



ASMOSIA XIII

19-24 SEPTEMBER 2022 | VIENNA

ASSOCIATION FOR THE STUDY OF MARBLE AND OTHER STONES OF ANTIQUITY

# ASMOSIA XIII

## 13<sup>TH</sup> INTERNATIONAL CONFERENCE



19-24 SEPTEMBER 2022  
KUNSTHISTORISCHES  
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ASSOCIATION FOR THE STUDY OF MARBLE  
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**VIENNA  
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**BOOK OF ABSTRACTS**

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# SESSIONS

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Quarries and Geology, Stone Properties, Weathering Effects and Restoration, Pigments and Paintings on Marble, Special Theme Session

# ABSTRACTS

## THE HISTORIC COLLECTION OF ANCIENT ROMAN SCULPTURE AT VIZCAYA, MIAMI: ARCHAEOLOGICAL DESCRIPTION AND MARBLE CHARACTERIZATION

Mark Abbe<sup>1</sup> – Scott Pike<sup>2</sup> – Remko Jansonius<sup>3</sup>

<sup>1</sup> University of Georgia, United States of America <sup>2</sup> Willamette University, United States of America <sup>3</sup> Vizcaya Museum and Gardens, United States of America

Keywords: Sculpture, collection, provenance

Vizcaya, the Italianate estate of American industrialist James Deering constructed on Biscayne Bay, Miami, between 1914–22, is decorated by an essentially unknown collection of more than ten large-scale ancient Roman marble works. These range from free-standing statuary, furniture (table legs, candelabra) and sarcophagi of different scales, and date from the 1st c. BC to the 5th c. AD. The estate's extensive archives provide unusually extensive documentation about the acquisition and collection history of these antiquities – several of which have distinguished provenances, including reportedly the »Borghese Archive« and the collections of the American architect Stanford White. Acquired by prominent antiquities dealers in Rome and New York, these works were creatively combined and reformulated by the Vizcaya's designer Paul Chalfin (fl. 1905–23) into larger site-specific interior and exterior sculptural ensembles, including notably fountains and garden ornaments to create and frame the unique visitor's experience of the lavish gilded age estate and gardens. Archaeological study and isotopic analysis have significantly elucidated these ancient marble objects distinguishing their post-antique restorations and reworkings, and defining their ancient quarry origins. Important unpublished objects include a pair of early »Neo-Attic« trapezophoroi, an extensively restored torso of a satyr reformulated to create an 18th or 19th statue of »Bacchus«, an elaborate post-antique »altar« generated from an Asiatic garland sarcophagus, and a monumental late antique Proconessian sarcophagus lid employed in a decorative fountain ensemble.

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## **PROVENANCE INVESTIGATION OF TWO NEWLY EXCAVATED MARBLE SCULPTURES FROM THE ROMAN BATHS, AMMAN, JORDAN**

Khaled Al-Bashaireh  
Yarmouk University, Jordan

Keywords: Roman baths, Philadelphia Amman, Thassos-3 marble

The salvage excavations at the Roman baths in the centre of Amman, the ancient city of Philadelphia, conducted by the Department of Antiquities, uncovered two white marble statues in addition to other materials. The baths were accidentally uncovered during the installation work of a water drainage system, in the central city, under the main street of the downtown. The baths were dated to the Roman period (2nd c. AD) based on the archaeological findings and the baths' style and structure. The quarry origin of the two sculptures will be investigated by different analytical techniques including mass spectrometry, x-ray diffraction and optical microscopy. Preliminary results show that the two sculptures are carved of dolomitic marble might indicate (in addition to the coarse grains) an origin from the Thassos-3 quarries. The presentation will show all the analytical results and discuss the suggested quarry origin of the two statues and compare the results to other sculptures uncovered from Roman baths in Jordan and neighbouring countries.

## **ROMAN STONE MONUMENTS FROM NORTHERN DOBRUDJA (ROMANIA) – PETROLOGICAL CHARACTERIZATION AND PROVENANCE DETERMINATION IN A HISTORICAL CONTEXT**

Cristina-Georgeta Alexandrescu<sup>1</sup> – Albert Baltres<sup>2</sup>

<sup>1</sup> Institutul de Arheologie »Vasile Pârvan«, Romania <sup>2</sup> Institutul Geologic, Romania

Keywords: Moesia, Roman quarries, Cretaceous

The currently ongoing project »Roman Stone Monuments from North Dobruja. Multidisciplinary Recovery of the Loss of Time and Context« (PN-III-P4-ID-PCE-2020-1031) focuses on petrological and

litho-stratigraphic investigations of well-dated Roman stone objects and fortifications. 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 – lithologies widespread in the northern Dobrudja. Archival materials as well as analyses of historical maps and high resolution airborne laser scans (ALS) are used to detect potential ancient quarry areas, which are ground-checked by geological methods. So far, provenance areas in the immediate surroundings of main ancient sites along the Danube, in the Măcin Mountains and in the Babadag Plain have been localized, providing deposits of different limestones and sandstones. The ancient quarrying areas are sometimes difficult to localize due to the continuous use in the modern times and/or today. This interdisciplinary approach promises to provide insight, not only into the provenance of stone material used during different historical periods (Greek, Roman, Late Roman and Byzantine) and for specific purposes (sculpture, architectural decoration, building slabs), but also into matters of transportation, workshops and economic interaction between the centres in Noviodunum, Troesmis, Halmyris, Ibida and the hinterland, as well as with the main harbour of the region in Tomi (Constanța) and, from there, with the Mediterranean region.

## **MARBLE FINDS FROM THE PALACE OF THE CONSULAR GOVERNOR OF THE THREE DACIAE (PRAETORIUM CONSULARIS) AT APULUM (ALBA IULIA, ROMANIA): PROVENANCE, USE AND REUSE**

Cristina-Georgeta Alexandrescu<sup>1</sup> – Viorica Rusu-Bolindeț<sup>2</sup>

<sup>1</sup> Institutul de Arheologie »Vasile Pârvan«, Romania <sup>2</sup> Muzeul Național de Istorie a Transilvaniei, Romania

Keywords: Marble, Apulum, praetorium

Although the province of Dacia had a short existence of less than two centuries, one of the most typical examples of praetorium consularis within the Roman Empire is the one in Apulum. This complex settlement included a legionary fortress, canabae, and two towns, colonia Aurelia Apulensis and municipium Septimium Apulense. The fast development of Apulum was favoured by the

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military presence of legio XIII Gemina, by the vicinity with the gold mines from Alburnus Maior, by the economic potential of the Mureş Valley and its location along the Roman imperial road. Starting with the second half of the 2nd c. AD, the epigraphic and archaeological evidences confirm the existence in Apulum of a complex and very large building structure, identified as the praetorium consularis of the province, with differentiated areas according to the needs of the governor, his offices, his guard, temples, a private residence quarter, etc. The excavations are made difficult by the fact that the ancient settlement is covered by today's city Alba Iulia. It seems that the public areas of the palace, which were most probably lavishly decorated, have not been yet excavated. Up to now, from the excavated areas the finds of marble pavements, marble stairs, architectural decoration and mosaic pavements are surprisingly few. Prior research of Roman stone monuments from Apulum focused on the epigraphical evidence. The finds of marble items from the palace complex were almost neglected. Our recently started project is dedicated to this category of material, will focus on the archaeologically well documented examples from the palace. The present paper introduces about 30 items made of imported marble uncovered in the area investigated by V. Rusu-Bolindeţ and her team since 1992. The aim is twofold: a) to localize, identify and properly interpret the individual marble finds and their context (which sometimes is a secondary one); b) to better understand the chronology of the building complex and the function of its different parts. For the latter purpose, the interior decoration is an indispensable source of information. In Roman Dacia various locally available stones are known to have been used, including the marble from Bucova. At the same time imported marble and craftsmen, mainly from Asia Minor, are well attested. Thus, the dedicated study of the marble finds from the praetorium consularis at Apulum provides insights into the building itself, as well as into the economic and social life of the province.

# **THE MARBLE DECORATIONS OF THE MOSAIC FLOORED BUILDING IN TOMI / CONSTANȚA (ROMANIA): PRELIMINARY STUDIES**

Cristina-Georgeta Alexandrescu<sup>1</sup> – Walter Prochaska<sup>2</sup> – Irina Sodoleanu<sup>3</sup>

<sup>1</sup> Institutul de Arheologie »Vasile Pârvan«, Romania <sup>2</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria <sup>3</sup> Muzeul de Istorie Națională și Arheologie, Romania

Keywords: Tomi, marble, trade

The Mosaic floored building, discovered by chance in ancient Tomi (nowadays Constanța) was systematically investigated between 1959 and 1966. A small part of its inventory has been published partially and selectively or only reproduced photographically in specialist articles or in popularization materials such as the few guidebook versions that have been published so far. The resumption of investigations into the building began with the investigation of archival materials from the institutions involved (MINAC, INP), which created the conditions for obtaining new information and locating the place or even the context of discovery for some of the categories of found archaeological materials. The marble wall cladding of the large mosaic hall, hitherto known only through photographs and brief references, sometimes only tangential, in guidebooks and technical studies on the architecture of the building, is the first category of material to be the subject of a collaborative project initiated in 2019. It aimed to investigate the pieces and the context in which they were uncovered using a combination of methods of analysis, in order to establish the provenance of the materials, their belonging to one of the stages of the building's functioning, their relationship with the chronology proposed for it, etc. The study of marble architectural decoration of one of the public buildings of Tomi differentiates our project from the prior dedicated research on marble provenance of different Greek and Roman finds from Romania.

At first, a selection of relevant specimens of marble decoration elements (capitals, plinths, and rectangular slabs with two decorative fields, as well as unspecific veneer fragments) from museum's storage was made, in order to establish the origin and terminology of the marbles, the sampling and analysis by petrographic and geochemical methods. The results of 26 analyses (by means of thin section, stable isotope analysis, chemical composition/ trace elements) on different white marble pieces from the mosaic building are the subject of this paper. The main

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determined provenance sources are Prokonessos, Paros, Dokimeion and Herakleia/Miletos. The specific investigations were limited by possible sample size (sometimes too small in terms of analysis needs).

## **ARTISANS AND LOCAL MARBLE WORKSHOPS IN ROMAN THRACE**

Petya Andreeva

Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: Artisans, marble workshops, Roman Thrace

The building and expansion of cities in the Roman province of Thrace generated a large demand for skilled artisans required in the construction and stoneworking process. The archaeological data so far suggest a large number of specialised stonemasons' workshops established in the 2nd c. AD, corresponding to the pattern of increased urbanization of the province as a result of a coherent Roman policy in the region. The semi-finished marble artefacts found in the cities and their territories – mostly sculpture and votive plates on a smaller scale, grave stelae and architectural details –, and the analysis of their archaeological context give ground to the assumption that some of the local marble workshops have been plausibly identified.

The low level of public recognition of craft work and its commemoration only in private dedications and funerary inscriptions set up primarily to those artisans who were considered the upper stratum of the craft gentry result on a remarkable paucity of data on the workshop organization. Therefore, the epigraphically attested names of stonemasons, and even the existence of their associations in the cities of Roman Thrace, encourage the debate about their social development, both in terms of public recognition and economic background, which might have led to their explicit mention in the inscriptions. They are further complemented by the records of architects and masons who created the urban fabric of Thrace, as the long and gradual monumentalization process went on.

The absolute dominance of Greeks and eastern settlers among the architects and marble-carving artisans in the epigraphic records from Roman Thrace opens up the discussion of »domestic«, »Roman«, and »eastern« influences in stoneworking, which is inextricably related to the analysis of stone market in the province marked by mass production

and individual orders. Furthermore, the data on possible movements of local skilled marble carvers between the cities of Thrace bring up the question of province-wide stonework and to what extent it was depended on local workshops, even if they were quarry-based.

## **ANCIENT WHITE MARBLE QUARRIES IN THE EASTERN AEGEAN**

Vasiliki Anevlavi<sup>1</sup> – Walter Prochaska<sup>1</sup>

<sup>1</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: white marble, islands, provenance

This research aims to explore, investigate and compare the ancient white marble quarries and outcrops of the north-eastern Aegean Islands in Greece and most specifically the islands of Samos, Fourni and Icaria. Studying the ancient quarries and the traces of the tool marks can help to get further information on the technological knowledge and the corresponding progress in each period. Ancient trade on land and sea route can be recorded, giving information on the transfer of the material, exchange of products, technicians and art. The last years' research showed that the Greeks and the Romans used first quality marble for many cases such as statuary or architecture. The very favourable logistic position of these high-quality marbles suggests not only the importance to cover the need for raw material on a local scale but also offers perfect conditions for the international distribution of these marbles.

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 and identifying the fingerprint of these quarries. Eight locations were studied and in total 120 samples were analysed with a petrographic microscope, stable isotopes analysis, fluids and ICP-MS analysis. The results of the investigation of the north-eastern Greek islands and the analytical data will be used in future researches and fulfil the list of the ancient white marble quarries of antiquity.

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## **MARBLE TRADE BETWEEN THE BORDERS OF ROMAN MACEDONIA AND THRACE: THE CASE STUDY OF THE REGIONAL HISTORY MUSEUM BLAGOEVGRAD**

Vasiliki Anevlavi<sup>1</sup> – Walter Prochaska<sup>1</sup> – Sabine Ladstätter<sup>1</sup> – Petya Andreeva<sup>1</sup> – Hristo Popov<sup>2</sup>

<sup>1</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

<sup>2</sup> National Archaeological Institute with Museum, Bulgarian Academy of Sciences, Bulgaria

Keywords: Macedonian-Thracian borders, Roman period, marble trade

The geographical location of the Strymon 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, signed by the Via Egnatia in the southern area. Recent epigraphic and literary studies have shown that the provincial boundaries had mainly a political significance and were not associated with trade.

The analyses of 35 artefacts from the Regional History Museum Blagoevgrad 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 Strymon 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 dolomitic marble artefacts are made of Thasian and Sivec marble, while a smaller number of objects are produced with marble from local sources. This research shows that trade networks extended 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 in the study of ancient marble production, which combines economic history, archaeology, and archaeometry.

# **KOURO-STORIES: AN EDUCATIONAL PROGRAM ABOUT THE MARBLE KOUROI OF NAXOS ISLAND, GREECE**

Emmanouil Anevlavis<sup>1</sup> – Vasiliki Anevlavi<sup>2</sup> – Aikaterini Panagiotopoulou<sup>3</sup>

<sup>1</sup> University of Piraeus, Greece <sup>2</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria – <sup>3</sup> Independent scholar

Keywords: Educational programme, Kouroi, Naxos

By treating education as the mechanism which communicates with the past and at the same time connects the daily reality of students, we designed an educational programme focused on the local history of Naxos Island, Greece. The design of a learning process in an interdisciplinary context with the use of play aims at the active involvement of children, at the development of their way of thinking and acting, at the development of skills that concern their wholeness. This work is based on the view that knowledge and learning are the result of a collaborative process and interaction of participants. Through a game that rotates between reality and fantasy, students explore the marble past of Naxos and meet Kouros of the Archaic era.

A combination of different characters designed for each day will help the students travel through history and learn. Mysterious letters arrive in the classroom which encourages them to become researchers by searching the past. The interdisciplinary approach of the educational programme invites and challenges the children to elaborate the condition by positively combining the history, art, geography, mathematics and archaeology of the island. The programme will focus on the marble as a material, in combination with other parameters such as trade, tool marks and tools, workshops, sculptures, preservation and conservation of marble and heritage. The programme, with correct adjustments, can be presented to various school levels as well as adults.

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## **MARMORA POMPEIANA: ARCHAEOOMETRIC ANALYSES OF ARTEFACTS IN THE FORUM GRANARIES**

Fabrizio Antonelli<sup>1</sup> – Alessandro Poggio<sup>2</sup> – Stefano Cancelliere<sup>1</sup>

<sup>1</sup> Università Iuav di Venezia, Italy; <sup>2</sup> IMT School for Advanced Studies Lucca, Italy

Keywords: Pompeii, Roman period, archaeometric study

This paper presents the results of the minero-petrographic and isotopic analyses of the white marbles used for some pieces of sculpture, architectural elements and furnishings found in Pompeii and currently held in the »Forum Granary«, one of the main storage areas in the famous Vesuvian city »crystallised« by the eruption of the Vesuvius in 79 AD. Although numerous marble artefacts belonging to different typologies were found in Pompeii, this important body of evidence has never been systematically examined unlike wall paintings and mosaics. The need of a thorough analysis of Pompeian marble artefacts, instead, is particularly felt since it would disclose a lot of information from various perspectives. The archaeometric analyses of this research depict an interesting variety of Mediterranean white marbles. The combination of these results with archaeological and art historical data offers a unique possibility to test a well-rounded approach to marble artefacts from Pompeii and it may confirm previous hypotheses or open up new avenues of research for studies on the use and circulation of white marble in the Vesuvian area. For instance, it is useful to reflect on the possible choice of specific marbles in association with certain typologies of artefacts. Moreover, it is possible to carry out a comparison with other Vesuvian sites in order to outline common tendencies.

## **SANDSTONE QUARRIES FROM THE HELLENISTIC PERIOD IN THE SOUTH-EAST OF THE IBERIAN PENINSULA. ARCHAEOLOGICAL FINDS IN THE AREA OF QART-HADAST / CARTHAGO NOVA**

Juan Antonio Antolinos Marín<sup>1</sup> – Begoña Soler Huertas<sup>1</sup>

<sup>1</sup> Universidad de Murcia (UM), Institut Català d'Arqueologia Clàssica (ICAC), Spain

Keywords: Quarrying, Hellenistic period, Qart-Hadast / Carthago Nova

The first evidence of quarrying in the area around Cartagena dates back to the Punic foundation of Qart-Hadast in 229/226 BC, a period in which the intensive exploitation of some of the main sandstone outcrops in the area began. The location of the quarries in the vicinity of the city and the characteristics of the material used were the result of a process of prospecting and searching for materials similar to those used in the north African capital, which led to the application of the same technical knowledge and the materialisation of certain building materials (*opus africanum*, *opus quadratum* and others), which were widely used in the Hellenised Mediterranean.

After the siege of Publius Cornelius Scipio in 209 BC, Carthago Nova embarked on a new political march, whose antiquity and prestige have been referred to in the written sources (Str. III, 2, 10; Liv. XXVI, 47, 6). Its consolidation as one of the most important ports in the western Mediterranean and the boom reached by its silver mines generated a demand for new architectural endowments and infrastructures of a utilitarian nature, with sandstone – together with limestone, basalt and andesite – being the protagonist of this first period of urban and building growth. The archaeological interventions carried out in the sandstone quarries, located some 4.2 km northwest of the Punic and Roman city of Cartagena, have made it possible to define the different sectors of exploitation that were active between the last third of the 3rd c. BC and the first half of the 2nd c. BC. In general terms, these archaeological interventions brought to light the structural remains of two ramps or inclined paths used to transport ashlar and other construction materials, which were later used as dumps for the rubble generated during the extractive works, roughing and elaboration of building and artistic productions. In addition to the discovery of a ceramic context clearly associated with the Hellenistic period, the archaeological excavation made it possible to recover several tools used in the mining activity, such as wedges, picks and chisels, and also iron slag, which undoubtedly suggests the existence of a forge workshop for the manufacture and maintenance of the tools used in the daily work.

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## THE MARBLE IN THE WRITINGS OF ISIDORE OF SEVILLE

Raúl Aranda González

Institut Català d'Arqueologia Clàssica, Spain

Keywords: Isidore of Seville, marble, quarries

I present a brief overview of Isidore of Seville's main contributions to the phenomenon of late antique marble. From the point of view of the legality of the exploitation of the mines and from the aesthetic considerations. Isidore of Seville (556–636) was archbishop of Seville for just over three decades (599–636), later considered among the Fathers of the Church. His literary production is one of the primary historical sources for the knowledge of Visigothic Hispania. Isidore's main work, *Etymologiae*, was written in the first half of the 7th century. In this text, Isidore collects a fairly precise definition of the concept marble, following some of Pliny's appreciations. This is the only definition of a confusing concept in Visigothic chronology. In addition, Isidore incorporates certain allusions to the forms of use of marble, to aesthetic questions and to the work in the quarries. In other texts attributed to Isidore, such as *De orto et obitupatrum*, chronologically framed in the last years of the 6th and the first years of the 7th century, mentions to the use of marble can be found. In short, we present a critical compilation of the presence of marble in the fundamental literary figure of Visigothic Hispania.

## TYPOLOGICAL STUDY OF THE MOULDED MARBLE SLABS AS PART OF THE WALL DECORATION OF THE FRIGIDARIUM IN THE MONUMENTAL THERMAL COMPLEX OF VALERIA (CUENCA, SPAIN)

Javier Atienza Fuente<sup>1,2</sup>

<sup>1</sup> Arkeografía, Cuenca, Spain <sup>2</sup> Rovira i Virgili University, Spain

Keywords: Marble, Roman decoration

Since 2014, archaeological excavations carried out in the Hispano-Roman city of Valeria (Cuenca, Spain) have brought to light the remains of a monumental thermal complex in an excellent state of preservation. The building conserves elevations that in some cases exceed 4 metres

in height and does not show signs of spoliation of its construction elements. Until now, the rooms corresponding to the frigidarium have been completely excavated, as well as part of an open and porticoed room that could correspond to a palaestra and, finally, part of the hot rooms with the underground heating system. The rooms of the frigidarium show an elaborate decorative programme that included wall and floor mosaics, as well as marbles of different colour shades and provenances. The archaeological excavations of the frigidarium have recovered a set of around 8,000 pieces belonging to the parietal decoration of the building, among which are cornices, grooved lesenes, paving slabs and, above all, wall cladding slabs. Although most of the marble slabs of wall cladding have a smooth surface, others have a decoration carved on their surfaces based on simple mouldings of straight, convex or concave section that, in some cases, are combined to form complex designs.

In this paper, the first results of the study carried out on this type of elements are presented, establishing a first classification of them both of the basis of the marble typology in which they are made and the type of moulded decoration they present. It is possible that the study of this type of decorated slabs found in Valeria could help establish parallels with other identical or similar models present both in other archaeological sites and/or in other periods of Roman history.

## **ARCHAOMETRIC IDENTIFICATION OF ROSSO ANTICO FROM CAPE TAINARON (PELOPONNESOS) AND RED MARBLES FROM CARIA (ASIA MINOR)**

Donato Attanasio<sup>1</sup> – Matthias Bruno<sup>1</sup> – Walter Prochaska<sup>2</sup> – Alì B. Yavuz<sup>3</sup>

<sup>1</sup> Independent scholar <sup>2</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria <sup>3</sup> Dokuz Eylül University, Turkey

Keywords: Red marble, Rosso Antico, provenance determination

This study reports systematic archaeometric work carried out on ancient red marble varieties and includes detailed analytical data obtained for the Rosso Antico marble quarried north of Cape Tainaron and in other locations of the Mani and Peloponnesos as well as the so-called Cipollino Rosso, including Iassense Brecciato and compact red varieties, quarried in Caria near Iasos and the red marble extracted from a recently reported large site near the village of Kalinağil, a few

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kilometers south-west of Milas. The latter quarries are still occasionally exploited and the marble is traded under the commercial names Ege Bordo or Rosso Laguna.

Despite much work carried out since 1971, when Raniero Gnoli first identified Rosso Antico with the red marble quarried north of Cape Tainaron near the village of Profitis Elias, the problem of ancient red marbles has not yet been fully clarified. Detailed analytical data have been partially published only in the case of Greek Rosso Antico but not for Marmor Iassense or the Milas red variety, that was still undiscovered. As a consequence provenance determinations are difficult or impossible and it is generally assumed that ancient red marble artefacts, especially if homogeneously coloured, are made of Rosso Antico marble from Cape Tainaron. Iasos marble is not considered as a likely alternative because uniformly red coloured blocks of this stone are rare. Marmor Iassense is generally identified with the stone exhibiting swirling white bands (Cipollino Rosso) or the brecciated variety (Rosso Brecciato) with white clasts in a red cement. Identification of Iasos artefacts, therefore, is generally based on these macroscopic features.

Now new data allow to clarify this rather confusing picture and demonstrate that many renowned sculptures generically thought to be made of Rosso Antico from Cape Tainaron, were, in fact, carved, using Carian red marbles from Iasos or Milas. Pertinent examples are several sculptures of Hadrianic Age, when the use of statuary red marbles became especially popular, and mostly come from the Hadrian's Villa near Tivoli. The very famous Capitoline Red Faun is certainly the best known example of this group of sculptures.

## **CATHODOLUMINESCENCE OF THASIAN CALCITIC MARBLE ARCHITECTURAL DECORATION OF BYZANTINE TIMES IN VARNA, BULGARIA**

Vincent Barbin<sup>1</sup> – Rémy Chapoulie<sup>2</sup> – John J. Herrmann Jr.<sup>3</sup> – Aleksander Minchev<sup>4</sup> – Brigitte Spiteri<sup>2</sup> – Vasil Tenekdjiev<sup>5</sup> – Annewies van den Hoek<sup>6</sup>

<sup>1</sup> Université de Reims Champagne-Ardenne, France <sup>2</sup> University Bordeaux Montaigne, France <sup>3</sup> Museum of Fine Arts, Boston, United States of America <sup>4</sup> Archaeological Museum Varna, Bulgaria <sup>5</sup> Varna Regional Museum of History, Bulgaria <sup>6</sup> Harvard Museum of the Ancient Near East, United States of America

Keywords: Macroscopic assessment, Proconnesian marble, chancel barrier, Ionic capital

Visual inspection indicates that Proconnesian marble products strongly dominated the market for architectural decoration in the Black Sea region during the Early Byzantine period (4th to 7th c.). Inspection of the largely fragmentary Byzantine marble pieces in the courtyard of the Archaeological Museum in Varna, Bulgaria suggested that in this case too, Proconnesian marble and Proconnesian sculptural types prevailed. A few pieces, however, seemed to have coarser grain than the others, which suggested a possible provenance from the calcitic marble quarries of the north Aegean island of Thasos. The soft gray spots on some pieces in the Varna Museum also reinforced this idea. The Thasian hypothesis was also supported by an Ionic capital in the courtyard: it is a type known to have been exported in a prefabricated state from Thasos.

Small chip samples were taken from the six suspected Thasian pieces, which were two capitals and four panels coming from enclosures of the altar area in Early Byzantine churches.

Thasian calcitic marble from the quarries of Aliko, Cape Fanari, and others is difficult to separate unambiguously from Proconnesian with most methods. The grayish white colour is similar, and there is considerable overlap in maximum grain size (mgs) and isotopic ratios of carbon and oxygen. Cathodoluminescence (CL), however, distinguishes clearly between the two: Proconnesian tends to have a dark blue-black CL and Thasian calcite is a brilliant orange. Examination of the samples with CL made it clear that two of the pieces were Proconnesian and four were Thasian marble, including the Ionic capital of Thasian type. The Thasian presence in Bulgaria, ancient Thrace, seems to have been rare. No Thasian candidates were identified in a survey of public collections in several other coastal cities.

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## **COMPARATIVE SOURCES FOR QUARRY LOGISTICS, WORKFORCES AND OPERATIONAL COSTS AND THEIR IMPLICATIONS FOR ANTIQUITY**

Simon Barker<sup>1</sup> – Ben Russell<sup>2</sup>

<sup>1</sup> Ghent University, Belgium <sup>2</sup> University of Edinburgh, United Kingdom

Keywords: Quarries, manpower, Mons Claudianus

This contribution focuses on what comparative sources from later historical periods (especially the 16th-19th c.) reveal about manpower, animal-power and labour organisation in stone quarries. The implications of these data for understanding how Roman quarries were will be examined. It follows on from previous work presented by B. Russell at ASMOSIA XI, and published in the subsequent volume (D. Matetić Poljak and K. Marasović (eds.), *ASMOSIA XI, Interdisciplinary Studies of Ancient Stone*, 2018), which examined labour organisation and wages at the imperial quarries of Mons Claudians in the Eastern Desert of Egypt and Dokimeion in Phrygia. This poster compares the evidence provided by the ostraka from Mons Claudianus to historical data from a range of marble and other stone quarries, including Carrara (Italy) and various sites across Europe and the US. Our focus will be on the range of workers (stoneworkers of various specialisms, metal-workers, hauliers, and other specialists), the composition and size of quarry work-teams and their organisation, the logistical importance of animal-use and the economic impact of their maintenance costs, as well as the size of working areas within quarries. Overall, this contribution employs archaeological and historical sources, coming with the methodology of architectural energetics, to consider vital questions about the relationship between ancient quarry organisation and their operational costs. The resulting data and organisational-models presented in the poster can then be applied to examine similar questions for Roman quarries.

## EGYPTIAN STONES IN THE DÉCOR OF VESUVIAN CITIES (1ST C. AD)

Simon Barker<sup>1</sup> – J. Clayton Fant<sup>2</sup>

<sup>1</sup> University of Ghent, Belgium <sup>2</sup> University of Akron, United States of America

Keywords: Roman décor, Egyptian granite, Eastern Desert

Decades of archaeology in Egypt's Eastern Desert and accrued documentary evidence, set alongside an ongoing census of lithic décor in Campania, allow a more nuanced understanding of the interplay of Roman investment in the Desert, conspicuous construction in Rome, and diffusion down the social hierarchy in Campania. Here we present work on two lesser-known Egyptian stones, gabbro eufotide and ophites (Granito della Sedia di S. Lorenzo/Pietro).

The »curator« inscription of 10/11 AD reveals Roman functionaries gathered in Wadi Wikala/Semna, the source of ophites, under the auspices of a legionary tribune and »Chief of All the Mines and Quarries of Egypt.« The caché of this stone amongst the Roman elite is suggested by inserts in the basketweave pavement of the Palatine nymphaeum of Nero's Domus Transitoria, fragments from 1st c. AD villas around Lake Nemi, which include ophites among other Egyptian rarities, and Lucan's (9.713) mention of Thebanus ophites.

Gabbro eufotide, from Wadi Maqhrabiya, has no contemporary documentation like that of ophites, but the absence of a lucky find like the »curator« stele hardly excludes similar Roman interest. Proximity to Wâdi Hammâmât, where the same quarry Chief's freedman is attested in AD 9, makes Roman interest all the more probable (surface pottery begins in the 1st c. AD but is not closely datable). Pliny's description (NH 36.55) of Marmor Augusteum, still unidentified, actually fits gabbro eufotide well. At Rome it was, like ophites, used for small items of high prestige.

One might expect such rarities, procured at cost by imperial resources operating at the far edge of the empire, to be for the benefit of the emperor himself and the elite whose support was important. However, a modest diffusion of both stones can be found in Campania. Ophites and eufotide are both notable in three rooms of the Casa dei Cervi and other houses at Herculaneum and Pompeii. While the use of eufotide in the elaborate sectilia panels from the Villa San Marco is of comparable elite level, the large plaque of ophites in a bar façade at VI 10, 1 at Pompeii points to its diffusion prior to 62 AD when many bars were

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upgraded with marble cladding. This diffusion stands in sharp contrast to that of purple porphyry or granito bianco e nero (Pliny's marmor Tibereum). Does this suggest different aims for the prospecting in Egypt with divergent recipients in mind for new and unusual stones?

## **ANALYSIS OF QUARRYING TRACES – THE POTENTIAL OF 3D DOCUMENTATION**

Paul Bayer<sup>1</sup> – Stephan Karl<sup>1</sup>

<sup>1</sup> Karl-Franzens Universität Graz, Austria

Keywords: Quarry tools, extraction traces, extraction techniques

In the framework of the research project on the Roman marble quarry zone of Spitzelofen (Austria) the visible quarry faces with extraction traces were completely documented by 3D data acquisition methods (on a surface of 230 m<sup>2</sup> in total). For this we used Structure-from-Motion technique (camera and drone) georeferenced by tachymetric measurements. Together with the additionally found 30 quarry tools like picks or wedges, the abundant archaeological record of quarrying traces on this site gives a unique opportunity for understanding Roman extraction techniques. In this contribution we explore the relationship between tools and tool marks as well as the quarrying procedure executed by these tools to gain marble blocks. The half negative traces of trenches preserved on the quarry faces reveal the specific trench cutting procedure while traces of channels and wedge holes on the quarry sole the splitting techniques. All these used techniques of stoneworking can be directly confronted with the used tools. The 3D data enables a qualitative and quantitative analysis of these quarrying traces. We evaluate the trench cutting procedure with regard to the distances of the single quarrying grooves and the block sizes obtained from the distances between ledges and intersections of trenches. It can be shown that the applied techniques are relatively homogeneous in the whole quarry zone with more than 18 marble quarries. They vary only in specific details depending on the respective micro-local geological constraints and obviously on the respective skills of the quarry workers. Additionally, the investigation of the quarry faces provide a lot of details for explaining the formation of the ledges and of the vertical concavity of the trench wall. Wedge splitting which was only observed

as lifting splitting, shows a regular system which consists of a small V-shaped channel with a depth of ca. 15–25 cm, in whose base wedge holes or a continuous slot are chiselled; a technique very similar to the evidence at Carrara. The quantitative analysis of quarrying traces using 3D techniques provides an appropriate visual indication of the level of intensity of an exploited marble resource. Especially in comparison with marble resources of other sites this data will be of importance.

## **HYDROGELS LOADED WITH SILVER NANOPARTICLES AND ESSENTIAL OILS: A NEW SOLUTION FOR CLEANING BIODETERIORATED MARBLE**

Elisa Boccalon<sup>1</sup> – Morena Nocchetti<sup>2</sup> – Monica Pica<sup>2</sup> – Aldo Romani<sup>3</sup> – Katja Sterflinger<sup>4</sup>

<sup>1</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

<sup>2</sup> University of Perugia, Italy, <sup>3</sup> University of Perugia and CIRCC, Italy <sup>4</sup> Academy of Fine Arts Vienna, Austria

Keywords: Biodeterioration, hydrogel, marble cleaning

Biodeterioration is one of the many causes of marble degradation. The colonization of microorganisms on the stone substrate produces chemical and structural alterations that lead to inexorable deterioration. Adequate cleaning of biodeteriorated stones requires mechanical and chemical actions to remove the undesired biopatina and achieve effective surface disinfection. Hydrogels fulfil both these requirements and provide a solution in which biocides remain confined, interacting mainly by surface contact with the stone and avoiding excessive penetration. With this purpose, poly(vinyl)alcohol-borax (PVA-borax) hydrogels containing active ingredients were designed and tested over two biodeteriorated stone fragments: Carrara marble and St. Margarethen stone.

The polymer network was reinforced with a synthetic clay (layered double hydroxide) which also acts as a carrier for compounds with antimicrobial activity and provides the system with an extraordinary stretchability. As a result of this composite network, the hydrogels can be easily cut, shaped and adapted to different stone surfaces. To limit the use of harmful substances, the hydrogels were filled with three alternative antimicrobials: silver nanoparticles (AgNPs), silver nanoparticles-silver chloride (Ag/AgCl) and thyme essential oil (EO),

used separately or in combination. The efficiency of the different active species was investigated by evaluating the effects of the hydrogel applications over the bacterial, fungal and algal strains grown on the two different stone substrates. These results were compared with the efficiency of hydrogels loaded with a traditional antimicrobial agent like methylisothiazolinone (MIT). The data collected show that AgNPs and thyme EO are the most efficient cleaning systems and are promising substitutes for other more common and harmful disinfecting compounds.

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

Rok Brajkovič<sup>1</sup> – Petra Žvab Rožič<sup>2</sup> – Bojan Djurič<sup>2</sup> – Bernarda Županek<sup>3</sup> – Blanka Cvetko Tešovič<sup>4</sup> – Katarína Holcová<sup>5</sup> – Luka Gale<sup>2</sup>

<sup>1</sup> Geological Survey of Slovenia, Slovenia <sup>2</sup> University of Ljubljana, Slovenia

<sup>3</sup> Museum and Galleries of Ljubljana, Slovenia <sup>4</sup> University of Zagreb, Croatia

<sup>5</sup> Charles University, Institute of Geology and Paleontology, Czech Republic

Key words: Multimethod analysis, limestone provenance, stone products

Colonia Iulia Emona (mod. Ljubljana) was a Roman town in Regio X in present-day central Slovenia. Several quarry areas of limestones used by the Romans have been proposed up to now, stratigraphically ranging from the Lower Triassic Werfen, Lower Jurassic Podbukovje (Krka Limestone Member, Lithotid Limestone Member and Spotty Limestone Member), Middle Jurassic Laze, Upper Cretaceous Lipica, and Miocene Laško Formation (Lithothamnium Limestone Member). However, high-resolution stratigraphic data from the proposed quarry areas, as well as detailed analyses of microfacies and geochemical composition of stone products, is missing. We examined stratigraphic successions on the proposed quarry areas and the lithology of the stone products to create a multimethod database that would increase confidence in provenance determination.

The database incorporates data from geological maps, sedimentological logs, data on microfacies and foraminifera obtained through optical and SEM microscopy, mineralogical (XRD) and geochemical (ICP-MS) composition, cathodoluminescence analysis, and analysis of

isotopic values of carbon ( $^{13}\text{C}/^{12}\text{C}$ ), oxygen ( $^{16}\text{O}/^{18}\text{O}$ ), and strontium ( $^{87}\text{Sr}/^{86}\text{Sr}$ ). Stone products were examined through a multilevel approach using the same methods (step 1 – macroscopic, step 2 – microscopic, and step 3 – geochemical analysis). 305 stone products were examined, 168 were sampled on previously damaged areas, and complete records were collected for 37 stone products.

Analyses of the stratigraphic successions in the proposed quarry areas show that all formations contain macroscopically distinct lithotypes, mostly biogenic limestones, as well as characteristic microfacies types that allow sufficient determination of provenance. Where facies distinction between stone products was insufficient, we relied on different foraminifer assemblages. When even foraminifera were absent, discrimination was based on geochemical and isotopic data. Using the multilevel approach, we were able to determine the provenance on macro and micro step for 49.5 % of the stone products studied. All the studied stone products with complete records of the methodology were traced back to a specific stratigraphic formation (or member) based on geochemical composition (specifically  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$  and  $\text{MnO}$  content), and measurements of carbon and strontium isotopes.

Using the multimethod database, we are able to distinguish all limestone types that outcrop on the previously proposed quarry areas. Furthermore antique stone products can be placed in each. In addition, a previously unknown type of limestone used in the production of stone products in Colonia Iulia Emona has been identified. It originates from the deeper marine Lower Cretaceous limestone.

## **LATE USE OF COLOURED MARBLES IN ITALY (1860–1920)**

Roberto Bugini<sup>1</sup> – Luisa Folli<sup>2</sup>

<sup>1</sup> CNR - Consiglio Nazionale delle Ricerche, Italy <sup>2</sup> Independent scholar

Keywords: Ancient marble, Italy, 19th century

The use of ancient coloured marbles in Italy was esteemed since the Middle Ages (i.e. Cosmati's workshop – Central Italy) and during the Mannerism (Medici's Opificio Pietre Dure – Florence) and the Baroque (Fanzago's workshop – Naples), reaching extraordinary standards of skill. Therefore, eye-catching artefacts, noticing the talent of craftsmen,

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were still created in the years 1860-1920 for churches, memorials, furniture or also to restore ancient works. The original quarries, from which the marbles came, were scattered in the eastern Mediterranean basin and they were almost always unknown in the late 19th c., so the use of the marbles was made through the exploitation of the marble stores established during the Roman Empire along the course of the Tiber (i.e. Portus Romae, between Fiumicino and Ostia; La Marmorata, between Aventino and Testaccio). Distinguished architects were involved and, according to the provenance of the marbles, the craftsmen were chosen from the marble workers (Marmorari) of famous ateliers of Rome. Marble slabs were used to make veneers and floors; shaped elements to decorate altars.

Some cases were enhanced in order to underline this late use of marbles in Italy:

\* Santa Maria Maggiore (church) – Rome; Virginio Vespignani, 1862–64. Materials (Confession): Alabastro Cotognino, Africano, Verde Antico, Occhio Pavone, Fior di Pesco, Semesanto, Bianco e Nero, Breccia Dorata etc.

\* Sacro Cuore/church, Via Marsala, Rome; Francesco Vespignani, 1879–1887. Materials: Alabaster, Granito Foro, Broccatello Spagna, Verde antico, Pavonazzetto etc.

\* Vittoriano/memorial, Rome; G. Sacconi 1885; G. Koch, P. Piacentini, M. Manfredi, 1911. Materials: Porfido Rosso Antico, Verde Antico, Granito Rosso, Granito Foro, Africano etc.

\* Beata Vergine Rosario/sanctuary, Pompei; A. Cua (main building, 1876–91); G. Rispoli (ornaments 1891, façade 1893-1901); S. M. Chiappetta (enlargement, 1933-39. Materials: Cipollino (open-book style), Griotte, Pavonazzetto, Alabastro Cotognino, Bianco e Nero, Breccia Quintilina etc.

\* Cappella Espiatoria/memorial, Monza; G. Sacconi and G. Cirilli, 1901–1910. Materials: Porfido Rosso Antico, Porfido Serpentino Verde, Africano, Giallo Antico etc.

The use of coloured marbles was again noticeable for more than twenty years after World War I (1919–42), always for veneers and floors. In this period, stones and marbles came from numerous quarries scattered in the whole Italian territory (i. e. Verde Polcevera from Genoa, Rosso Porfirico from Verzegnis, Broccatello from Montagnola Senese, Portasanta from Caldana etc.) and, in many cases, the marbles were never used before.

## **ENCAUSTIC PAINTING ON MARBLE STATUARY: HARD EVIDENCE FROM THE GROUP OF BOSTON 00.348 COLUMN KRATER (MMA 50.11.4)**

Patricia A. Butz

California State University, United States of America

Keywords: Marble, encaustic, metatext

This paper presents one of the most underdiscussed yet important pieces of archaeological evidence for the encaustic painting of marble statuary: 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. On the obverse, the vase depicts a statue of Herakles in white marble, brilliantly positioned in Polykleitan contrapposto, in the process of being painted by the artist, attended by an assistant preparing the brazier for the heating of the encaustic materials. The overall composition is exceptional with a series of deities, including Herakles himself, as well as the humans witnessing the event. The reverse of the vase with the goddess Athena seated in central position and surrounded by divinities, features touches of the same added white used for the marble on the obverse. The crowning element of the vase, the dominant ivy wreath encircling the wide neck, prefigures and coordinates with the placement of such a wreath in stone, as seen on the marble columella of Hieronymos from the 3rd c. BC in the Epigraphical Museum at Athens (Butz, *Horos* 8-9, 1990-91, 67-74).

Lightly published, the krater is, in fact, a major metatext, explicitly proving the act of painting statuary by showing how to do it on a painted vase. As stated by the MET, ([www.metmuseum.org/art/collection/search/254649](http://www.metmuseum.org/art/collection/search/254649)), »Representations of artists at work are exceedingly rare«. Focusing on the actual coloration of pigments visible on the Herakles statue and the difference in stone type implied by the two different bases, this paper offers a new, more petrographic context for analysis of the unique artwork.

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## THE ANCIENT QUARRIES IN PANNONIA

Marija Buzov

Association Croate pour l'Étude de la Mosaique antique, Croatia

Keywords: Pannonia, quarry, stone

The knowledge of quarrying activity in ancient Pannonia amounts to the larger economic and cultural centres of the provinces. From these we have learned of the highly developed construction and artistic technique used at that time. In a certain manner, these quarries brought Romanization and urbanization to the areas, to the building sites as well as to the stonemason's workshop and to art in general. In this contribution I will try to reconsider from various points of view the ancient quarries in Pannonia. On the eastern Adriatic coast, but also in the continental part, where the Roman colonies were situated, we come across ancient monuments built of local stone. There are a number of quarries in Pannonia from which stone was extracted. Stone from each individual quarry has its own characteristics and quality. But according to archaeology stone quarried in the karst hinterland was used for building. It seems that large quantities were extracted, as judged by the number of quarries (Dugi Dol, Mračin, Štirkovac etc.) in a relatively small area southwest of Karlovac (near Roman Siscia). Today one finds in quarries a large number of stone trunks and lids as well as unfinished sarcophagi and building fragments. They are very frequently found built into mediaeval structures. We encounter such finds also in river beds, where they mostly served as structural improvement of a river crossing, that is, as a foundation for a river ford. On the basis of frequent finds of stone urns and sarcophagi with a round inscription field, one can presume a strong influence from nearby Noricum or even direct administration from that province. Irrespective of the time and expensive influence of the well-known quarry centres, there existed without a doubt a whole series of smaller quarries from which stone for local building needs in the small regional and provincial areas was quarried. Unfortunately, the result of this research is not finished, because we must get an overall picture of the whole process and its organization of collecting and classifying the data of the autochthonic stone and all of the ancient stone quarries as well as creating a stone database.

## **LOCAL GREEN MARBLES IN AUGUSTA PRAETORIA (AOSTA, NORTHERN ITALY)**

Maurizio Castoldi  
Independent Scholar

Keywords: Alpine green marble, Augusta Praetoria, local stones trade

Items about imported marbles from the excavations of the forum and thermae of Augusta Praetoria (Aosta), Augustan colonia founded in 25 BC for the control of the territory between Alpes Poeninae and Graiae, are now in course of publication. In addition to these lithotypes, the ongoing studies revealed 30 roman floor and wall slabs made of local green marble, today known and released as Verde Alpi. This is an important contribution to the knowledge of local lithic production in roman age: the exploitation of this marble was not considered possible before the first decades of the 20th century, assumption already denied by P. Framarin ten years ago, without confirmation. Now the archaeological analysis of these finds allows to assert that the local green marble was actually known to the Romans: the excavations in the sacred area of the Forum, in the Terme del Foro and especially in the so-called Grandi Terme have revealed fragments of ophicalcite slabs, with different lithological characteristics. Today at least 20 types of green marble are exploited in Aosta Valley: among these, the roman slabs have a bright green background with white speckles of calcite, very similar to Verde St Denis marble, (the name of the village of the modern quarries). Green marble decorative systems propose chronological questions: if this stone is used in place of other imported materials such as the Thessalian Verde Antico, it represents an important terminus post quem, fixing his stratigraphic contexts not earlier than the 2nd c. AD. The percentages for Augusta Praetoria also indicate how, in line with the public complexes of other cities in Northern Italy, the green is associated with unofficial public buildings: like the other local marble, the Bardiglio of Aymavilles, this alpine green stone is almost absent in the Forum, in contrast to a decent abundance from the city baths. The dynamics of the Verde Alpi stone trade at a supra-regional level in Roman Age, also suggested by the evidence of a column in alpine green marble preserved at the Museo Maffeiano in Verona, and the survey of the quarries, still unknown because of the modern exploitation, are the new goals of the research.

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## **INSCRIPTIONS AND THEIR MARBLE(S): SOME EXAMPLES FROM ROMAN CORINTH**

Chiara Cenati<sup>1</sup> – Vasiliki Anevlavi<sup>2</sup> – Walter Prochaska<sup>2</sup>

<sup>1</sup> University of Vienna, Austria <sup>2</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: Epigraphy, trade, white marble

Corinth was in Roman times one of the most significant harbour cities in the Mediterranean and represented a pivot point in the commercial routes between Rome and Ephesos. In particular, archaeological evidence has shown the strong commercial connections of the Roman colony with Asia Minor. In this context of research, marble provenance studies provide significant details that contribute to outline the map of trade and economy of the Greek city. Among all marble monuments, inscriptions are extremely important for this purpose, as they carry precise information about the time of production, the function and the commissioners of the monument itself. During the last marble sampling campaign of the Austrian Archaeological Institute, 15 samples were taken from inscriptions on the archaeological site, at the archaeological museum and in its depots. These inscriptions are mainly connected with the evergetism of the colonial elites and with the imperial cult, two traits which are strikingly present in Roman Corinth. The monuments date from the foundation of the Roman colony in the 1st c. BC to the 3rd c. AD, are of a different types, have different functions and their texts are both in Greek and Latin. For the provenance analysis of white marbles, a series of methods are used. The techniques applied to these samples include petrographic investigations, chemical (trace elements) and isotopic analysis ( $\delta^{18}\text{O}$ ,  $\delta^{13}\text{C}$ ). Statistical treatment for each sample is applied. The artefacts are compared with a database of 4,500 quarry samples from the classical marble quarries known in antiquity. The identification of the origin of the marbles used for these inscribed objects will allow shedding more light on how and if the marble use changed during the time, according to the type and the function of the monument (public or private), as well as to the status of the people involved. Furthermore, it will be considered if the provincial borders had some meaning in the marble trade, or, on the contrary, if the commerce was organized on the basis of extended macro areas. The results of this research show the use of regional marbles like those from Mani and from sub-regional quarries such as Prokonnesos and Penteli.

# FOSSILIFEROUS ORNAMENTAL ROCKS IMITATED IN GLASS IN ANTIQUITY

Miguel Cisneros<sup>1</sup> – Esperanza Ortiz<sup>2</sup> – Juan Paz<sup>2</sup>

<sup>1</sup> Universidad de Cantabria, Santander, Spain <sup>2</sup> Museo de Zaragoza, Spain

Keywords: Skeuomorphism, marbled glass, marble

This paper is the result of a long and comprehensive analysis of glass skeuomorphs of ornamental and precious stones in antiquity examining their background and duration.

We will analyse the group of fossiliferous ornamental rocks and their corresponding glass skeuomorphs of bicolour and polychromic models. This collection constitutes one of the most solid groups, with peculiar traits and characteristics, which fostered widespread artistic glass production especially during the reigns of Tiberius-Nero (c. 20–68 AD), but loaded with inherited material and intangible elements.

Lumachelle provide some of the most outstanding patterns, with coils and spirals reproduced in glass – conceptually very close to the wide range of patterns of dots and concentric circles, some of which could be identified as eyes. In this sense, the underlying message conveyed by most of these objects is the search for protection, a permanent and deeply rooted need in the ancient world. A comprehensive analysis of the cultural, historical, economic, social, religious and magical network explains from a multidimensional perspective, even supported through various channels, the apotropaic element attached to many of the manmade ornamental items. This peculiarity usually originated in nature itself, based on ornamental, precious stones and other elements regarded as gemstones. Glass, due to its peculiar properties, was considered a similar substance and served a comparable purpose. The intrinsic features of the aforementioned materials (colour, pattern, shape) were supposed to aid parasymphathetic magic, as archaeology reveals and ancient literary sources confirm.

This paper explores this manifold phenomenon and examines the imitated chromatic variants and shapes paying particular attention to instances in Hispania in the context of imitations of ornamental rocks.

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## **MARBLE AND PATINA ANALYSIS FOR THE INTERPRETATION OF SCULPTURES FROM ANTIQUARIAN COLLECTIONS. A SET OF THE MUSEU D'ARQUEOLOGIA DE CATALUNYA (BARCELONA) AND THE MUSEO NACIONAL DEL PRADO (MADRID)**

Montserrat Claveria  
Universitat Autònoma de Barcelona (UAB), Spain

Keywords: Antiquarian sculptures, archaeometry, patinas

Data on the original archaeological context of most sculptures from antiquarian collections are not known or are insufficiently substantiated. This aspect ostensibly hinders the interpretation of important properties of these works, such as their correct dating or to understand the function they performed. The scope of these challenges is even greater if we take into account that among these pieces there are productions from the Ancient and Modern periods, carved following common styles and techniques.

Two projects on antiquarian sculptures directed by the author and conducted by the GREEC (Research Group for the Sculpture of Classical Style) have examined about 150 ambiguous pieces of this type in order to determine their ancient or modern chronology. This presentation will focus on a representative set of these works in order to make known the results concerning this research and to distinguish the contributions of the analysis of marble as a complementary technique in the study of this type of sculptures. This group consists of 39 sculptures from well-known antiquarian collections now preserved in the Museu d'Arqueologia de Catalunya (Barcelona) and the Museo Nacional del Prado (Madrid). Most of them are portraits, 9 ideal statues and 1 sarcophagus. Analysing them under optical microscopy (OM), visual examination, spectrophotometry to quantify the greyscale tones, cathodoluminescence (CL) and stable C and O isotope, it has been determined that 69 % of the pieces are made of Carrara marble. The remaining 31 % are carved in marble from quarries in the eastern Mediterranean (Paros-1 and 2, Pentelic, Proconessus, Göktepe marbles). Combining these results with others derived from different study approaches such as technical, style, iconography, epigraphic or archival documentation led us to determine that 16 sculptures are ancient and 20 modern productions. We also applied the method approach based on

the observation and analysis of the patinas remaining on the sculptures surfaces and relevant results were obtained, some of which verifying the ancient origin of some studied artefacts; other cases provide light on the conservation contexts of several sculptures throughout their history.

Multimethod marble and patina analyses are crucial in the equivocal field of study of antiquarian sculptures. Its application contributes to the verification of results obtained by other archaeological-artistic approaches and even provides new data to advance the knowledge of the conservation/use contexts of these works and on the ways of proceeding in reusing ancient marbles to produce modern sculptures.

## **COLUMN SHAFTS FROM HIPPO REGIUS: QUALITY SELECTION AND EASTERN EXPORTATION**

Julia E. Cox<sup>1</sup> – John J. Herrmann Jr.<sup>2</sup> – Annewies van den Hoek<sup>3</sup>

<sup>1</sup> University of Georgia, United States of America <sup>2</sup> Museum of Fine Arts, Boston, United States of America <sup>3</sup> Harvard Museum of the Ancient Near East, United States of America

Keywords: Column shafts, Algeria, stone exportation

In the course of our recent travels in the Mediterranean, we have seen column shafts that appear macroscopically to be »Greco Scritto,« that is, the gray-white marble from Cape de Garde, Algeria (near the ancient city of Hippo Regius). On some occasions we have been able to take tiny samples from these shafts, and laboratory analysis of isotopic ratios of carbon and oxygen and measurements of maximum grain size have confirmed the macroscopic identifications. These identifications of marble from Hippo in widely spread locations clarify the selections made to satisfy distant markets and reveal a significant eastern expansion of Hippo marble's reach.

In Hippo marble shafts preserved in the neighbourhood of the quarries, white areas tend to dominate the gray spots and streaks. Farther away, as in Tunisia (Haidra, Carthage), shafts from Hippo are almost always a darker variety, in which dark gray bands and striations dominate. The preferences of distant markets for the dark variety is especially evident in Rome, where the decorative possibilities of Hippo marble are on display in a section of shaft that is highly polished for use as a sculpture pedestal in Palazzo Altemps, Rome. Another handsome (but

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unpolished) example is in its ancient context in the Villa of the Quintilii on the Via Appia just outside Rome. The shaft from Hippo is mixed in with other gray (bigio) marbles and Cipollino Verde and is not part of a uniform colonnade. This preference for dark striations in column shafts contrasts with a preference for clear white in capitals of Hippo marble. Hippo marble shafts have previously been scientifically identified in Leptis Magna, Libya, and it is now possible to track their exportation much farther eastwards. Several examples were seen on Cyprus, and samples could be taken from shafts in Saranda Kolones, Paphos, and in the agora of Kourion. They are again the dark banded and streaked variety. A few more shafts that appeared to be Hippo marble were seen on the eastern coast of the Mediterranean at Caesarea and Askelon but were not sampled.

## **GEOLOGICAL PROVENANCE OF ROMAN BUILDING AND ORNAMENTAL STONES USED IN THE COLONIA CLUNIA SULPICIA (HISPANIA TARRACONENSIS)**

José Antonio Cuchí Oterino<sup>1</sup> – María Pilar Lapuente Mercadal<sup>2</sup> – Francesc Tuset Bertran<sup>3</sup> – Anna Gutiérrez García-M<sup>4</sup>

<sup>1</sup> Universidad de Zaragoza, Escuela Politécnica Superior de Huesca, Spain

<sup>2</sup> Zaragoza University, Spain <sup>3</sup> Barcelona University, Spain <sup>4</sup> Institut Català d'Arqueologia Clàssica (ICAC), Spain

Keywords: Clunia, geology, marble provenance

Colonia Clunia Sulpicia is located on a flat inselberg in the north central part of Spain. It had the status of a Roman municipality in the time of Tiberius (14–37 AD). According to Pliny, in the mid–1st c. AD, it became the capital of one of the *conventus iuridici* of the province of *Tarraconensis* (*Hispania Citerior*). It is thought that, after the stay Servius Sulpicius Galba hidden in Clunia in 68 AD, the city was granted the status of colony and renamed *Colonia Clunia Sulpicia*. From the 3rd c. the city declined, perhaps in relation with water supply problems from a small aquifer located under the city. Having lost its episcopal character, it is admitted that some population was living after the arrival of the Muslims in the 8th c. but was already abandoned in the 10th century. A number of local geological materials were used in the Roman city. Two units of lacustrine limestone, Paramo P1 and P2, from the Upper continental Miocene of the Duero valley were nearby

quarried for the most representative public buildings such as the forum, two thermae and the theatre. *Opus africanum* is commonly recognized in the excavated houses. Several quarries of different stones are located in the periphery of the inselberg. Sandstone ashlar from the Albien (Utrillas formation) were used in the furnace of the baths and related kaolinite rich clay and quartz sand were probably used for grounds, having been carried from the nearby Iberian range.

The city had its corresponding phases of monumentalization. The quarries of Espejón, located about 10 km from Clunia, supplied the colony with different lithotypes of Cretaceous ornamental stones, all highly prized for their vivid colours in yellow and purple. They were extensively used from Julio-Claudian times onwards both in the public and private sphere. In addition, a varied number of non-local marbles have been recovered during the archaeological excavations. In particular, Cipollino Mandolato from Campan (French Pyrenees) are very common in pavement slabs. Other architectural decorative pieces (plates, moldings, cornices) in white marble and in white/grey banded marbles from the thermal buildings (Los Arcos I and II baths, the Forum baths) have been studied archaeometrically. The multimethod analytical approach (Petrography, cathodoluminescence and stable isotopes of C and O) has provided evidence of the competition between two supraregional marble supply areas, the marble districts located in southern Gaul and that Lusitanian of Estremoz Anticline.

## **MACROSCOPIC OBSERVATIONS OF THE COLOURED STONES OF THE BISHOPRIC CHURCH IN PYTHAGOREION (SAMOS) – A CONTRIBUTION TO THE MONUMENT STUDY**

Georgia Delli<sup>1</sup> – Vasiliki Anevlavi<sup>2,4</sup> – Wioletta Tenczar<sup>3,4</sup>

<sup>1</sup> National and Kapodistrian University of Athens, Greece <sup>2</sup> Salzburg University, Austria <sup>3</sup> University of Vienna, Austria <sup>4</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: Coloured material, Samos, marble

On the eastern Aegean lies the island of Samos, mostly known for its ancient wealth and power. The centre of the island was the city of Samos, nowadays known as Pythagoreion. The current study focuses

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on the macroscopic observations of re-used material in the 7th c. AD basilica in the byzantine castle of Pythagoreion.

The church was built after the destructive attack of Arabs in 665/6 using salvaged material from the city. The research is mainly focused on the coloured material of the coloured stones, especially the columns of the central aisle, which indicate diverse origins. Part of the coloured material can be either found in situ within basilicas peristyle or scattered around the castle ground. Excavations revealed that the basilica was built on top of a Hellenistic-Roman villa that may have been used by Emperor Augustus. Material from Asia Minor: Euromos and Iasos quarries indicate the wealth and extensive trade network between Pythagoreion other cities of the region. This material cannot be found in any other Byzantine church on the island of Samos.

These aspects are part of the preliminary material studies of the basilica. Future analyses could specify not only the origin of the coloured material but also white marbles. The pioneering research conducted during this study in combination with further mortar study of the monument will shed light on the history of the building as well as the general area.

## **PLIO-QUATERNARY FACIES EMPLOYED AS BUILDING MATERIALS IN ANCIENT GREECE: PRELIMINARY CLASSIFICATION OF THE »PÔROS« OF THE GULF OF CORINTH**

Marilou de Vals<sup>1</sup> – Isabelle Moretti<sup>1</sup>

<sup>1</sup> Sorbonne Université, IStEP, France

Key words: Ancient Greece, poros' classification, building materials

Local stones were the primary material used in ancient construction, but exchanges of building stones at a larger scale have been documented, for example between the region of Corinth and Delphi, in the Gulf of Corinth. In this area, limestones and conglomerates represent the majority of the volume of stone employed in monuments, whereas marbles were employed for sculpture mostly. New data show an underappreciated diversity of limestones used in archaeological sites, for example in Delphi, opening a new door to the understanding of ancient construction.

The presented study focuses on the stones of the Gulf of Corinth, from

Northern Peloponnesus and the Isthmus, usually called ›poros‹ when employed as building materials. This work also aims to better define this term, which covers a large variety of facies: usually recent detrital or chemical sedimentary stones with high porosity. A large-scale approach combined with field works and petrological analysis enabled significant progress in the establishment of a database for the »pôros« of the Corinth region. The nature, origin, and uses of the stones were gathered, and petrophysical analyses were performed to understand their attractiveness as building materials.

From well-known quarries in the areas of Corinth, Kenchries and Kleones, as well as smaller and new quarries around Isthmia, Sikyon, Perachora and Megara, were extracted the plio-quadernary deposits of the Corinth Rift. They were exposed by the uplifting of the Peloponnesus and the Isthmus: they did not undergo strong diagenesis. Thus, they are usually lighter and softer than other stones, mainly Mesozoic limestones, but additional characteristics may have been involved. Travertines, grainstones, sandstones and marine limestones were clearly favoured by ancient builders: it seems that they were exported more than expected and provided building materials throughout the Gulf of Corinth.

## **THE BAIÆ CASTS ONCE AGAIN: TECHNIQUE OF CASTING**

Fabiano Fiorello Di Bella  
Scuola Superiore Meridionale, Italy

Keywords: Baiae casts, plaster casts, casting process

The paper presents an in-depth analysis of the famous plaster casts discovered in the sumptuous Baths of Sosandra at Baiae on the Gulf of Naples. In 1954, the excavation of more than 400 plaster fragments was a turning point for the study of ancient copying techniques, which was previously based on literary sources (Kopienkritik). Many of the moulds found at Baiae were from Greek masterpieces of the 5th and 4th c. BC. They were employed in an important workshop of copyists in order to create life-size marble copies for rich Roman patrons. Christa Landwehr-von Hees correctly identified 67 fragments belonging to 12 statues, among them the Tyrannicides, the Amazons of Ephesus,

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Eirene carrying Ploutos, etc.

The main object of the research is to shed light on the technique of making casts through the direct autopsy of the casts itself conducted by the author. The majority of the casts are kept in the storeroom of the Archaeological Museum of the Phlegrean Fields in Baiae.

The fragments show that the casting process of the marble sculptures was carefully executed in sections (e. g. head, arms, torso etc.), whereas small anatomic pieces were cast separately. Moreover, the copyists didn't expect to be able to reproduce an exact copy of the Greek original. On the contrary, comparisons between casts and marble copies underline that each Roman copy is unique due to the rendering of the details. To conclude, the paper demonstrates that the casting technique is not just a mechanical operation, but it requires highly-skilled artisans. The cost of labour and the transportation of plaster casts from Greece to Italy must also be quantified as part of an expensive manufacturing process.

## **THE PROTECTION OF ARCHAEOLOGICAL HERITAGE IN THE OUTDOOR ENVIRONMENT: STUDYING THE EFFECTIVENESS OF ANTI-GRAFFITI PRODUCTS**

Simona Dichiarà<sup>1</sup> – Giorgio Sobrà<sup>1</sup> – Luciana Festa<sup>1</sup> – Silvestro Antonio Ruffolo<sup>2</sup>  
– Francesco Mauro La Russa<sup>2</sup>

<sup>1</sup> Istituto Centrale per il restauro, Italy <sup>2</sup> University of Calabria, Italy

Keywords: Archaeological site, graffiti, anti-graffiti, cultural heritage

One of the problems encountered on archaeological heritage in the outdoor environment, such as archaeological parks, is the presence of graffiti vandalism in the form of writing and drawings. The phenomenon is an old one, e.g. graffiti is known to have been written on walls and artefacts to leave a mark of one's presence but has recently seen a considerable increase in graffiti, also due to the greater availability and variety of defacing materials. At best, graffiti is done in pen or pencil, but unfortunately it is not uncommon for graffiti to be written with felt-tip pens or spray paint, or even engraved. Inside the Archaeological Park of the Colosseum the problem of graffiti is particularly serious, especially in the entrance area of the site, which is also used as a waiting area for visitors. The graffiti is mainly present on the bricks that make up the structure of the Colosseum, but also on the marbles and stone

elements, also erratic, placed within the Park. The removal of such defacing graffiti is very problematic, as the inks and paints used are absorbed by the stone and cause often permanent stains. Preventing the phenomenon is very problematic, as it is impossible to guarantee continuous surveillance due to the vastness of the area affected. The aim of the study was to test solutions for the removal of graffiti vandalism and, at the same time, to prevent its persistence on the objects. The focus was on comparative testing to compare the effectiveness of different anti-graffiti products currently on the market, which are specifically formulated for application on cultural property. The selected products were applied to different substrates, reproducing the main and most sensitive materials present in the site: Greek marble and terracotta bricks handmade with traditional techniques. After the protective treatment, all samples were smeared with the most commonly used materials. In order to establish the effectiveness of the anti-graffiti products and to compare their performance even after some time, some of the samples were cleaned according to the manufacturer's instructions after 24 hours, while others were artificially aged in a climatic chamber before the removal of the soiling agents. The results of this study provide a contribution to the experimentation of protective agents and constitute an indication for the Heritage protection bodies and more generally for the managers of archaeological parks in order to contain, if not eliminate, the damage caused by graphic vandalism.

## **ARCHAOMETRIC APPROACHES TO VOLCANIC TUFF IN ROME. THE RECENT WORK OF THE QUADRATA PROJECT**

Daniel Diffendale<sup>1</sup> – Fabrizio Marra<sup>2</sup>

<sup>1</sup> Scuola Superiore Meridionale, Naples, Italy <sup>2</sup> Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy

Keywords: Tuff, Rome, archaeometry

Despite a century of archaeological and historiographic work in Rome and its tuffaceous catchment area, contemporary understanding of volcanic tuff use still relies on century-old studies. The ongoing »Quarry provenience and Archaeological Dating of the Roman-Area Tuffs in Antiquity« (QUADRATA) project applies trace-element analysis and

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thin-section petrography to establish provenience of volcanic tuffs used for construction in Rome, within the framework of a broader reconsideration of the economics and logistics of quarrying in the hinterland of the city during the Republic and Empire. QUADRATA targets well-dated monuments with the aim of a better understanding of the historical development of tuff exploitation in the lower Tiber valley during antiquity; the project's recent research suggests that many of the lithotypes identified by early 20th c. archaeologists were employed in Roman architecture earlier than previously understood, in some cases by centuries. The use of trace-element analysis on tuff presents special problems compared with marble, but various strategies including combination with petrography can aid in the process. In particular, the potential to differentiate between geographically-distant products of the widespread Tufo Lionato deposit is discussed.

## **TRADING PULVIS PUTEOLANA WEST. FIRST EVIDENCE OF THE USE OF CAMPANIAN PYROCLASTIC MATERIALS IN MIDDLE IMPERIAL NORA (SARDINIA, ITALY)**

Simone Dilaria<sup>1</sup> – Caterina Previato<sup>1</sup> – Jacopo Bonetto<sup>1</sup> – Michele Secco<sup>1</sup> – Domenico Miriello<sup>2</sup> – Donatella Barca<sup>2</sup>

<sup>1</sup> University of Padova, Italy <sup>2</sup> University of Calabria, Italy

Keywords: Pumices, Phlegrean fields, pulvis puteolana

In the framework of the archaeological mission coordinated by the Department of Cultural Heritage of the University of Padova in Nora (Sardina), large efforts are being devoted, in recent years, to the study of buildings materials (stones, mortars) and constructive techniques of the site (Bonetto, Cespa, Erdas 2011; Previato 2016; Cespa 2018; Secco et al. 2020; Bonetto, Dilaria 2021). In this paper, new data on the raw materials employed in the mortars of Nora Imperial buildings will be presented.

Recent excavations carried out in the ancient town allowed to highlight the use of pyroclastic materials in either structural, preparation and joint mortars and concretes of the Middle Imperial phases of two buildings: the so called ›Roman Temple‹ and the ›Temple of Eshmun‹. Dimensions of the volcanic clasts are extremely variable and range

from micrometric to pluri-centimetric size, thus making quite simple the recognition of different lithotypes after careful in situ macroscopic observations. Their presence in mortar-based materials is abundant, in particular in the Roman Temple, and the occurrence of pumice clasts has been also observed in the mortar coatings of several water-tanks of the site (Secco et al. 2020; Bonetto, Dilaria 2021).

Petro-mineralogical and geochemical provenance analyses, performed through OM, XRPD, SEM-EDS, XRF and LA-ICP-MS investigations in the laboratories of the Department of Geosciences of the University of Padova and of the Department of Biology, Ecology and Earth Sciences of the University of Calabria, allowed to define the provenance of 30 samples collected from centimetric rock fragments of the two temples mentioned above. From the preliminary investigations carried out, the provenance of most part of the volcanic rocks seem to be safely circumscribed to Campanian deposits of the Phlegrean fields (CI, NYT, post-NYT facies), while only sporadically their origin could be different. This evidence opens to new discussions about the size and the extent of the exportation of the Vitruvian pulvis puteolana (De arch., II, 6, 1–2; V, 12, 2) in the Western Mediterranean Sea, less investigated in respect to the Eastern one (Oleson et al. 2014). According to the data we are obtaining, Sardinia, in its dominant position in the Mare Nostrum, seems to have played a central role in the westward distribution of this material, so far never in depth investigated.

## **THE MARBLE PRODUCTION IN RATIARIA**

Zdravko Dimitrov

National Institute of Archaeology and Museum Sofia, Bulgaria

Keywords: Marbles, Danubian limes, Ratiaria

New excavations of Ratiaria began ten years ago. As a result, large parts of the late ancient capital of the province of Dacia Ripensis were discovered – the »Residence« building, public bathroom, residential building A, which is in the whole insula. A number of other finds have been found in other areas of the ancient city, possibly a temple to the goddess Diana from the Ratiaria's period as a Roman colony. The most important excavations have been made in the last two years. In 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.

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They have an area of almost 9 decares. During all these excavations, a large number of architectural details and interior elements were found which are made of marble. Just describing the finds and registering them in the catalogue, many different marble types stand out.

This study, which I am proposing for the ASMOSIA XIII International Conference, aims to raise the scientific question of the study of marbles in Ratiaria. This important building material has never been studied before such as 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.

## **CHARACTERISING OBSIDIAN ARTEFACTS WITH USING PORTABLE XRF FROM THE 1960S EXCAVATIONS OF NEOLITHIC SETTLEMENT SÜBERDE, CENTRAL ANATOLIA**

Murat Dirican<sup>1</sup> – Murat Karakoç<sup>2</sup> – Hasan Can Gemici<sup>3</sup> – Çiğdem Atakuman<sup>3</sup>

<sup>1</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

<sup>2</sup> Karamanoğlu Mehmetbey University, Turkey <sup>3</sup> Middle East Technical University, Turkey

Keywords: p-XRF, Central Anatolia, Süberde settlement

Central Anatolia is relatively rich in obsidian resources. Evidence showed that the inhabitants of this area frequently exploited these resources to make tools in prehistoric times. In addition, artefacts made on central Anatolian obsidians (e.g. Acıgöl, Göllüdağ, Çiftlik, Nenezi Dağ, etc.) have been found in various prehistoric settlements in Cyprus, the Levant, and the Zagros regions. For this reason, the relationship of obsidian artefacts obtained from prehistoric areas with the sources from which they were obtained plays an important role in prehistoric studies.

Obsidian resources in Central Anatolia have been researched since the 1960s. In these studies, initiated by Renfrew and colleagues, geochemical methods were used to examine obsidian artefacts from prehistoric sites in the Near East. The significance of their work is that they reveal the existence of long-distance circulation and networks between prehistoric sites and these sources. Obsidian samples, which

are the subject of this study, were found in the excavations carried out by Bordaz in the Süberde settlement for only two seasons in 1964 and 1965. Süberde (also known as Görüklük Tepe) is a late Aceramic Neolithic site in the Beyşehir-Suğla lake basin, Turkey. Located in the southwest of the Central Anatolian obsidian sources, this site is approximately 350 km away from these source areas. On the other hand, the chipped stone assemblage uncovered during the excavations was mostly (about 91 %) made of obsidian. Our study aims to determine the possible raw material source areas of the obsidian artefacts belonging to the Süberde settlement. Thus, these artefacts, which have been preserved for nearly sixty years in the warehouses of the Konya Museum after the Bordaz excavations, were examined within the scope of this study for the first time with the official permission obtained in 2019.

More than a thousand samples were examined within the scope of the study. First of all, these examples were classified according to their techno-typological features, and examples that could point to different source areas were marked. Then, measurements were made with the p-XRF method and compared with the possible source area data from which they were obtained by using some geochemical methods. The results of the analysis show that the Süberde finds were obtained mainly from two source areas. These are the source areas known as Nenezi Dağ and Göllüdağ East in the literature. Although the raw material preference differs proportionally according to the techno-typologies of the artefact, both sources were used in the production of all kinds of tools.

## **IN THE LIGHT OF NEW DATA, PROVENANCE ANALYSIS OF LATE NEOLITHIC/EARLY CHALCOLITHIC (6–5TH MILL. BC) SMALL MARBLE ARTEFACTS FROM ULUCAK HÖYÜK AND UĞURLU HÖYÜK, WEST ANATOLIA, TURKEY**

Murat Dirican<sup>1</sup> – Vasiliki Anevlavi<sup>1</sup> – Walter Pochaska<sup>1</sup> – Sabine Ladstätter<sup>1</sup> – Burçin Erdoğan<sup>2</sup> – Özlem Çevik<sup>3</sup>

<sup>1</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

<sup>2</sup> Akdeniz University, Turkey <sup>3</sup> Trakya University, Turkey

Keywords: Neolithic, Chalcolithic, bracelets, marble, provenance

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Marble is probably a symbolically important stone for prehistoric people due to its brightness, patterns, colour, homogeneity, and durability. Likely, the symbolic value of small marble objects such as bracelets, beads, and stone bowls would have become more diverse in prehistoric lifeways, leading to its increased symbolic as well as practical importance. In western Anatolia, especially marble bracelets appear for the first time around 5600/5500 BC. This period shows significant changes both in the material aspects of cultural and social life itself.

Besides in Ulucak Höyük and Uğurlu Höyük, similar small artefacts were also found in Orman Fidanlığı and Kanlıtaş in Eskişehir, Çine Tepecik in Aydın, Emporio and Agio Gala in Chios and Aktopraklık in Bursa. Their distribution in a wider region may indicate that their symbolic meaning was shared by the 6th–5th millennium communities in western Anatolia. Some sites appear to have played an important role in their distribution in western Anatolia as shown by the manufacturing remains of marble bracelets from Kanlıtaş and Orman Fidanlığı in the Eskişehir region. The Kulaksızlar Marble Workshop is the only known workshop in western Anatolia dated to the 5th millennium BC, where marble vessels as well as various types of figurines, including Kilia figurines, were produced. Although the Kulaksızlar workshop dates later than the marble bracelets from Ulucak and Uğurlu, the Manisa-Akhisar region with its rich marble sources may still have been the origin of the marble artefacts.

Marble bracelets and other small artefacts might be introduced into the regional exchange system not as a commodity, but as a prestige good used for signalling social identity, position or relationships. The objective is to understand the exchange systems of the 6th–5th-millennium western Anatolian communities in the light of Ulucak and Uğurlu marble artefacts. This poster aims to briefly introduce marble bracelets and small marble artefacts from Ulucak and Uğurlu and to evaluate the preliminary results of their provenance analysis in light of the new data.

## **MARBLE AND OTHER STONES IN COLONIA AELIA MURSA (OSIJEK, HR) – REGIONAL RESOURCES AND MEDITERRANEAN IMPORTS**

Bojan Djurić<sup>1</sup> – Slavica Filipović<sup>2</sup> – Sándor Kele<sup>3</sup> – Igor Rižnar<sup>4</sup>

<sup>1</sup> University of Ljubljana, Slovenia <sup>2</sup> Archaeological Museum Osijek, Croatia

<sup>3</sup> Institute for Geological and Geochemical Research, Hungary <sup>4</sup> G. E. Geološke ekspertize, Slovenia

Keywords: Alpine marble, regional limestone, coloured marbles

Hadrian's colony Mursa (modern Osijek, HR) was situated in the centre of Pannonia in a marshy region on the right bank of the Drava River, not far from its confluence with the Danube, near the Roman limes. Its nearest possible stone material resources could be the Mecsek Mts., some 90 km to the north in the area of the Roman town Sopianae (Pécs, HU), and Slavonian Mts. (Papuk, Krndija) some 60–80 km to the WSW. In both cases, the river (Drava, Danube) was a preferable route for the transport of heavy loads.

The architectural remains of the colony, as well as the sepulchral and votive monuments discovered in the town and its vicinity, show a predominant use of different limestone rocks, mostly Budakalász travertine imported from Aquincum. East Alpine marbles (Gummern, Pohorje) were used for some sepulchral and votive monuments as well as sculpture. For the cult sculptures, white Mediterranean marble was used occasionally, and coloured Mediterranean marbles (Africano, Cipollino Rosso, Cipollino Verde, Pavonazzetto, Greco Scritto) for opus sectile pavements only.

For the construction of the bridge over the Drava River Romans used blocks of the Budakalász travertine, material which they used for the construction of the colony's walls as well.

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## **THE POHORJE MARBLE QUARRY COMPLEX ŠMARTNO/FRAJHAJM (SLOVENIA)**

Bojan Djurić<sup>1</sup> – Igor Rižnar<sup>2</sup> – Edisa Lozić<sup>3</sup> – Katharina Zanier<sup>1</sup> – Walter Prochaska<sup>4</sup>

<sup>1</sup> University of Ljubljana, Slovenia <sup>2</sup> Geološke ekspertize Igor Rižnar, Ljubljana, Slovenia <sup>3</sup> Institute of Archaeology, Ljubljana, Slovenia <sup>4</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: Marble quarry, Eastern Alps, quarry organization

One of few marble production centres (apart of the Gummern and Kainach quarries) that was exporting their products in Pannonia is Šmartno/Frajhajm quarry complex on Pohorje Mt. In recent years, using Airborne Laser Scanning technology (LIDAR) and geological/archaeological survey, a large quarry complex has been uncovered on the slopes along the Velika Polskava stream. Its valley was the main route for transporting the marble blocks out and down to the officina at Velenik located on the main road (via publica) Celeia (mod. Celje) – Poetovio (mod. Ptuj). The quarry complex consists of different quarrying areas – quarries of which only small parts were known until now due to the dense spruce forests covering them. These parts bear names after the nearest mountain farms – Motaln, Brančurnik, Videc or topographic names – Bojtina. One of the quarries (Videc quarry) was thoroughly investigated in 2020/21. It revealed the characteristics of the marble and its layers, the dynamic and the method of quarrying and its internal organisation. The large spoil dumps were used in modern times for the exploitation of dimension stone and burning lime in the limekiln located in the quarry. The archaeological excavation of the kiln confirmed its use in the 19th century.

## **STONE CARVING CHRONOLOGY AT HELLENISTIC AND ROMAN IMPERIAL SAGALASSOS (SOUTH-WESTERN ANATOLIA)**

Frans Doperé  
KU Leuven, University of Leuven, Belgium

Keywords: Stone carving, ashlar, chronology

Observations on archaeological sites/buildings show that stone carving techniques on ashlar change. As masonries often go back to distinct building activities, the question arises whether these technological changes are sufficiently characteristic for specific periods and thus whether a stone carving chronology can be established based on the tool traces on the ashlar's facing surfaces. This question was tested on the Hellenistic and Roman Imperial masonries of the urban site of Sagalassos, excavated for over more than 30 years by KU Leuven, thus allowing observations and registrations of stone carving techniques in optimal conditions on freshly exposed masonries. The chronologies of the different buildings/masonries were obtained from stratigraphical analyses, epigraphic data, or cross-dating in case of decorated architectural elements. The periodisation applied on the chronologically classified masonries relies on the presence of specific tool traces. All ashlar masonries were examined, resulting in more than 200 observation-points. The registrations distinguish between the traces of the stonemason's tools on the central zone of the ashlar's facing surfaces and those on the drafted margins. The pointed claw chisel was the most frequently used tool, particularly during Roman Imperial times. To obtain a finer chronology, this tool was not only identified as such, the width of the cutting edge and the number of pointed teeth was registered as well. During the first half of the 2nd c. BC (Middle Hellenistic period), the ashlar are characterised by punched/broached dressings (pic/point) on rustications with double drafted margins. Somewhat later, during the late 2nd-early 1st c. BC (Late Hellenistic period), ashlar are still similarly dressed, but now with single drafted margins. A whole set of pointed claw chisels appears during the early Roman Imperial period, but only those with 8 and 11 teeth are period specific. The others continue to be used during the 2nd c. AD, only the one with 4 teeth is exclusively present during the 2nd c. AD. At this point, these results are valid at Sagalassos only. Therefore, this lecture will extensively focus on the methodology, thus encouraging building archaeologists working at other classical archaeological sites to apply it to their ashlar masonries as well, so that future data comparisons and geographically-oriented projects can be programmed in collaboration between archaeological sites.

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# **GEOARCHAEOLOGICAL PROSPECTION OF QUARRIES IN THE HINTERLAND OF VINDOBONA AND CARNUNTUM (AUSTRIA)**

Erich Draganits<sup>1</sup> – Michael Doneus<sup>1</sup> – Gabrielle Kremer<sup>2</sup>

<sup>1</sup> University of Vienna, Austria <sup>2</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: Vienna Basin, archaeological prospection, quarries

In context with the interdisciplinary Austrian Science Fund project P 26368 »Stone monuments and Stone Quarrying in the Carnuntum – Vindobona Area« (CarVin) a diachronic geoarchaeological remote sensing prospection and documentation of quarries was carried out. The project focused on Middle Miocene, relatively porous, calcareous sandstone, conglomerate, breccia and limestone from the southern Vienna Basin, Leitha Mountains, Rust Hills and Hundsheim Mountains, i. e. the hinterland of both Roman centres at the Danube Limes.

The main aims were (1) the localization of potential source areas of Roman stone monuments and (2) the methodological improvement of geoarchaeological prospection of quarries in Central European landscapes and vegetation conditions. At the same time, provenance determination of the ancient stone monuments, ground inspection and lithological classification of the detected quarries as well as comparison of the quarry samples with the Roman monuments were performed.

This study was based on archaeological remote sensing based on aerial photography (0.2 x 0.2 m resolution) and airborne laser scanning (ALS) digital terrain models and their visualizations (1 x 1 m resolution). Geological information and existing mining documentation, included geological maps at a scale of 1:50,000 and the quarry data base of the Austrian Geological Survey which were integrated with the interpretation of the remote sensing data in a geographical information system (GIS) environment. Chronological information was gained from text sources, historical maps – dating back to 1756, cadastral maps as well as historical pictures and photography.

In the whole study area, 479 certain or probable quarries, 106 possible quarries and 71 shallow possible extraction sites have been mapped in Miocene sediments, mainly based on the ALS data – and additional 30 probable burial mounds. Of the 479 certain or probable quarries, 198 (41 %) were not recorded in the quarry data base of the geological

survey. As one example of these numerous documented quarries, an area at the base of Pfaffenberg near Carnuntum is discussed in greater detail, elaborating our research approach and results.

## **QUARRIES ON DESPOTIKÓ AND TSMÍTIRI ISLANDS (CYCLADES, GREECE): EXPEDIENT EXPLOITATION OF LOCAL RESOURCES**

Erich Draganits  
University of Vienna, Austria

Keywords: Aegean, quarries, provenance

The islands in the Aegean Sea which are covered with stones and rocks are easily accessible in many areas. There are many studies about stone provenance, but most of these studies focus on (white) marble from a few large quarry centres – while other rock types and less important quarry areas have been relatively neglected. In this study, we investigate building stones and quarries of the archaic sanctuary on Despotikó, but also trace evidences of possible earlier and later quarrying activities, which are evidenced by small rock extractions near Early Bronze Age stone cist cemeteries as well as nearby the Panagía chapel.

Altogether, 11 different rock types have been recorded in the main building of the archaic sanctuary so far. White mylonitic gneiss, medium grained white calcitic marble, coarse white calcitic marble, grey orthogneiss and calcrete represent the most common lithologies; additionally, Pleistocene eolianite, pegmatitic gneiss, grey banded calcitic marble, dolomite marble, rhyolite and mica schist occur.

Despotikó and Tsimítiri islands, which were connected with Antíparos in the past, have been geologically mapped at a scale of 1:5000 and with exception of the coarse white calcitic marble, all rock types can be found on the island. Despite the island's small size, 17 quarries/rock extractions have been documented in 7 different areas on both islands. Excluding 3 small eolianite small quarries at Livádi and one east of Konstaninopoúlou, as well as the 4 small white mylonitic gneiss quarries southeast of Panagía chapel, all other quarries are situated within 420 to 880 m distance from the sanctuary. All these quarries are generally found at higher altitudes than the sanctuary. Only the large eolianite quarry in the northeast of Tsimítiri Islet and a diffuse

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area of rock extraction for dolomitic marble are situated lower than the sanctuary. Unambiguous quarrying traces are very rare, because in most cases rocks most likely have been loosened along tectonic fractures and foliation, without leaving clear traces. This study shows that in the main building of the archaic sanctuary, with exception of large building stones (e. g. thresholds, columns, architraves, friezes and geisa), which are made from coarse white calcitic marble, which does not occur on Despotikó, all other building stones probably originate from small-scale quarrying of local sources. The existence of this high number of small quarries is interpreted that expedient use of nearby sources dominated the rock extraction during several periods.

## **A PECULIAR ORNAMENTAL STONE IN THE CIVITAS TREVERORUM USED IN FUNERARY MONUMENTS AND THE ANTIQUE THEATRE OF DALHEIM (GRAND DUCHY OF LUXEMBOURG)**

Roland Dreesen<sup>1</sup> – Eric Goemaere<sup>2</sup> – Gabrielle Kremer<sup>3</sup> – Christine Ruppert<sup>4</sup>

<sup>1</sup> Ghent University, Belgium <sup>2</sup> Geological Survey of Belgium, Belgium <sup>3</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

<sup>4</sup> University of Luxembourg, Luxembourg

Keywords: Roman funerary monuments, Sinemurian stone, Civitas Treverorum

One of the main objectives of a current research project dealing with the funerary monuments of the Western part of the civitas Treverorum (straddling four different countries) and conducted by the Austrian Academy of Sciences together with the University of Luxembourg and the Geological Survey of Belgium, was to obtain a better knowledge of the use of decorative stones in northern Gaul, to answer questions related to the organization of the workshops, their economics and chronology. Petrographical analysis was carried out as the main investigation tool, on both archaeological material and in situ natural rocks. Besides various white decorative stones native of the Moselle basin in French Lorraine and red decorative stones of the Trier area (civitas capital), several Luxembourgian stones - three of which are new - have been identified that have been used, not only for funerary monuments but also for architectural elements and as building materials.

This poster will introduce the stone of Altwies (new denomination) that was used a.o. to build the benches of the antique theatre in Dalheim/Ricciacum, a vicus on the main road linking Divodurum/Metz to the capital Augusta Treverorum/Trier. The extraction site is located only a few kilometres from the vicus and is still visible today near the village of Altwies (Mondorf-les-Bains). During the Gallo-Roman period, the latter open-air quarries (of rather limited extension) have extracted a white, coarse-grained and gravelly, bioturbated, quartzarenitic sandstone, enclosing pluricentimetric shells (often mouldic) of large molluscs and gastropods. Several facies of this sandstone co-exist and they can be differentiated on the base of differences in their grain size, frequency of pebbles and/or fossils. This particular rock type represents a confined facies at the base of channels in sandstones and calcareous sandstones of the Sinemurian (Lower Jurassic) in the southeastern corner of the Grand Duchy of Luxembourg.

## **DECORATIVE STONE TRADING AND FLUVIAL TRANSPORT REFLECTED BY THE LITHOLOGICAL SPECTRUM OF THE NEHALENNIA VOTIVE ALTARS (ZEELAND, THE NETHERLANDS)**

Roland Dreesen<sup>1</sup> – Wim De Clercq<sup>1</sup>

<sup>1</sup> Ghent University, Belgium

Keywords: Nehalennia altars, petrography, provenance

More than 160 stone votive altars (dedicated to the goddess Nehalennia) were erected by sailors and merchants in two Roman sanctuaries (2nd–3rd c. AD) situated on the coast of Zeeland (the Netherlands), to show gratitude for a safe passage across the North Sea. These altars were discovered in 1647 and 1970, respectively near Domburg and in the Scheldt estuary, north of Colijnsplaat: they constitute the largest collection of Roman altar stones discovered in the Low Countries. However, no systematic petrographical study on the whole collection had been done before, thereby potentially ignoring valuable information on the mineralogical nature, geographic origin and socio-economic interpretations of the imported stones. During the last 4 years, in situ macroscopical inspection and comparative petrographical analysis of all available material (600 specimens), revealed a broad

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lithological spectrum of decorative stone types. Petrographical analysis allowed to identify the exact rock types and to induce their probable geological and geographical provenances. The source areas clearly correspond to distinct fluvial basins, supporting riverine transport routes. Vesicular basaltic lava and Römer Tuff were derived from the Eifel area. Limestones represent the largest lithological group, mostly derived from N-France, less commonly from the Low Countries: they include Jurassic limestones from the Lorraine area (Norroy, Chémery, Jaumont and Euville limestones) and Normandy (Caen stone), as well as Cretaceous limestones (Avesnes limestone) from NW-France and Lower Carboniferous limestones (Meuse limestone) from the Meuse valley, Belgium. The second most important group consists of sandstones, including Miocene Nivelstein sandstone from the Netherlands and a few sandstones from behind the limes in Germany (Upper Carboniferous Ruhr Sandstone and Cretaceous Rùthener Sandstone). A minor group consists of sandy limestones, represented by the Lutetian Lede and Gobertange stones (N-Belgium). Almost 80 % of the studied material is made of Jurassic limestones from the Lorraine area. The latter were transported along the Moselle-Rhine, Meuse river basins respectively. The Avesnes stone and Lede-Gobertange stones were transported through the Scheldt river. Transport of Meuse limestone, Nivelstein sandstone and Maastricht limestone used the Meuse river, whereas that of the volcanic rocks and the German sandstones went by the Rhine and its affluents. The rare Caen stone finally must have travelled over sea.

## **RED, GREY AND GREEN MARBLES IN THE CIVITATES TUNGRORUM AND NERVIORUM: LOCAL AND REGIONAL RESOURCES VERSUS MEDITERRANEAN SUPPLIES**

Roland Dreesen<sup>1</sup> – Catherine Coquelet<sup>2</sup> – Vilma Ruppiani<sup>3</sup> – Eric Goemaere<sup>4</sup>

<sup>1</sup> Ghent University, Belgium <sup>2</sup> Agence Wallonne du Patrimoine – AWAP, Belgium <sup>3</sup> Ruhr Universität Bochum, Germany <sup>4</sup> Geological Survey of Belgium, Belgium

Keywords: Belgian-German marbles, substitutes, Gallia Belgica

Local and regional natural stones represent the bulk of the building materials of Roman constructions in both urban and rural sites within the civitates Tungrorum and Nerviorum. However, different choices of decorative stone were made to meet identical uses in architectural elements of official buildings, villas and funerary monuments: white Jurassic limestones from Lorraine in the civitas Tungrorum, local white limestones (calcaire d'Avesnes) in the civitas Nerviorum. Private houses were embellished with coloured marble floor and wall decorations during the High Empire. These comprise local grey limestones (Meuse limestone, pierre de l'Avesnois, pierre de Tournai) in combination with red and grey Belgian Marbles, a few regional German decorative stones and some Mediterranean marbles. The Meuse limestone displays a broad spectrum of grey hues, including a black marble. The »Gris des Ardennes« and the purple-red »Griotte« represent the most popular Belgian marble varieties. They were all quarried in the Entre-Sambre-et-Meuse and Famenne-Calestienne areas, located in the heart of the civitas Tungrorum. The white calcite veins of the Gris des Ardennes have been used as substitutes for metamorphic white marbles in opus sectile and mosaics. Both marble types have been exported abroad, including the civitas Augusta Treverorum (Trier), Colonia Ara Claudia Agrippinensium (Cologne) and Colonia Ulpia Traiana (Xanten). A dark-green diabase, the Trier diabase (called Granito verde a erbeta by modern Italian stone masons), quarried near Trier (Germany), was certainly one of the most frequently used ornamental stones in Roman Germania inferior and Gallia Belgica. It takes a good polish and slightly resembles in its colour and texture, the Porfido Verde Antico, for which it possibly represented a good substitute. The choice of local (Belgian) and regional (German) stones was completed by the import of minor amounts of green and red Mediterranean marbles. However, the appreciation of local and regional ornamental stones by the Romans, is reflected by the presence of marble imitations of the latter in their wall paintings.

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## **PROVENANCE AND PETROPHYSICAL CHARACTERIZATION OF AN ANCIENT ROMAN STONE BRIDGE: PERPIRA BRIDGE**

Felat Dursun<sup>1</sup> – Fatma Meral Halifeoglu<sup>2</sup>

<sup>1</sup> University College London, United Kingdom <sup>2</sup> Dicle University, Turkey

Keywords: Provenance, Roman bridge, stone

Perpira, a registered bridge that spans the banks of Batman Stream-Turkey, was most probably constructed during the Late Roman/Early Byzantine period. The bridge was demolished for an unknown reason and at an unknown period. Only a few portions of the bridge (the foundations and the piers) remain today. The bridge has not been repaired since it was discovered, according to reports. As a result, the structure's remaining portions, particularly the cut stone blocks, are original and provide valuable information about the period's construction processes and material selection. In this study, it is aimed to assess the provenance, petrographic and physicochemical characterization of the stones used in the construction of the bridge. In order to achieve this, samples were collected from the downstream and the upstream sections of the piers. In addition to the bridge, samples were collected from the possible quarries in the vicinity. Stable isotope analyses were carried out on seven samples to petrographically characterize the stones used in the bridge and to determine their provenances. The findings indicate that the stones used in the downstream and upstream sections are significantly different both in petrographic and physicochemical aspects. Stable isotope analyses, on the other hand, reveal that the stones used in the structure originated from nearby quarries.

## **AUGUSTUS IN THE DESERT**

J. Clayton Fant

University of Akron, United States of America

Keywords: Egypt, Roman quarrying, history

Augustus never returned to Egypt after defeating Antony, but it was always on his mind. This is clear not only from the special governance

he provided for it but also from the craze for Egyptian decorative motifs that spread from his circles, led by obelisks with their complex royal symbolism. Recent archaeological and geological survey in the eastern Desert of Egypt, together with new documentary sources, can support a broader synthesis and conclusions than have been made to date. This paper explores developments attributable to the Augustan period.

In Wâdi Hammâmât, on the road to the Red Sea port of Quseir, by 9 AD, a Roman military tribune, »Director of all mines and quarries« in Egypt, had restarted quarrying of Bekhen stone, building facilities from scratch after Ptolemaic neglect. A complex of documentary evidence also suggests that quarrying of Aswan red granite had been restarted under Augustus. In 11 AD a freedman of the same quarry director dedicated a shrine in Wâdi Semna, to the north, opening a new quarrying district. Its output, ophites (granito della sedia di S. Lorenzo) was reaching Rome for elite use by the early Neronian period when Lucan (9.713) could expect his readers to visualize it from name, Thebanus ophites; indeed, they could see it in the pavement of the Domus Transitoria's Palatine nymphaeum if they were in Nero's good graces. A centrepiece plaque in a Pompeian bar façade, salvaged from earthquake debris of 62 AD, suggests that it was more widespread earlier than might be expected.

The new Roman road system extending northeast from Coptos was built not for trade but to service the quarry complex at Mons Porphyrites. A stele dated 18 AD at Porphyrites boasts of discovering more than five prized stones. Such extensive prospection and the years needed to develop highway infrastructure push the initiative back to that in Wâdi Hammâmât, if not earlier.

Pliny (NH 36.55) describes two stones, Augusteum and Tibereum, discovered, he says, under those emperors. Augusteum has remained unidentified. Pliny's words rule out a suggestion that it was ophites, but they fit gabbro eufotide, from Wadi Maqhrabiya, closely (argued in a forthcoming paper). There is no contemporary documentation like that for ophites, but its ancient name and proximity to quarrying in Wâdi Hammâmât makes similar Roman interest probable.

Hence we can now begin to see the full scope of Rome's massive effort in Egypt in Augustan period.

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## **ROMAN DECORATIVE STONE COLLECTIONS IN THE KELSEY MUSEUM OF ARCHAEOLOGY**

J. Clayton Fant<sup>1</sup> – Leah Long<sup>2</sup> – Lynley McAlpine<sup>3</sup>

<sup>1</sup> University of Akron, United States of America <sup>2</sup> Independent scholar; <sup>3</sup> San Antonio Museum of Art, United States of America

Keywords: Museum collections, Roman marble, architectural fragments

We would like to request space in a poster session of ASMOSIA XIII to present the book *Roman Decorative Stone Collections in the Kelsey Museum of Archaeology*, scheduled to be published this year by the University of Michigan Press.

The stone collections of the museum differ from most European ones in that most of the pieces are archaeological artefacts and have not been cut into uniform sample plaques. The largest collection was amassed by F. W. Kelsey himself as he expanded the purview of the university's Classics Department to include material culture (1890–1920). His intent of his collecting, and that which he prevailed on other department members and a number of wealthy lay supporters to do on his behalf, was to use the objects as a teaching collection. The book catalogues over 700 objects, which span almost the entire range (geographical, chronological and geological) of decorative lithics used during the Roman Empire (centring on Rome and Italy).

Chapters discuss the formation of the collections, the archaeological aspects of the objects, and laboratory analyses carried out by the Laboratory for the Analysis of Ancient Materials of the University Institute of Venice. In addition to the Catalogue, the chapter »Lithotype Profiles« summarizes the state of knowledge as of 2021 and presents essential literature.

## **THE PAVONAZZETTO-LIKE MARBLES AND THE IMAGES OF BARBARIANS: A STATUE OF AN EASTERNER IN BEYLER BRECCIA FROM ROME**

Eleonora Ferrazza<sup>1</sup> – Matthias Bruno<sup>2</sup>

<sup>1</sup> Vatican Museums, Vatican <sup>2</sup> Independent scholar

Keywords: Pavonazzetto-like marbles, barbarian, Rome

A large number of white and coloured marble quarries have recently been discovered in Asia Minor, among which a large group, in macroscopic appearance, resembles the renowned Phrygian marble, the so-called Pavonazzetto. These marbles, to be considered as replacement stones of the imperial Phrygian marble, have been named as Pavonazzetto-like marbles; they come from various quarries close to Aphrodisias, Muğla and Milas in Caria, as well as Beyler near Teos in Lydia. Of these marbles, which were used for column shafts and revetment slabs, very rare evidence of figurative use is known so far, namely a small statue of a barbarian from Aphrodisias and an imposing pillar-statue of a barbarian from Rome on display in the Vatican Museums. The latter, archaeometrically identified as Beyler Breccia, offers the opportunity to investigate some aspects of the use of coloured marbles in Imperial Rome.

The sculpture, which portrays a standing eastern Barbarian with Phrygian cap, trousers and cloak, can probably be attributed to a multi-storey funerary monument of aedicule type, attested by the mid-1st c. AD. Specifically, it would attest the assimilation in the private sphere of figurative language transmitted by the imperial authority and exemplified by the statues of the Basilica Aemilia in the Roman Forum or by the kneeling barbarians now in Naples and Copenhagen. We are at the beginning of a tradition that associates this specific subject with mottled marbles such as Pavonazzetto and Giallo Antico, which were most likely not obtainable to a private citizen. However, a private client could use a replacement stone, with a macroscopic effect similar to that of the prestigious imperial marble, especially if the statue was placed at a certain distance or height, which a tomb of this type implies. Our case therefore seems to constitute an example of how one could conform to the official art with alternative marbles to those reserved for authority.

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## REFLECTIONS ON MARBLE AND PAINT

Agneta Freccero

Swedish Institute for Classical Studies in Rome, Italy

Keywords: White marble, polychromy, experiments

Brightly painted copies of ancient white marble statuary have been shown in museums during the last decades. The objects' appearances are based on scientific identification of pigments, archaeological evidence, and ancient literary sources and presented as showing what the items originally looked like. In my opinion, these meticulously painted copies are suggestions of what the items might have appeared in Antiquity. They are interpretations based on selected facts, just as the present paper, in which the same kinds of sources are referred to. I will also discuss painting and copying, based on experiences and experiments. Copies are not equal to originals, and remnants of paint can be interpreted and reproduced in many ways. Even though a pigment is easily identified, the paint is not, and neither is the manner in which the application of paint was made. My main question is how we can claim that modern reconstructions correspond to ancient originals which we did not see in their original appearance. Scientific laboratory analyses of artists' materials are objective, but the interpretation of the information achieved is subjective. Further, an original work of art reflects the artists' schooling, capacity and taste, which in turn is linked to a specific period in time. The painted copy is a modern product, and as such it can be useful for discussions regarding ancient polychromy.

## REFLECTIONS ON WHITE MARBLES AT LABRAUNDA

Agneta Freccero

Swedish Institute for Classical Studies in Rome, Italy

Keywords: Labraunda, white marble, ancient quarries

A project aiming at the conservation of marble was initiated in 2010 at the Sanctuary at Labraunda, and it soon developed into a broader marble study. The buildings at the site belong to three main phases; the Hekatomnid, the Roman, and Late Antiquity. Different kinds of

white marble were identified during observations of the marble's state of preservation, which led to some questions. The first inquiry regarded the marble's provenance, which according to tradition was ancient Mylasa. A second question was whether the distinctly different qualities could be linked to epochs or to type of object, such as architectural elements and statuary. Ancient written sources and research reports regarding marble identification, quarrying and trade, have been studied in order to understand which quarry areas in the region were known and approachable in the periods investigated, and quarries in the area such as Mount Sodra, Euromos, Herakleia at Latmos, Miletus, and Stratonikeia were visited. Different scientific methods were applied on a limited number of samples. One result achieved was the notable difference in the choice of marble related to period rather than to type of object in the Hekatomnid period and the Roman era. Many questions are still unsolved.

## **TRANSPORT AND LOGISTICS OF WHITE MARBLE IN THRACE. ANALYSIS OF THE MARBLE LANDSCAPE IN THE 1ST-3RD CENTURY AD**

Benjamin Frerix

Austrian Archaeological Institute, Austrian Academy of Sciences,  
Austria

Keywords: Marble, Thrace, transport

The Poster provides visual insight into an ongoing dissertation project of the Austrian Archaeological Institute of the Austrian Academy of Sciences in cooperation with the National Archaeological Institute with Museum of the Bulgarian Academy of Sciences at the University of Vienna. Positioned between the fields of landscape archaeology, economic history and archaeometry, the project aims to analyse the logistics of the white marble trade in Thrace in the 1st-3rd c. AD.

By systematically sampling and analysing white marble artefacts and comparing the typological classification with a database of ancient Mediterranean and Thracian marble quarries, the source of origin of the marble artefacts can be pinpointed. Applying Geographical Information Software to process the data, gives the opportunity to map the marble landscape of whole Roman province on the basis of nine

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preselected project cities and three exceptional villae rusticae. The focus is on transport methods & routes and economic implications resulting from the cost analysis.

## **SEARCHING FOR THE MARBLE SOURCES OF ROMAN THRACE. THE MULTIDISCIPLINARY APPROACH IN THE CASE OF THE IVAYLOVGRAD REGION**

Plamen Georgiev<sup>1</sup> – Walter Prochaska<sup>2</sup> – Ivan Ivanov<sup>3</sup> – Vasiliki Anevlavi<sup>2</sup> – Gergana Kabakchieva<sup>3</sup> – Sabine Ladstätter<sup>2</sup> – Hristo Popov<sup>1</sup> – Benjamin Frerix<sup>2</sup>  
<sup>1</sup> National Archaeological Institute and Museum at the Bulgarian Academy of Sciences, Bulgaria <sup>2</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria <sup>3</sup> Independent scholar

Keywords: SE Bulgaria, prospection, white marble

Villa Armira is the most sumptuous and the best-studied Roman villa in present-day Bulgaria. Taking into account the extraordinary lavishness and quality of its marble decoration, as well as the marble deposits that exist in the region of modern Ivaylovgrad, a hypothesis is often put forward in the scholarly publications that the richness of Villa Armira is directly related to the local marble. Until now, no direct evidence has been offered to support this hypothesis.

In 2018, the Austrian Archaeological Institute at the Austrian Academy of Sciences and the National Archaeological Institute at the Bulgarian Academy of Sciences started a pilot project aimed to investigate the marble objects from two Roman villas (Armira and Kasnakovo) including the investigation of the local quarries. This initial research led to the large-scale project *Fingerprinting White Marbles: Quarries and Cities of Roman Thrace, 1st–3rd c. AD* (OFWF 033042). A central place in it was reserved for the investigations of the sources of raw materials (marbles and metals) in the microregion of Ivaylovgrad and its surroundings. The team adopted a combined, interdisciplinary approach by sampling archaeological materials and quarries in combination with traditional field surveys.

Modern remote nondestructive methods were applied in the fieldwork. ÖAI-ÖAW and NAIM-BAS funded an airborne laser scanning (LiDAR) in the winter of 2020–2021. The surveyed polygons in the lands of Ivaylovgrad, Kamilski Dol, and Valche Pole covered an area of more

than 40 km<sup>2</sup>. In the autumn of 2021 and the spring of 2022, campaigns were organized to verify the information obtained from airborne laser scanning. The terrain to the west of the villa is mountainous, often covered with dense deciduous forests. For this reason, the preliminary airborne laser scanning proved to be very successful and of high efficiency. The subsequent prospection on the ground corroborated the existence of numerous old quarries for gneiss and marble in the mountains to the west of Villa Armira. Some of them yielded pottery from the Roman Period. Due to the large scanned area (more than 40 km<sup>2</sup>), it was impossible to study it in detail within two short campaigns. The work in the field will continue in order to broaden our knowledge of the human activities in the Roman Period not only in the immediate surroundings of the villa but also in its farther periphery. The current studies of the region of Ivaylovgrad and Kamilski Dol will confirm if these sources are among the important sources of raw material for the marble industry of Roman Thrace.

## **THE AESO MARMOR (ISONA, LLEIDA) AS EPIGRAPHIC MEDIA: NEWS FROM NEW TRENDS IN EPIGRAPHIC AND ARCHAEOLOGICAL RESEARCH**

Diana Gorostidi Pi<sup>1</sup> – Isabel Rodà de Llanza<sup>1</sup> – Pilar Lapuente Mercadal<sup>2</sup> – Anna Gutiérrez García-M.<sup>1</sup> – Hugo Feliu Pérez<sup>1</sup>

<sup>1</sup> Institut Català d'Arqueologia Clàssica (ICAC), Spain <sup>2</sup> Universidad de Zaragoza, Spain

Keywords: Archaeometric analysis, epigraphic media, marble similarities

The Roman city of Aeso (modern Isona, Lleida, NE of the *Tarraconensis*) has yielded a small but significant number of Latin inscriptions. The exceptional series of 30 pedestals for honorary and funerary statues stands out among them. Most of these pedestals were made for prominent local magistrates using a distinctive light-coloured local cretaceous limestone, the so-called *pedra d'Isona* (Isona stone). The preserved pedestals can be typologically divided into two series. The honorary series coincides in module and form with that of the same kind produced in Tarraco's workshops.

These popular monuments were widely distributed throughout the *conventus Tarraconensis*. The Aeso examples date to the Trajanic and

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Hadrianic periods. The second series, although dating to the same period includes funerary inscriptions, whose pedestal's form results from the continuation of the medium applied to this type of monument. The quality of the marmor of Aeso allowed the development of an important local workshop that supplied public and private supports for inscriptions to the city. The epigraphic workshops of Tarraco used a local limestone of excellent quality called ›pedra de Santa Tecla‹. Recent studies have shown that the tripartite molded honorific pedestal prevails over the monolithic one in cities with documented capital magistrates. The hypothesis is that a standardized type of honorific media was applied based on aesthetic preferences given the visibility of these pedestals in the provincial capital's public spaces. Such type might have reached other cities, either by being directly imported or by local copying and imitation. Moreover, it may have been encouraged by the availability of stones of similar quality and of itinerant stonecutters. A review of the module, shape, paleography, and ordination of the series of honorary pedestals of Aeso has been carried out. This has led to the identification of certain pieces typical of the Tarraco workshops. The petrographic analysis will help differentiate between the two types of pedestals, although the material of the supports is in both cases a Cretaceous limestone. Sedimentological analysis will further address any potential differentiating markers.

## **THE USE OF ALCOVER STONE IN ROMAN TIMES (TARRACO, HISPANIA CITERIOR). CONTRIBUTIONS TO THE OFFICINA LAPIDARIA TARRACONENSIS (II): EVIDENCE OF EARLY SUPPLIES OF EPIGRAPHIC MATERIALS BEYOND THE CITY OF TARRACO**

Diana Gorostidi Pi<sup>1</sup> – Isabel Rodà de Llanza<sup>1</sup> – Andrea Collado Padilla<sup>1</sup>  
<sup>1</sup> Institut Català d'Arqueologia Clàssica (ICAC), Spain

Keywords: Local limestone, late Republican-Augustan stonecutters, distribution of Tarraco workshops

An important inscription related to M. Porcius, a well-known wine trader recorded in several amphora stamps from the Augustan period, has been recently discovered in Baetulo (modern Badalona, Barcelona). The inscription also stands out for its material, the so-called pedra

d'Alcover (Alcover stone), a sedimentary carbonate rock used only in Tarraco as epigraphic support in the late Republican-early Imperial period. For this reason, a review of the materials in the collection of the Badalona Museum has been carried out and has led to the identification of three more inscriptions in Alcover stone. The use of such characteristic brown, grey, or crème-coloured stone is in line with the first epigraphic honorific inscriptions dating back to the foundation times of the Colonia Tarraco and Augustus's stay in the city during the Cantabrian wars (29–19 BC). Baetulo, on the other hand, was founded by the Romans at the end of the Republican period. It underwent a massive urban development under Augustus thanks to a prospering wine industry. Nevertheless, the city has yielded no inscriptions from that period. Given their morphology, content, and palaeography, the four inscriptions from Baetulo belong to the series of private monuments found in Tarraco in the Augustan and Tiberian periods. In those years, local stone workshops were producing a considerable number of monuments, mainly for wealthy freedmen and freeborn individuals. The earliest chronology of Alcover stone workshops in Tarraco coincides with that of M. Porcius' inscription in Baetulo. Therefore, the Badalona inscriptions must date to the same period as they may have all been commissioned in Tarraco to be then displayed in the city of destination. Such evidence allows us to document the first case of epigraphic media distribution outside of the capital of Citerior, a phenomenon previously documented only for the ›pedra de Santa Tecla‹ (Santa Tecla stone) also known as Tarraco marmor. This micritic calcite was also profusely widespread in the neighbouring cities, pushed by the intense development of stone workshops that provided magnificence to the provincial capital's new buildings and public spaces under Vespasian. In conclusion, Alcover stone was used as a huge epigraphic medium for honorary monuments not only in the capital city itself but also for deliveries beyond Tarraco from the late Republic onwards until the emergence and exploitation of Santa Tecla stone under the Flavians.

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## GO WEST! SARCOPHAGI BETWEEN RAVENNA AND WESTERN CISALPINE: THE CASE OF PIEDMONT

Maria Elena Gorrini  
Università degli Studi di Pavia, Italy

Keywords: Ravenna sarcophagi, Western Cisalpine Alpine stones

On the basis of new data from petrographic analyses the paper reconsiders the question of the presence of the so-called architectural sarcophagi in Piedmont (Regio XI). These pieces were carved in Ravenna in imported Prokonnesian marble (similar specimens are known in Ravenna itself, in Mutina, Ferrara, Bononia, Mediolanum and Ticinum and at other sites along the coast of the Adriatic Sea). The new analyses will allow us to understand which sarcophagi were imported from Asia Minor and which were, instead, worked in situ with local stone on models from Ravenna. The group that will be analysed includes the following 9 examples:

- 1) An example with a moulded case with erotes and tabula ansata (Turin Museum);
- 2) A fragment of a shingled lid reused in the floor of 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 Procle (Vercelli, Museo Leone);
- 5) A fragment of an acroterion with lid (Vercelli, Museo Leone);
- 6) A fragment of a front (tabula ansata with two erotes and inscribed to the deceased, Metia Valeriana, today in the church of Santa Maria in Lucedio);
- 7) A fragment of a sarcophagus (?) from Pollentia, with the inscription of the deceased, Lollia, placed by Terentius, 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;
- 9) A fragment of a sarcophagus from Centallo, now in the Civic Museum of San Francesco in Cuneo, with inscriptions mentioning Salvia Verina and Sextius Catesius Verus.

The petrographic analyses provide us with new insights which allow us to both reconstruct the stages of the trade of the architectural type of sarcophagi in Piedmont and to distinguish imports and imitations

in local stones. The result will provide us with a better understanding of the connectivity of the cities and areas of Regio XI, the ability to possibly confirm the existence of local workshops and, lastly, increase our understanding of the society which chose these types of funerary monuments.

## **THE AUGUSTEAN TROPHY OF SAINT-BERTRAND-DE-COMMINGES. A NEW ARCHAEOMETRIC STUDY**

Anna Gutiérrez García-M<sup>1</sup> – Isabelle Pianet<sup>2</sup> – Marie-Claire Savin<sup>1</sup> – Nicolas Frerebeau<sup>3</sup> – José Antonio Cuchí Oterino<sup>4</sup> – María Pilar Lapuente Mercadal<sup>4</sup>

<sup>1</sup> Institut Català d'Arqueologia Clàssica (ICAC), Spain <sup>2</sup> Université Bordeaux Montaigne, France <sup>3</sup> Université Toulouse - Jean Jaurès, France <sup>4</sup> Universidad de Zaragoza, Spain

Keywords: Marble quarries, Pyrenees, Roman period

The trophy of Saint-Bertrand-de-Comminges (Haute-Garonne, southwestern France) is an assembly of 134 pieces including mannequins carrying weapons and couples of Gallic and Hispanic captives sculpted in full rounds. Excavations between 1926 and 1931 uncovered all these fragments near the Augustan Temple in the Roman town of Lugdunum Convenarum. (This monument, clearly representing a grandiose commemoration of the Augustus victories over Gaul and Spain, allows to date its erection around 16–13 BC). This monumental white marble piece of work stimulated numerous research including three different restitutions, always asserting a tripartite distribution of the trophy. Despite all these efforts, this sculptural group still raises some problems concerning stylistic discrepancies and sculptures arrangement. At the beginning of the 1990s, the archaeometric study using a limited number of techniques carried out by C. Costedoat on four trophy's fragments pointed to the probably use of Saint-Béat marble. However, as the trophy is greatly fragmented, we conducted a larger sampling campaign in order to verify if material once accompany the documented stylistic divergences between certain pieces. On the other hand, the present study is an opportunity to check our extensive reference database on the different marble quarries of the Saint-Béat district.

A detailed study of fifteen samples collected in scattered areas of the whole was performed combining petrography, CL, XRD, IRMS of C

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and O isotopes, NMR and ICP-OES and the results obtained compared to marbles extracted from neighbouring quarries using ACP tools. This work revealed few significant differences between the pieces except for two samples, which show slight microstructural CL and isotopic differences, suggesting the use of two different supply marble sources.

## **ROCKY MOUNTAINS: NEW INSIGHTS INTO THE INTRA- AND SUPRA-REGIONAL ORGANIZATION OF THE ECONOMY OF STONES IN NORTHERN NORICUM**

Dominik Hagmann

ARDIG – Archäologischer Dienst GesmbH, Austria

Keywords: Rural Noricum, spatial analysis, geographic information systems in archaeology

The talk presents new considerations on ancient Roman mining, the processing, and distribution of the extracted material on an inter- and supra-regional scale. The area under investigation is located in the north of the province of Noricum in the hinterland of the former Roman border along with the so-called Danube Limes between the rivers Erlauf and Traisen in present-day Lower Austria (AUT). The study was conducted as part of the author's dissertation project, »Roman Rural Landscapes in Noricum.« Belonging to the southern part of the Bohemian Massif located south of the Danube, in Roman times, this area was a regional-scale mining domain of conglomerate rocks and, sporadically, also of marbles (so-called Hiesberg, Häusling, and Lunzen marbles). The immediate vicinity of the mining areas (today's Dunkelsteinerwald and its adjacent regions) was hardly populated in ancient times – also, today is still relatively heavily forested and, in places, very impassable. Based on previous scientific petrographic and cultural studies on this area, a new model for the economic functioning in the area of stone processing enterprises of a Roman microregion in the outermost periphery of the Roman Empire will be presented: By considering current datasets on the existing natural geological resources, all archaeologically relevant information on economically motivated work with local stones in the broadest sense of the Roman Imperial period and late antiquity was integrated into a (GIS). The aim was to evaluate it in combination with new, GIS-based data on rural settlement sites

and ancient traffic routes proposed employing tailored least-cost analyses. This approach aimed to gain insights into the local, intra-regional, and supra-regional characteristics of the economic activity in stone quarrying and related products in the area under investigation. Based on a settlement-archaeological evaluation of the archaeological finds and features, the GIS-based analysis showed that an increase of finds could be recorded in zones that have a favourable location in terms of transport along reconstructed pathways determined by least-cost analyses. A mass of stone monuments in the same area and the indication of a local Roman stonemason's workshop suggest a rural settlement/vicus as a processing centre in the area of today's St. Leonhard am Forst/Ruprechtshofen, through which the adjacent settlement sites (villas, auxiliary forts, towns) were supplied with products.

## **EUROMOS MARBLE (GRECO DISLOCATO): ASSEMBLAGES IN MINTURNO, EMILIA-ROMAGNA, CYPRUS, AND TYRE**

John J. Herrmann Jr.<sup>1</sup> – Julia E. Cox<sup>2</sup> – Annewies van den Hoek<sup>3</sup>

<sup>1</sup> Museum of Fine Arts, Boston, United States of America <sup>2</sup> University of Georgia, United States of America <sup>3</sup> Harvard Museum of the Ancient Near East, United States of America

Keywords: Euromos marble, Cyprus, Lebanon

Marble with stepped gray and white veins has long been known at Rome as Greco Dislocato, and it can often be identified confidently by eye, since the »steps« can be very conspicuous. The source of this marble has recently been traced to Iasos in Caria, where column shafts and pedestals are made of marble from the nearby quarries of Euromos, and the marble has been characterised archaeometrically (Bruno et al. 2018; Bianchi et al. 2018). During our travels over the last few years we have spotted other examples in new contexts. In many cases the »stepping« of the veins is not very conspicuous, and in one case we have taken a sample for verification. Our sample from the Imperial period Forum of Minturno proved to be isotopically compatible with Euromos. The isotopic signature of Euromos marble, however, overlaps those of Ephesus/Hasançavuslar and Proconnesus 2, but macroscopically the choice is clear. Over a dozen sections of gray-and-white, patterned column shafts lie in the Forum and apparently come from a basilica. A

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few shafts of Bigio Antico seem to be mixed in, but most of the shafts appear to be Greco Dislocato. Another large group from Euromos may be the shafts reused in the nave of the church of Monte Sorbo inland from Ravenna in Emilia-Romagna. They have been tentatively identified as Greco Scritto from Hasançavuşlar (Antonelli et al. 2015), but slight stepping of the veins in some shafts indicates that they could be from Euromos, and the archeometric data is compatible with this origin. Many column shafts of Euromos marble were also seen in Cyprus. They appear in the Roman Agora and in the Sanctuary of Apollo Hylates at Kourion. Several more were seen further east at Tyre in Lebanon, where they appeared in the Hippodrome and in the basilica. Blocks intended to be cut up into plaques for paving and incrustation may also have been an export product from Euromos. Plaques of stepped marble were seen in the Episcopal Basilica at Kourion and in the early 6th c. Archiepiscopal Chapel in Ravenna.

## **EXPORTATION OF PREFABRICATED STATUES FROM THASOS**

John J. Herrmann Jr.<sup>1</sup> – Donato Attanasio<sup>2</sup> – Annewies van den Hoek<sup>3</sup>

<sup>1</sup> Museum of Fine Arts, Boston, United States of America <sup>2</sup> CNR (Italian National Research Council), Italy <sup>3</sup> Harvard Museum of the Ancient Near East, United States of America

Keywords: EPR, Roman sculptural workshops, Roman copies

It has previously been shown that several types of small statuettes and a few large scale statues were exported from Thasos in Roman times. Identical figures carved of Thasian dolomitic marble can be found on the island and in distant markets, and the agreement of style, material, and distribution strongly indicates production on Thasos. The statuettes tend to be modest compositions primarily for fountain or garden decoration. Larger scale sleeping satyrs of Thasian dolomitic marble in the Vatican and on Thasos are rather provincial work and again for fountains. The »Woman from Polygiros« in the Chalkidiki, however, is a more ambitious work, a replica of a grand 4th c. Athenian prototype of the 4th c. BC. The statue has another replica in Brindisi, and a third is in the Thasos museum itself. All three are dolomitic marble and must have been carved by Thasian sculptors on the island or closely connected with it.

Paramagnetic resonance spectroscopy (EPR) has now been used to show that a statue of a woman in the garden of Palazzo Colonna at Rome is made of Dolomitic marble. This woman tightly wrapped in her himation is a rare Hellenistic type, and the only replicas are fragmentary pieces at Philippi and in the Thasos museum. The northern Greek examples macroscopically appear to be the Thasian marble. All four of these statues must have also been produced on Thasos.

A group of four life-size fighters in the Albertinum in Dresden were found together near Rome, and EPR shows that all four are made of dolomitic marble. The fighters are virtually identical pairs of warriors and athletes in almost identical lunging poses. A fragmentary statue of a highly similar warrior apparently made of Thasian dolomitic marble is in the Thasos museum. Since no other replicas of these two fighters are known, all five statues were probably produced on Thasos, and four of them were shipped to Rome, while the fifth stayed on the island. These new identifications confirm the production of high quality copies of famous works in Roman Imperial times on Thasos. Plaster casts of Classical and Hellenistic Greek statues must have been available there, and accomplished sculptors capable of producing such elite works either came to the island or were trained in workshops there.

## **THE ARTEMISION AND THE MARBLE QUARRIES IN THE KAYSTROS-VALLEY: SOURCES AND PROBLEMS**

Vera Hofmann

Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: Ephesus, Artemision, quarries

The extraordinary role of the marble quarries in the Kaystros-valley for the construction of the Ephesian Artemision is mirrored in the often-quoted legend of their discovery told by Vitruvius: The fortunate shepherd Pixodaros, who had found the nearby quarries, was renamed Euangelos and worshipped as a hero thereafter. Although the sanctuary was the prime beneficiary, Vitruvius seems not to have doubted the city's key role in the quarries' exploitation and we have no direct evidence that the Artemision might have owned these or other quarries. Although a set of Roman boundary stones could be interpreted as to indicate that the most important quarries in the Kaystros valley did indeed belong to the sanctuary and not to the city, the question has not been further

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explored. In order to determine to whom the quarries really belonged at what time, the following questions need to be addressed: Is Vitruvius's version perhaps a muddle of sources and facts stemming from different ages? How reliable is the information provided by the boundary stones that were, moreover, set up on imperial initiative? How and why could the sanctuary have gained control of the quarries in the Roman Era and what role did the city of Ephesos and imperial interventions play in this matter? What other (indirect) insights might the written sources offer in respect to the exploitation of the quarries and why are the sources so scarce and at times misleading? Starting from these questions I would ultimately like to explore new methodological pathways to a more comprehensive picture of quarries in relation to sanctuaries and their administration

## **PHOTOGRAMMETRY APPLIED TO STONE ARTEFACTS: METHODOLOGY, CONSTRAINTS AND OBJECTIVES**

Ariadni Ilioglou  
Musée d'Achéologie National, France

Keywords: Photogrammetry, stone objects, 3D model, Roman

The process of creating 3D accurate and exact textured models from the digital overlapping of 2D images has been a major endeavour within the cultural heritage field. This field has general requirements, such as accuracy, portability, recipient, and costs, that are often integrated by specific needs, such as the integration of colour information, reproduction of material aspects (metal, clay, glass, bone, stone, wood, etc.) and visibility of wear or manufacturing marks, decoration and stylistic details. The aim of this paper is to show how photogrammetry can be applied in marble and limestone objects, underlying their specificities and providing a high-quality scientific result. More explicitly, the materials featuring difficult optical properties such as absorptivity, reflectivity, and scattering due to high or low emissive colour and shining surfaces providing interesting challenges of geometry/shape and textures. The main objective is establishing some core specifications for data acquisition (studio setup, manipulation of the objects, lighting process, flash positioning, photogrammetry, and macrophotography) and modelling (post 3D production for alignment,

geometry modifications, and textures), in order to guarantee the scientific quality of data and the interoperability of 3D models among the archaeologists, specialists and the public. All these aspects are taken into consideration and presented with two case studies (a marble bust of the Roman Emperor Augustus and a limestone column with relief decorations, both stored in the National Archaeological Museum of France-MAN). The established, comprehensive, and accessible guidelines for the creation of complex artefacts into 3D models in the field of cultural heritage and museum collections are presented and discussed.

## **THE USE OF PROKONNESIAN MARBLE IN THE ARCHITECTURE OF IMPERIAL EPHEOS – AN ARCHAEOLOGICAL EVALUATION**

Sophie Insulander  
Wien Museum, Austria

Keywords: Ephesos, Prokonnesian marble, stone imports

According to provenance analyses conducted by Walter Prochaska (Austrian Archaeological Institute), Prokonnesian marble was used for the construction of seven buildings in the Imperial period of Ephesos. These include the four large bath-gymnasium complexes (Harbour Baths, Theatre Gymnasium, Vedius Gymnasium and East Gymnasium), two monumental temple buildings (the neokorate temple of Hadrian (Olympieion) and the so-called Serapeion) as well as the funerary monument of the local benefactor T. Flavius Damianus.

Based on a master's thesis written at the University of Vienna, this paper aims to examine the archaeological implications of these observations against the backdrop of Ephesos' privileged position regarding the use and trade of marble, as well as the rise in popularity of Prokonnesian marble during the 2nd c. AD. Ephesos had more than 40 local quarries at their disposal, several of which produced high-quality white marble well-suited for architectural purposes. Their use has been attested in multiple building projects since the Archaic period. At the same time, the city's harbour, which also served as a major port of transshipment, enabled the cost-effective importation of various stones.

While the majority of these were polychrome stone varieties used for

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decorative purposes, the import of marble from Prokonnesos can be proved for the buildings mentioned above. Examining the different ways in which this marble was employed and combined in their architecture, as well as the general advantages of using Prokonnesian marble, helps us to approximate the potential factors that could have led to the decision to import this type of marble. Another interesting aspect is the chronological development of the use of Prokonnesian marble in Imperial Ephesos.

Thus, the results of this investigation can hopefully contribute to the on-going research into the exploitation and use of marble in Ephesos and the industries connected to it.

## **SPOLIA IN THE BASILICA OF ST PAUL OUTSIDE THE WALLS: PROVENANCE AND RESTORATIONS**

Tommaso Ismaelli<sup>1</sup> – Giorgio Sobrà<sup>2</sup>

<sup>1</sup> CNR - Istituto di Scienze del Patrimonio Culturale, Italy <sup>2</sup> Istituto Centrale per il Restauro, Italy

Keywords: Pavonazzetto, spolia, ancient restorations

In the Basilica of St. Paul Outside the Walls, a series of rudented Pavonazzetto shafts of considerable height (almost 9 m) had been reemployed in the colonnades between the naves. It has been convincingly proposed that the reuse of these elements is not to be traced back to the construction phase of the Theodosian basilica, but rather to a restoration attested after 441 AD. The pavonazzetto shafts, which were irreparably damaged in the fire of 1823 that destroyed the Basilica, were then partly reworked to obtain lining elements for the subsequently rebuilt neoclassical structure. The origin of these spolia, although exceptional in number, dimensions and materials, has not been investigated in detail by scholars. Modern-age sources speculated about their origin, which was the Mausoleum of Hadrian in the opinion of F. Albertini and S. Peruzzi (first half of the 16th c.), or the »Palace of Caracalla« according to J. W. Goethe (in his Italian Journey).

The shafts were joined to Corinthian capitals in white Prokonnesian marble of similar proportions, many of which are still preserved in the lapidarium of the Basilica. These capitals show some peculiar decorative features and – in most of the past studies – have been dated to the Severan Age. A careful analysis allowed us to confirm the observation

by P. Liverani about the perfect analogy with some capitals located on the Clivus Palatinus. Moreover, new data emerged from the study of blocks preserved in the same area of the Palatine Hill, such as fragments of pavonazzetto shafts and modillion cornices, similar in shape and size to the blocks reused within St Paul's Basilica.

The paper discusses the provenance of the columns reemployed in the Basilica Ostiense from the Palatine Hill and specifically from a monument of outstanding dimensions and decorative richness. Secondly, special attention is given to the widespread traces of ancient repairs visible on all the blocks, which are discussed with reference to the history of the original monument and the technology of ancient restoration.

## **LICHENOMETRIC DATING OF ROCK SURFACES IN ANCIENT QUARRIES – A REVIEW AND A CASE STUDY**

Thorsten Jakobitsch

Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: lichenometry, dating, quarries

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. When Beschel was studying the radial growth rates of lichens on rock surfaces, he concluded that the largest lichens on a rock are potentially the oldest individuals, having the same age as the exposure of the rock surface they grow on. 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. The initial use of this method was to investigate Holocene glacial events by dating glacial rock deposits (moraines). Soon after the establishment of lichenometry as a science, the method was used in many other disciplines, like the dating of earthquake-generated rock falls, the occurrence of landslides, sea-level changes, and in archaeology for dating stone walls, quarries, and other stone-made monuments and structures. The first and most famous example of the application of lichenometry in archaeological research was the dating of the monumental statues on the Easter Islands.

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Species used in lichenometry are slow-growing crustose lichens with a long lifespan, such as members of the genus *Aspicilia* or *Rhizocarpon*. Especially in growth-limiting environments (cold or arid climates), these species have very low radial growth rates and a long lifespan up to centuries or even a few thousand years.

This method of dating stone and rock surfaces is cheap and non-destructive and it has the potential in answering archaeological questions like dating walls, buildings, or the last activities in quarries. A literature review and a case study in an ancient quarry of serpentinite on the Greek island of Tinos will be presented to evaluate lichenometry in archaeological research.

## **STONE PROVENANCE OF THE ANTIQUE AND MIEVEAL MONUMENTS FROM THE SELECTED SITES IN DALMATIA**

Mirja Jarak<sup>1</sup> – Ana Maričić<sup>1</sup> – Ante Jurčević<sup>2</sup>

<sup>1</sup> University of Zagreb, Croatia <sup>2</sup> Archaeological Museum in Split, Croatia

Keywords: Limestone, Dalmatia, Antiquity and Middle Ages

The paper is aimed at the investigation of the stone provenance of the monuments from different periods from several important localities in Dalmatia. The represented periods are Early Roman Empire, Late Antiquity and Middle Ages. The chosen localities are Kapitul near Knin, Rižinice and Hollow church in Solin and the town of Split. The goal of the research is to determine stone varieties used for antique and medieval monuments. Chosen localities were very important during Antiquity and Middle Ages. Kapitul, Rižinice and Hollow church are famous for early medieval royal Benedictine monasteries. In the Roman period a military unit was stationed at Kapitul (1st c. AD), and in Rižinice and Hollow church early Christian architecture existed. The development of Split is well known. The samples from Kapitul originate from a military Roman inscription, an early medieval fragment of church furniture and sarcophagus from the later Middle Ages. According to macroscopic and microscopic petrographic determination all three samples were determined as white colour limestones of bioclastic type that are partially dolomitized. Although it was observed that all three samples

show differences in petrographic characteristics and composition. Especially sample taken from the Roman inscription cannot be fully compared with the other two samples. Samples from sarcophagus and church furniture show similarities in bioclasts composition and in the ratio of bioclasts to micrite, although the dimensions of bioclasts and its distribution are slightly different. There is a possibility that these two samples were taken from the similar rock formation or quarry. The sample from Roman inscription differs, therefore it is assumed that this stone material belongs to other formation or quarry.

Samples from Solin and Split broaden the existing data on stone provenance of the monuments in Dalmatia. The samples originate from the early Christian and early medieval monuments. To determine more accurately and reliably the origin of the stone material it is necessary to make further analysis and to take more samples from the surrounding old quarries. In addition, determination of qualitative and semiquantitative mineral composition with the X-ray powder diffraction is planned.

## **A NEW ROMAN MARBLE QUARRY ZONE IN THE EASTERN ALPS: TREFFEN/ALT-TREFFEN**

Stephan Karl<sup>1</sup> – Edisa Lozić<sup>2</sup> – Walter Prochaska<sup>3</sup>

<sup>1</sup> Karl-Franzens-Universität Graz, Austria <sup>2</sup> Research Centre of the Slovenian Academy of Sciences and Arts (ZRC SAZU), Slovenia <sup>3</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: Austroalpine marble, Roman quarry zone, marble characterization

On the hill with the ruins of the medieval castle Alt-Treffen in Carinthia (Austria) an unknown Roman marble quarry zone was recently detected. This site was already mentioned by the antiquarian Michael F. von Jabornegg-Altenfels in the year 1862. Although he did not recognise quarries in the preserved rock faces with their characteristic quarrying traces, he led to the right identification, because he saw the resemblance to the »rock temple« of Spitzelofen and the »Heidentempel« (pagan temple) of Treffen (Pölling), both known Roman marble quarries today. To distinguish the two quarry zones, 1.5 km apart, in the surrounding of Treffen we call the new one as Treffen/Alt-Treffen, the other as Treffen/Pölling. The objective of this contribution is to present the new quarry zone of Treffen/Alt-Treffen regarding the scale and extent of the

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quarries and the spatial delineation of the exploited marble resource including a marble characterisation. For the mapping we use LiDAR data, while the quarrying traces and castle walls are documented by terrestrial photogrammetry and measurements. A special focus is on the connection of these quarries to the medieval castle, which was already built in the 11th century. First results show that the quarry zone extends over an area of about 2 ha, which is delimited on the eastern side by a deep ravine. Several quarries are located on the southwestern slope of the castle hill on three levels. The quarry faces on the upper level were used as the outer castle wall; the defensive wall was erected directly over these faces. These quarries and their soles are forming the so-called Zuhof, an external additional court of the castle. The quarry faces themselves show characteristic traces of the Roman extraction technique. In addition, there are also traces of recent quarrying activities (holes by hand plug drills), a common feature in almost all Austroalpine marble quarries, even though its precise dating by historical sources is still open. However, these new quarries show one more time the widely distributed exploitation of appropriate white marble resources in the Eastern Alps by the Romans, also of small-scale outcrops.

## **THE ÉCHAILLON AND HAUTEVILLE DIMENSION STONES IN WORLD ARCHITECTURE**

Albert Kollar

Carnegie Museum of Natural History, United States of America

Keywords: Échaillon, Hauteville, architecture

Early Cretaceous French limestones known as Échaillon Stone and Hauteville limestone, quarried from the western Alps, were a source of decorative stone for Gilded Age, 19th and early 20th century Beaux-Arts style architecture in Europe and the United States of America. Many historic buildings, sculptures, and fountains utilized these dimension stones for their colour, texture, appearance, and durability. Urgonian limestones (Échaillon and Hauteville) are reef building facies that contain a diverse fossil biota that creates a high polish and, especially in the case of Échaillon, the appearance of Brocattelle marble. The Échaillon Stone first used in the Gallo-Roman period in Grenoble, found application in the Palais Garnier opera house (1875)

and Pont Alexandre III (1900) in Paris, and in 137 other architectural applications in France. At the Carnegie Institute Extension (1907) in Pittsburgh, USA, 146 tons of Échaillon Stone were used in columns, pillars, and walls. The Hauteville limestone history does not reach into antiquity but the stone is used in the Louvre Museum (1793) flooring in Paris, the Empire State Building in New York City, and in the Carnegie Museum, where 386 tons were installed as flooring, steps, balcony, and railings. The objective of this research is to present a detailed review of the geographic distribution of the Échaillon Stone and Hauteville limestone and its applications to historic buildings in France and the United States. Research on the Échaillon Stone was published in 2019, 2020, and 2021 but the Hauteville work remains to be completed. The intention is ultimately to provide a unified account of the two stones.

## **WHEN ARCHITECTURAL PIECES ARE TALKING ... A NEW RESTITUTION OF THE »ARA PACIS«**

Tony Koželj<sup>1</sup> – Manuela Wurch-Koželj<sup>1</sup>

<sup>1</sup> École française d'Athènes, Greece

Keywords: Thasos, monument of Caesar, »Ara Pacis«

Observation of architectural pieces revealed their purpose place on a known foundation in the Agora of Thasos, and authorise us to present a new restitution of this monument, which is to consider as a small replica of the Ara Pacis in Rome.

Some of the architectural pieces were found a long time ago, studied by archaeologists and have been stored in the Archaeological Museum of Thasos; others, still »abandoned«, are lying in the Agora; and one (the lintel) has disappeared since 1991/1992. All these blocks were precisely measured and drawn with all details (mortices, grooves, tenon-joints ..., decorations, colours, ...), so that they integrate the 3D model of restitution.

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## **USE OF AURISINA LIMESTONE IN THE TERRITORY OF SLOVENIA (REGIO X)**

Andreja Krašna  
University of Ljubljana, Slovenia

Keywords: Aurisina limestone, Roman period, regio X

The main quarry of the Latin colony of Aquileia (181/180 BC) has been a Cretaceous limestone quarry in Aurisina/Nabrežina since the end of the 2nd c. BC. Its products and their distribution in the northern part of Italy are quite well known. Much less known are those discovered in the area of the western part of Slovenia, including the colony of Iulia Emona (mod. Ljubljana), which belonged to the Regio X, Venetia et Histria. A recent analysis of stone products and characterization of their material has shown the early presence of Aurisina/Nabrežina products in this area. And the connection of distribution of Aurisina/Nabrežina limestone products with the penetration of the Romans to the east. Aurisina/Nabrežina limestone products are known from the Roman pre-Augustan trading post Nauportus (mod. Vrhnika) and slightly later colony Emona as well as at other places 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 of the Tuscan (column bases, capitals, and architraves) and Corinthian (fluted column shaft, composite capital) orders. They were discovered mainly in Emona, Nauportus and Fluvio Frigido/Castra (mod. Ajdovščina). In Emona and Nauportus the presence of the Aurisina/Nabrežina products is documented in the 1st century. In Fluvio Frigido/Castra they lasted to the 4th century inclusive.

## **NOT ALWAYS A QUESTION OF DISTANCE! MARBLE PROVENANCE STUDIES ON ROMAN STATUES IN NORICUM**

Sabine Ladstätter<sup>1</sup> – Vasiliki Anevlavi<sup>1</sup> – Walter Prochaska<sup>1</sup>

<sup>1</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: Noricum, Roman period, marble trade

There are comparatively few marble statues from the northern provinces of the Roman Empire. However, they represent Roman culture like hardly any other group of finds. Of extraordinary quality and cultural-historical significance is that group of statues, which has been uncovered at the beginning of the 20th century in an intra-urban insula in Virunum, the capital of the Roman province of Noricum. However, there are other round sculptural, life-size figures, whose original context is not certain. In the archaeological literature it is noted that both regional Eastern Alpine marble and marble of Mediterranean origin were used for the production of these statues. The attribution was made solely on the basis of macroscopic observations, however, led to far-reaching cultural-historical conclusions. On the one hand, the import of finished statues from Italy was postulated, as well as a large sculptor's workshop in Noricum, influenced by Aquileia.

In the course of a recently initiated research project, samples were taken from all the statues and analysed. A combination of different scientific methods was used to characterize the composition of the marbles. To compare these results with quarry data a collection of approx. 4,500 samples from quarries of the ancient world (regional and international) was available. Through these scientific analyses, the origin of the marbles could be clearly identified. The consequence is a paradigm shift as these results. They include regional alpine marbles, but also others from Prokonnesos and Thasos. If we look at the statues from both an archaeometric and an art-historical perspective, several production variants can be identified. On the one hand, local marble was produced in local workshops, on the other hand, raw material – in blocks or roughly modelled – was delivered from the Mediterranean region and further processed on site. For individual pieces, however, it is also possible that finished objects were actually imported. A clarification of this can only be provided by a new stylistic-craft analysis of the objects, the marble analyses, however, have shown the way.

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## **THE LUSITANIAN ESTREMOZ ANTICLINE, THE MAIN MARBLE SOURCE IN THE WESTERN ROMAN EMPIRE**

Maria Pilar Lapuente Mercadal<sup>1</sup> – Trinidad Nogales-Basarrate<sup>2</sup>

<sup>1</sup> Zaragoza University, Spain <sup>2</sup> National Museum of Roman Art, Spain

Keywords: Estremoz Anticline, marble provenance, archaeometry

The Estremoz Anticline (EA), located in the Alto Alentejo of Portugal, is an elongated Variscan macrostructure of the Ossa Morena Zone in the Iberian Massif, about 40 km long and 5 to 7 km wide. Contrary to what was thought until very recently, the marble of this anticline, in all varieties (white, pinkish, greyish and banded in white and grey), was not exclusively destined for local Lusitanian market. Due to the large extension of its marble outcrops and its great aesthetic and technical quality, the marble of the EA is among the Hispanic and southern Gaul marbles, the noble material most widespread in different archaeological remains, not only from all Roman provinces of Hispania but also in several points of North Africa.

After more than three decades of archaeometric studies carried out in the University of Zaragoza in closed collaboration with the Roman Art National Museum of Mérida, we have compiled an extensive reference collection of the EA marble with a reliable database of their fingerprints, based on a multi-method analytical approach. Once we have focused on discriminating them from other Hispanic marbles and from the main classical marbles, we have checked their markers of identification in a vast number of marble artifacts found in the Augusta Emerita territory, mainly in statuary, but also in epigraphy, funerary and decorative architectural elements of the major public buildings. The verification of the usefulness of the identification parameters in the pieces from the capital of Lusitania, which, logically due to its geographical proximity (110 km) to the EA, was supplied with the different varieties of EA marble, has facilitated the task of identifying the provenance of marbles used in other decorative and sculptural programmes in territories far away from the immediate sphere of distribution of this raw material.

The main objective of this contribution is to present a global vision of the great potential achieved by EA marble in its Roman exploitation and its distribution in the Western Roman Empire. For this purpose we have compiled the information of pieces authenticated as EA marble in different sites and museums, mostly with our own data, some already published and others that until now had remained unpublished.

# **A FIRST MINERO-PETROGRAPHIC AND ISOTOPIC CHARACTERISATION OF MARMOR NUMIDICUM (GIALLO ANTICO)**

Lorenzo Lazzarini  
Università IUAV di Venezia, Italy

Keywords: Giallo Antico, use, archaeometry

The most beautiful yellow stone used in antiquity came from the town of Symitthus, modern Chemtou in NW Tunisia. Its Roman name was a geographical one, Marmor Numidicum, since Numidia was the ancient name of the region where numerous quarries were already in production by the end of the 3rd c. BC. Those of Symitthus were increasingly exploited after the Roman conquest, and much enlarged in imperial times up until the 4th c. AD. This period saw a large Mediterranean distribution of this yellow stone which was one of the most expensive listed in Diocletian's edict of 301. Later on, only reuse of spolia took place, especially in Rome and other parts of Italy where in Renaissance times the stone was re-named Giallo Antico. A further, quite limited, exploitation resumed at the beginning of the last century. Giallo Antico was employed for architectural elements such as columns, cornices, flooring slabs and more rarely for carving statues, especially of barbarians and wild animals with obvious symbolic meanings. In spite of its utmost importance, to date, it has not been satisfactorily characterized minero-petrographically and geochemically. Such a characterization is needed also for a positive distinction from similar »substitution« stones such as the Giallo di Siena. The results of a first characterization made by X-Ray diffraction (PXRD), microscopic and microchemical examination of thin sections (OM, SEM+EDS) are presented here. Giallo Antico is of Jurassic age, and may be classified as a micritic limestone of marine origin that underwent a very weak regional metamorphism that transformed the originally contained small amounts of clay into albitic plagioclase whose common presence is fingerprinting this rock, which otherwise in general is rather pure. Its insoluble residue formed by quartz, plagioclase, iron oxides/hydroxides (responsible for its colour), varying from 0.03 to 6.20 %, is in fact normally below 1 %. As for its isotopic composition, the results of the mass-spectrometric analysis (SIRA) of 10 quarry samples span from -0.25 to +2.54 of  $\delta^{13}\text{C}$ , and from -3.73 to -10.16 of  $\delta^{18}\text{O}$ .

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## **GROTTA OSCURA OR TUFO GIALLO DELLA VIA TIBERINA: A CASE OF THROWING THE BABY OUT WITH THE BATHWATER?**

Christopher J. Lyes  
Jesus College, University of Oxford, United Kingdom

Keywords: Tuff Terminology Ontology

Over recent years, archaeological approaches to the study of stone in antiquity, particularly the tufo of Rome, have received criticism from earth scientists. In many ways, this criticism has been entirely justified – the use, by anglophone archaeologists, of the term ›tufa‹ when referring to the volcanic ignimbrite tuff being one example where change was sorely needed. However, in several important papers from the first decade of the current century, this criticism was extended to the use of a series of more specific archaeology terminologies that have been applied to these materials since at least Tenney Frank’s 1924 publication in which they were codified. This paper will contend that the rejection of terms such as Cappellaccio in favour of those proposed by geologists may lead to the abstraction of our studies away from the archaeological nature of the material, and runs the risk of deprecating the archaeological and historical significance of the intense economic activity that resulted from the extraction of these stones in the first four centuries BC. We shall explore this contention by looking at the field evidence of exploitation of one of these stones – that proposed by Karner to be Tufo Giallo della Via Tiberina and known to generations of archaeologists as Grotta Oscura. We will see that this material was exploited from multiple quarries, considerable distances apart, and that for provenance studies more refinement will be needed to understand which quarry was the source for a particular ancient building project, such as the Servian Wall or the Basilica Aemilia. We will see that these are archaeological problems that neither the old nor the new terminologies can adequately deal with, and that the loss of a sense of place that the new geological terms create needs to be challenged and amended to allow for a growing number of sources of these economically and historically significant materials.

## THEORISING ANCIENT QUARRYING: HOW FAR HAVE WE COME?

Christopher J. Lyes

Jesus College, University of Oxford, United Kingdom

Keywords: Archaeological theory, stone quarrying, methodologies

»There is a damaging and self-defeating assumption that theory is necessarily the élite language of the socially and culturally privileged ... the Olympian realms of what is mistakenly labelled ›pure theory‹ are assumed to be eternally insulated from the historical exigencies and tragedies of the wretched of the earth« (Bhabha, HK. 1994, *The Location of Culture*). Theoretical discourses are well-established within academic archaeology, yet less so within the study of marble and other stones in antiquity. For those who practice a theoretically-integrated form of archaeology there is a danger that we may see ourselves as the sole creators and practitioners of theory. By what right do we proclaim ourselves so? Do insights such as Bhabha's, clue us in to what might be the chief pitfall, and cause of stagnation, of all theoretical discourse – its perceived elitism? Can, then, a case be made that theoretical approaches have failed to develop a vertical integration with those who practice primarily in the field? An echo, perhaps, of CW Mills' distinction between grand theory and abstract empiricism, where the first ignores real-world problems in favour of abstract theoretical models, and the second focuses exclusively on method and data?

This paper will explore these questions through the study of the quarrying and use of marble and other stones in antiquity. We will consider the state of theory in this field, exploring where academic interest is being targeted and how far theory has penetrated. We shall also ask ourselves whether we need to work harder to integrate with those working at the quarry-face, to avoid the prevalence of small-scale studies that remain isolated from their larger context. Subsequently, we will explore how, in this specific field, we might begin to make this transition and whether this approach can be extrapolated to other fields of archaeological enquiry.

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## **TOR CERVARA AND THE TUFO QUARRIES OF THE MID-ANIENE VALLEY, ROME**

Christopher J. Lyes

Jesus College, University of Oxford, United Kingdom

Keywords: Tufo, industrial landscapes, quarrying

Occupying over a thousand acres of the Roman campagna, the tufo quarries of the mid-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 autostrade, 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 yet connected extractive zones. Through a multi-scalar analysis of the quarry landscape, this paper will explore this large zone, its associated archaeological evidence and will seek to question established beliefs with regard to the effectiveness of water and road transportation. The paper will use as a case study the large, but damaged, quarries at Tor Cervara as its primary focus, but will also draw in other similarly extensive quarries from elsewhere in the Valley to illustrate aspects of the wider analysis of industrial tufo-quarrying landscapes currently being worked on as part of my doctoral research.

## **THE STONE QUARRIES WHICH PRODUCES THE BUILDING STONE TO CONSTRUCT THE ROMAN-BYZANTINE OBODA (AVDAT), THE NEGEV HIGHLANDS, ISRAEL**

Haim Mamalya<sup>1</sup> – Isaac A. Meir<sup>2</sup>

<sup>1</sup> Israel Antiquities Authority (IAA), Israel <sup>2</sup> Ben-Gurion University of the Negev, Israel

Keywords: Negev, Oboda (Avdat), quarries

The paper will present new data on the quarries of building stones used in the construction of the Roman-Byzantine urban settlement of Oboda. The site of Oboda (Avdat) is located on the Avdat Plateau of the Negev Desert Highlands. Archaeological research has dated the beginning of Oboda to the Nabataean caravanserai on the Incense Route founded in the 3rd c. BC. The urban settlement, established in the 2nd c. AD as part of the Negev annexation to the Roman Empire, reached its peak — and maximum size — in the Byzantine period (4–7th c. AD). The site was declared by UNESCO a World Heritage Site.

The Oboda Acropolis, the urban settlement around it, and the nearby agricultural area extended over 270 dunams (27 ha) and included many dozens of public and private buildings and agricultural Installations. The construction of all these required a significant mass of building stones. 1,009 building stones were mapped in Geoarchaeological Survey over walls of five public, religious, and residential buildings. Sedimentology classification shows seven different archetypes of carbonate stones that were used in the construction of the settlement's buildings. 43 stone quarries have been identified and mapped in an Archaeological Survey (Permit No. S-919/2019) across the Avdat Ridge. 33 of them are characterized by horizontal bedrock units (shelf morphology), constituting together a sequence of 5,834 m. 10 planar quarries extend over a total area of 22,860 m<sup>2</sup>. The stone quarries' archaeological findings include pickaxe and chisel marks, quarry waste, and raw material for construction. Two main methods have been used to examine the connections between the surveyed quarries and the Oboda building stones: (a) spatial geographic analysis by GIS statistical tools; (b) Correlations enabling to establish association and sedimentological relations between the bedrock layers in the rock columns and the construction stones. Sedimentology eliminated quarries bedrock through the geological column sections. The results show a clear geographical-archaeological connection between the quarries and the construction site in Oboda. Furthermore, much resemblance can be found in the sediment and fossil components that make up the construction stones and the mapped quarries rock. These findings demonstrate insights about the stone economy in the Roman-Byzantine Negev.

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## **AN UPDATED DATABASE OF WHITE AND GREY PROKONNESIAN MARBLES: PETROGRAPHY, CATHODOLUMINESCENCE AND ISOTOPES**

Sara Mandera<sup>1</sup> – Bogusław Bagiński<sup>2</sup> – Maciej J. Bojanowski<sup>1</sup> – Mehmet Cemal Gönçüoğlu<sup>3</sup>; Dagmara Wielgosz-Rondolino<sup>2</sup>

<sup>1</sup> Polish Academy of Sciences, Poland <sup>2</sup> University of Warsaw, Poland <sup>3</sup> Middle East Technical University, Turkey

Keywords: Prokonnesos, petrography, isotopes

Provenance determination of marbles used for ancient artefacts is one of challenges for petro-archaeometrists, which requires a combination of various analytical methods and interdisciplinary approach. Databases created by investigating rocks from the ancient quarries still need to be improved and updated. Among the most famous white and grey marbles used in antiquity are those from Prokonnesos (Marmara Island, Turkey), which were certainly extensively extracted and widely exported for a relatively long time. Artefacts made of the Prokonnesian marbles can be identified by regular parallel gray banding, which may seemingly allow for a relatively easy identification of their source. However, other classical marbles may exhibit similar banding as well, e.g. Paros, Ephesos. Moreover, there are varieties of the Prokonnesian marble, which are represented by homogeneous white or gray pieces. Therefore, a reliable identification of supposed Prokonnesian marble requires a multi-method analytical investigation, especially in case of homogeneous varieties.

The aim of the current study was to make the Prokonnesian marble provenance identification more reliable by updating the existing mineralogical and isotopic databases. The research presented here was conducted within the ›Marmora Asiatica. Towards archaeopetrology in Poland‹ project financed by the National Science Centre (grant no. 2012/07/E/HS3/03971) and supported by the Ministry of Culture and Tourism of the Republic of Turkey. It focused mainly on calcite samples taken from the ancient quarries situated in the northern part of the Marmara Island, however, dolomitic samples have also been collected from the western quarries. Petrographic examination, using polarizing microscopy and cathodoluminescence, confirmed the characteristics reported so far: mortar texture and dark blue glow in CL for the vast majority calcite samples. Calcite is often accompanied by finer-grained dolomite crystals with weak purple or red luminescence. Dolomitic

marbles are characterized by fine-grained granoblastic texture and red luminescence. Maximum grain size measured in this research fits a slightly narrower range than previously reported. The application of SEM-EDS analysis revealed characteristic accessory minerals, mainly specific mica-type phyllosilicates. Results of stable C and O isotope analysis obtained in this work extended the isotopic variability of the Prokonnesian marble, which resulted in merging of the two separate isotopic fields plotted on isotopic reference diagram so far into a single, large field. Sr isotope measurements carried out in this work did not alter the current range of  $87\text{Sr}/86\text{Sr}$  values for the Prokonnesian marble.

## **WHITE MARBLES FROM ASIA MINOR AT ROMAN ATHENS: NEW PROVENANCE IDENTIFICATION RESEARCH ON FIGURAL SCULPTURES FROM THE AGORA**

Yannis Maniatis<sup>1</sup> – Dimitris Tambakopoulos<sup>1</sup> – Brian Martens<sup>2</sup>

<sup>1</sup> Institute of Nanoscience and Nanomaterials, NCSR Demokritos, Athens, Greece <sup>2</sup> American School of Classical Studies at Athens, Greece

Keywords: Asia Minor, provenance identification, white marble

Recent research has demonstrated the large quantity and wide dispersal of figural sculptures of the Roman Imperial period that were carved from fine-grained, white marbles quarried in Asia Minor, especially from Dokimeion (Afyon) and Göktepe. It remains to be considered how widely Asiatic marbles were deployed in Roman-period Greece, particularly in marble-rich Athens, and the historical implications of such use. This study presents the results of white marble provenance identification for 19 Roman-period statuettes found during excavations of the Athenian Agora, conducted by the American School of Classical Studies at Athens. The statuettes were selected for study because their very small grain size seemed visually inconsistent with the local marble from Mount Pentelikon. Of particular interest, ten of the statuettes are so roughly worked that they can be objectively considered unfinished. Samples were collected from each statuette for analyses. The analytical techniques included (1) verification measurements of Maximum Grain Size (MGS) and Most Frequent Grain Size (MFS) under a stereoscopic microscope, and qualitative examination of the crystalline features of the

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marbles; (2) Isotopic Ratio Mass Spectroscopy (IRMS) for measurements of the stable isotopes of carbon and oxygen; and (3) measurement of the strontium (Sr) content using a portable X-Ray Florescence analyzer (pXRF). The results of the above analyses were compared to the data for known ancient marble quarries from Greece, Turkey, and Italy, a dataset having been compiled through the fieldwork and analyses of the Laboratory of Archaeometry, NCSR »Demokritos« (Athens, Greece), amalgamated with all relative data published in the scholarly literature. The results demonstrate the presence of marbles from both Dokimeion and Göktepe in Roman-period Athens. The unfinished works were carved in Athens from stone imported from Dokimeion. The finished works were either carved in Athens, or imported from Dokimeion and Aphrodisias as readymade sculptures.

## **THE STONE TESSERAE FROM THE ROMAN MOSAIC FLOORS OF ANCIENT MESSENE. FIRST RESULTS ON MATERIALS IDENTIFICATION AND PROVENANCE**

Elisavet Mantzana<sup>1</sup> – Eleni Zimi<sup>1</sup> – Ioannis Iliopoulos<sup>2</sup> – Nikolaos Zacharias<sup>1</sup>

<sup>1</sup> University of the Peloponnese, Greece <sup>2</sup> University of Patras, Greece

Keywords: Tesserae, identification, preservation

Mosaic is not an ordinary form of art. The use of multiple small pieces of stone, placed by hand on top of a fine mortar layer, is a particular choice for the decoration of several square meters of architectural surfaces. Although the construction of such surfaces demands time and hard labour, in the Greek world it appeared already in the late 5th c. BC. During the Hellenistic period, pebbles were gradually replaced by small, near cubic pieces of stone, ceramic or glass, the tesserae. Romans perfected the technique and mosaics were established as a dominant form of art for the decoration of houses and public places. Although mosaic floors have been found in high numbers, their study initially focused on iconographic themes, ignoring the nature and the characteristics of construction elements. Nowadays, the need for an interdisciplinary approach towards the cultural heritage preservation, directs the research to the analysis of the construction materials. Stone tesserae and mortars, as inorganic materials, have given mosaics great

durability and resistance to deterioration phenomena.

The floor mosaics of ancient Messene (3rd–4th c. AD) are relatively well-preserved examples with interesting figurative and geometric themes. Polychromy is present and macroscopically the tesserae can easily be grouped. The present study is focused on the chemical and petrographic analysis of visually different types of stone. The aim of this process is to identify the materials used and evaluate their likely provenance. X-Ray Diffraction (XRD), Raman spectroscopy, X-Ray Fluorescence (XRF), and Scanning Electron Microscopy (SEM) equipped with EDS are used for the determination of the chemical composition, the mineralogical characterization but also the documentation of stone surfaces. The analysis of ancient Messene stone tesserae reveals new separation groups and specific mineralogical identity. Furthermore, the observation of external surfaces provides useful information as far as deterioration is concerned.

The results contribute to stone categorization and enrich our understanding about the materials chemical and physical properties. This knowledge is crucial not only in stone provenance research but also for the proper evaluation of preservation state; two parameters which are necessary to secure a successful conservation project.

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## **REGIO X – VENETIA ET HISTRIA BETWEEN MEDITERRANEAN AND ALPS. IMPORTED LITHOTYPES USED IN THE ROMAN THEATRE OF VICENZA (VENETO, ITALY)**

Beatrice Marchet<sup>1</sup> – Prof. Jacopo Bonetto<sup>2</sup>

<sup>1</sup> Università degli Studi di Padova, Italy <sup>2</sup> Università degli studi di Padova, Italy

Keywords: Vicenza, Teatro Berga, marble

This paper aims at presenting the first results of a research project on marble artefacts (architectural and coating elements) used in the so called Teatro Berga, i. e. the Roman theatre of Vicenza (Veneto region, Italy) and their contribution to the understanding of trade, use and diffusion of imported marbles and other ornamental stones in northern Adriatic regions during the Roman times.

The first purpose of the paper is to report results of the characterization, provenance determination, quantification (by count, dimensions and weight) and function of the main lithotypes used for wall and floor coating (slabs, round billets, cornices, ...) and as architectural elements (columns, pieces of entablature, ...) in the Roman theatre. This is made in order to increase our knowledge about the types and volumes of marble used in Roman Vicenza and to compare this case with other contemporary buildings of a great social, cultural and political importance in north-eastern Italy.

Furthermore, data collected show the deep integration of Vicenza, like other towns in northern adriatic Italy into marble and other ornamental stones trade flow within the Roman Mediterranean, with particular reference to the Greek/Eastern routes. These results thus increase knowledge about marble's trade and distribution networks and give a better understanding of trades between the Mediterranean Basin, the X Regio Augustea – Venetia et Histria and Alpine regions during the Roman period.

# THE HISTORICAL QUARRIES OF BUIXCARRÓ LIMESTONE IN L'ÉNOVA (VALENCIA). EVOLUTIONARY ANALYSIS OF EXTRACTIVE AND TRANSFORMATIVE TECHNIQUES

Miquel Ramon Martí<sup>1</sup> – Juan Antonio Marín<sup>2</sup> – Begoña Soler Huertas<sup>2</sup>

<sup>1</sup> Ayuntamiento de L'Énova, Spain <sup>2</sup> Universidad de Murcia (UM), Institut Català d'Arqueologia Clàssica (ICAC), Spain

Keywords: Quarrying, notae lapicidinarum, architectural heritage

The Buixcarró limestone (Xàtiva, Valencia) is currently one of the most widely used ornamental rocks in the decorative programmes of the southeast quadrant of the Iberian Peninsula. The material has been defined as a micritic limestone with pink, yellow and white tones, characterised by the presence of recrystallised calcite and fine mineralised stylolites with iron oxides which give it a brecciated appearance. The aesthetic qualities and chromatic diversity of this rock have led to the development of a historical stonemasonry linked to the exploitation of its different varieties from Roman times to practically the present day (Álvarez and others 2009). Proof of this is the diffusion reached by marmor satebitanum within the ornamental rock markets existing within the limits of the province of Citerior Tarraconensis, with oriented production on the carving of architectural elements and epigraphic supports (Cebrián 2008 and 2012). Since then, the existing outcrops in the area have maintained a continuous supply of ornamental rock to important construction companies considered significant elements of the Architectural and Historic-Artistic Heritage of the Valencian Community, such as the Romanesque façade of the Cathedral of Valencia or the 19th c. Collegiate Church of Xàtiva.

The continuity of quarrying in the area has generated a living landscape made up of active and inactive quarries located in the municipalities of Barxeta, Quatretonda, Barx and Pinet. Among them, there is a group of inactive quarries located in the municipality of L'Énova (Valencia), an extensive quarrying area made up of several quarries that have benefited from a traditional exploitation system and that preserve important evidence related to the processing and transfer of the material from the quarry of undeniable heritage value (Martí 2021).

This paper presents the results obtained from the research work carried out between 2008-2021 in the quarrying area, the aim of which is the

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topographical study of the quarries and their exploitation techniques from ancient times to the present day.

## **MARBLE AND OTHER STONE DECORATIONS FROM THE COLLECTION OF THE BUDAPEST HISTORY MUSEUM – AQUINCUM MUSEUM**

Anita Polgár-Nyerges

Budapest History Museum – Aquincum Museum, Hungary

Keywords: Aquincum, traces of decoration, Danube

Aquincum, the provincial capital of Pannonia Inferior (from 106 AD), lies at the most important crossing point of the Pannonian Danube frontier. The civil settlement north of the legionary fortress was elevated to town status by Hadrian. The Civil Town flourished until about the middle of the 3rd c. AD; several richly-decorated public and private buildings are known from the 2nd–3rd century. The researched fragments of marble and other stones used for decorating buildings can be found in the collection of the Aquincum Museum (Budapest). Unfortunately, many fragments cannot be linked to precise find-spots. The processing of the fragments is carried out on the basis of the inventorying and identification of the fragments (original location, function). The finds reviewed show a varied picture, with fragments of different shapes and colours. We were able to separate fragments of large slabs, small and coloured framing fragments, and fragments of profiled door and window frames. On many fragments we could observe traces of processing and decoration (chisel marks). In 1997, stable oxygen, carbon isotope and trace element analyses were carried out on 14 marble monuments from Aquincum, as well as thin section analyses by light microscopy to determine the origin of the marbles (H. W. Müller). Based on the analyses, the material of 7 marble monuments could be linked to the quarry in Gummern (Carinthia, Austria), two dolomite marble objects and one calcite marble monument to the island of Thassos, while the closer origin of 4 objects could not be clearly determined. One of the main reasons for the widespread use of marble from Gummern is the favourable location of the quarry along the river Drava, which allowed the marble to be transported along the Danube to Aquincum. A petrological analysis of the marble fragments used to

decorate the footing and floor close to the entrance in a building at the Civil Town of Aquincum was also carried out in 2008 (O. Palya). The white marble slabs came from Italy (probably from Carrara), while the narrow red marble strips were of local red limestone types, which can be found, for example, in the Transdanubian Mid-Mountains. It would be worthwhile to continue the investigations on the marble and other stone fragments used to decorate the floors and footings of buildings, and to compare the results with those of similar investigations conducted in Aquincum and Pannonia.

## **INCOMPLETENESS AND IMPERFECTION OF ARCHITECTURAL DECORATION IN DIOCLETIAN'S PALACE IN SPLIT**

Daniela Matetić Poljak<sup>1</sup> – Katja Marasović<sup>2</sup>

<sup>1</sup> Ars Academy University of Split, Croatia <sup>2</sup> University of Split, Croatia

Keywords: Diocletian's Palace, architectural decoration

On different edifices in Diocletian's Palace, there is a certain number of incomplete or erroneously fabricated elements of architectural decoration. They are made in local limestone, while on the imported elements made in different marbles of Greek or Egyptian provenance this phenomenon cannot be detected. The unfinished elements can be divided into two categories: the elements with partially finished mouldings belong to the first category; to the second, the elements with partially carved (or even omitted) motives. Certain elements of the east colonnade of the Palace main square (traditionally called ›Peristyle‹) belong to the first category: on several ionic attic bases the moulding is completed only on the side looking toward the square, while on the opposite side (looking toward the temenos area of the Mausoleum) it is left in a state of a carved ›prefabricate‹; one Corinthian capital has on the side facing the intercolumnium smaller part of the upper register left roughly shaped. The incompleteness of the motifs is more frequent. There are cases where on two adjacent blocs the motif is carved on the one, omitted on another, as it is a case of the string course of octagonal towers, the cornice blocs of Mausoleum peripteros etc. While the unfinished elements are positioned on less visible parts of the edifices, the imperfect ones are quite visible: the length of the door cornice of the

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rectangular temple has been corrected (as a consequence the flow of the anthemion on the joint of two blocs is interrupted); inside the rectangular temple the dimensions of the blocs of the cornice running under the barrel vault have also been corrected, as a result, the joint of cornices on two angles is different: on the northwest angle, two modillions are fused into one of a rather in unusual M shape, while on the southwest angle they enclose a cassette. The incompleteness and imperfection of the architectural decoration elements in the Palace could be related to the different skill capacities of the carvers. The number of unfinished elements could, however, point out to delay on the construction site, or to an acceleration of the construction activities (intending to complete the work before and receive the abdicated emperor).

## **THE ROMAN GRANITE QUARRIES OF THE LAVEZZI ARCHIPELAGO (SOUTHERN CORSICA, FRANCE)**

Nadine Mattielli<sup>1</sup> – Sébastien Clerbois<sup>1</sup> – Antoine Triantafyllou<sup>2</sup> – Catherine Coquelet<sup>3</sup> – Nicolas Paridaens<sup>1</sup> – Nicolas Authom<sup>4</sup> – Gaël Brkojewitsch<sup>5</sup> – Henry-Louis Guillaume<sup>1</sup> – Arnaud Schenkel<sup>1</sup>

<sup>1</sup> Université libre de Bruxelles (ULB), Belgium <sup>2</sup> Université Claude Bernard – Lyon 1, France <sup>3</sup> Université catholique de Louvain, Belgium <sup>4</sup> Independent scholar <sup>5</sup> Aix Marseille Université, CNRS, France

Keywords: Roman quarries, Corsica, Lavezzi

Granite is a valued material under imperial Rome, particularly for the monolithic column production, used in public and private architecture. The Romans were looking for a particular stone, i.e. leucocratic granodiorite, with colours and textures similar to that extracted from the Egyptian quarries of Mons Claudianus, used for many imperial programs.

Since 2016, we are studying the granitoids' quarries scattered throughout the islands of the Lavezzi archipelago in the Strait of Bonifacio (Corsica), including the large quarry located on the contiguous islands of Cavallo-San Bainzu. From a methodological point of view, the approach combines archaeology, technology and geological observations to produce a holistic study of the stone, from its characterization to its exploitation and its diffusion on a regional scale. Archaeological surveys carried out in 2019-2020 have shown that the rock exploitation is dated to the Flavian period, with an extension

in the 1st half of the 2nd century. The Romans extracted large blocks to produce monolithic columns of 3 sizes, 30, 15 and 10 Roman feet. The quarrymen used to carve V-shaped trenches into which the corners were inserted. The technical study shows that these trenches were used to control and guide the fracture lines: only this technique can ensure regular cutting planes for a rock as hard as granite.

Physical and chemical signatures of the extracted rocks were conducted using portable magnetic susceptibilimeter and X-Ray fluorescence spectrometer. Along with archaeological records, our multi-method approach allows us to study the stone circulation on a regional scale.

Our conclusion emphasizes that interdisciplinary study is crucial to produce a holistic study of quarrying activity and constrain the circulation vector of produced stones. It also emphasizes the lack of the produced columns in the Lavezzi on Corsican Roman sites and suggests several further hypotheses regarding the circulation of the Corsican granite.

## **ANCIENT MARBLE IN URBAN ATMOSPHERE: UNVEILING THE AIR POLLUTION IMPACT ON THE LIBRARY OF HADRIAN IN ATHENS, GREECE**

Dimitris Mitsos<sup>1</sup> – Vasiliki Kantarelou<sup>2</sup> – Eleni Palamara<sup>1</sup> – Andreas Germanos Karydas<sup>3</sup> – Nikolaos Zacharias<sup>1</sup>; Dr. Evangelos Gerasopoulos<sup>4</sup>

<sup>1</sup> University of the Peloponnese, Greece <sup>2</sup> FZU – Institute of Physics of the Czech Academy of Sciences, Czech Republic <sup>3</sup> National Centre for Scientific Research Demokritos, Institute of Nuclear and Particle Physics, Greece

<sup>4</sup> National Observatory of Athens, Institute for Environmental Research and Sustainable Development, Greece

Keywords: Particulate matter, marble weathering, black crust

An integrated approach has been used in examining dark decay layers on the surface of the Roman era monument of the Library of Hadrian in Athens, Greece. The samples were collected and prepared in order to perform a chemical and mineralogical characterization of the degradation products and unveil the role of each of many possible pollution sources in the process of marble deterioration. The degradation products were found to consist of typical dendritic black crusts and one Fe-rich aluminosilicate patina. In order to determine groups of elements clearly related to specific pollution sources and to investigate

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how these elements are related to each other, the chemical composition of the crusts and the element distribution along the decay layer profile were combined. The main typologies of particles that were identified are: a) carbonaceous particles from diesel exhausts and domestic boilers, b) Si-rich particles from vehicular emissions and mineral dust, and c) metallic Ti-rich and Fe-rich particles from coal combustion and domestic heating, respectively. Profiling of the samples using  $\mu$ -XRF was instrumental in showcasing the potential of this technique in recovering the »past pollution effect« on marbles. Ultimately, traffic was found to pose a clear fingerprint on both the type and the chronological development of the anthropogenic pollutant deposition on marbles of the monument. This project was implemented within the scope of the »Exceptional Laboratory Practices in Cultural Heritage: Upgrading Infrastructure and Extending Research Perspectives of the Laboratory of Archaeometry« and »PANhellenic infrastructure for Atmospheric Composition and climatE change« (MIS 5021516) projects co-financed by Greece and the European Union under the auspices of the program »Competitiveness, Entrepreneurship and Innovation« (NSRF 2014–2020).

## **A LITTLE-KNOWN SARCOPHAGI QUARRY FROM LATE ANTIQUITY AND THE EARLY MIDDLE AGES IN BERRY (SANCERRE, CHER, FRANCE)**

Daniel Morleghem  
UMR 7324 Citeres-LAT, France

Keywords: Sarcophagi quarry, extractive practices

The quarry of Vinon is located in eastern Berry, below a Roman road and a few kilometres from the Loire River. It was opened in a white, chalky and bioclastic Upper Oxfordian limestone, characteristic of the Sancerre region. The site is first mentioned in 1970 and was almost filled in at the turn of the 2000s, without any archaeological study having been carried out. The tops of the faces are now only visible over a height of 1 m, and data available are limited to around thirty black and white and a few colour photographs taken in 1970 and the 1990s, the examination of which in 2011 – as part of a doctoral thesis on ancient and Merovingian stone sarcophagi – has nevertheless made it

possible to restore a plan of the quarry and to characterise the nature and chronology of the production. The quarry is approximately 15 m long, 10 m wide and 8 m high. It is an open-pit quarry, by stages and high faces, whose shape and techniques are characteristic of ancient quarrying practices in the southern half of Gaul. The tool marks and block scars visible on the faces have made it possible to identify the tools used by the quarrymen (pick, »escoude«, cutting hammer) and to reconstitute the techniques (trenches, notches and metal wedges). The extracted blocks are parallelepipeds of rectangular or trapezoidal plan, about 2 m long and 40 to 80 cm in section. The blocks scars, a few blocks found in the quarry waste, and a rectangular block in the process of being extracted with the preparatory layout for its hollowing out, make it possible to affirm that this quarry was used – but perhaps not exclusively – for the production of sarcophagi at the end of antiquity and the beginning of the early Middle Ages, which is confirmed by the petrographic study of the sarcophagi in the area. The stop of quarrying in the second half of the 6th c. was due to competition from another sarcophagi production centre.

## **COLOURED MARBLES OF THE IMPERIAL PALACE ON THE PALATINE HILL: RESEARCH INSIGHTS**

Alessandro Mortera<sup>1</sup> – Francesca Caprioli<sup>2</sup> – Patrizio Pensabene<sup>2</sup>

<sup>1</sup> Ca' Foscari University of Venice, Italy <sup>2</sup> Sapienza University of Rome, Italy

Keywords: Imperial Palace, coloured marbles, marble veneers

With this paper we would like to add a contribution to the knowledge of the Imperial Palace of the Flavians on the Palatine Hill through the study of the distribution of coloured marbles, not only used for columns' shafts but also for floor and wall veneers. Their richness is recorded in the literary sources of the Domitian period, as the Statius' famous passage testifies (*Silv.*, IV.2.18–31). Studying the architectural decoration of the Palace of Domitian, we have noted the presence of floors made of large polychrome slabs used in the main reception halls (as in the case of the *Aula Regia* and the *Coenatio Iovis* in the so-called *Domus Flavia*); even the smaller rooms were entirely covered in coloured marbles. The existence of these veneers is documented in many cases by the layers

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of mortar which still survive on floors and walls. When the quality of the used marbles can be recognised, it emerges a continuous dialogue between the colours of the marble and the light (called »splendour«). In fact, each room with its architecture, its furniture and function must have played a fundamental role in the choice of the different marble varieties and their positioning. Here, we would like to present some results of our study, focusing in particular on the lower peristyle of the ›Domus Augustana‹ and some of the rooms around it, as well as some other important contexts of the upper levels of the ›Domus Flavia‹ and the ›Domus Augustana‹. Many of these veneers and the rooms in which they are located have not enjoyed much success in the previous studies. Through our new data we can better understand the role of colour and also the function of the rooms in a continuous dialectic relationship with light and polychromy.

## **ARCHAOMETRICAL STUDY OF THE MARMORA FROM VETUS VRBS OF ITALICA (SANTIPONCE, SEVILLA, SPAIN): THE SPHERE OF THE HILL OF SAN ANTONIO, THE THEATRE AND THE ISEUM**

Esther Ontiveros Ortega<sup>1</sup> – José Beltrán Fortes<sup>2</sup> – María Luisa Loza Azuaga<sup>1</sup> – Daniel Becerra Fernández<sup>3</sup>

<sup>1</sup> Instituto Andaluz de Patrimonio Histórico, Spain <sup>2</sup> Universidad de Sevilla, Spain <sup>3</sup> Universidad de Córdoba, Spain

Keywords: Marble, vetus urbs, Italica

This work is the archaeometric analysis of an array of architectural and sculptural fragments, from the so called vetus urbs of the Roman city of Italica (Santiponce, Seville, Spain). Specifically, it analyses the marble found in the street plot La Feria nº 19 and Clavel nº 1. These excavations sites are located on the hill of San Antonio, a part of the city near the theatre. Furthermore an ensemble of marbles from the Iseum and two sculptural fragments from the theatre were analysed. These analyses are going to complete the data already known about the marble used in Italica; they confirm the use of southern Hispanic materials, together with other Hispanic marbles and a great variety of marble from all over the Mediterranean. The archaeometric techniques employed have been the petrographic study by thin sections, the mineralogical characterisation by X-ray diffraction and the elemental

chemical characterisation by X-ray fluorescence.

## **THE ARCHITECTURAL REUSE OF ANCIENT MARBLE IN ST CATALD CATHEDRAL, TARANTO (APULIA, ITALY): A PRELIMINARY ANALYSIS**

Adalberto Ottati<sup>1</sup> – Maria Serena Vinci<sup>2</sup>

<sup>1</sup> Universidad Pablo de Olavide de Sevilla (UPO), Spain <sup>2</sup> Universidad Nacional de Educación a Distancia, Madrid (UNED), Spain

Keywords: Ancient marble, reuse, southern Italy

Built on the ancient city's acropolis, St Catald Cathedral in Taranto (Italy) is the oldest Christian church in the Apulia region. The archaeological excavations and studies of the building have allowed us to define some of its construction phases, beginning at least as early as the end of the 6th c. and the 7th c. AD up to the Norman church. Taranto Cathedral preserves an interesting corpus of architectural elements consisting of reused ancient and early medieval materials, as well as some well-known original elements from the Romanesque period. Among these, the ancient materials from the Classical era have not received adequate attention so far. These are the bases, columns and capitals reused in the porticos between the naves, as well as in the underlying crypt. The materials, which are different both in terms of the marble and their dimensions, are not homogenous. The columns are the result of the assembly of sections of stems from different columns, an aspect that requires some consideration. The materials must have come from contexts that were already in a precarious state of conservation. Although by tradition local historians and scholars affirm that they have the same origin, i. e. a pagan temple over which the Christian church was built, the research and excavations recently conducted on the city's acropolis exclude this hypothesis. Unfortunately, therefore, it is difficult to attribute these materials to specific monuments within the Greek polis or the Roman town. The objective of this contribution is to catalogue and offer a preliminary analysis of these elements. A consideration of the material and stylistic aspects or even the worksite that characterise the use of archaeological remains in Taranto Cathedral will be attempted. At the same time, the contextualization of this use within the phenomenon of reuse in southern Italy will contribute to a

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greater knowledge of the ancient city of Taranto.

## **THE »RESTORATION« OF THE MARBLE COLUMNS IN THE CONSTRUCTION SITE ECONOMY OF THE IMPERIAL RESIDENCES: THE CASES OF HADRIAN'S VILLA AND TRAJAN'S VILLA IN ARCINAZZO (ITALY)**

Adalberto Ottati

Universidad Pablo de Olavide de Sevilla (UPO), Spain

Keywords: Marble columns, Roman architecture, economy of construction

The aim of this contribution is to provide the first catalogue of and some considerations on the use of columns restored or reinforced with metal bars in two imperial residences among the most important in the ancient world: Hadrian's Villa near Tivoli and Trajan's Villa in Arcinazzo Romano. It is known that the use of valuable columns involved considerable costs related to quality and transport of materials. As a result it is quite common to find »defective« columns used in various imperial buildings. These were broken or cracked but had been reinforced and restored in a process that was practically invisible to the ancient observer.

There are many notable cases including the used columns in the theatre of Italica and those stored in Portus and today preserved in the Ostia lapidary. In the latter case the repair is so invasive that it demonstrates how the widespread use of metal to reconstruct a column did not affect its subsequent sale, perhaps precisely because the internal restorations were often invisible to the buyer. There were two reasons why the restoration of the columns in public contexts made sense. One was the distance between the customers and the procurement site, which made the quality control system more reliable. The second was the considerable cost saving in some contexts, at a time when resources, although consistent, were still limited. A separate case must be made for imperial residences, in which the financing available was practically unlimited. The reasons behind the restoration or reinforcement of columns, when it was not due to static reasons, probably lay in the need to keep the construction site constantly in operation and therefore speed was essential. From this perspective, with this contribution we wish to highlight two cases, the well-known Hadrian's Villa and Trajan's Villa in Arcinazzo Romano. The latter is particularly interesting, as it contains a large number of reinforced columns and therefore deserves

some considerations on the static need for them and their usefulness within the construction site economy.

## **THE MARBLE PROVENANCE OF THE PEDIMENTAL SCULPTURES OF THE TEMPLE OF ATHENA ALEA AT TEGEA**

Olga Palagia<sup>1</sup> – Yannis Maniatis<sup>2</sup>

<sup>1</sup> National and Kapodistrian University of Athens, Greece <sup>2</sup> National Centre of Scientific Research Demokritos, Greece

Keywords: Doliana marble, Skopas, Tegea

The pedimental sculptures of the temple of Athena Alea at Tegea, Arcadia, rank among the most important assemblages of 4th c. BC sculpture in the Peloponnese. The temple was visited by Pausanias, who attributed its architecture to the sculptor Skopas of Paros. He did not mention the name of the sculptor who designed the pediments. Skopas is usually credited with the pediments as well as the architecture but there is no evidence for this. The provenance of the marble of both the temple and its sculptures is thought to be the quarry of Doliana, at a short distance from Tegea. This assumption was based on visual identification only. We obtained permission to test the marble of the pedimental sculptures which are divided between the Athens National Museum and the Tegea Museum. On account of difficulties due to the pandemic, we have so far tested the marble of the boar's head from the east pediment now in Athens. Isotopic analysis indicates that its marble is from Doliana. We plan to test more sculptures from the pediments in the Tegea Museum and will present the final results of our research in Vienna.

## **IASOS RED CIPOLLINO SLABS: FROM USE IN COATING TO THEIR PICTORIAL IMITATION**

Diego Peirano<sup>1</sup> – Fede Berti<sup>2</sup>

<sup>1</sup> Ministry of Education, University and Research, Italy <sup>2</sup> Museo Archeologico Nazionale Ferrara, Italy

Keywords: Red Cipollino, use of marble, marble imitation

Recent researches on Iasian marble have focused on its use in sculptures and on its aesthetics, with special reference to the associations with other

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marbles (ASMOSIA XII). The latter research is still ongoing. The large imperial tomb built against the aqueduct named »Balik Pazari« at the beginning of the 6th century was turned into a sawing workshop, using waterpower. On a thick layer of sand used to saw marble 114 blocks were found. Their dimensions were compared to those of slabs still in place in coeval monuments, both in flooring that in wall cladding.

Thanks to the cooperation of Archaialogiki Etaireia and Ephorate of Antiquities of Magnesia it was possible to examine the Red Cipollino slabs used in Nea Anchialos basilica C. Here the presbytery's short sides were framed with medium-large slabs with different length and width. However, such differences had to be hardly noticeable because the conserved opus sectile panels show intricate motifs and those lost should had the same character. The presence of a ciborium and of high barriers should also dissimulate these differences, respectively from within and from outside. With regard to marble association both presbytery flooring and synthronon alternates white veined marble with Red Cipollino while in the short Solea Green Breccia is added. As to the differences between floor slabs, observing how marbles in wall cladding were arranged in mirror-like or open stain disposition, a possibility of unpaired stock slabs should be considered, marbles sawn to be arranged in a paired disposition but whose vein suddenly interrupt.

It seems that in its floruit era, and in times of difficult supplying, the wavy veins of Red Cipollino began to be imitated by painting on walls or by mosaic in flooring. We found its painted imitation in Iasos, where the marble never appears in wall coating, in the north room of the »tripartite building«. In Ravenna, in the Arian Baptistery, the painted Red Cipollino stands out in the window arches and on the wall. In domestic settings Iasos marble seems to appear in Hadrianopolis in Paphlagonia, in a room of the domus where a plinth imitates book matched slabs, and surely in a luxury house in Sardis where painting reproduces large slabs. A reference of marble imitated by mosaic could be found in the Teodorician villa at Galeata, where the veins of Iasos marble appear in a threshold leading to the octagonal hall.

## **ALEXANDRIA TROAS. THE PORT AND THE ROLE OF THE CITY IN THE DISTRIBUTION OF GRANITE SHAFTS**

Patrizio Pensabene<sup>1</sup> – Isabel Rodà<sup>2</sup> – Javier Domingo<sup>3</sup> – Eleonora Gasparini<sup>4</sup>

<sup>1</sup> Sapienza–Università di Roma, Italy <sup>2</sup> Universitat Autònoma de Barcelona – ICAC, Spain <sup>3</sup> Pontificia Università della Santa Croce, Italy <sup>4</sup> Università della Campania »Luigi Vanvitelli«, Italy

Keywords: Troad granite, Alexandria, quarries

At the Vienna Conference we intend to present our fifth paper on the granite columns of Troad in north-western Turkey. Our other papers have already been published in the preceding volumes of *ASMOSIA* and constitute the basis for this contribution. One of the aims of this study has been to quantify the number of Troad granite columns in Italy and in other Roman provinces. Although our catalogue cannot be considered complete, given that we are continuing to find yet more columns, even in areas that have already come under examination, a provisional total of 1,000 testifies to the importance of this particular type of architectural element in the ancient Roman world.

In our preceding papers, we observed how the Troad columns were largely intended for the principal cities and in particular the private market. In Rome, on the other hand, since the Flavian Age, the granite of the Forum, produced in the quarries of the Eastern Egyptian Desert, had been chosen as a representative stone of imperial power in the main public monuments of the city, such as the *Domus Flavia*, the *Trajan Forum*, the *Pantheon* and the *Baths of Caracalla*. This contribution addresses the mechanism of expedition and distribution of the Troad columns through the study of those that had been abandoned, for whatever reason, close to the port of Alexandria Troas.

Through the analysis of the column distribution, we aim at investigating the function of the different sectors of the port. The latter consisted of an external port and an interior harbour, beyond which lay a marshalling yard and a loading and unloading bay. All around the port we recorded columns and blocks of several marbles, such as *Pavonazzetto* and *Proconnesian*, which were unloaded for the local market of Alexandria. We also take into consideration the routes the columns took from the quarry to the city, to analyse their transport system and establish whether they passed through main or peripheral roads. These data can shed light on the role of the government of the city in the management

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of the quarry: Did the Troad quarries belong to the city and to what extent were the quarries contracted out to important members of the urban élite? What was the relationship between the quarry and the region around it?

## **ARCHAOMETRIC STUDY OF THE GRECO SCRITTO MARBLE SLABS FROM THE EDIFICIO DEI TRICLINII AT MURECINE (POMPEII, ITALY)**

Simona Perna<sup>1</sup> – Fabrizio Antonelli<sup>2</sup> – Prof. Lorenzo Lazzarini<sup>2</sup>

<sup>1</sup> Institut Català d'Arqueologia Clàssica (ICAC), Spain <sup>2</sup> Laboratorio di Analisi dei Materiali Antichi (LAMA), Università Iuav di Venezia, Italy

Keywords: Murecine, Greco Scritto marble, archaeometric analyses

The so-called Edificio dei Triclinii, discovered at Murecine in 1959 and then re-excavated in 1999–2000, was an inn or *statio negotiatorum* on the Sarno riverbank in Pompeii's suburbs. During the second excavation campaign, a marble stack of circa 180 rectangular panels was found in the kitchen of the building, which was undergoing refurbishment when Mount Vesuvius erupted in 79 AD. In all probability, the slabs were meant for the decoration of the small *thermae* that were still under construction at the time of the eruption. Moreover, several examples bore the abbreviation SVL of the cognomen Sulpicii, bankers and businessmen of Campanian origins that have been identified as the possible owners of the Murecine building.

The stone composing the slabs was summarily classified as white marble by its excavators. Following the recent reanalysis of the panels, now stored in the House of the Criptoporticus at Pompeii, the stone was macroscopically identified as Greco Scritto. A possible Ephesian origin was put forward (Perna and Scognamiglio, ASMOSIA XII), based on comparisons with recently published research and the varieties that can be seen at the Hasançavuşlar, Ephesus. It was thus essential to assess such hypothesis through petrographic and geochemical analyses carried out by the LAMA –Laboratory for Analysing materials of Ancient origin of Iuav-University of Venice.

A total of 14 samples were collected and subjected to thin sections' study, isotopic and XRD analyses. The study displayed that all the samples correspond to an average-coarse grained marble (MGSs values from 2.16 to 4.88 mm) with heteroblastic microstructure, sometimes

weakly foliated; graphite and rarer muscovite are the only accessory minerals. These minero-petrographic data together with the specific isotopic signature recorded point to an Ephesian origin of the studied Greco Scritto. Such results, combined with the textual evidence and the 79 AD chronology of the eruption, which make the Murecine marble almost a unique case study, represent the first step towards a systematic contextual and geo-chemical study of the Greco Scritto of Ephesian origins used in Roman contexts and its respective contribution to the Roman stone trade.

## **»GRECO SCRITTO« MARBLE TYPES IN PUBLIC- AND SEMI-PUBLIC BUILDINGS ON THE EASTERN COAST OF HISPANIA TARRACONENSIS (1ST–2ND C. AD)**

Simona Perna<sup>1</sup> – Laura Galán Palomares<sup>1</sup> – Begoña Soler Huertas<sup>2</sup> – Anna Gutiérrez-García Moreno<sup>1</sup>

<sup>1</sup> Institut Català d'Arqueologia Clàssica (ICAC), Spain <sup>2</sup> Institut Català d'Arqueologia Clàssica (ICAC), Universidad de Murcia, Spain

Keywords: Archaeometric analysis, architecture, stone trade

A medium to coarse grained stone with black to blue speckles and streaks that can be macroscopically identified as Greco Scritto-like marble features among the varieties of marble decorating several sites along the eastern coast of Spain, from Catalunya to Murcia, within the borders of the ancient Roman province of Hispania Tarraconensis. Greco Scritto marble types in the shape of panels, tiles, and other decorative elements are found in important public as well as private, but with an openly public function, buildings dating to the first and second century AD, like the Augusteum of Carthago Nova (Cartagena). Other sites include the Roman villa of Els Munts (Tarragona), where the impressive bathing complex had several areas decorated with thick Greco Scritto panels. The use of this stone in such contexts finds direct architectural parallels in Italy, at sites like Ostia and Pompeii (Murecine: Perna and Scognamiglio, ASMOSIA XII), where some of the public or semi-public buildings decorated with Greco Scritto seem to be connected with patrons of libertine origins. Moreover, macroscopic comparisons with recently published varieties and those that can be seen at the Hasançavuşlar quarries near Ephesus seem to point in the

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direction of a possible Ephesian provenance, rather than an Algerian origin, for most of the Greco Scritto marble types found at Roman sites in Hispania. Such evidence combined with the potential Turkish identity of the marble adds important data on the distribution of this stone in Roman contexts in the Tarraconensis area as well as on the trade and procurement by private individuals.

The poster presents new data emerging from the survey of the lithic decoration of Roman buildings in the Hispanic province. Such data is further contextualized within the wider uses of Greco Scritto marble types in contemporary contexts in Roman Italy. Moreover, the results of the analyses carried out by the Unitat d'Estudis Arqueomètrics laboratory at ICAC on the samples from the Els Munts bath complex will be presented. Such study integrates current research on the Greco Scritto of non-Algerian origins (Perna, Antonelli and Lazzarini forthcoming) aimed at understanding the contextual uses and geo-chemical characteristics of the Greco Scritto marble types used in Roman contexts in and outside Italy in the early Imperial period.

## **PORPHYRY AND OTHER HARD STONE VASES FROM THE EARLY IMPERIAL PERIOD**

Simona Perna

Institut Català d'Arqueologia Clàssica (ICAC), Spain

Keywords: Carving techniques, Julio-Claudian sculpture, private collecting

The production of architectural and statuary sculpture in porphyry in the Roman period reached its peak between the 2nd and the 5th c. AD, although the use of this stone is attested as early as the Julio-Claudian period. Several porphyry artefacts from this epoch include vases of various shapes and size. Overarching narratives on the symbolism of porphyry sculpture as expressing imperial power coupled with the scattering, private collecting and the lack of a typological framework of these vases have often led scholars to view them as late products (Delbruck 1932; Del Bufalo 2010). However, recent archaeological evidence (Slavazzi 2010) combined with a closer analysis of the material compels us to review such chronology.

The present contribution discusses the physical and technical features of vases carved from porphyry and other hard stones, such as granite, basalt and greywacke by gathering a body of material up till now

dispersed and fragmented. In particular, it emerges that working tools included the lapidary lathe, while proportions, finishing of the surface and the overall elegance of the profiles testify to virtuoso carving by skilled artisans, who were able to translate the most popular motifs and shapes into the hardest stones. These objects were fine products destined to a high-ranking clientele that included, but was not limited to, the Imperial family. When compared to contemporary containers in other stones and media (Perna 2015; Perna forthcoming), it becomes apparent how such porphyry vases can be more confidently recognized as artistic productions from the Julio-Claudian and Flavian periods.

## **REAL, PAINTED OR BOTH? A CONTEXTUAL ANALYSIS OF THE ALABASTER DECORATION IN THE VILLA OF THE MYSTERIES (POMPEII)**

Simona Perna<sup>1</sup> – Simon Barker<sup>2</sup>

<sup>1</sup> Institut Català d'Arqueologia Clàssica (ICAC), Spain <sup>2</sup> University of Ghent, Belgium

Keywords: Calcite alabasters, visual arts, architecture

By the early imperial period, calcite alabaster was one of the most popular decorative stones used in domestic contexts. Egyptian, African, Turkish and Italian varieties came into use in Roman houses in the Vesuvian area from the mid-1st c. BC onwards. The frequency and accuracy of the painted reproductions in 1st-, 2nd- and 4th-Style frescoes mirrored the growing popularity of real Egyptian and non-Egyptian alabaster types. However, both real and painted alabaster are rarely found in the same context. At Pompeii, only 6 out of the 44 houses that presented alabaster contained both real and painted varieties. The Villa of the Mysteries, located in Pompeii's suburbs, represents a remarkable case in point due to its impressive display of both real and painted alabaster in a single context and for the date of its construction – the late republican period – a key period for the introduction and increasing popularity. This contribution discusses the real and painted alabaster decorating Villa of the Mysteries' most emblematic rooms. The objective is to understand the materials function, aesthetics as well as possible semantic attributions. Huge quantities of real Egyptian and non-Egyptian alabaster inserts decorate many of the villa's floors (cf.

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F1-F3, P1-P4, 1, 2, 4, 62). Moreover, a total of 6 rooms featured several panels of painted alabaster of which four (rooms 3, 6, 15, 16) can be identified as Egyptian onyx. The »Mysteries room« (room 5) contained one of the most realistic painted representations of Turkish Alabastro Fiorito known from Pompeii, used to frame the upper part of the famous Dionysiac scenes. When considered within the overall context of the villa, the relevance and significance of such an abundant display of alabaster become particularly meaningful. The Villa represents one of the most grandiose examples of late Republican private architecture, which also shows close affinities with that of contemporary religious and public buildings. It has been suggested that the owner, who remains anonymous, might be one of Silla's high officials who constructed the villa not long after the dedition of the colony in 80 BC. The sumptuous interior decoration, which included outstanding 2nd-Style wall paintings and pavements, was clearly meant to underline the status and prestige of its owner. The choice of calcite alabaster, one of the earliest polychromes to be imported and used at Pompeii, further enhanced the social value of the villa's decoration while its painted counterparts added new values to its aesthetics and semantics.

## **TECHNOLOGY, TRADITION AND INNOVATION OF CLASSICAL GREEK AND HELLENISTIC STONE VASES**

Simona Perna

Institut Català d'Arqueologia Clàssica (ICAC), Spain

Keywords: White marble, carving techniques, gender archaeology

White marble vases of various shapes (pyxides, oinochoai, kraters, louthrophoroi, exaleiptra) were produced in Greece between the 5th and the 3rd c. BC. Dozens of examples were discovered in mainland and insular Greece, the Black Sea and southern Italy; however, many are now scattered among several museums and private collections across the world. These vases reveal skilled workmanship and the use of fine tools, such as the lapidary lathe. What is more, it appears that these objects were ritual paraphernalia as they have been found in religious and funerary contexts. However, textual and visual evidence also suggests that certain shapes had a deeper symbolic meaning in both domestic and ritual contexts as they were above all linked to

womanly practices. Despite some previous studies, mostly taxonomical in nature (Caskey 1939; Zephiropoulou 1973; Gaunt 2013), these objects remain a heavily understudied class of ancient lithic artefacts. Yet, they have the potential to inform us on the making of non-statuary and architectural stone sculpture in Greek and Hellenistic times as well as on the socio-cultural importance of the consumption of non-ceramic vases in Classical societies. The MSCA funded project »Technological innovation and knowledge networks: a multidisciplinary approach to Graeco-Roman stone vases« (TECHNET: 895286) has among its objectives to carry out a comprehensive analysis of these stone vases from a comparative perspective and to shed light on carving techniques and the technology employed in their production.

The present contribution discusses the physical and technical features of such marble vases in light of the preliminary analyses carried out by the present author. In particular, it emerges that working tools and techniques entailed cross-crafting. The carving was done into separate, lathe turned elements. This reveals continuity with earlier and later stone vase carving procedures and the existence of knowledge networks among artisans formed within a certain tradition, on the one hand; on the other, it appears that such tools and techniques fit the actual design of the vase, the shapes being skeuomorphs of wood, metal and pottery containers. Other features include the presence of painted decoration often using precious pigments, like gold or Egyptian blue. Reassessing these vases means deepening our understanding of the technical, human and wider socio-cultural factors behind the production and use of stone artefacts in the Classical Greek and Hellenistic periods.

## **LOST IN THE FOREST AND FOUND BY LIDAR: THE PRE-ROMAN LIMESTONE QUARRY AT MĂGURA CĂLANULUI (ROMANIA)**

Aurora Peșan

Study Centre of Dacica Foundation, Romania

Keywords: Limestone quarry, LiDAR, pre-Roman Dacia

The Dacian Kingdom with its centre in Transylvania, in the Șureanu Mountains, functioned in the 1st c. BC–1st c. AD at the edge of the Greco-Roman world. One of its main forms of expression of power was

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monumental architecture, the result of an unusual fusion of military and religious architectural techniques and concepts from the Classical world and the late European Iron Age. The main source of stone for these constructions was the oolitic limestone quarry at Măgura Călanului. It functioned throughout the Dacian kingdom, and after the conquest of Dacia in 106 AD, it was used by the Romans. It was abandoned in antiquity and has been well preserved to this day. The existence of this quarry has been known for a long time, but no archaeological research has ever been done there. Several petrographic and mineralogical analyses have confirmed that the Dacian fortresses in the Şureanu mountains, today inscribed on the UNESCO World Heritage List, were built with stone extracted from this place. The size of the quarry, the exploitation techniques and other aspects have remained unknown until now, largely due to the difficult access to the site and the forested land. In this paper I will present an analysis of a LiDAR-based digital terrain model, which reveals for the first time the real extent and complexity of this quarry, the way it was organized and its stages of development. LiDAR data were correlated with information obtained during several field surveys.

The results are remarkable and show on the one hand the high degree of development of the Dacian society and its relations with the Greco-Roman world, and on the other hand, the huge potential of LiDAR technology in researching ancient stone quarries.

## **A FOREIGNER IN MOESIA: AN ALABASTER BOXER HEAD FROM NOVAE**

Kalina Petkova

National Archaeological Institute with Museum, Bulgarian Academy of Sciences, Bulgaria

Keywords: Alabaster, Aegyptiaca, Novae

The proposed poster presents a male head discovered within the territory of Novae. Discovered in the 30s of the 20th century, it now belongs to the collection of the Historical 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 comes from other representations on different media around the Mediterranean. The Novae exemplar, which represents a boxer, was

likely produced from alabaster with pale yellow colour in the 1st c. AD. Its discussion can be set in the broader context of Aegyptiaca imports on the territory of the Danube province of Moesia Inferior.

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

Scott Pike<sup>1</sup> – Kenneth Sheedy<sup>2</sup> – Elena Familetto<sup>3</sup>

<sup>1</sup> Willamette University, United States of America <sup>2</sup> Macquarie University, Australia <sup>3</sup> Utrecht University, the Netherlands

Keywords: Naxos marble, Sangri Valley, stable isotope analysis

Stable isotope analysis of Early Cycladic marble artifacts recovered from the recent archaeological excavations by Renfrew and Boyd on Keros and Dhaskalio, as well as published studies of other Early Cycladic material (including the Keros Hoard), indicates that the marble was typically sourced from southern Naxos. As there are no known ancient white marble quarries in this part of the island, however, it has been proposed that these Cycladic artifacts were perhaps carved from well-rounded beach cobble collected along the shore. Interestingly, Sheedy and Pike in an accompanying paper at this conference, present data that suggests that the marble used to make the colossal marble statue of Apollo dedicated to the god by the Naxians in his sanctuary on Delos ca. 600 BC may also have originated in southern Naxos. The well-known quarries of Melanes and Apollonas that contain surviving larger-than-life unfinished archaic kouroi are to the north and their geochemical signatures do not match those of the Bronze Age figurines from Keros and Dhaskalio or the Naxian Apollo on Delos. Is it possible then that there is at least one white marble source on southern Naxos that has so-far escaped detection?

The paradoxical question of geochemically sourcing white marble artifacts to quarries that have yet to be recognized led to a 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 that share the same textural and stable isotope signature as those of artifacts identified as being from southern Naxos. Our limited survey revealed at least one abandoned quarry pit within the white marble outcrops. It is highly likely that these white marble outcrops are the

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source for many of the well-known Cycladic figurine sculptures and possibly the Naxian Colossus of Apollo on Delos. However, before a definitive answer can be given and to get a sense of the extent of the marble resource, a thorough and proper geoarchaeological survey of the Sangri Valley is being planned for the near future.

## **THE PORPHYRY OBELISK: A ROMAN MONUMENT OF CONSTANTINOPLE**

George Pinkerton  
University of Edinburgh, United Kingdom

Keywords: Porphyry, obelisk, Constantinople

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 century 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 recognized. Like the column monuments of Constantinople and Rome, obelisks were erected in both Roman capitals for emperors who 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.

## **MARBLE FOR THE GODS – THE ARCHITECTURE OF THE SANCTUARY OF SAMOTHRACE FROM THE AUSTRIAN EXPEDITIONS**

Georg Plattner<sup>1</sup> – Walter Prochaska<sup>2</sup>

<sup>1</sup> Kunsthistorisches Museum Vienna, Austria <sup>2</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: Samothrace, marble, Greek architecture

Almost 150 years ago, the then newly founded Institute of Classical Archaeology at the University of Vienna undertook the first major scientific field research on the Greek island of Samothrace, which was then under Ottoman administration. In the two expeditions in 1873 and 1875 led by Alexander Conze, the focus was – remarkably for the time – less on discovering valuable finds than on the scientific research in the excavation, the documentation of the preserved ruins and the understanding of the mystery sanctuary.

The selection of finds brought back to Vienna is accordingly unusual; they are mainly architectural pieces representative of the respective buildings. The few sculptures selected are also pediment figures or building ornaments as friezes or coffers.

In Vienna, the finds were acquired by the Imperial collections and are now exhibited in the Ephesos Museum of the Kunsthistorisches Museum Vienna. After some sampling of the sculptures, the current focus is on the analysis of the marble of the buildings. The aim is to present results that can complement the recent work of Greek and American colleagues (ASMOSIA IX). By means of isotopic analyses and the analyses of trace element composition the marbles of the architectural elements were investigated in order to get information on the sources of the marbles used. The marble inventory of the three investigated complexes is not homogenous due to either the specific original materials or later additions. A variety of marbles from different sources was detected. The marbles of the Arsinoeion all are from Thasos (Alikí). In the samples from the Propylon ('Ptolemaion') and the Hieron marbles from Thasos, Prokonnesos III and Lesbos(?) are represented. It is worth to note, that no single artefact could be found made of the main Proconnesian marble (Prokonnesos I) or from Parian marbles.

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## **STONE AND SCULPTURE IN ERETRIA: BETWEEN LOCAL EXPLOITATION AND IMPORTATION**

Laureline Pop<sup>1</sup> – Chloé Chezeaux<sup>1</sup>

<sup>1</sup> University of Lausanne, Switzerland

Keywords: Eretrian, sculpture, quarries

Even though Pliny did not dwell on the local rock while praising the qualities of Eretrian soil (Plin. Nat. Hist. 35, 21), Euboean stone was rather famous. Throughout the Imperial period, the Eretrian Marmor Chalcidicum and the Cipollino from the southern part of the island were widely distributed in the Mediterranean. However, these polychrome marbles, which have inspired a great number of publications, were clearly not the material of choice for Eretrian building activities. As an ongoing study is shedding new light on their formerly unidentified sources, it turns out that a considerable number of quarries supplied the construction sites in the territory of Eretria. In this paper, we therefore want to raise the question whether local stone was also exploited for sculpture.

Current research suggests that although regional limestone was widely used for buildings and their embellishment in Eretria, it was rarely employed for sculpture. While some funerary reliefs were carved into local stone, the majority of free-standing statues as well as certain small sculptures were made of imported monochrome marble. Recent studies have notably shown that the marbles from the temple of Apollo Daphnephoros came from a Parian quarry. Such marble imports seem to have continued in the Hellenistic and Imperial period.

This paper will present the current state of research on the stone used for sculpture in Eretria, with an emphasis on the material's origin.

## **THE EXPLORATION OF NEW ANCIENT QUARRIES IN DODECANESE AND THE USE OF THE EXTRACTED STONES**

Eirene Poupaki

Hellenic Ministry of Culture and Sports, Greece

Keywords: Dodecanese, quarries, stone provenance

The intense research programme on Kos and its neighbouring islands conducted during the past two decades by a scientific team of Athens University in order to locate possible stone sources which provided the needed material used in the Hellenistic Sanctuary of Halasarna brought to light important evidence about the stone-quarrying activity during antiquity in Dodecanese. The information gathered had been included in the writer's thesis »Koan stones and Koan stone-carving activity«, submitted in Athens University in 2011, under the supervision of Prof. Georgia Kokkorou - Alevras.

Our recent archaeological research during surveys conducted in Dodecanese as employees in the Greek Archaeological Service added important information to the catalogue of the Dodecanesian quarries, whereas the archaeometric methods enabled us to determine the origin of the material of several archaeological findings. In this paper there will be a short presentation of the recently discovered quarries: of »poros« (sedimentary rock) at Asklepieion of Kos, at Ialysos and Lardos of Rhodes, of volcanic rocks at Argos of Nisyros, at Pacheia and Pergoussa (islets close to Nisyros) and grey hard limestone at Levitha (islet west of Leros), as well as a connection of the extracted stone with known archaeological findings, basing on the recent archaeometric research, visual observation, and literary sources.

## **BUILDING STONE MATERIALS IN DEULTUM-DEVELT (QUARRY, LITHOSTRATIGRAPHY, COMPOSITION)**

Hristo Preshlenov

National Archaeological Institute with Museum - Bulgarian Academy of Sciences, Bulgaria

Key words: Deultum, building stones

Colonia Flavia Pacis Deultensium is the only Roman colony founded in 70 AD on the west coast of the Black Sea, at the »bottom« of the Burgas Bay, west of the Mandren flowing firth, on the left slope of the Sredetska river valley.

The rock composition of the quarry elaborations on the territory of the colony along the lower flow of the Sredetzka River, before the Mandren firth, is represented by tuffs, lapilli, volcanic tuff bombs, andesite-basalt

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composition, infrequent lava flows, gravels and sands, deposited on the tuffs. Under the modern surface (alluvial-meadow soils) and the destructions of the Roman colony, the late Roman and early Byzantine city, construction embankments are laid river alluvium taken from the lower flow of the Sredetzka river and mortar layers. The geological horizons below them consist of »buried« soil, diffuse transitional soil layer and strongly disintegrated tuffs. The street pavements are made of rectangular and polygonal slabs of greenish sandy tuff, tuff-sandstone with volcanic lapidaries, yellowish sandstone with augite and mica. The foundations and the smooth part of the walls of the Roman constructions are built with untreated (quarried and crushed in the quarries) and face-processed building stone, mostly greenish (amphibole-biotite amphibole-pyroxene) andesite and andesitic tuff. The late Roman constructions are made of crushed, spalled and rough-face processed stones – tuff sands and andesitic tuffs (predominant), gabbro, andesitobasalt, basaltoid. In the construction of the Late Roman/Early Byzantine fortifications andesite tuffs predominate, but olivine basalts and stones carved from biotite syenite, spherical explosive lavas with zonal structure, high potassium-alkali trachytes also appear. Square blocks of tuff-sandstone rocks are used for the exterior cladding of the fortress walls. The core of the wall and its inner front surface are built with crushed, respectively front processed-at place stones of andisite tuffs and alkaline basaltoid. In the construction of houses, in addition to the usual used types of building stones, trachybasalt (?) stones are also used, rhyolite tuffs and fine-grained quartzite.

## **A DATABANK FOR THE PROVENANCE ANALYSIS OF ANCIENT WHITE MARBLES**

Walter Prochaska

Austrian Archaeological Institute, Austrian Academy of Sciences. Austria

Keywords: Trace element analysis, isotope analysis, statistical evaluation

»Multi-method-approach« has now been for many years the keyword in marble provenance analysis. This is often claimed in these investigations but rarely applied in the sense of the combined simultaneous use of a large number of analytically obtained variables. The prerequisites are the availability of a number of characteristic analytical data that may be expressed numerically (e.g. isotope analysis, chemical data, etc.) of

an artefact and of course also of a corresponding database. Naturally, there are different suitable methods available to compute these data.

A major disadvantage of using a true multi-method-approach is the lack of the availability of published numerical data in the form of a databank. Usually average data or diagrams without the single underlying numbers (e.g. a stable isotope diagram) can be found, which is of little use for further integration of these data in a statistical analysis of an artefact.

Presented in this paper is a databank for the major classical marbles, with the single numerical data for isotope analysis, trace element analysis and the chemical analysis of micro-inclusions in the marbles and a suggestion how to use these data. Of course, future researches may use these data when investigating marble artefacts and apply their own statistical methods. Furthermore, a number of examples of the assignment of marble artefacts will be presented. It will be shown that the precision of the provenance analysis increases substantially by simultaneously computing a large number of analytically obtained variables. Finally, it should be explicitly pointed out that the unreflected collection of data for the chemical composition of marbles from different sources (and different analytical procedures) most probably implies severe differences in their comparability.

## **MOSAIC AS OPUS SECTILE: IMITATION OF COLOURED MARBLES ON THE NEVIODUNUM (DRNOVO, SI) MOSAIC PAVEMENT**

Jana Puhar  
Posavje museum Brežice, Slovenia

Keywords: Marble imitation, Roman mosaics, opus sectile, Neviodunum

During archaeological excavations in Drnovo pri Krškem, Slovenia (Municipium Flavium Latobicorum Neviodunum, Pannonia superior) in 1964, fragments of the mosaic pavement were discovered, dated in the late second to early third centuries. Its central field is imitating opus sectile pavement composed of large square plates of coloured marbles. Remains of 6 plates are preserved which are imitating four different types of marble. Three of them show the same schematic design with big ovoid elements accompanied by smaller ones defined by black

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outlines. They are filled mostly with the ochre and white, but also some deep red tesserae in the way Giallo Antico Brecciato marble (Chemtou) was usually painted in antiquity. Formally similar to this design is another one with the filling in pink, grey, white and some green tesserae, showing probably the pink variant of the Breccia Policroma della Vittoria marble (Akrini, Kozani). Two other types of marble are clearly recognizable as red porphyry (Gebel Dokhan) and Porfido Verde Antico (Krokea). Mosaic imitations of opus sectile pavements are known from at least the early 3rd c. onwards as a substitution for precious coloured marbles. The Neviadunum pavement seems to be one of the few such pavements made at the beginning of this fashion.

## **SOLVING AMBIGUITIES AMONG COARSE GRAINED GREY GRANITE IN NON-DESTRUCTIVE SOURCING TECHNIQUES APPLIED TO ANTIQUITY**

Pierre Rochette<sup>1</sup> – Jean-Paul Ambrosi<sup>1</sup> – Marion Defrance<sup>1</sup> – Pierre Deschamps<sup>1</sup> – Jerome Gattacceca<sup>1</sup> – Abel Guihou<sup>1</sup> – Jacques Planchon<sup>2</sup> – Claudia Sciuto<sup>3</sup>

<sup>1</sup> Aix Marseille University, CNRS, France <sup>2</sup> Musée de Die, France <sup>3</sup> Università di Pisa, Italy

Key words: Non destructive methods, granite, Corsica

A well established method combining visual inspection and magnetic susceptibility measurement (Williams-Thorpe 2008) allows to discriminate without sampling the major sources of antique grey granite shafts described in literature: Troad, Mysium, Elba-Giglio and Claudianus. However, when considering sources previously considered as minor (Spain 3, Corsica, Nicotera see Williams-Thorpe 2008, Williams-Thorpe and Rigby 2006, Antonelli et al. 2010) their differentiation from Claudianus remain ambiguous: they all share a coarse grained black and white texture, with similar susceptibility in the 3-9 mSI range (not known for Nicotera). Typical for Claudianus is a mineral foliation, but foliation may also be present in the other sources, and observation conditions do not always allow detecting this foliation. Our systematic survey of granite shafts in Gaul (Rochette et al. 2021) identified several “Claudianus-alike” shafts in Die and Lyon, lacking foliation and with a colouration not perfectly black and white (some grey and some faintly pink-orange patches), while one shaft in Lyon was foliated with a more typical colour. We attempted to solve the ambiguity left by identical

magnetic susceptibility using portable XRF on the surface of ten shafts from Die and Lyon, as well as on fragments of these shafts and samples of the Corsican quarry in Cavallo island. According to (Williams-Thorpe 2006), Rb and Sr may be the trace elements of choice for discrimination using pXRF, although caution was raised for biases due to weathering. Coarse grain nature produces large variability in single measurement results. However, averaging data over at least 7 positions produces consistent values. The Claudianus-alike shaft population produced consistent Rb and Sr values close to Corsican geologic samples, with significant Rb depletion. This depletion is reduced when measuring freshly cut surfaces. However, they all strongly differ from the single different shaft in Lyon, which fits with literature data for Claudianus. To further confirm that all but one suspect shafts studied in Gaul came from Corsica rather than Egypt, we undertook Sr and Nd isotopic measurements on small samples detached from few shafts. In the future we plan to investigate similar shafts (in terms of texture and magnetism) that we identified in Tarragona and Pisa, bearing in mind the necessity to better characterize Spain 3 and Nicotera sources.

## **SYSTEMATIC SOURCING OF GRANITE SHAFTS FROM GALLIA NARBONENSIS AND COMPARISON WITH OTHER WESTERN MEDITERRANEAN AREAS**

Pierre Rochette<sup>1</sup> – Touatia Amraoui<sup>1</sup> – Valérie Andrieu<sup>1</sup> – Alain Badie<sup>1</sup> – Philippe Borgard<sup>1</sup> – Andreas Hartmann-Virnich<sup>1</sup> – Marc Panneau<sup>1</sup> – Jacques Planchon<sup>2</sup>

<sup>1</sup> Aix Marseille University, CNRS, France <sup>2</sup> Musée de Die, France

Keywords: Granite, shaft, source

Granite shafts became a major decorative and structural element of monumental architecture during the Roman Empire. Only a few sources quarries have been identified and shaft trade was established at the whole Mediterranean basin scale (Lazzarini 1992; Williams-Thorpe 2008), with major sources in Egypt (Assouan and Claudianus), Turkey (Troad and Mysium) and Tuscan islands (Elba and Giglio). Other antique quarries are known in Corsica-Sardinia and Spain, in particular, with assumed minor long distance diffusion. The only attempt to pursue granite sourcing in Gaul, besides local studies, is found in (Mazeran 2005), but without a systematic and quantitative

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aspect. We have undertaken such a systematic study using magnetic susceptibility and visual criteria, following Williams-Thorpe 2008.

269 granite shafts remains (complete or as fragments) were identified in 20 sites from Gallia Narbonnensis. To achieve a statistical significance in terms of initial importation, we attempted to generate composite shafts from fragments of similar characteristics, leading to a corpus of 173 full shafts. Major sites (with >15 shafts) are Arles, Riez, Die, Aix and Orange. Turkish sources strongly dominate (73 %, 2/3 of which from Troad), Elba being second (19 %). Besides the overall predominance of Troad, some site specificities appear with predominance of Elba in Orange and Vienna, of Mysium in Marseille and Riez. Minor sources are pink granites of Assouan (3 shafts) and Olbia (3 shafts), as well as grey granite presumed from Corsica (5 shafts in Die, see discussion in Rochette et al. 2021). No local granite source from Gaul is identified, setting apart Esterel porphyry (4 shafts near Esterel). Comparison with other western Mediterranean areas (Williams-Thorpe 2008) highlights the specificities of granite trade. Egyptian granites are abundant only in Roma (with Turkish sources being second), signing their more prestigious value. Local sources are dominant in Andalusia, Sardinia and Tuscany, while Turkish sources dominance is observed only in Narbonnensis, Tarragona and Maghreb (Roda I. et al. 2012 and Antonelli et al. 2010 plus our unpublished investigations). The majority of shafts from Narbonnensis are found reused in late antiquity to modern settings, and we may question the implicit assumption of previous authors that present corpus has not been biased by post-roman importation of spoliae.

## **REVIEW PAPER: ASMOSIA AT 34 YEARS: THE TRAJECTORY OF RESEARCH ON ANCIENT STONE AND ITS RELEVANCE TO ART HISTORICAL QUESTIONS**

Irene Bald Romano

University of Arizona, United States of America

Keywords: Marble, art history, museum studies

Since its first meeting in 1988, the primary focus of ASMOSIA has been on determining the provenance of stones used in Greek and Roman architecture, sculpture, and other objects, with marble studies

predominating. ASMOSIA has fostered ground-breaking research and publication of scientific methods used to identify the »signatures« of marbles from ancient Mediterranean quarries and the identification of new quarry sites. With the accumulated evidence it has been possible to rewrite the history of aspects of the marble trade and networks, chronological span of the use or popularity of certain marble types, and relationships among quarries, manufacturing centres, civic, domestic, and sanctuary sites, and sculptors.

The usefulness of this kind of research for art historical analysis in academic settings and in museums cannot be overstated. It is now standard practice to include marble identification in labels or catalogues and to cite whether the information comes from scientific testing. Understanding the marble source sometimes makes it possible to provide a closer determination of the date of an object, project the likelihood the object is a forgery, or narrow down the ancient findspot of an object when that information might be lost. ASMOSIA has also fostered the dissemination of research on polychromy in ancient stone architecture and sculpture, a topic that has garnered much interest among scholars, museums, and the general public. The use of the »object biography« approach to the study of antiquities in which the full »life history« of an object is traced from its manufacture to the present day has gained traction among ancient art historians; in this methodology an understanding of the quarry site, carving techniques, workshop methods, and ancient transfers are of interest. Materiality and the symbolic uses of a particular stone are also important topics in art historical studies. All the studies championed by ASMOSIA have brought art historians and museum curators closer to conservators, geologists, chemists, and archaeological scientists of all kinds and have promoted the importance of interdisciplinary research on ancient stone artefacts.

Taking stock of ASMOSIA's past accomplishments naturally leads to questions of the future of studies of marble and other stones in antiquity and the kinds of research trajectories that will provide the greatest impact for art history and museums. The training of scientists in analytical techniques related to stone provenance studies, the accessibility and sharing of scientific data, and the funding for this kind of research are future concerns.

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## **BOOK-MATCHING: WHY AND SINCE WHEN ARE MARBLE SLABS LAID SYMMETRICALLY?**

Rosenberg Raphael  
University of Vienna, Austria

Keywords: Aesthetic of marbling, Pliny, eye tracking

From an art-historical perspective, I tried to show that aesthetic interest for »marbling« goes far beyond artifacts of multicoloured stones and includes materials such as wood veneer, ceramics, glass, and painting (Rosenberg 2021). I argued that marbling is one of the oldest and probably the longest-lasting form of ornament – from the Neolithic to the present. However, within this almost anthropological continuity, people at some places and in some epochs were more interested in marbling than others. They developed new materials and innovative forms. A particularly sustainable invention was the »book-matched« laying of reversed stone slabs from the same block. It produces irregular symmetry, which to this day exerts a strong aesthetic appeal. In order to better understand this appeal, my »Lab for Cognitive Research in Art History« (<https://crea.univie.ac.at/>) is about to conduct an eye-tracking study comparing irregular and (artificially mirrored) regular symmetrical marble slabs.

In this paper I would like to show 1) that although the practice of marbling is much older, book-matching was used for the first time, hence »invented«, in Rome in the early 2nd c. AD, 2) that this was a time with an extraordinary interest for the aesthetic of marbling. Whereas archaeological evidence for increased use of marble since the 1st c. is well known and Pliny's statements on the veins of myrrhine are often quoted, they were not yet related to his almost identical descriptions of furniture made with citrus wood and tortoiseshell which we can no longer trace physically. 3) Assuming that the empirical study above mentioned and conducted with a student is finished in September, I would also like to report some results.

# ROMAN MARBLE STATUES FROM TARRACO (HISPANIA CITERIOR): IMPORTS AND LOCAL PRODUCTION

Julio C. Ruiz

Institut Català d'Arqueologia Clàssica (ICAC), Spain

Keywords: White marbles, local production, importation

Studies on production centres of Roman sculptures are more favourable in large ensembles, as happens in Tarraco, capital of Hispania citerior. Various parameters allow proposals about workshops and production centres. These parameters are mainly:

- degree of accuracy with respect to the copied or reworked model
- raw materials used
- observation of technical aspects such as the assembly system or the markings of the roughing and sculptural modelling process
- stylistic quality of the pieces
- comparison with sculptures produced in known production centres

In this lecture the results of a study applied to the Roman sculptures of Tarragona will be presented. The aim is to distinguish between local productions and imported works, at various stages of production. Attention will be paid to the various sculptural typologies, considering the type of representation (divinities or portraits), the dimensions and the qualitative aspects of the marbles used. The original contexts for which the sculptures were intended will also be considered. The results of the study show that a large part of the statues had to be made in workshops in Tarraco. However, I have also detected several sculptures that were most likely sculpted in workshops in Rome or Italy, and others that may be related to production centres in the eastern Mediterranean. This study provides new data on the production process of Roman marble sculptures in this important city of Hispania.

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## **TRADE WITH MEDITERRANEAN MARMORA IN THE ROMAN NORTHWEST: THE PROVENANCE OF ARCHITECTURAL ELEMENTS IN AUGUSTA TREVERORUM (TRIER, GERMANY)**

Vilma Roppiene<sup>1</sup> – Walter Prochaska<sup>2</sup>

<sup>1</sup> Ruhr Universität Bochum, Germany <sup>2</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: Augusta Treverorum, provenance of stones, architectural elements

Roman Augusta Treverorum (today's Trier), the capital of the Roman Gallia Belgica, is favourably situated on the shore of the river Moselle in the West of Germany. Here, numerous architectural elements (capitals, bases, columns and architraves) are preserved in the Rheinisches Landesmuseum Trier and its magazines or scattered at the archaeological sites such as Barbara-Baths (Barbarathermen), Imperial-Baths (Kaiserthermen) and Amphitheatre. A large number of them are surely made not of local/regional stones (sandstone of Buntsandstein formation, diverse Jurassic limestones from Lorraine), which were widely used by the Romans in this region. In contrast to the knowledge of the widespread use of Mediterranean marmora for the incrustations in the buildings of Augusta Treverorum, nothing was previously known about the trade with architectural elements made of Mediterranean stones in the Roman province Gallia Belgica.

70 architectural elements (fragments or whole pieces), which are certainly made not of local/regional materials, were selected in 2019/2020 for provenance investigations. The aim of this study was to carry out an initial documentation of imported elements in order to record the variety of imported stones used in the architecture and to determine their origin. Furthermore, new insights in the Roman trade with Mediterranean marmora in the periphery of the Roman Empire should be gained. The selected objects/samples were partly examined macroscopically and partly investigated using scientific analyses (polarization microscopy, analyses of fluid-inclusions, and isotopes of carbon and oxygen). The investigations revealed that the studied artefacts are made of 20 different stone types originating from different quarries in Italy (Carrara marble, Granito Elbano), Greece (pentelic and hymettian marble, Cipollino Verde, Porfido Verde Antico, Verde Antico), Turkey (Proconnesian marble, Proconnesian Greco Scritto, Cipollino

Rosso, Pavonazzetto, Africano, Broccatellone, Granito Violetto, marmor Misium), Egypt (Porfido Rosso Antico, Alabastro Cotognino) and France (Cipollino Mandolato, marble from Châtelperron/Champ-Robert and limestone of Comblanchien formation (?)). These results show that architectural elements from Mediterranean marmora reached not only the cities that were well and closely connected to the seaports, but also the inland provinces that could only be supplied by river routes and land transport.

## **VARIETY AND PROVENANCE OF STONES USED IN THE FORUM BUILDINGS OF MENINX (DJERBA, TUNISIA)**

Vilma Ruppene<sup>1</sup> – Johannes Lipps<sup>2</sup>

<sup>1</sup> Ruhr Universität Bochum, Germany <sup>2</sup> Johannes Gutenberg Universität Mainz, Germany

Keywords: Meninx (Djerba), marble provenance, Roman forum

The planning of the forum of Meninx and the construction of the first monumental buildings began in the early Imperial period. A fundamental redesign and modernization of the forum took place in Antonine times, when a basilica on the south-eastern edge of the square was built, further the new porticoes and the so-called southern temple on the south-western edge of the square. Numerous architectural elements, which are still visible on the archaeological site were systematically documented by the team from the University of Tübingen during an architecture survey in 2017–2019 and assigned to the various forum buildings. As part of this study, samples were taken from ca. 40 architectural elements (bases, capitals, entablature, columns) and nine statues in order to determine the variety and provenance of stones used in architecture and sculpture and to prove whether the same stones were used for buildings of different dates. In addition, reference samples from the limestone quarries north and north-west of the city were collected and compared with archaeological samples to determine if the limestones used were of local origin. All samples were subjected to detailed minero-petrographic examination under a polarising microscope. In the case of marble, the ratio of the stable isotopes of C and O was also determined. The results of the investigation show that both rocks of local/regional origin and marble from various quarries in the Mediterranean area were used at the forum of Meninx.

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The structures from the early Imperial period were constructed of local Pleistocene limestone (Eolianite) quarried in the occurrences north of the city. Entablature parts which presumably belonged to this earlier forum phase, are made from Alabastro a Pecorella, which was imported either from the Algeria (Bouhanifia) or from Tunisia (Djebel Oust). The floor slabs used to pave the square are made of an Upper Cretaceous pelagic limestone, probably from northern or central Tunisia. In the forum buildings erected in the second half of the 2nd c. AD, two types of imported marble were used instead of local stones. The bases, capitals and entablatures of the porticoes and the so-called South Temple were made of Pentelic marble, whereas bases, capitals and entablature of the forums basilica consist of Proconnesian marble. The column shafts of the basilica were made of Euboean Cipollino Verde, those of the porticos – of Fior di Pesco. Four different types of marble were used for sculpture: Carrara, Penteli, Thasos 3 and Paros 4.

## **EXPLOITATION AND USE OF MARBLE IN GALICIA FROM ROMAN TIMES TO THE COMPLETION OF THE ROMANESQUE CATHEDRAL OF SANTIAGO DE COMPOSTELA (1ST–13TH CENT. AD)**

Marie-Claire Savin<sup>1</sup> – María Pilar Lapuente Mercadal<sup>2</sup> – Anna Gutiérrez García-M<sup>1</sup> – Isabelle Pianet<sup>3</sup> – Silvia González Soutelo<sup>4</sup> – Dr. Mauro Brillì<sup>5</sup>

<sup>1</sup> Institut Català d'Arqueologia Clàssica (ICAC), Spain <sup>2</sup> Universidad de Zaragoza, Spain <sup>3</sup> Université Bordeaux Montaigne, France <sup>4</sup> Universidad Autónoma de Madrid, Madrid Institute for Advanced Studies (MIAS), Spain

<sup>5</sup> Istituto di Geologia Ambientale e Geoingegneria, IGAG-CNR, Italy

Keywords: Galicia, Antiquity, Middle Ages

The question of the exploitation of marble has received little attention from researchers on the Galician territory, in the north-west of Spain, despite the heritage importance in this area of some Roman and medieval pieces shaped in this material. This contribution is an attempt to cover this lack. On the scale of this geographical area, it combines fieldwork and quarry survey-inventory with the analysis of a set of miscellaneous archaeological pieces (inscriptions, capitals, column shafts, sarcophagi, etc.), including some from emblematic buildings such as Santa Eulalia de Bóveda, Santa Comba de Bande and

the Cathedral of Santiago de Compostela. Although we gave special attention to shed light on the exploitation and use of this material, the study is mainly based on the archaeometric analysis. We applied the sequential method used successfully in other Hispanic sectors, combining petrographic/cathodoluminescence examination and stable isotope ratios of carbon and oxygen. We put an additional effort to improve the protocol with a finer definition of the descriptive criteria of the cathodomicrofacies and the use of complementary examination techniques that are either uncommon (spectrophotolorimetry, SEM-EDS, XRD, SEM-CL, RAMAN, ICP-OES), or totally innovative with the first application of Carbon-13 NMR. Among other conclusions, a coarse-grained marble from Gondrame, a location near to the antique capital of conventus Lucus Augusti was identified for the first time in Roman pieces. However, stone production of the well-known local sources such as O Incio marble was not documented before the Middle Ages. This study also showed the sporadic use of imported materials from Luni-Carrara as well as from the Portuguese districts of the Estremoz Anticline and Trigaches-São Brissos.

## **THE SYMBOLIC DESTRUCTION OF THE STATUES: HOW TO INVESTIGATE THE STAGING OF THIS FINAL USE?**

Marie-Claire Savin<sup>1</sup> – Andrea Collado Padilla<sup>1</sup>

<sup>1</sup> Institut Català d'Arqueologia Clàssica (ICAC), Spain

Keywords: Statues, destruction, analytical procedure

Intentional destruction of statues is a specific use of them. The recent defacement, de-pedestalling and destruction of many statues around the world as part of the Black Lives Matters protests remind us how symbolically this type of action can be. In almost every museum collection, deliberate alteration of statues seems visible. However, the interpretation of this phenomenon and its identification, especially of its symbolic implications, remain mainly understood through textual sources. Archaeology, and in particular the physical and chemical study of ancient materials could play a more significant role in the understanding of this phenomenon. This poster presents a state of the art, from an archaeological point of view, on this question. It compiles the most significant studies on this matter and suggests possible avenues of reflection to go further.

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## **A CACHE OF MARBLES FOR RESALE AND REUSE FOUND AT OPLONTIS B**

Rita Scognamiglio

University of Texas at Austin, The Oplontis Project, United States of America

Key words: Oplontis, reuse, resale

The complex originally called Villa B («of Lucius Crassius Tertius»), located in present-day Torre Annunziata, Italy, was not a villa but rather a kind of emporium focused on the handling of wine and perhaps other agricultural products. Following the initial excavation of the site by the Soprintendenza Archeologica di Pompeii (1974–1991), the Oplontis Project has, since 2012, conducted a series of explorations, including geo-prospection, conventional trenches beneath the 79 AD levels, analysis of the organic remains, and study of the old finds. This paper presents the results of a study of a total of 30 boxes containing marble, found in the Italian excavations and currently stored at the site in rooms 42 and 43. This material includes: marble slabs, mouldings, laths, sectilia, and fragments of thresholds.

Although the documentation concerning the excavation of the marbles has almost completely disappeared, this study proposes their original function, the reasons why the pieces were found stored, out of place, and their likely use in the original building. By studying and drawing more than 1,000 pieces, it was possible to classify the different categories of objects and to determine their role in the decoration of the walls of Oplontis B. Furthermore, this paper presents a typology of the different types of mouldings based on their profiles and dimensions. A comprehensive database of the marbles, accompanied by all of the drawings, will be available for further study.

The finds studied include mouldings in Giallo Antico and Rosso Antico, a few panels, and some floor elements. It is important to note that none of these elements have a bedding cement on the backs. Combining this information with the three recently published studies of the stone elements of Villa A, it is clear that the finds did not belong to the decoration of Oplontis B. Rather, they were stored there, probably after the earthquake of 61 AD, to be sold or relocated. As such, they fit with the profile of Oplontis B as a centre for storage and sale – not only of foodstuffs – but also of marble revetments.

## **THE USAGE OF MARBLE AT HAMAT GADER (GADARA THERMAE) IN ISRAEL**

Dror Segal

Archaeology Museum Gan-Hashlosha, Israel

Keywords: Roman baths, local stones, imported stones

The baths of Hamat Gader are located in the northeastern part of Israel. During the Roman period, a magnificent bathing structure was built on this site, taking advantage of the group of geothermal springs that originate in the area. The baths belonged administratively to the city of Gadara, which is located above the baths and was part of the Decapolis city alliance. For the construction of the complex, the magnificent bath structures, and the public assemblies around it, an imported stone was often used. Most of the construction, though is in local stone, basalt, and limestone. In addition, imported marble is widely used for wall cladding, flooring, signage, and many architectural elements. In this review, we will focus mainly on the fountain structures, most of which were made from imported white marble. The fountains are altar-shaped and almost identical in size, form, and shape. A thorough examination of the marble, in terms of texture and geochemical composition, shows a wide and surprising variety of distant quarries sources. Origin and transportation route analysis of the marble to the borders of the empire attests to the complex issues associated with marble quarries, the production and the transportation throughout the Roman Empire. In this review, we will present the various and fascinating optional import routes for the marble items, especially the fountains, from the quarry of the source to the final location – the bath structures. As research continues and more quarries, workshops, warehouses, and stranded ships are uncovered, we will get to know more about the entire trading system. On some of the research questions, we will probably never get an answer.

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## THE DELOS COLOSSUS PROJECT 2019

Kenneth Sheedy<sup>1</sup> – Scott Pike<sup>2</sup>

<sup>1</sup> Macquarie University, Australia <sup>2</sup> Willamette University, United States of America

Keywords: Stable isotope analysis, Cycladic marble sculpture, Cycladic marble sources

This paper presents the results of stable isotope analysis of all surviving fragments associated with the colossal marble statue of Apollo dedicated to the god by the Naxians in his sanctuary on Delos ca. 600 BC. All evidence suggests that it was the Naxians who pioneered marble sculpture in Greece, and the Delian colossus is arguably the earliest surviving example of a monumental statue made by Cycladic artists. The figure has been estimated to stand 8.5 m in height and to weigh 50 tons (with an extra 35 tons for the base). It remains the largest archaic Greek statue in existence. The attribution to one statue of some six fragments, all belonging to a huge statue of the god, all of the same period and all found on Delos however, can be challenged (though this is rarely acknowledged). There are two left hands (one slightly smaller). Stylistic studies have not been decisive in separating the other fragments so it was decided to employ stable isotope analyses of the marble to solve the question. The project began with the analysis and publication of data for the plinth and foot fragment in London (B322). In 2019 the study was completed with the analysis of the fragments still on Delos: a base, the well-known upper and lower torso, and the two left hands (Delos Mus A4044, A4095). Our results indicate that more than two statues are present. This paper is accompanied by a second study (Pike and Sheedy) of marble sources on Naxos and the evidence for the quarry from which the stone for these Naxian »giants« was taken.

# **TINOS' LOST ANCIENT SERPENTINITE QUARRY (CYCLADES, GREECE): AN INTERDISCIPLINARY APPROACH**

Alkiviadis Sideridis<sup>1</sup> – Vasiliki Anevlavi<sup>2</sup> – Christoph Hauzenberger<sup>3</sup> – Petros Koutsovitis<sup>1</sup> – Anastasia Aggelopoulou<sup>4</sup>

<sup>1</sup> University of Patras, Greece <sup>2</sup> Austrian Archaeological Institute, Austrian Academy of Sciences, Austria <sup>3</sup> Karl Franzens Universität Graz, Austria

<sup>4</sup> Greek Ministry of Culture and Sports, Greece

Keywords: Serpentinite, Cyclades, ancient quarry

In recent years, research is increasingly focused on individual marble production centres of antiquity. However, the commercial term »marble« oftentimes includes rocks with different origins than that described by the geological term i.e. metamorphic carbonate rocks. Tinos' recent mining activity is focused on ophalcites, yet the abandoned ancient quarry of Ag. Georgios Ras (Ras) comprise a unique type of serpentinite deprived of any carbonate minerals. The site consists of two small-scale open pits facing north and south respectively. Characteristic tool marks and grooves for the separation of the stone from the parental one, as well as the holes for the insertion of wedges were noticed. The Ras' serpentinite is composed of two serpentine varieties; the darkest is a massive dark-green coloured serpentinite that is cross-cut by a light green serpentine network. Small concentrations (< 1 %) of other minerals include: talc, chlorite and iron oxides. Research on serpentinite provenance is rather limited and there is a substantial lack of information and data. Therefore, this study is an effort to enrich the present database using contemporary technics, including EMPA, LA-ICP-MS to determine the chemical make-up of the Ras serpentinite ancient quarry pit. The new geochemical data are interpreted accordingly to depict the environment that these rocks were formed, in other words, their unique chemical imprint that will distinguish them from similar occurrences. Finally, this research helps to shed light in the intriguing quarrying history of the Aegean islands.

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## **ROMAN LIMESTONE QUARRIES IN ISTRIA, CROATIA — A GROWING REFERENCE DATABASE**

Katarina Šprem<sup>1</sup> – Robert Matijašić<sup>1</sup>

<sup>1</sup> Juraj Dobrila University of Pula, Croatia

Keywords: Istria, limestone, quarries

The Roman history of Istria began in the middle of the 1st c. BC with the foundation of the colonies of Pola and Parentium. Most of the building material for the colonies and other settlements came from limestone quarries opened along the coastline, since the cheapest mode of transportation was by sea. However, several of the quarries were also discovered in the hinterland of the Istrian peninsula using different techniques, one of which is Airborne Laser Scanning data or LiDAR visualizations. Using this kind of data, we were able to spot quarries otherwise overgrown with vegetation and subsequently document them during targeted field surveys. One of these quarries – Monte del Vescovo – was selected for an archaeological excavation. New quarries were also discovered while analysing topographic maps or by accident while conducting other field surveys. We will present our database of Roman limestone quarries located in the Istrian peninsula, the process of discovering, documenting, and researching them as well as our geological database of limestone lithotypes that were extracted in the quarries.

## **DISTRIBUTION PATTERNS OF MARBLE FINDS IN SOUTHERN COASTAL LATIUM (ITALY)**

Michael Teichmann

Freie Universität Berlin, Germany

Keywords: Roman marble, kernel-density-estimation, central Italy

The present project analyses the spatial distribution patterns of marble fragments, which were discovered at extra-urban sites in southern coastal Latium. The core area of investigation ranges from the Tiber Valley in the north to the westward-facing slopes of the Alban Hills, the Lepini and the Ausoni Mountains and to Terracina in the southeast. From a historical point of view, the study area was very important in view of its strong connections to Rome. Legacy data for various micro-

research areas was collected from published sources and archives. These areas were selected in respect to the state of research and publication. Respective sources comprise volumes of the »Forma Italiae project«, further archaeological maps as well as the original documentation of the Carta dell' Agro Romano.

The paper will present the results of GIS-based analyses, in particular the kernel-density-estimation method. This way, the spatial distribution of marble finds at extra-urban sites was mapped and the areas with the highest density of finds were identified. All sites, where ancient marble was present, were considered, comprising sites that had received only little attention so far due to the scarcity of finds. In a further step, the distribution patterns of marble finds are compared with the distribution patterns of further luxury indicators. The chosen approach might be of methodological interest beyond the present case study.

## **AGAINST THE TREND. MARBLE DYNAMICS IN ROMAN IN ROMAN IMPERIAL MILETUS**

Natalia Toma

German Archaeological Institute, Germany

Keywords: Miletus, Bafa Lake marble(s)

This paper discusses the results of an intensive archaeometric research undertaken as part of the DFG-funded project »Marble Dynamics in Roman Imperial Miletus« (TO1102/1-1). The study is based on a set of 400 samples including geologic references of the Meander valley's quarries (Miletus, Herakleia, Myus, Euromos, Magnesia, Priene) now preserved in the collections of K. Germann, T. Cramer and G. Borg as well as archaeological samples from Miletus' main architectural complexes (e. g. Theater, Faustina Baths, Serapeion). The results indicate the predominant use of local marble resources throughout the antiquity and allow to reassess the significance of the so-called quarry district of Miletus West. This district – localized by A. Peschlow-Bindokat in the 1970s on the south shore of the Bafa Lake – is ever since covered by the touristic complex Silva Oliva that altered its quarriescape features, especially by building up quarry faces and removing the debris piles. The proximity of the quarry faces to the actual coastal line of the Bafa Lake, the numerous quarry artefacts lying in water suggest that the district's ancient limits – now under water – must have been larger than

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observable today. The fact that the mineable resources including white and dark grey marble varieties are exhausted, underlines the extensive ancient exploitation of this outcrop. The Miletus West district was probably the first quarry to have been established within the chora of Miletus and it is likely to be identified with the quarries of Ioniapolis mentioned in the Hellenistic building accounts of the Apollon Temple at Didyma.

The archaeometric analysis of the archaeological samples evidences an extensive – if not an almost exclusive – use of local and regional outcrops from the shores of the former Latmian golf (now Bafa Lake): primarily the city owed quarries (on the south) but also, though on a considerably reduced scale the quarries of Myus (on the north) and Herakleia (on the east). In spite of the poor quality of the local marbles (dolomitic veins, bauxite inclusions), their limited suitability for construction purposes, the urban adornment of Milesian imperial Miletus relied primarily on local supplies and made only limited use of imported marbles from fashionable centres.

## **TOPOGRAPHY AND ISOTOPIC SIGNATURE(S). CHALLENGES OF CHARACTERISING THE MILESIAN MARBLE**

Natalia Toma  
German Archaeological Institute, Germany

Keywords: Milesian marble, Miletus West, Lefka Bur-Dag, Milet 1 and Milet 2

The poster discusses the challenges of characterising the local marble supplies of the Ionian city of Miletus whose quarry districts are situated in the immediate proximity on the south shores of the Latmian Gulf (nowadays Bafagözü, Turkey). My study considers the topographical references of A. Peschlow-Bindokat that localized two distinctive quarry districts within the chora of Miletus, to the west of the Mersinet valley: the so-called Miletus East quarries on the hill of Lefka-Bur-Dag and the Miletus-West-area situated on the Zeytin-Tepe hill, and directly on the shores of the lake near the facilities of the touristic complex of Silva Oliva. These quarries have been successively surveyed and sampled by the geologists K. Germann (whose sample collection is now in the custody of the Antikensammlung, Berlin) and G. Borg (his collection is

stored in the Martin-Luther-University, Halle, Germany) as well as by M. Bruno and D. Attanasio (the latter collection is now at the Austrian Institute in Vienna). These samples and the existing analytical data have been reviewed and in certain cases new measurements (isotopes, trace elements ICP-MS) have been commissioned. Furthermore, the analytical data was supplemented by mineralogical studies based on thin sections that examined under polarized microscope.

The poster presents different approaches to characterize these marble deposits (topographical, isotopic) and demonstrates that analytical results are highly dependent on knowledge of topography, accuracy of the sampling and the maintenance of the data base. The focus is set on isotopic diagrams that represent the data analysis based on different criteria (topographical or arbitrary selection) and variables (isotopic signature, trace elements).

## **PREHISTORIC OBSIDIAN TRADE TO NORTHEASTERN-MOST ITALY**

Robert H. Tykot<sup>1</sup> – Andrea Vianello<sup>1</sup>

<sup>1</sup> University of South Florida, United States of America

Keywords: Obsidian Neolithic trade

In the central Mediterranean, obsidian from four Italian islands was acquired starting in the Early Neolithic (ca. 6,000 BC) and distributed long distances northward toward the Alps and western Austria. In the five northeastern-most regions of Italy, obsidian artifacts have been identified at >40 different prehistoric archaeological sites, and >1400 artifacts have been analyzed to determine their geological origins.

The nearest source is the tiny island of Palmarola, several hundred km to the south, while Lipari, Monte Arci (Sardinia), and Pantelleria are even further away. Previous studies demonstrated that obsidian from all four reached far north, raising questions about quantity and frequency from each of them and how they may have changed over three millennia. Our study used a non-destructive portable X-ray fluorescence spectrometer to conduct analyses within different museums and storage facilities in Italy. This research significantly increased the number of archaeological sites and artifacts tested, allowing comparisons between time periods and sites and provides some interpretations for the socioeconomic factors involved in this variation.

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Five sites in the Emilia-Romagna region have large assemblages of obsidian artifacts that were tested, including Pescale (926), Gaione (111), Case Catena (56), Pontetaro (66), and Guidorossi (47). Along with mostly small blades, obsidian cores have been found at some of these sites, confirming the local production of the final tools used. Other obsidian artifacts tested come from further north at 10 sites in the Friuli-Venezia Giulia region, but found in lesser quantities, while obsidian found at fewer sites in Lombardia, Trentino Alto Adige, and the Veneto also was tested. Only two of the artifacts tested come from Carpathian obsidian sources, while the low percentage from the Sardinia B source subgroup supports most of these sites dating later in the Neolithic. Overall, it appears that the distribution of obsidian from the Italian islands matches well with the geographic region of initial settlement and agricultural sites with Cardial Ware decorative style pottery. The results obtained in this study also show some striking differences between sites in the proportions of the Sardinia and Lipari obsidian sources used, as well as changes over time which may be related to increasingly complex socioeconomic patterns over the course of the Neolithic. The obsidian distribution patterns are used to propose potential sea and land transportation routes while assessment of the typo-technology of the artifacts addresses the involvement of lithic specialists in various stages of the chaîne opératoire.

## **A ROMAN DORIC PORTICO OF NAXIAN MARBLE AT ALEXANDRIA TROAS**

Robert H. Tykot<sup>1</sup> – John J. Herrmann, Jr.<sup>2</sup> – Annewies van den Hoek<sup>3</sup>

<sup>1</sup> University of South Florida, Tampa, United States of America <sup>2</sup> Museum of Fine Arts, Boston, United States of America <sup>3</sup> Harvard Museum of the Ancient Near East, United States of America

Keywords: Carbon and oxygen isotopes, macroscopic identification, Roman marble trade

Architectural elements of a Doric portico were excavated between 2004 and 2007 by a German and Turkish team at Alexandria Troas on the northwest coast of Turkey. The elements, which came from the agora and were dated to the early 2nd c. AD, were reassembled on the ground in the display area of the site. In the publication of the portico by Wiegartz and Çobanoğlu, the marble was identified macroscopically as Proconnesian. It was described as a bright marble with gray layering.

On a visit to the site, however, the marble seemed too white and too large grained to be Proconnesian, and it looked much like the marble of Thasos, as if some elements were the dolomitic marble of Cape Vathy and others were the Calcitic marble of Aliki or Cape Fanari. In any case, the marble looked very different from the typical banded Proconnesian marble used in other architectural elements stored nearby. Five tiny chip samples were taken from the elements of the portico and analysed with a mass spectrometer at the University of South Florida. To our surprise, the marble proved to have isotopic ratios of carbon and oxygen quite different from Thasian values. One section of column could well be Proconnesian, but the most probable provenance for the others seems to be Naxos. Marbles with similar isotopic ratios appear in the western Mediterranean, but they are very implausible sources for this northern Aegean structure. Two other architectural elements nearby, part of a Doric pediment and an architrave, had similar looking marble, and their isotopic values also corresponded to Naxos. Although the excavators did not place them in direct contact with the Doric elements, they could also have belonged to the portico project. Artefacts of Naxian marble dating from the Roman period are difficult to identify outside the island. This portico at Alexandria Troas seems to open up the possibility that Naxos did, indeed, play a role in the Roman Imperial marble market.

## **MARBLE AT SETIF (SETIFIS) AND DJEMILA (CUICUL), ALGERIA: IDENTIFICATIONS WITH PXRF AND ISOTOPES OF CARBON AND OXYGEN**

Annewies van den Hoek<sup>1</sup> – John J. Herrmann Jr.<sup>2</sup> – Robert H. Tykot<sup>3</sup>

<sup>1</sup> Harvard Museum of the Ancient Near East, United States of America

<sup>2</sup> Museum of Fine Arts, Boston, United States of America <sup>3</sup> University of South Florida, United States of America

Keywords: Sculpture, architectural decoration, macroscopic features

Two ancient cities, Setifis and Cuicul, are grouped together not only because of their proximity but also because they have some similar problems of marble identification. Samples were chosen because of their art-historical interest and the possible identifiability of their marble. Isotopically the white marble of Mt. Filfila in Algeria overlaps the signatures of several Aegean marbles, creating difficulties in

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determining sources. Analysis by stable isotope mass spectrometry and with portable X-ray fluorescence, nevertheless, often made it possible to confidently determine the most likely sources. In a few cases, macroscopic features were decisive in establishing priorities.

Distinctive isotopic ratios, made it virtually certain that a colossal statue is marble from Mt. Filfila and that an elegant statuette is marble from Marathi, Paros. Several statues and portraits in Setif and Djemila proved to be Thasian marble on the basis of their dolomitic fabric and their isotopic ratios. Three fine-grained sculptures have isotopic values of carbon and oxygen that coincided with those of marble from Göktepe near Aphrodisias, Turkey, and the trace elements Sr and Mn confirm this identification for two of them. One is a head of Asklepios that can be attributed on art-historical grounds to a sculptor from Aphrodisias, and the other is an imperial portrait, a characteristic use for Göktepe marble.

Architectural decoration was sporadically tested at Djemila, and our results largely coincide with those in Antonelli et al. 2010. The primary materials for architectural decoration at Djemila were limestones and sandstones, whose origins are still unknown. The Algerian quarries of Hippo/Cap de Garde and Mt. Filfila provided the marble used for columns and capitals in several major public buildings. Granite and marble from Turkey were used in the Temple of Venus. Its granite shafts came from Kozak, Pergamum (Antonelli et al 2010), and the Corinthian capitals appear to have been imported fully carved from the Proconnesus. Coloured marble revetment plaques imported from the Aegean and from North African sources have previously been identified at Djemila (Antonelli et al. 2010; Herrmann et al. 2017).

## **SPOLIA NABRISSENSIA: AN APPROXIMATION TO THE ROMAN MARBLES REUSED IN THE CHURCH OF SANTA MARÍA DE LA OLIVA (LEBRIJA, SEVILLA, SPAIN)**

Diego Romero Vera<sup>1</sup> – Daniel Becerra Fernández<sup>2</sup>

<sup>1</sup>Universidad de Sevilla, Spain <sup>2</sup>Universidad de Córdoba, Spain

Keywords: Nabrisa Veneria, marble, spolia

In the medieval church of Santa Maria de la Oliva (Lebrija, Sevilla, Spain) various shafts of columns from the Roman Age were used to build the

original temple dating from the Reconquest period (13th c. BC). More specifically, we are referring to elements of architectural decoration which originally would be part of several public buildings from the Imperial Age. In this presentation we intend to identify the precedence of this piece of marble, to analyse their reuse in Medieval period and finally, to make a preliminary approximation to the building projects conducted in this Baetican city. This study is going to complete the scarce data known about the monumental constructions and the marble used in Nabrisa Veneria, a probable municipium flavium located at the mouth of the Baetis river.

## **MARBLE PROVENANCE STUDY IN DELOS ISLAND ARCHITECTURE**

Tommy Vettor<sup>1</sup> – Violaine Sautter<sup>1</sup> – Laurent Jolivet<sup>2</sup> – Jean-Charles Moretti<sup>3</sup> – Sylvain Pont<sup>1</sup>

<sup>1</sup> Museum National D'Historie Naturelle, France <sup>2</sup> Sorbonne Université, IStEP, France <sup>3</sup> Institut de Recherche sur l'Architecture Antique, Université Lumière Lyon 2, MOM, France

Keywords: pXRF, carbon and oxygen isotopes, architecture

This study presents for the first time geochemical data on the ancient (antiquity period) marble quarries of Delos Island and architectural marbles from its famous and exceptionally well-preserved archaeological site. The study was conducted after Hadjidakis' et al (2003) work describing for the first time Delos quarries at macroscopic scale. Delos' geological substratum is mostly composed of granite including four decametric marble enclaves that were excavated during antiquity. It has been shown that a large quantity of marble had to be imported from neighbouring Cycladic Islands and continental Greece but their provenance remains mostly unknown. The present study reports two provenance methodologies applied to Delian marbles. The first one is non-invasive, based on a portable X-ray fluorescence (pXRF) analyser detecting major and trace elements, tested in association with Principal Component Analysis (PCA). The second one is micro-destructive, mainly based on Maximum Grain Size measurement and isotopic ratios of carbon and oxygen ( $\delta^{13}\text{C}$ ,  $\delta^{18}\text{O}$ ). A few thin sections and X-ray Diffraction analyses were also used. The non-destructive approach brought preliminary promising results while the

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multi-technique approach obviously allowed to go further into our provenance diagnostics. Our results allow to decipher indigenous well characterized Delos marble from imported marble coming from well define quarries of neighbouring Cycladic Island.

## **QUARRY INSCRIPTIONS FROM THE ROMAN FORUM AND THE PALATINE IN ROME**

Sabrina Violante  
Parco archeologico del Colosseo, Italy

Keywords: Quarry-inscriptions, Roman Forum, Palatine

Given the historical, political and religious role of the area and its close relationship with the imperial patronage, the Roman Forum and the Palatine hill are among the most interesting archaeological contexts for the study of ancient stones.

Historical events have greatly altered this reality over the centuries, as a result of spoliation, earthworks, piling, dispersion or reduction into pieces of the materials, often used to make lime. In spite of this, the large amount of stone material still preserved in the area gives an echo of its ancient splendour, providing valuable information on the marble trade in Rome, on the supply of materials and on the organization of the quarries.

These latter aspects are referred to by a few sporadic inscriptions, not always easily recognisable. There are about ten epigraphs, mostly unpublished, engraved on rough-hewn shafts, smooth or stepped blocks and slabs of white and coloured marble. The engraving mostly on rough surfaces often makes them difficult to read. They are mainly numerals and short inscriptions, often only partially preserved. They enrich the repertoire known to date, although in most cases they do not provide precise chronological information. For many of these artefacts the place of discovery is unknown and their current location does not help to establish the monument to which they belong. Some of them appear to have been put in place, while others appear unused. From a chronological point of view, this material is rather heterogeneous, ranging from the Augustan period to the full Imperial Age.

Two inscriptions known only from archival documents, transcribed in the early 1900s during the excavations at the Basilica Emilia, also seem

to refer to the same kind of documentation. They had already attracted attention at the time, although their function was not fully understood.

## **ZOOMORPHIC SCULPTURES IN ALABASTER FIORITO FROM THE PALATINE IN ROME**

Sabrina Violante<sup>1</sup> – Paola Quaranta<sup>1</sup>

<sup>1</sup> Parco archeologico del Colosseo, Italy

Keywords: Sculpture, interraso marmore, Alabastro Fiorito

Two sculptures of polychrome marble representing animals were found in the area of the imperial palaces at the Palatine during the excavations carried out by the Soprintendenza archeologica of Rome. The first one is a full-sized tiger, without head, legs and tail, while the second is a small turtle, of which only the carapace is preserved. Both sculptures share not only the place where they were found, but above all the use of the same marble, an Alabastro Fiorito with warm and rather uniform tones. A distinguishing feature of the feline is the peculiar technique of workmanship called *interraso marmore*, where marble inlays are inserted on a stone support different for typology and colour. Although it is widely used in wall and floor coverings, this technique is attested in statuary for what is known only by this item, which represents a real unicum of its kind. The plastic effect of the sculpture is obtained by carving the body in alabaster and shaping the mottling of the fur with pieces in Bigio Morato, of which only one specimen is preserved. The stones were chosen by the artisan to echo the natural colours of the tiger's coat. The sculpture, currently exhibited in the Palatine Antiquarium, has recently been enriched with a further unpublished fragment probably pertaining to the animal's muzzle not preserved. Also unpublished is the small turtle. The carapace is marked by undercut hexagonal elements and has recesses at the end and on the sides, for the insertion of the missing parts. Also in this case the marble chosen matches the real aspect of the tortoise shell, which often shows shades tending to yellow. These two sculptures, which can be traced back to the Julio-Claudian period or more broadly to the first two centuries of the empire, enrich the repertoire of representation of animals in polychrome stones, which today shows a limited number of specimens from excavations, including the statue of a dog in *serpentina moschinata* from the gardens of Maecenas on the Esquiline

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and the crocodile in cipollino from the Canopus of Villa Adriana. The archaeometric analyses still in progress will be able to provide useful data about the provenance of the stones, the craftsmanship at work and the choices of the marbles made by the imperial patronage for the imperial palaces on the Palatine.

## **EARLY CHRISTIAN COMPLEX KAMENICA (VINKOVCI, HR) – AN ISLAND OF STONE IN THE SEA OF CLAY**

Hrvoje Vulic<sup>1</sup> – Bojan Djurić<sup>2</sup>

<sup>1</sup> Vinkovci municipal Museum, Croatia <sup>2</sup> University of Ljubljana, Slovenia

Keywords: Mediterranean marble, opus sectile, Valentinian I

Colonia Aurelia Cibalae (Vinkovci, HR) was a Roman town in south-eastern Pannonia lying between Sirmium (Sremska Mitrovica, RS) and Mursa (Osijek, HR). The area is geologically rich in clay with no stone resources. Stone was transported via the Bosut river, a confluence of the Sava river and linked with the Danube by a channel. It was always a rare resource in these parts, and Roman stone monuments are quite rare in Vinkovci and its surroundings. They were heavily reused in the Roman and post-Roman times. All localities bearing a modern name deriving from stone such as Kamenica (kamen = stone) are therefore of particular interest.

During three excavation campaigns, Kamenica revealed to be an Early Christian complex built in the 4th century on the place of martyrdom of the local saint lector Polio and was an imperial donation. One of the most striking features of this site, situated one mile east of Cibalae, is the presence of a great amount of stone, mostly marble, used primarily for floor and wall revetment in opus sectile. The marble is all white (Proconnesos) and coloured Mediterranean marble (red porphyry, Porfido Verde Antico, Giallo Antico, Breccia Corallina, Verde Antico, Breccia Policroma della Vittoria, Greco Scritto etc.) and the set of the marbles used has its parallels in the Imperial palace in Sirmium. During the renovation of the palace by Valentinian the First, some of these marbles were used, strengthening our hypothesis that Kamenica was his donation.

## **MANAGING BANDS: CARVING AND AESTHETIC**

# **CHOICES IN THE USE OF PROCONNESIAN MARBLE DURING THE ROMAN AND LATE ANTIQUE PERIODS**

Courtney Ward<sup>1</sup> – Simon Barker<sup>2</sup>

<sup>1</sup> Norwegian Institute in Rome, Italy <sup>2</sup> University of Ghent, Belgium

Keywords: Proconnesian, banding, aesthetic choices

Proconnesian marble from the island of Marmara, off the coast of modern Turkey, was much used throughout the Roman and Late Antique periods, especially after the 2nd c. AD. The grey-blue banding of this coarse-grained calcite provided aesthetic opportunities for those carving and/or commissioning objects in this marble. We see this particularly in columns, which were quarried and finished so that the banding ran vertically along the length of the column. While some of this may have been due to structural concerns, it is clear that there was also a consideration of the aesthetic impact of the finished product. At Lepcis Magna (North Africa), for example, a monolithic statue base was carved specifically to showcase the vertical banding on the sides of the base while at the same time presenting a front face that was band-free for its inscription. Here, the carver was careful to align the bands in a manner that would provide a pleasing aesthetic appearance without sacrificing the inscribed text. This poster will explore examples such as this to evaluate the use of Proconnesian marble on a variety of objects – columns, capitals, statue bases, sarcophagi. This will provide a better understanding of the ways in which the characteristic banding of individual blocks of this marble was ‘managed’ for its aesthetic impact.

## A MULTI-METHOD APPROACH TO THE ARCHAEO-METRIC STUDY OF EPHESIAN MARBLES

Dagmara Wielgosz-Rondolino<sup>1</sup> – Fabrizio Antonelli<sup>2</sup> – Maciej Bojanowski<sup>3</sup> – Patrick Degryse<sup>4</sup> – Marcin Gładki<sup>5</sup> – Mehmet Cemal Gönçüoğlu<sup>6</sup> – Lorenzo Lazzarini<sup>2</sup> – Leah Long<sup>7</sup> – Sara Manderà<sup>8</sup>

<sup>1</sup> University of Warsaw, Poland <sup>2</sup> LAMA – Laboratorio di Analisi dei Materiali Antichi, Iuav University of Venice, Italy <sup>3</sup> Institute of Geological Sciences, Polish Academy of Sciences, Poland <sup>4</sup> Earth and Environmental Sciences, Centre for Archaeological Sciences, KU Leuven, Belgium <sup>5</sup> DAJNA – Jerzy Okulicz-Kozaryn Foundation, Poland <sup>6</sup> Middle East Technical University, Turkey <sup>7</sup> Mercersburg Academy, United States of America <sup>8</sup> Institute of Paleobiology, Polish Academy of Sciences, Poland

Keywords: Ephesian marbles, petrography, geochemistry

Fieldwork in 2017 in the quarries of the ancient city of Ephesos yielded a collection of more than 300 marble samples for archaeometric analysis in an effort to complete a database of the Ephesian marbles initiated earlier by other scholars. The samples came from approximately 60 quarries located around the ancient city (e. g. Kuşini Tepe, Belevi, Ketli Çiftliği, Zimpara, Urfalıdağı, Hasançavuşlar, Aya Klıkiri, Göllüce) providing grounds for a full characterization, not only of the white marble, but also of the so-called Greco Scritto. The multi-method approach involved a series of petrographic and geochemical analyses performed on the samples, including standard microscopic examination of thin sections, XRD, and stable carbon and oxygen isotope analyses. The results of this analytical research, presented briefly in this paper, indicate that some Ephesian marbles might easily be confused with those extracted on the island of Prokonnesos. The study may enable a more precise discrimination between these two and other marbles used in antiquity. As for the Ephesian Greco Scritto variety, its mineralogical-petrographic and isotopic features resulted clearly different from those showed by the Algerian marble from the Cape de Garde quarries. The research was carried out by an international team within the frame of the ›Marmora Asiatica: towards archaeopetrology in Poland‹, which was funded by the National Science Centre of the Republic of Poland (DEC-2012/07/E/HS3/03971) and supported by the Ministry of Culture and Tourism of the Republic of Turkey.

## **MARMORA ORIENTALIA. MARBLE OBJECTS FROM THE SYRIAN MUSEUMS**

Dagmara Wielgosz-Rondolino  
University of Warsaw, Poland

Keywords: Syrian museums, marbles, sculpture

Hundreds of marble objects, mainly sculptures, have been subjected to standard archaeometric studies within the frame of a wider project »Marmor. The Graeco-Roman marble artefacts from Syria. Their archaeometric identification, archaeological and art«, financed by the European Commission (Marie Curie Intra-European Fellowship). These are fragments of sarcophagi, public statues and mythological sculptures, not to mention architectural elements, from the collections of Syrian archaeological museums in Damascus, Latakia, Tartus, Aleppo, Hama, Homs, and others, part of them unpublished and presented here for the first time. Some are unprovenanced, while others were found in important Syrian cities, such as Antioch-on-the-Orontes representing the major foundations of Seleukos I Nikator in northern Syria from the end of the 4th c. BC, and smaller towns like Arethusa. The task of identifying the origin of the marble used for these sculptures was approached through a standard set of archaeometric studies: microscopic observation of thin sections and stable isotopic ratios of carbon and oxygen. The results indicate a variety of marble quarry sources, including Prokonnesos, Dokimeion, and Mount Pentelikon.

## **THE EXTRACTION TECHNIQUES OF SCULPTURES, THASSOS (GREECE)**

Manuela Wurch-Koželj<sup>1</sup> – Tony Koželj<sup>1</sup>

<sup>1</sup> École française d'Athènes, Greece

Keywords: Quarrying-technique, kouros, sculpture

Observation of traces of marble extraction in the ancient quarries revealed many cuttings which testify to different techniques of extraction during the Antiquity. Eleven of them were innovative and correspond to determined period of exploitation. Others were permanent, as the

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extraction of monolithic column-shafts; of cylinders, whether millstones or column drums; as well as the extraction for sculptures. A sculpture is not carved from a parallelepiped block previously extracted, but it is cut out directly from the bed-rock. Its global shape was given along the process of extraction. Remains of these extractions («negatives») reveal that some rough shapes were worked out, laying on their back (face up), whilst others were set on their side (face looking in front). Nonetheless, it seems that the position of the model is the distinguishing characteristic. The one, lying on its back was employed for the kouros extraction, while the other position, side-set, seems to have been more appropriated to the quarryman-sculptor who improved this second method afterwards.

## **MARBLES OF THE ROMAN PUBLIC BATHS AT THAPSUS**

Ameur Younes  
Université of Tunis, Tunisia

Keywords: Thapsus, Roman baths, marbles

Thapsus is an ancient coastal town located in east-central Tunisia, at 46 km south of the town of Sousse (Hadrumetum) and 16 km north of the town of Mahdia (Gummi). The archaeological site is known under the name of Ras Dimas situated about 5 km east of the modern town of Bekalta. Thapsus was very likely founded during the Libyco-Phoenician period. The current archaeological data attest its existence in the 5th c. BC. The harbour city was known through the ancient authors who related the conquest of Thapsus by Agathocles in 310 BC and particularly the battle of Thapsus which took place in 46 BC between the Pompeians and Julius Caesar. Thapsus was considered a medium-sized town, covering an area of about 42 ha under the Empire. Few excavations have been undertaken on the archaeological site since the middle of the 19th century. The Roman public baths are among the rare excavated and identified monuments. These baths, located on the western part of the town and covering an approximate area of 1705 m<sup>2</sup>, are not in a very good state of preservation. Pending the archaeological survey and the plan of the *thermae* by the architect, a few descriptions can be provided: the medium-sized baths are composed of a *frigidarium* and a *caldarium* decorated with nice marble slabs. A few fragments of marble are still *in situ* and the others have been collected during the excavation and ranged in the small museum at Bekalta. Some of the marbles can

be determined on the base of their macroscopic characteristics (colour, fabric and grain size), whereas others need microscopic analyses to be identified. This study is aimed to identify the types of most of the marbles used in the public baths of Thapsus (Proconnesian, Pentelic, Cipollino verde, Greco scritto), to determine their provenances (Africa, Greece, Asia Minor), and to precise in which parts of the baths they were precisely employed. Besides, this study will allow us to determine one of the economic aspects of the urbs Romana Thapsitana, the trade of marble.

## **THE SANCTUARY OF ARTEMIS AS BENEFICIARY OF THE EXPLOITATION OF THE EPHESIAN MARBLE QUARRIES?**

Lilli Zabrana

Autrian Archaeological Institute, Austrian Academy of Sciences, Austria

Keywords: Ephesos, Artemision, marble quarries

The large construction projects of the monumental marble temples within the temenos of the Ephesian Artemision were only feasible due to the local resources of high quality marble quarries nearby. The white marble quarries exploited for these temple buildings are located in the territory of the Artemision in Roman times documented by »Horos« or boundary stones. The investigation of the sanctuary's territory and its role in the marble business has so far never been examined in an overall study. In this context the current project on the »Temenos and Territory of the Ephesian Artemision« aims to enlighten the economic development and achievement of the sanctuary.

Taking into account that the most important local quarries are located at the edge of the Caystros valley within the territory and possession of the Artemision, it is highly likely that large-format construction units were prefabricated by workers and craftsmen in service of the Artemision or employed by tenants under the authority of the sanctuary, transporting the marble blocks to the construction site and reworking them after fitting. Since initially the use of the local white marble was reserved exclusively for sacred buildings within the Temenos, in the Roman Imperial era it became the commonly used building material for representative buildings within the city, sometimes highlighted with

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imported pieces of Prokonnesion marble or Phrygian Pavonazetto. The marble imports as well as the local exports were favoured by their smooth shipping handling in the Ephesian harbour encouraging the development of new markets for local products. The scale of public marble building projects in the city of Ephesos in Roman times raises questions about the institutional framework of the exploitation of these local resources especially regarding the economical relation between the city of Ephesos and the sanctuary. Besides the central organisation and administration of the marble business, which most likely has its place within the tax-free Temenos, stonemason workshops with different and various levels of specialization can be assumed within the Temenos as well as near the marble quarries in the Caystros valley and at the branches in the harbour area which presumably were all in service of the Artemision. As a result the sanctuary became in Roman times a major employer in the local marble business forming a significant and stable factor in the development of the city and the whole region.

## **CHARACTERIZATIONS OF THE FAMOUS ANTIQUE WHITE MARBLE QUARRIES OF QUYANG AND FANSHANG IN CHINA**

Judit Zöldföldi<sup>1</sup> – Yuanqi Cao<sup>2</sup> – Heinrich Taubald<sup>3</sup> – Kristof Csorba<sup>4</sup> – Balazs Szekely<sup>5</sup>

<sup>1</sup> MPA Stuttgart, Germany <sup>2</sup> China Art Academy, China <sup>3</sup> University of Tübingen, Germany <sup>4</sup> Budapest University of Technology and Economics, Hungary <sup>5</sup> Eötvös Lorand University, Hungary

Keywords: White Chinese marble, Quyang, Fangshan

White marble plays an important role in a large extent in the history of art in China since the Han dynasty, when marble was used for statues. Firstly, they are important for the guardian inside the tomb. After Buddhism was transported to China since Eastern Han Dynasty (1st c. BC – 3rd c. AD) until the Northern Dynasties (4th c. AD – 6th c. AD), it became the National belief in whole China, and the influence by Alexander the Great brought the custom for carve the figures, in the same time the promotion of the imperial power to Buddhism. In that time, numerous of the Buddhism sculptures have been carved among the Northern Dynasties; in some area particularly in the Hebei province plenty of the marble statues were excavated which were dated to the 4th c. AD to 10th c. AD. Since the 20th c., especially at the archaeological

excavation in the Xiude temple and the excavation in Yecheng in 2012, marble statues in surprisingly high amount of quantity and quality have come to light. For architectural construction marble plays an important role as well, the main material in the Forbidden City (14th c.) is mostly Fangshan marble. In this contribution, we give an overview about the white marbles of Quyang and Fanshang quarries in China, used since antiquity. Based on systematically sampling the most important properties, commonly used in provenance analysis, like  $\delta^{13}\text{C}$ ,  $\delta^{18}\text{O}$ , mineralogical and petrological analyses (polarizing microscopy, X-ray diffraction and Raman spectroscopy) description of texture, grain size analysis (GraitAutLine), chemical composition of these marbles have been determined and were compiled for the first time for archaeometric purposes. The relevant marble properties were compared on the one hand within the quarry itself and on the other hand they were contrasted to the properties of known marble occurrences of the Mediterranean, Europe and Indian Subcontinent. The data evaluation was carried out in order to find the gaps in the resulted data base. The compiled data may help to solve various questions, like provenance analyses of archaeological and art-historical material of the Far East, but also may be used to detect forgeries.

## **THE USE OF MARBLE FOR CULTIC AND VOTIVE SCULPTURE IN URBAN AND RURAL SETTLEMENTS OF MOESIA INFERIOR (1ST–4TH CENT. BC)**

Judit Zöldföldi<sup>1</sup> – Cristina-Georgeta Alexandrescu<sup>2</sup> – Heinrich Taubald<sup>3</sup>

<sup>1</sup> MPA Stuttgart, Germany <sup>2</sup> Institutul de Arheologie Vasile Pârvan, Romania

<sup>3</sup> University of Tübingen, Germany

Keywords: Moesia Inferior, Roman, provenance

Part of the research correlated to the »Corpus Signorum Imperii Romani Romania«, the provenance analyses for the used lithic materials included also more than 100 marble objects dated to the Roman period. For the province Moesia Inferior it is evident that the provincials were very much aware of the local resources of stone and their suitable use, being at the same time able to import marble for particular purposes. The present paper will present the results on cultic and mythological sculptures from the Greek cities on the Black Sea Coast versus those

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from the Roman settlement of Tropaeum Traiani and those from other important Roman centres (like Noviodunum and Troesmis) in the northern part of the province and their surroundings. This particular differentiation is caused by the history of the sites, the available information on their economics and trade, but also by the different state of their archaeological research.

Up to now, several projects approached the topic of marble provenance for the region of interest, some with published results. Those are going to be considered as well, in order to give preliminary answers to the archaeological questions on the matter and to point out the methodological requirements when dealing with such multidisciplinary projects. The first examination and measurements on the marble items took place in the museum. The object was examined throughout under cold light and UV source and described macroscopically (coloured patches, veins, foliation etc.) Using a magnifying glass and a millimetre scale, the representative maximum grain size (MGS<sub>v</sub>) of the marble was measured in situ, exploiting all the surface of the objects. Subsequently powdered samples were taken by using a micro drill machine with diamond driller. Places bearing sculptured artwork or aesthetic and historical information were avoided entirely. In addition, care was taken that the samples were representative for the bulk composition of the marble objects. Stable isotope analysis ( $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$ ),  $^{87}\text{Sr}/^{86}\text{Sr}$  isotopic analysis and power diffractometric measurements were performed at the laboratory. The analytical results indicate that the raw materials of the investigated white marble objects originate predominantly from the Island Paros (lychnitic and non-lychnitic), Thasos (Alikí) and Naxos. Some fine grained marbles might come from Penteli, Dokimeion and Miletus. The architectural ornamentation (determined for the 2nd–3rd c. Tomis and for Late Roman buildings in Tropaeum Traiani and Ibida) was carved in Proconesian marble.





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# AUTHORS

Abbe	Mark	abbe@uga.edu
Al-Bashaireh	Khaled	khaledsm@email.arizona.edu
Alexandrescu	Cristina-Georgeta	cgetalexandrescu@gmail.com
Andreeva	Petya	petya.andreeva@oeaw.ac.at
Anevlavi	Vasiliki	vasiliki.anevlavi@oeaw.ac.at
Anevlavis	Emmanouil	emanolios@hotmail.com
Aranda González	Raúl	raranda@icac.cat
Atienza Fuente	Javier	arkeografia@gmail.com
Attanasio	Donato	donato.attanasio45@gmail.com
Barbin	Vincent	vincent.barbin@univ-reims.fr
Barker	Simon	barker@klassarch.uni-kiel.de
Bayer	Paul	paulbayer@gmx.net
Becerra Fernández	Daniel	dbecerra1@us.es
Boccalon	Elisa	elisa.boccalon@oeaw.ac.at
Brajkovič	Rok	rok.brajkovic@geo-zs.si
Bugini	Roberto	bugini@icvbc.cnr.it
Butz	Patricia A.	pabutz@earthlink.net
Buzov	Marija	marija.buzov@iarh.hr
Castoldi	Maurizio	castoldi.ma81@gmail.com
Cenati	Chiara	chiara.cenati@univie.ac.at
Chezeaux	Chloé	chloe.chezeaux@unil.ch
Cisneros	Miguel	miguel.cisneros@unican.es
Claveria	Montserrat	montserrat.claveria@uab.cat
Clerbois	Sébastien	sebastien.clerbois@ulb.be
Cox	Julia E.	juliaec@uga.edu
Cuchí Oterino	José Antonio	cuchi@unizar.es
de Vals	Marilou	marilou.de_vals@sorbonne-universite.fr
Delli	Georgia	delligorgia991@gmail.com
Di Bella	Fabiano Fiorello	fdibella@unime.it
Dichiara	Simona	simona.dichiara06@gmail.com
Diffendale	Daniel	diffendale@gmail.com

Dilaria	Simone	simone.dilaria@unipd.it
Dimitrov	Zdravko	zdravkodimitrov@abv.bg
Dirican	Murat	murat.dirican@oeaw.ac.at
Djurić	Bojan	bojan.djuristic@gmail.com
Domingo	Javier	javdomingo78@gmail.com
Doperé	Frans	frans.dopere@kuleuven.be
Draganits	Erich	erich.draganits@univie.ac.at
Dreesen	Roland	roland.dreesen@telenet.be
Dursun	Felat	felatdursun@gmail.com
Fant	J. Clayton	jcfant@protonmail.com
Ferrazza	Eleonora	eleonora.ferrazza@scv.va
Freccero	Agnetta	agnetafreccero@gmail.com
Frerix	Benjamin	Benjamin.frerix@oeaw.ac.at
Georgiev	Plamen	pl_georgiev@hotmail.com
Gorostidi Pi	Diana	dgorostidi@icac.cat
Gorrini	Maria Elena	mariaelena.gorrini@unipv.it
Hagmann	Dominik	d.hagmann@ardig.at
Herrmann, Jr.	John J.	jherrmannjr@gmail.com
Hofmann	Vera	vera.hofmann@oeaw.ac.at
Ilioglou	Ariadni	ailioglou13@gmail.com
Insulander	Sophie	sophie.insulander@wienmuseum.at
Jakobitsch	Thorsten	thorsten.jakobitsch@oeaw.ac.at
Jarak	Mirja	mjarak@ffzg.hr
Karl	Stephan	stephan.karl@uni-graz.at
Kollar	Albert	kollara@carnegiemnh.org
Kozelj	Tony	tonykozelj@hotmail.com
Krašna	Andreja	andrejaakrasnaa@gmail.com
Ladstätter	Sabine	Sabine.Ladstaetter@oeaw.ac.at
Lapuente Mercadal	M. Pilar	plapuent@unizar.es
Lazzarini	Lorenzo	lorenzo@iuav.it
Lyes	Christopher J.	christopher.lyes@jesus.ox.ac.uk
Mamalya	Haim	mamalya7@gmail.com

Mandera	Sara	sarmander@twarda.pan.pl
Maniatis	Yannis	y.maniatis@inn.demokritos.gr
Mantzana	Elisavet	mantzeli@hotmail.com
Marchet	Beatrice	beatrice.marchet@phd.unipd.it
Matetić Poljak	Daniela	daniela.matetic-poljak@umas.hr
Mitsos	Dimitris	d.mitsos@go.uop.gr
Morleghem	Daniel	daniel.morleghem@gmail.com
Mortera	Alessandro	alessandro.mortera@unive.it
Ottati	Adalberto	aott1@upo.es
Palagia	Olga	palagia@enternet.gr
Peirano	Diego	diego.peirano@polito.it
Perna	Simona	simona.perna8@gmail.com
Peřan	Aurora	apetan@gmail.com
Petkova	Kalina	kalina.petkova@gmail.com
Pike	Scott	spike@willamette.edu
Pinkerton	George	george.pinkerton@live.co.uk
Plattner	Georg	georg.plattner@khm.at
Poggio	Alessandro	poggio.alessandro@gmail.com
Polgár-Nyerges	Anita	nyerges.anita@gmail.com
Poupaki	Eirene	ipoupaki@culture.gr
Preshlenov	Hristo	hristo.preshlenov@abv.bg
Prochaska	Walter	walter.prochaska@oeaw.ac.at
Puhar	Jana	janapuhar@gmail.com
Rochette	Pierre	rochette@cerege.fr
Romano	Irene Bald	ireneromano@email.arizona.edu
Rosenberg	Raphael	raphael.rosenberg@univie.ac.at
Ruiz	Julio C.	julioruiz92@hotmail.es
Ruppiene	Vilma	vilma.ruppiene@rub.de
Savin	Marie-Claire	msavin@icac.cat
Scognamiglio	Rita	rita_scognamiglio@tiscali.it
Segal	Dror	mus@gan3.co.il
Sheedy	Kenneth	ken.sheedy@mq.edu.au
Sideridis	Alkiviadis	a.sideridis@upnet.gr

Sobrà	Giorgio	giorgio.sobra@beniculturali.it
Soler Huertas	Begoña	bsoler@um.es
Šprem	Katarina	katarina.sprem@unipu.hr
Teichmann	Michael	mbwteichi@web.de
Toma	Natalia	nataliatoma@gmx.de
Tykot	Robert H.	rtykot@usf.edu
van den Hoek	Annewies	annewies_vandehoek@harvard.edu
Vettor	Tommy	tommy.vettor@edu.mnhn.fr
Vinci	Maria Serena	svinci@geo.uned.es
Violante	Sabrina	sabrina.violante@beniculturali.it
Vulic	Hrvoje	hrvoje@muzejvk.hr
Ward	Courtney	ward.courtneya@gmail.com
Wielgosz-Rondolino	Dagmara	dagmara.wielgosz@uw.edu.pl
Wurch-Kozelj	Manuela	manuela_wk@hotmail.com
Younes	Ameur	amyounes.univ.tunis@gmail.com
Zabrana	Lilli	lilli.zabrana@oeaw.ac.at
Zöldföldi	Judit	zoeldfoeldi@yahoo.de









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**CONTACT**

Austrian Archaeological Institute at the Austrian Academy of Sciences  
Franz Klein-Gasse 1, A-1190 Vienna  
asmosiaXIII@oeaw.ac.at  
[www.oeaw.ac.at/conferences/asmosia-xiii-vienna](http://www.oeaw.ac.at/conferences/asmosia-xiii-vienna)