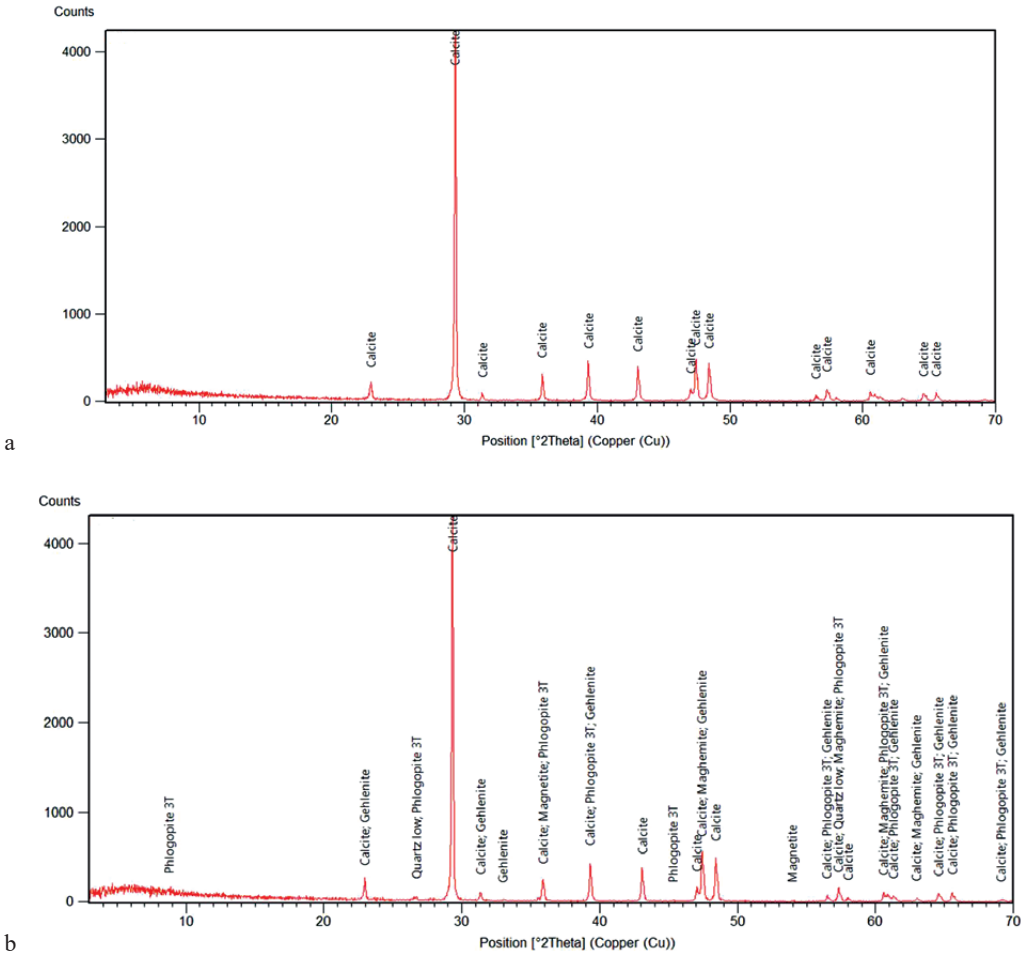
isomorphous with a metallic lustre and are probably magnetite. The rock sample is crossed by a 0.5 cm-thick quartz vein. The sample was reacted with 10 : 1 diluted hydrochloric acid (HCl).

Microscopic Description

Two thin sections were made across the largest surface of the specimen, labelled »a« and »b« in figure 4. In cross-section, we can see that the layering of the specimen is at an angle of about 120° to it. We observe the alternation of thicker (0.2 mm) and finer- (0.05 mm) grained bands. Within the band, the grain size is uniform (homoeoblastic), rarely non-uniform (heteroblastic). Calcite grains of euhedral to subhedral shape predominate. The calcite grains are not oriented parallel to the orientation of the bands in the rock. In the coarser-grained parts, the contacts between the calcite grains are predominantly straight and have a polygonal structure (fig. 4). In the fine-grained parts, the curved contacts predominate. Without crossed polars, opaque black to brown minerals are observed, sometimes having a square cross-section, suggesting that they may be magnetite. Among accessory minerals, colourless mica predominates, aligned parallel to bands in the rock. Colourless minerals with high relief, high interference colours, without pseudo absorption and with a brown rim were observed. Quartz grains are rare.

Mineral Composition: X-Ray Powder Diffraction

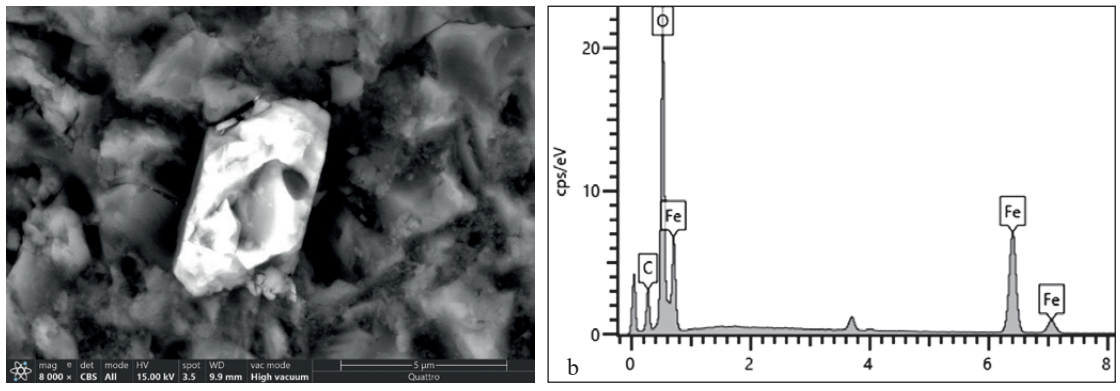
Two samples were analysed by X-ray powder diffraction – one completely white and one coloured. The only mineral in the white sample is calcite (fig. 5 a). In the coloured sample (fig. 5 b), in addition to calcite (95 %), magnetite ($Fe_2+Fe_3+2O_4$) and phlogopite ($KMg_3(AlSi_3O_{10})(OH)_2$) are present, as well as possibly quartz, maghemite ($(Fe_3+0.67\square0.33)Fe_3+2O_4$) and gehlenite ($Ca_2Al(AlSiO_7)$) in small amounts. Magnetite, phlogopite, and gehlenite are characteristic of contact metamorphic rocks. Maghemite is formed by the weathering of magnetite. We assume that the pink colour of the rock is due to extremely fine, scattered magnetite grains oxidised to iron oxides on the weathered surface.



a

b

5 XRD pattern. a: White marble. b: Coloured marble (graphics: A. Šoster)



a b

6 Euhedral magnetite grain. a: With weathering traces. b: With spectrum (graphics: A. Šoster)

Mineral Composition: Scanning Electron Microscopy/Energy Dispersive Spectroscopy

Using scanning electron microscopy/energy dispersive spectroscopy (SEM/EDS), we examined the thin section b, covered with carbon. The analysis revealed that magnetite grains with a regular shape occur in single bands, showing signs of weathering (fig. 6). In addition to magnetite, fluorapatite and individual flakes of mica are also common. Fluorapatite, which was not detected in the X-ray diffraction (XRD) analysis, is a common mineral in contact metamorphic marbles (scarns). We also found a grain of zinc (Zn) spinel gahnite ($ZnA_{l2}O_4$) and a grain of maghemite.

Sample	Colour	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	$CaCO_3$	K_2O	TiO_2	P_2O_5	MnO
Marble 1	Grey	1.17	0.84	0.45	0.39	55.40	98.62	0.04	0.06	0.04	1.016
Marble 2	Grey	1.09	0.82	0.50	–	55.32	98.48	0.05	0.05	0.03	1.321
Marble 3	White	0.90	0.47	0.05	0.28	55.58	98.93	–	0.05	0.04	281
Marble 4	White	0.62	0.36	0.05	0.30	56.04	99.75	–	0.05	0.05	251
Marble 5	Pink	2.59	1.71	0.75	0.42	53.85	95.85	0.28	0.11	0.06	663
Marble 6	Pink	3.18	2.11	2.47	–	51.86	92.30	0.41	0.16	0.06	1.030
Marble 7	Pink	2.98	1.99	1.43	–	53.00	94.34	0.37	0.15	0.05	387
Marble 8	Pink	4.09	2.64	2.14	–	50.38	89.68	0.58	0.18	0.06	352
Marble 9	White	3.84	1.67	0.29	0.42	53.13	94.57	0.09	0.08	0.13	341
Marble 10	White	1.43	1.01	0.54	0.49	55.04	97.98	0.06	0.07	0.05	287

Sample	As	Ba	Cr	Pb	Rb	Sr	Sn	Zn	Zr	Y	S
Marble 1	27	350	61	17	4	249	51	41	2	5	0.06
Marble 2	39	408	53	20	6	240	50	33	6	5	0.05
Marble 3	4	251	45	18		285	46	9		2	0.07
Marble 4	4	266	63	19		280	49	12		3	0.05
Marble 5	27	290	56	19	11	201	52	40	2	4	0.06
Marble 6	64	276	60	23	25	198	48	77	17	5	0.06
Marble 7	35	314	82	22	15	194	40	31	13	3	0.07
Marble 8	44	373	81	20	28	130	57	43	18	3	0.06
Marble 9	20	250	50	18	2	271	46	17		3	0.08
Marble 10	33	302	63	17	2	270	56	31		3	0.05

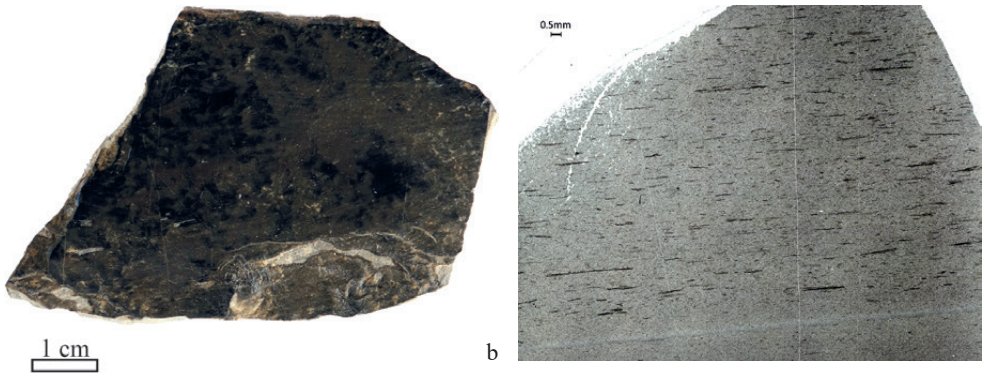
Table 2 Chemical composition of marble. Oxides are given in %. MnO and trace elements are given in mg/kg

Chemical Composition: X-Ray Fluorescence

The composition of the rock was analysed by X-ray fluorescence (XRF) at ten points. According to the profile, we covered five different colour layers and performed measurements at two points in each (fig. 1). The analysis (tab. 2) confirmed that the marble is quite pure. In the white and grey parts, the calcite content calculated from the CaO content is above 98 %, only in one measurement in the white part is it slightly lower (95 %). In the coloured (pinkish and grey) parts, the marble is less pure, but still in the range of 90–95 %. The CaO content is followed by SiO_2 and $A_{l2}O_3$ with contents of about 0.5–4 %. Both are found mainly in the pinkish parts, where the content of K_2O and TiO_2 is somewhat higher than in the other parts, confirming the presence of aluminosilicates (phlogopite). Due to its slightly higher SiO_2 content (> 1 %), quartz may occur as an accessory mineral in white parts of marble. Increased Fe_2O_3 content was detected in the grey parts of the rock by XRF analysis, in the pinkish parts (up to 2.5 %) and in the grey parts up to 0.5 %. The content of MnO is also higher in the grey parts (< 1,000 mg/kg). In two places in the pinkish part, the MnO content is also slightly higher.

Black Laminite

A black laminated marly limestone (laminate; fig. 7) is inferred to be a feature of the Miocene provenance. More or less dense distribution of the long thin lenses of organic material up to 5 mm long in the limestone defines the lamination of the rock. There are no bioclasts or other alochems in the rock to define its age or stratigraphic position.



7 a: Fragment of black laminate. b: Thin section of fragment (photos: B. Djurić, I. Rižnar)

8 a: Fragment of dark-grey limestone. b: Thin section of fragment (photos: B. Djurić, I. Rižnar)

Dark-Grey Limestone

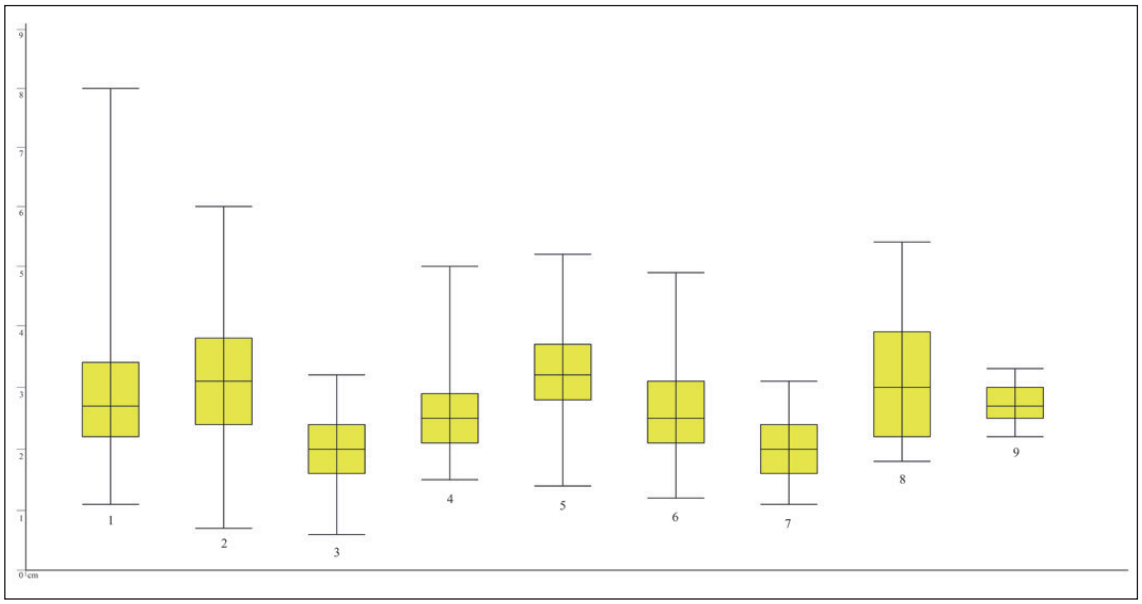
Dark-grey limestone refers to medium-dark grey (N 4) moderately imbricated packstone (fig. 8) with angular and rounded grains up to 0.5 mm. The matrix is micritic and partly limonitised. Grains are moderately sorted. Prevailing angular bioclasts belong to echinoderms; rounded and subrounded grains belong to red algae and intraclasts. Glauconite is also present. Up to 5 % of grains are opaque and belong to pyrite. The Miocene age is inferred due to a lack of deep burial cementation and the presence of red algae clasts and miliolids.

FORMS OF ELEMENTS FOR THE *OPUS SECTILE* PAVEMENT

The shapes of the elements of the pavement (fig. 9) in the *opus sectile* of the third phase of architecture in Kamenica unequivocally show that the pavement was designed »a piccolo modulo«[10]. These are mainly square and rectangular, smaller and larger tiles in Giallo antico, banded marble, black laminite and dark-grey limestone, but not in white marble. In addition to the two different triangle shapes, white marble is only found in narrow rectangles made from recycled strip tiles. Hexagonal plates in two sizes are also made in black laminite, probably laid in combination with triangles in a manner common in the 5th- and 6th-century floors[11]. Triangles were also made in Giallo antico, banded marble, black laminite, dark-grey limestone, Pavonazzetto and alabaster. Common small deltoid tiles were made of Giallo antico, black laminite, Pavonazzetto, alabaster and mostly of white marble. All these forms can be combined into various simple patterns typical of late antique floors.

10 Guidobaldi 2010.
11 Guidobaldi 1985, 212 fig. 26 e.

9 Forms of the *opus sectile* elements in diverse stone types. 1: Giallo antico. 2: Banded marble. 3: Black laminate. 4: Dark-grey limestone. 5: White marble. 6: Alabaster. 7: Pavonazzetto. 8: Porfido verde antico (photos: B. Djurić)



10 Thicknesses of *opus sectile* tiles by stone types. 1: Banded marble. 2: Black laminate. 3: Dark-grey limestone. 4: White marble. 5: Alabaster. 6: Giallo antico. 7: Porfido verde antico. 8: Breccia verde di Sparta. 9: Breccia policroma della Vittoria (graphics: B. Djurić)

The colours of the floor of the third architectural phase in Kamenica were mainly determined by light (golden) Giallo antico and similar banded marble. Black laminite and dark-grey limestone, which together make up a third of the floor's surface, were probably combined with white marble to create the pure bichrome effects popular in sacral buildings of the 5th and 6th centuries. Some fields of the floor must have also contained geometrical vegetal motifs, as shown by the parts of flowers and leaves in white marble and Giallo antico.

The diverse thicknesses of the elements used for the *opus sectile* floor (fig. 10) allow the possibility that prefabricated composite square panels, which were in use since the Neronian period onwards[12], were used for the installation of the floor.

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FINDINGS OF THE CONFERENCE

Walter Prochaska

ASMOSIA XIII

FINDINGS OF THE CONFERENCE

In many fields of archaeology the application of scientific methods are more and more involved. Many branches of archaeological investigations like archaeozoology or archaeobotany are no longer conceivable without the application of scientific methods. Today well established geoscientific analytical methods are indispensible when investigating geomaterials like stones, wall plaster pigment and paints, etc., and modern archaeological investigations are inconceivable without the use of actual scientific methods. These combinations of different scientific methods and analytical approaches can contribute substantially to the question of the provenance of many kinds of raw-material. Furthermore, it is essential in investigating transport networks, distribution of different kinds of goods, the mobility of workshops and similar questions. Of similar importance is the characterization of the raw materials of ceramics like clay and aggregates with modern analytical methods in order to investigate the production techniques and the regional distribution of the products.

This volume represents 45 oral presentations and 31 poster contributions to the ASMOSIA XIII conference, which extensively deal with the above mentioned scientific questions using all kinds of methodological and analytical approaches representing the state of the art in this field. Of special importance for further investigations are the archaeometric case studies presented and even more important the extension of the existing databanks for different analytical methods.

Applications to Specific Archaeological Questions: Use of Marble

The first thematic focus comprises a large spectrum of contributions: different types of marble (in a wider sense) from different locations in the ancient world and the use of these types in architecture, decorative architecture, and sculptures throughout antiquity.

The contribution of Sophie Insulander demonstrates that the famous and widely used Proconnesian marble found its way into the city of Ephesos not before the Flavian period although this prominent type of marble was used elsewhere already in Archaic times. The first use of this marble in Ephesos can be found with major projects like the so-called Serapeion or the Olympieion (mid 2nd cent. AD) Most probably this is due to the excellent availability of high quality marble in the immediate surroundings of the ancient city of Ephesos during the heyday of the urbanization of the city in the 1st and at the beginning of the 2nd century AD.

Julia E. Cox and colleagues make the distribution of the recently discovered marble quarries of Euromos on Lake Baffa in Asia Minor the subject of their investigations. Additionally to the already known locations they testify the use of this marble in Cyprus, Lebanon, Croatia, mainland Italy, and Sicily thus confirming the trans-regional importance of this very characteristic type of marble. Robert H. Tykot and colleagues describe the use of Naxian marble at a Roman portico in Alexandria Troas. This is a rather surprising and not expected result, for the use of marble from the island of Naxos in Roman times is rather rare and not frequently documented so far.

The question and discussion of local workshops versus imported marbles is an issue of different contributions in this chapter (Matthias Bruno and Eleonora Ferrazza, John J. Herrmann

and colleagues, Julio C. Ruiz), and this issue is treated with various examples. In all cases exclusively white marbles were concerned. Especially for the production of sculptures and statues it is of pivotal importance whether these objects were locally produced or imported as finished or half-finished products. Thus, on the basis of findings in shipwrecks an export of Thasian statues as finished products was proven. Investigations of the sculptural inventory of Tarraco in Spain showed that here imports of finished products both from Rome and the Eastern Mediterranean were found but also artefacts made by local workshops.

A series of contributions in this chapter concerns the use and application of coloured marbles in a wider sense. Presented here are some sculptures made of ›Pavonazzetto-like‹ marbles following the Roman tradition of the use of the highly esteemed Phrygian marble. A very original and novel idea is the imitation of fossils using glass or ceramics emulating different kinds of marble structure. The technique of symmetrical book-matching layout of marble slabs in order to achieve special aesthetic effects are presented by Raphael Rosenberg. The ›Marble Hall‹ in the Terrace House 2 in Ephesos with its book-matching symmetrical Cipollino plates is an impressive example of this technique, which most likely was invented in the Pantheon in Rome already in about AD 100.

Daniela Matetić Poljak and Katja Marasović, Francesca Caprioli and colleagues, and Javier Atienza Fuente describe the marble decoration from different imperial Roman major projects from the baths of Valeria in Spain, from the imperial palaces in Split (Croatia), and from the Palatine in Rome. According to the importance of these projects only the most expensive and prestigious types of marble were used for the decoration of these buildings thus providing an impressive picture of the polychromy and the elaborate and perfect finishing of these objects.

For the first time during an ASMOSIA conference an educational programme involving children in an interdisciplinary context was presented. Through a game that rotates between reality and fantasy, students explore the marble past of Naxos and meet the kouroi of the Archaic era and approach the topic »marble in art and history«.

Provenance Identification I: Marble

Numerous marble artefacts (architecture and decorative architecture) from the northwestern region of Spain (Galicia) were investigated by Marie-Claire Savin and colleagues, and they demonstrate clearly that besides the use of local raw material the import of marble from other locations on the Iberian Peninsula was of essential importance. Thus, the knowledge of the marble inventory of this area and the relation to Roman and Medieval eras is essentially extended. A famous marble producing area of the Iberian Peninsula, the Estremoz Anticline of Portugal, is reported by María Pilar Lapuente Mercadal and Trinidad Nogales-Basarrate, and they describe the diffusion of this characteristic and prominent type of marble in the west of the Roman Empire and also in the provinces in northern Africa. A valuable contribution for further use and application is the presentation of new and updated analytical data thus facilitating the discrimination from other Hispanic classical marbles.

A similar documentation is provided by Esther Ontiveros Ortega and colleagues, who testify the major use of Iberian (Baetican and Lusitanian) marble in Italica (Santiponce, Seville, Spain). However, according to the paramount importance of the city all kinds of international marbles were imported for prestigious projects.

A series of coloured marbles is the topic of several contributions. Maurizio Castoldi investigates a characteristic green marble found in the excavations of the forum and the thermae of Augusta Praetoria (Aosta), an Augustan colonia founded in 25 BC. Most probably this green marble from the Western Alps was used as a substitute for the expensive Thessalian Verde antico. Donato Attanasio and colleagues present an overview of famous red marbles (Rosso antico from the Peloponnese and other locations in Asia Minor). Besides the characterization of the quarries and the lithologies the sustainable result of this contribution is the publication of analytical data, which are made available publicly for further use. Thus, it will be possible to discriminate a series of similar marbles on a scientific basis.

Chiara Cenati and colleagues discuss a spectrum of well-dated inscriptions on marble plates from Roman Corinth and establish a sound chronology on the basis of this research. Besides the use of local limestone, Proconnesian and Pentelic marbles were used for these inscriptions. The investigations by Yannis Maniatis and colleagues of the material used for Roman statuettes from the Agora in Athens reveal the prominent and expected use of Pentelic marble. However, also some examples are reported which could be assigned to sources in Asia Minor. Similarly the investigations of Olga Palagia and Yannis Maniatis at the Temple of Athena Alea at Tegea prove that the long-standing opinion of the Doliana origin of these artefacts has to be revised. Three different sources (Paros, Penteli and Doliana) were now found in this context.

Preliminary results of the investigations of prehistoric adornments from Western Anatolia are presented by Murat Dirican and colleagues. Though certain similar and special types of marbles for these figurines, bracelets, beads, or bowls were found, the assignment to a special local source is still debated.

Provenance Identification II: Other Stones

Within this section Daniel P. Diffendale und Fabrizio Marra investigate the building materials in and around Rome in order to assign these construction materials to their corresponding sources or quarries. The focus of this project was put on the analysis of volcanic tuffs which are (besides travertine) the most important building materials of the metropolis. Alkiviadis Sideridis and colleagues characterize a green ›marble‹ occurring in two quarries on the island of Tinos. This ultrabasic rock is actually a serpentinite, and research on serpentinite provenance (for art historical applications) is rather limited so that a substantial lack of information and data exists. Therefore, this study is an effort to enrich the present database using a variety of technics, including X-ray diffraction (XRD) and laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). Different types of building materials from Roman Trier (civitas Treverorum) in Germany are discussed by Eric Goemaere and colleagues. The investigation shows that the materials used (different types of limestone, quartzarenite, calcareous arenite, etc.) are of local origin. Different types of yellow marble play an important role in decorative architecture in antiquity. Lorenzo Lazzarini presents chemical analytical data and petrographic investigation of the famous Giallo antico which, according to Diocletians's Edict of prices, was one of the most expensive marbles. This contribution will help essentially to distinguish this special type of marble from other similar stones such as the Algerian Kristel yellow and the Italian Giallo di Siena and the Breccia dorata used in antiquity and in Medieval times. Red coloured marbles from mosaic floors in Messene (Peloponnese) are reported by Elisavet Mantzana and colleagues and assigned to the local famous Rosso antico quarries in the south of the Peloponnese. Very similar red marble with an origin from Asia Minor (Marmor Iassense) was used in the marble decoration of the episcopal residence in Pythagoreio in Samos (Georgia Delli and colleagues).

Diana Gorostidi Pi and colleagues, and Hugo Feliu Pèrez investigated the stone inventory of epigraphic media from Baetulo on the Iberian Peninsula. These objects are partly related to the Tarraco workshops, however, also local stones were used. Very interesting results from a series of monuments in Dalmatia throughout antiquity and Medieval times are presented by Mirja Jarak and colleagues. These outcomes may form a very useful basis for the chronology of the use of the different types of limestone from Dalmatia.

New results concerning the well-known marble deposits of Mediterranean coast from Cap de Garde in Algeria (Greco scritto, Greco striato) are published by John J. Herrmann and colleagues. Widespread use of this marble is known from Africa Proconsularis and Numidia. Presented here for the first time are further findings of this marble in Cyprus and Italy.

Advances in Provenance Techniques, Methodologies and Databases

For any kind of provenance analysis of geomaterials (marble, limestone, granite, etc.) the availability of reference information in the form of databanks is a prerequisite. Already in the early

days of the ASMOSIA activities, the assembling and the collection of these data was of utmost importance. This session of the conference deals with new data and the completion of the data for these materials.

Vasiliki Anevlavi and colleagues provide new data for several ancient marble quarries of the northeastern Aegean Islands in Greece, basically on Samos, Fourni and Ikaria. Eight locations were studied, and 120 samples were analysed in total by means of the petrographic microscope, stable isotopes analysis, fluid inclusion analysis and inductively coupled plasma-mass spectrometry (ICP-MS) analysis. The data are made available for general use. The use of local limestones in the area of Roman Emona (todays Ljubljana) as well as the local sources for this building material are investigated by Rok Brajkovič and colleagues. The databank presented for these limestones comprised the analysis of the microfacies and cathodoluminescence data. Another set of archaeometric data presented in the conference and this volume concerned the provenance analysis of granites, a topic that so far has only marginally been exploited. Pierre Rochette and colleagues show that by the use of the portable X-ray fluorescence (pXRF) non-invasive analyses can be performed with suitable detection limits. Quite a large number of quarries occur in the region of Sarmizegetusa Regia, the capital of Dacia. Aurora Peţan gives an overview of these quarrying activities in different epochs before and after the conquest of Dacia by Trajan.

Thorsten Jakobitsch and Vasiliki Anevlavi introduce a novel and innovative method for the dating of rock surfaces by bioarchaeological methods. The method is based on the development and progress of lichen growth on surfaces (e.g. ancient quarry faces). A prerequisite is the calibration of the method using well-dated surfaces under the same climatic conditions.

Quarries and Geology: Quarrying Techniques, Organization, Transport of Stones, New Quarries, Stone Carving and Dressing, Hazards to and Preservation of Quarries

Scott Pike and colleagues submit information on the geology and the methods of marble extraction in the south of the island of Naxos. The contribution is part of an on-going project dealing with Archaic marble mining in that area. Eirene Poupaki's research is focussed on the Hellenistic stone quarrying in the Dodecanese especially on Kos and the neighbouring islands and introduces so far unknown quarries of different kinds of stone material. The island of Thasos was one of the most important suppliers of sculptural marble throughout antiquity. In their contribution Manuela Wurch-Koželj and Tony Koželj give an overview of their long-standing investigations of the marble extraction and the interpretation of the tool-marks of the famous ancient Thasian quarries. Frans Doperé and colleagues present their results on chronological and functional aspects of different kinds of building materials of Sagalassos and the relevant quarries in the surroundings of the city.

Another important key-topic in the ASMOSIA conferences besides marbles is the investigation of mining and use of granites. In their contribution Patrizio Pensabene and colleagues report on the traditional mining areas of the granites in Alexandria Troas. Further granite production areas in Corsica were investigated by Nadine Mattielli and colleagues, who discuss the geological background and the archaeological significance of these granite mines. Egyptian stones of different types are investigated by J. Clayton Fant and Simon J. Barker, especially the interplay between Roman investment in the Eastern Desert and the diffusion of the stone in Campania.

Stone Properties, Weathering Effects and Restoration

Montserrat Claveria investigated the surfaces of some 40 marble sculptures using a combination of different methods like isotope analysis, Cathodoluminescence and petrographic analyses. The results here presented were used for information on weathering and patina in order to obtain data on the environments in which these sculptures have been preserved throughout their history.

The Porphyry Obelisk erected in Constantinople in the Theodosian period was made of one of the hardest and most precious stone in antiquity. George Pinkerton discusses the circumstances of the finding of the different fragments and as well as the dedicatory inscriptions.

Pigments and Paintings on Marble

A column krater of the Boston group is discussed by Patricia A. Butz with regard to the once-controversial subject of whether ancient stone sculpture was painted. A statue of Herakles, believed to be made out of white marble, was depicted in the process of being painted thus presenting a valuable contribution to this long-standing discussion. Agneta Freccero's paper is also dedicated to the topic on the painting of ancient objects from an art-historical point of view as well as using scientific methods of investigation.

Production and Trade of Marble and Other Stones in the Alpine and Danube Provinces: Regional Resources and Mediterranean Imports

As is customary in the ASMOSIA conferences one session is designed by the conference organizers. At the ASMOSIA XIII conference this session was devoted to »Production and Trade of Marble and Other Stones in the Alpine and Danube Provinces: Regional Resources and Mediterranean Imports«. Several contributions concerning this topic were the results of the Austrian Science Fund (FWF) project »Fingerprinting White Marbles – Quarries and Cities of Roman Thrace, 1st–3rd century AD« (P 33042).

Zdravko Dimitrov presents results from the investigations of new findings of Roman marble artefacts from the limes region on the Danube (Castell Rataria in today's Bulgaria). According to the position on the Danube a wide spectrum of imported marbles was found as well as local marble from deposits in the area of Montana. Similarly from the province of Moesia from the territory of Novae a very interesting unique finding was discussed by Kalina Petkova. The boxer head is probably made of Egyptian alabaster and is another example of Aegyptiaca imports into the territory of the Danube province of Moesia inferior.

Cristina-Georgeta Alexandrescu and colleagues investigate the marble of decorative architecture and of mosaics from the province of Dacia from Roman Constanţa on the Black Sea coast. Because of the lack of marble occurrences in the region and the position of the city directly on the coast only imported marbles were used. Marble from Thasos, Prokonnesos, Dokimeion, and one remarkable artefact made of marble from Herakleia/Miletos were identified. Another investigation in the province Moesia inferior in the northern Dobruja revealed the use of different local limestones (Cristina-Georgeta Alexandrescu and Albert Baltres).

In a number of contributions Petya Andreeva and colleagues, Vasiliki Anevlavi and colleagues, and Benjamin Frerix report on different aspects of production, trade and use of marble in Roman Thrace. In detail the marble networks of the province and the interconnections with other provinces are investigated in detail by scientific marble provenance analyses. This include aspects of art-historical investigations concerning the chronology of the artefacts but also the logistic conditions and possibilities for transport in the region.

A prominent group of topics is dedicated to Roman marble business in the region of today's Slovenia. Bojan Djurić and colleagues discuss the Roman marble production and quarrying activities in the Pohorje Mountains and the distribution of this marble. A series of grave monuments are investigated including also artefacts made of local limestone. Also related to his thematic field is the contribution of Andreja Krašna on the famous Aurisina limestone which was found in Aquileia and in Emona (today's Ljubljana).

A contribution concerning the use of marble in sepulchral artefacts in the northwest of Italy is presented by Maria E. Gorrini and colleagues. Local high-quality types of marble and also international imports could be proven in this context.

New insights into the trans-regional trade of stone material and information on the transport routes in Roman Noricum are provided by Dominik Hagmann. He gives an overview on his preliminary results about an on-going project applying geographic information system (GIS) investigation for northern Noricum. Sabine Ladstätter (†) and colleagues present a fundamentally new scientific analysis and evaluation of the marble inventory for southern Noricum (Noricum Mediterraneum) especially from the famous sculpture assemblage of Virunum. As the high quality sculptures turned out to be made only to a lesser extent of local marble and imported marble from Thasos and Prokonnesos were identified, the work of the so-called Master of Virunum – a workshop operating in the capital with local resources – is reconsidered.

This condensed summary of the contributions of the conference and the proceedings cannot play up to the vast spectrum of presentations related to marble investigations in a wider sense. The diversity of methods applied in these studies encompasses a wide range from geologic investigations of ancient marble quarries to the use of pigments when studying painting of marble artefacts. The ASMOSIA XIII 2022 conference in Vienna demonstrated impressively where research stands in the investigations of marble and stone in antiquity and brought together all relevant scientists working in this field. It is a very complete overview of the present state of the art of the ASMOSIA activities.

ASMOSIA XIII presents in two volumes the papers and posters from the regularly organised international conference of the »Association for the Study of Marble and Other Stones in Antiquity«, which took place in Vienna in 2022. The 77 papers of the Viennese symposium reflect the current state of research in the field of archaeometry and provenance of ancient marbles and are dedicated to eight major topics: the different types of marble and their use in architecture and sculpture during antiquity; provenance research on marbles and other types of stone; the development of databases and methodology; geology and quarries, including their organisation; specific properties of stone and the effect of climatic influences on stone and its restoration; pigments and the application of colour to marble and finally, the production and trade of stone and marble in Alpine regions and the Danube provinces. There are also contributions on transport networks, the distribution of various goods, the mobility of workshops and the characterisation of ceramic raw materials and aggregates in order to describe production techniques and the regional distribution of products.

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