

# The Use of Limestones as Construction Materials for the Mosaics of Diocletian's Palace

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**Nota bene**

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# CONTENT

<b>PRESENTATION</b> .....	15
<b>NECROLOGY: NORMAN HERZ (1923-2013) by Susan Kane</b> .....	17
<b>1. APPLICATIONS TO SPECIFIC ARCHEOLOGICAL QUESTIONS – USE OF MARBLE</b>	
Hermaphrodites and Sleeping or Reclining Maenads: Production Centres and Quarry Marks <i>Patrizio Pensabene</i> .....	25
First Remarks about the Pavement of the Newly Discovered Mithraeum of the Colored Marbles at Ostia and New Investigations on Roman and Late Roman White and Colored Marbles from Insula IV, IX <i>Massimiliano David, Stefano Succi and Marcello Turci</i> .....	33
Alabaster. Quarrying and Trade in the Roman World: Evidence from Pompeii and Herculaneum <i>Simon J. Barker and Simona Perna</i> .....	45
Recent Work on the Stone at the Villa Arianna and the Villa San Marco (Castellammare di Stabia) and Their Context within the Vesuvian Area <i>Simon J. Barker and J. Clayton Fant</i> .....	65
Marble Wall Decorations from the Imperial Mausoleum (4 <sup>th</sup> C.) and the Basilica of San Lorenzo (5 <sup>th</sup> C.) in Milan: an Update on Colored Marbles in Late Antique Milan <i>Elisabetta Neri, Roberto Bugini and Silvia Gazzoli</i> .....	79
Sarcophagus Lids Sawn from their Chests <i>Dorothy H. Abramitis and John J. Herrmann</i> .....	89
The Re-Use of Monolithic Columns in the Invention and Persistence of Roman Architecture <i>Peter D. De Staebler</i> .....	95
The Trade in Small-Size Statues in the Roman Mediterranean: a Case Study from Alexandria <i>Patrizio Pensabene and Eleonora Gasparini</i> .....	101
The Marble Dedication of Komon, Son of Asklepiades, from Egypt: Material, Provenance, and Reinforcement of Meaning <i>Patricia A. Butz</i> .....	109
Multiple Reuse of Imported Marble Pedestals at Caesarea Maritima in Israel <i>Barbara Burrell</i> .....	117
Iasos and Iasian Marble between the Late Antique and Early Byzantine Eras <i>Diego Peirano</i> .....	123

Thassos, Known Inscriptions with New Data <i>Tony Kozelj and Manuela Wurch-Kozelj</i> .....	131
The Value of Marble in Roman <i>Hispalis</i> : Contextual, Typological and Lithological Analysis of an Assemblage of Large Architectural Elements Recovered at N° 17 Goyeneta Street (Seville, Spain) <i>Ruth Taylor, Oliva Rodríguez, Esther Ontiveros, María Luisa Loza, José Beltrán and Araceli Rodríguez</i> .....	143
<i>Giallo Antico</i> in Context. Distribution, Use and Commercial Actors According to New Stratigraphic Data from the Western Mediterranean (2 <sup>nd</sup> C. Bc – Late 1 <sup>st</sup> C. Ad) <i>Stefan Ardeleanu</i> .....	155
<i>Amethystus</i> : Ancient Properties and Iconographic Selection <i>Luigi Pedroni</i> .....	167
<b>2. PROVENANCE IDENTIFICATION I: (MARBLE)</b>	
Unraveling the Carrara – Göktepe Entanglement <i>Walter Prochaska, Donato Attanasio and Matthias Bruno</i> .....	175
The Marble of Roman Imperial Portraits <i>Donato Attanasio, Matthias Bruno, Walter Prochaska and Ali Bahadır Yavuz</i> .....	185
Tracing Alabaster (Gypsum or Anhydrite) Artwork Using Trace Element Analysis and a Multi-Isotope Approach (Sr, S, O) <i>Lise Leroux, Wolfram Kloppmann, Philippe Bromblet, Catherine Guerrot, Anthony H. Cooper, Pierre-Yves Le Pogam, Dominique Vingtain and Noel Worley</i> .....	195
Roman Monolithic Fountains and Thasian Marble <i>Annewies van den Hoek, Donato Attanasio and John J. Herrmann</i> .....	207
Archaeometric Analysis of the Alabaster Thresholds of Villa A, Oplontis (Torre Annunziata, Italy) and New Sr and Pb Isotopic Data for <i>Alabastro Ghiaccione del Circeo</i> <i>Simon J. Barker, Simona Perna, J. Clayton Fant, Lorenzo Lazzarini and Igor M. Villa</i> .....	215
Roman Villas of Lake Garda and the Occurrence of Coloured Marbles in the Western Part of “Regio X Venetia et Histria” (Northern Italy) <i>Roberto Bugini, Luisa Folli and Elisabetta Roffia</i> .....	231
Calcitic Marble from Thasos in the North Adriatic Basin: Ravenna, Aquileia, and Milan <i>John J. Herrmann, Robert H. Tykot and Annewies van den Hoek</i> .....	239
Characterisation of White Marble Objects from the Temple of Apollo and the House of Augustus (Palatine Hill, Rome) <i>Francesca Giustini, Mauro Brilli, Enrico Gallochio and Patrizio Pensabene</i> .....	247
Study and Archeometric Analysis of the Marble Elements Found in the Roman Theater at Aeclanum (Mirabella Eclano, Avellino - Italy) <i>Antonio Mesisca, Lorenzo Lazzarini, Stefano Cancelliere and Monica Salvadori</i> .....	255

Two Imperial Monuments in Puteoli: Use of Proconnesian Marble in the Domitianic and Trajanic Periods in Campania <i>Irene Bald Romano, Hans Rupprecht Goette, Donato Attanasio and Walter Prochaska</i> .....	267
Coloured Marbles in the Neapolitan Pavements (16 <sup>th</sup> And 17 <sup>th</sup> Centuries): the Church of <i>Santi Severino e Sossio</i> <i>Roberto Bugini, Luisa Folli and Martino Solito</i> .....	275
Roman and Early Byzantine Sarcophagi of Calcitic Marble from Thasos in Italy: Ostia and Siracusa <i>Donato Attanasio, John J. Herrmann, Robert H. Tykot and Annewies van den Hoek</i> .....	281
Revisiting the Origin and Destination of the Late Antique Marzamemi 'Church Wreck' Cargo <i>Justin Leidwanger, Scott H. Pike and Andrew Donnelly</i> .....	291
The Marbles of the Sculptures of Felix Romuliana in Serbia <i>Walter Prochaska and Maja Živić</i> .....	301
Calcitic Marble from Thasos and Proconnesos in Nea Anchialos (Thessaly) and Thessaloniki (Macedonia) <i>Vincent Barbin, John J. Herrmann, Aristotle Mentzos and Annewies van den Hoek</i> .....	311
Architectural Decoration of the Imperial Agora's Porticoes at Iasos <i>Fulvia Bianchi, Donato Attanasio and Walter Prochaska</i> .....	321
The Winged Victory of Samothrace - New Data on the Different Marbles Used for the Monument from the Sanctuary of the Great Gods <i>Annie Blanc, Philippe Blanc and Ludovic Laugier</i> .....	331
Polychrome Marbles from the Theatre of the Sanctuary of Apollo Pythios in Gortyna (Crete) <i>Jacopo Bonetto, Nicolò Mareso and Michele Bueno</i> .....	337
Paul the Silentiary, Hagia Sophia, Onyx, Lydia, and Breccia Corallina <i>John J. Herrmann and Annewies van den Hoek</i> .....	345
Incrustations from Colonia Ulpia Traiana (Near Modern Xanten, Germany) <i>Vilma Ruppinić and Ulrich Schüssler</i> .....	351
Stone Objects from Vindobona (Austria) – Petrological Characterization and Provenance of Local Stone in a Historico-Economical Setting <i>Andreas Rohatsch, Michaela Kronberger, Sophie Insulander, Martin Mosser and Barbara Hodits</i> .....	363
Marbles Discovered on the Site of the Forum of Vaison-la-Romaine (Vaucluse, France): Preliminary Results <i>Elsa Roux, Jean-Marc Mignon, Philippe Blanc and Annie Blanc</i> .....	373
Updated Characterisation of White Saint-Béat Marble. Discrimination Parameters from Classical Marbles <i>Hernando Royo Plumed, Pilar Lapeunte, José Antonio Cuchí, Mauro Brilli and Marie-Claire Savin</i> .....	379

Grey and Greyish Banded Marbles from the Estremoz Anticline in Lusitania <i>Pilar Lapuente, Trinidad Nogales-Basarrate, Hernando Royo Plumed, Mauro Brilli and Marie-Claire Savin</i> .....	391
New Data on Spanish Marbles: the Case of <i>Gallaecia</i> (NW Spain) <i>Anna Gutiérrez García-M., Hernando Royo Plumed and Silvia González Soutelo</i> .....	401
A New Roman Imperial Relief Said to Be from Southern Spain: Problems of Style, Iconography, and Marble Type in Determining Provenance <i>John Pollini, Pilar Lapuente, Trinidad Nogales-Basarrate and Jerry Podany</i> .....	413
Reuse of the <i>Marmora</i> from the Late Roman Palatial Building at Carranque (Toledo, Spain) in the Visigothic Necropolis <i>Virginia García-Entero, Anna Gutiérrez García-M. and Sergio Vidal Álvarez</i> .....	427
Imperial Porphyry in Roman Britain <i>David F. Williams</i> .....	435
Recycling of Marble: Apollonia/Sozousa/Arsuf (Israel) as a Case Study <i>Moshe Fischer, Dimitris Tambakopoulos and Yannis Maniatis</i> .....	443
Thasian Connections Overseas: Sculpture in the Cyrene Museum (Libya) Made of Dolomitic Marble from Thasos <i>John J. Herrmann and Donato Attanasio</i> .....	457
Marble on Rome's Southwestern Frontier: Thamugadi and Lambaesis <i>Robert H. Tykot, Ouahiba Bouzidi, John J. Herrmann and Annewies van den Hoek</i> .....	467
Marble and Sculpture at Lepcis Magna (Tripolitania, Libya): a Preliminary Study Concerning Origin and Workshops <i>Luisa Musso, Laura Buccino, Matthias Bruno, Donato Attanasio and Walter Prochaska</i> .....	481
The Pentelic Marble in the Carnegie Museum of Art Hall of Sculpture, Pittsburgh, Pennsylvania <i>Albert D. Kollar</i> .....	491
Analysis of Classical Marble Sculptures in the Michael C. Carlos Museum, Emory University, Atlanta <i>Robert H. Tykot, John J. Herrmann, Renée Stein, Jasper Gaunt, Susan Blevins and Anne R. Skinner</i> .....	501
<b>3. PROVENANCE IDENTIFICATION II: (OTHER STONES)</b>	
Aphrodisias and the Regional Marble Trade. The <i>Scaenae Frons</i> of the Theatre at Nysa <i>Natalia Toma</i> .....	513
The Stones of Felix Romuliana (Gamzigrad, Serbia) <i>Bojan Djurić, Divna Jovanović, Stefan Pop Lazić and Walter Prochaska</i> .....	523
Aspects of Characterisation of Stone Monuments from Southern Pannonia <i>Branka Migotti</i> .....	537



The Budakalász Travertine Production <i>Bojan Djurić, Sándor Kele and Igor Rižnar</i> .....	545
Stone Monuments from Carnuntum and Surrounding Areas (Austria) – Petrological Characterization and Quarry Location in a Historical Context <i>Gabrielle Kremer, Isabella Kitz, Beatrix Moshhammer, Maria Heinrich and Erich Draganits</i> .....	557
Espejón Limestone and Conglomerate (Soria, Spain): Archaeometric Characterization, Quarrying and Use in Roman Times <i>Virginia García-Entero, Anna Gutiérrez García-M, Sergio Vidal Álvarez, María J. Peréz Agorreta and Eva Zarco Martínez</i> .....	567
The Use of Alcover Stone in Roman Times ( <i>Tarraco, Hispania Citerior</i> ). Contributions to the <i>Officina Lapidaria Tarraconensis</i> <i>Diana Gorostidi Pi, Jordi López Vilar and Anna Gutiérrez García-M.</i> .....	577
<b>4. ADVANCES IN PROVENANCE TECHNIQUES, METHODOLOGIES AND DATABASES</b>	
Grainautline – a Supervised Grain Boundary Extraction Tool Supported by Image Processing and Pattern Recognition <i>Kristóf Csorba, Lilla Barancsik, Balázs Székely and Judit Zöldföldi</i> .....	587
A Database and GIS Project about Quarrying, Circulation and Use of Stone During the Roman Age in <i>Regio X - Venetia et Histria</i> . The Case Study of the Euganean Trachyte <i>Caterine Prevato and Arturo Zara</i> .....	597
<b>5. QUARRIES AND GEOLOGY</b>	
The Distribution of Troad Granite Columns as Evidence for Reconstructing the Management of Their Production <i>Patrizio Pensabene, Javier Á. Domingo and Isabel Rodà</i> .....	613
Ancient Quarries and Stonemasonry in Northern Choria Considiana <i>Hale Güney</i> .....	621
Polychromy in Larisaeon Quarries and its Relation to Architectural Conception <i>Gizem Mater and Ertunç Denktaş</i> .....	633
Euromos of Caria: the Origin of an Hitherto Unknown Grey Veined Stepped Marble of Roman Antiquity <i>Matthias Bruno, Donato Attanasio, Walter Prochaska and Ali Bahadır Yavuz</i> .....	639
Unknown Painted Quarry Inscriptions from Bacakale at <i>Docimium</i> (Turkey) <i>Matthias Bruno</i> .....	651
The Green Schist Marble Stone of Jebel El Hairech (North West of Tunisia): a Multi-Analytical Approach and its Uses in Antiquity <i>Ameur Younès, Mohamed Gaied and Wissem Gallala</i> .....	659
Building Materials and the Ancient Quarries at <i>Thamugadi</i> (East of Algeria), Case Study: Sandstone and Limestone <i>Younès Rezkallah and Ramdane Marmi</i> .....	673

The Local Quarries of the Ancient Roman City of <i>Valeria</i> (Cuenca, Spain) <i>Javier Atienza Fuente</i> .....	683
The Stone and Ancient Quarries of Montjuïc Mountain (Barcelona, Spain) <i>Aureli Álvarez</i> .....	693
<i>Notae Lapidinarum</i> : Preliminary Considerations about the Quarry Marks from the Provincial Forum of <i>Tarraco</i> <i>Maria Serena Vinci</i> .....	699
The Different Steps of the Rough-Hewing on a Monumental Sculpture at the Greek Archaic Period: the Unfinished Kouros of Thasos <i>Danièle Braunstein</i> .....	711
A Review of Copying Techniques in Greco-Roman Sculpture <i>Séverine Moureaud</i> .....	717
Labour Forces at Imperial Quarries <i>Ben Russell</i> .....	733
Social Position of Craftsmen inside the Stone and Marble Processing Trades in the Light of Diocletian's Edict on Prices <i>Krešimir Bosnić and Branko Matulić</i> .....	741
<b>6. STONE PROPERTIES, WEATHERING EFFECTS AND RESTORATION, AS RELATED TO DIAGNOSIS PROBLEMS, MATCHING OF STONE FRAGMENTS AND AUTHENTICITY</b>	
Methods of Consolidation and Protection of Pentelic Marble <i>Maria Apostolopoulou, Elissavet Drakopoulou, Maria Karoglou and Asterios Bakolas</i> .....	749
<b>7. PIGMENTS AND PAINTINGS ON MARBLE</b>	
Painting and Sculpture Conservation in Two Gallo-Roman Temples in Picardy (France): Champlieu and Pont-Sainte-Maxence <i>Véronique Brunet-Gaston and Christophe Gaston</i> .....	763
The Use of Colour on Roman Marble Sarcophagi <i>Eliana Siotto</i> .....	773
New Evidence for Ancient Gilding and Historic Restorations on a Portrait of Antinous in the San Antonio Museum of Art <i>Jessica Powers, Mark Abbe, Michelle Bushey and Scott H. Pike</i> .....	783
Schists and Pigments from Ancient Swat (Khyber Pukhtunkhwa, Pakistan) <i>Francesco Mariottini, Gianluca Vignaroli, Maurizio Mariottini and Mauro Roma</i> .....	793
<b>8. SPECIAL THEME SESSION: „THE USE OF MARBLE AND LIMESTONE IN THE ADRIATIC BASIN IN ANTIQUITY”</b>	
Marble Sarcophagi of Roman Dalmatia Material – Provenance – Workmanship <i>Guntram Koch</i> .....	809

Funerary Monuments and Quarry Management in Middle Dalmatia <i>Nenad Cambi</i> .....	827
Marble Revetments of Diocletian's Palace <i>Katja Marasović and Vinka Marinković</i> .....	839
The Use of Limestones as Construction Materials for the Mosaics of Diocletian's Palace <i>Branko Matulić, Domagoj Mudronja and Krešimir Bosnić</i> .....	855
Restoration of the Peristyle of Diocletian's Palace in Split <i>Goran Nikšić</i> .....	863
Marble Slabs Used at the Archaeological Site of Sorna near Poreč Istria – Croatia <i>Đeni Gobić-Bravar</i> .....	871
Ancient Marbles from the Villa in Verige Bay, Brijuni Island, Croatia <i>Mira Pavletić and Đeni Gobić-Bravar</i> .....	879
Notes on Early Christian Ambos and Altars in the Light of some Fragments from the Islands of Pag and Rab <i>Mirja Jarak</i> .....	887
The Marbles in the Chapel of the Blessed John of Trogir in the Cathedral of St. Lawrence at Trogir <i>Đeni Gobić-Bravar and Daniela Matetić Poljak</i> .....	899
The Use of Limestone in the Roman Province of Dalmatia <i>Edisa Lozić and Igor Rižnar</i> .....	915
The Extraction and Use of Limestone in Istria in Antiquity <i>Klara Buršić-Matijašić and Robert Matijašić</i> .....	925
Aurisina Limestone in the Roman Age: from Karst Quarries to the Cities of the Adriatic Basin <i>Caterina Prevato</i> .....	933
The Remains of Infrastructural Facilities of the Ancient Quarries on Zadar Islands (Croatia) <i>Mate Parica</i> .....	941
The Impact of Local Geomorphological and Geological Features of the Area for the Construction of the Burnum Amphitheatre <i>Miroslav Glavičić and Uroš Stepišnik</i> .....	951
Roman Quarry Klis Kosa near Salona <i>Ivan Alduk</i> .....	957
Marmore Lavdata Brattia <i>Miona Miliša and Vinka Marinković</i> .....	963
Quarries of the Lumbarda Archipelago <i>Ivka Lipanović and Vinka Marinković</i> .....	979

Island of Korčula – Importer and Exporter of Stone in Antiquity <i>Mate Parica and Igor Borzić</i> .....	985
Faux Marbling Motifs in Early Christian Frescoes in Central and South Dalmatia: Preliminary Report <i>Tonči Borovac, Antonija Gluhan and Nikola Radošević</i> .....	995
<b>INDEX OF AUTHORS</b> .....	1009

# THE USE OF LIMESTONES AS CONSTRUCTION MATERIALS FOR THE MOSAICS OF DIOCLETIAN'S PALACE

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## Abstract

The production of the mosaic core of the Diocletian's palace in Split is attributed to the Salonitan mosaic workshop. A previous comparative analysis of individual samples of mosaic components and certain decorative motifs done according to a catalogue model (a globally accepted scientific method) has proven that thesis.

To make progress in this research, with the goal of continued examination of influence models of the same mosaic workshop, research and mapping of the materials utilized is required, in which limestone, marble and dolomite dominate quantitatively. This article gives the results of the first (pilot) laboratory processing and a comparison of several mosaics' structural matter in Diocletian's Palace. The broader agenda of the article is to form catalogues of the materials used and to map their distribution inside the Salonitan workshop's area of influence.

## Keywords

mosaic, Salonitan mosaic workshop, Diocletian's palace

## Introduction

Remains of mosaics, no matter which way we look at them – as a craft or art, are very frequent inside the Roman province of Dalmatia. This has been confirmed by findings of mosaic remains within archeological research in this area. The collection of mosaics known to us today counts as many as 650 catalogued examples, and it is certain that not all findings have been noted in the scholarly literature, or in any other publicly available source. . Keeping in mind the quantity of what was found, it was hypothesized that there was in the province a school or workshop, responsible for this enormous amount of production, or at least most of the work which we are acquainted with today.<sup>1</sup>

In the middle of the 1990s, a systematic, catalogue treatment of mosaic findings inside the province began, based on an internationally acknowledged form and approach in analyzing mosaic samples, different from the previous ways in which they were published and interpreted<sup>2</sup>. These earlier interpretations were quite subjective and based on personal whims, making it hard to realise that the different authors were describing the same mosaic finding with a given artistic display.<sup>3</sup>

By contrast, the catalogue of artistic displays on mosaics, with the acronym DÉCOR<sup>4</sup>, uses a name (worded description) for each sample, and also assigns a combined – alphanumeric code. The beginning of analysis and examination according to this sample catalogue, after a more careful look, provided a new perspective on and interpretation of data known earlier. From this new interpretation came interesting insights into the structure and frequency of the motives, that is, the topographical relations between mosaic samples and the orientation of a certain area from the province according to influences from other areas of the Empire. The conclusion to the interpretation and analysis is that the source of a large number of mosaics and the overall production was the center of the province itself – the city of Salona, which is also a testament to the existence of the Salonitan mosaic school

made by dr. sc. Marija Buzov and prof. dr. sc. Branko Matulić. See: BUZOV 1985; MATULIĆ 1995; JELIČIĆ-RADONIĆ 2003, 513-52.

2 That graphic and descriptive form was established by the international association for research and examination of Ancient mosaics "Association internationale pour l'étude de la Mosaique antique" (A.I.E.M.A.), which counts over 350 members, people or organizations, across the globe.

3 An exception was prof. dr. sc. Branko Matulić, whose master's thesis and afterwards doctorate and later works took the form of artistic analysis of mosaics, presented in the catalogues "Bulletin de l'AIEMA" (abb. BAIEMA) and "La decor geometrique da la mosaique Romaine" (abb. DÉCOR); MATULIĆ 1994, the same, 2000.

4 DECOR 2002.

1 The thesis was presented by several researchers, among which the most significant contribution was

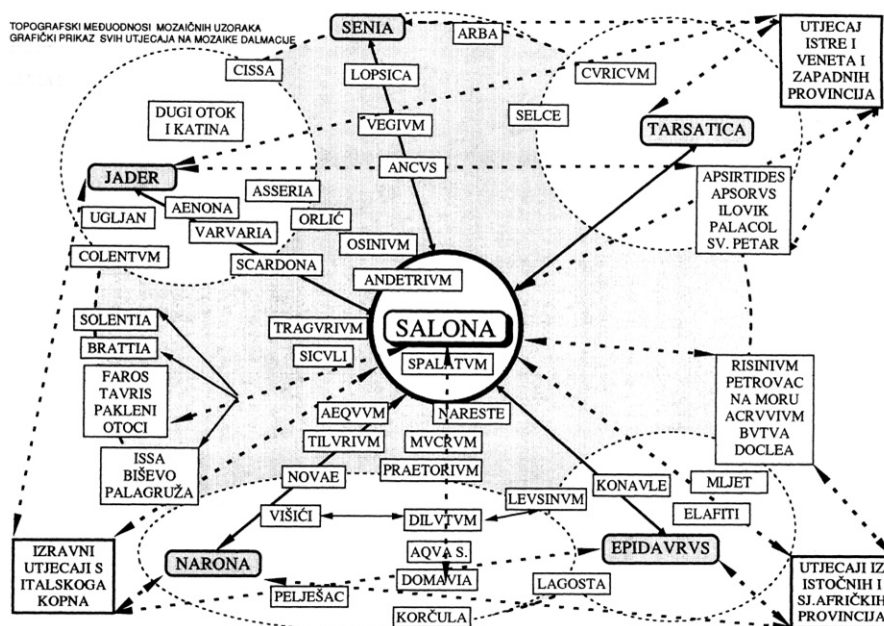


Fig. 1.  
Topographic relations of  
mosaic samples; graphic  
depiction of all the influences  
on the mosaics of the  
province of Dalmatia

or workshop, although there are mosaic findings which predate the time of influence of this workshop. (Fig. 1)

What is not known or understood with clarity about the workshop is the exact time of its founding, the scope of its work and influence, while the specifications of its work in the choice of motives or materials can be defined only circumstantially.<sup>5</sup>

Even though we cannot speak of the exact time of its founding, the start of its influence can probably be assigned to the 2<sup>nd</sup> century A.D.; and we can follow its most exemplary pieces during the third century, and in the phase of Antiquity, that is, from the fifth to the sixth century during Early Christianity, while its decline probably came in the seventh century, as suggested by there being so few examined samples of mosaics in the Middle Ages in the workshop's sphere of influence.

### Motivation of the research

Since no significant discoveries have been made in the area of the Roman province of Dalmatia since the last cataloguing capable of making an impact on the knowledge attained through earlier means of examination of the Salonitan school, other methods of studying and analyzing the available materials are needed, for the sake of the development of a pool of information about previously known findings and the acquisition of new knowledge through careful examination of findings already known.

This attitude resulted in the idea of creating a catalogue of the materials used to assemble mosaics in the wider Salona area, that would include not only the city but also nearby localities within its sphere of influence. Since it is in the nature of all ancient craft workshops (whether they are Greek or Roman) to use more or less same sources of material once they are found, the assumption that the same practice would have been resorted to during the acquisition of materials for mosaics to be produced by the Salonitan workshop is logical.

What is specific about the mid-Dalmatian area is the abundance of quarries that exploit white limestones,<sup>6</sup> but there are far fewer quarries that produce black, brown, red, yellow or green stone. Because of this limited availability of resources, it is easier to assume and, eventually, determine their origin and connect the quantity of use of a certain material with the tendencies, that is, preferences of a certain workshop in its use (Fig. 2). Analogously, the specific use of white limestones is hard to assign to any workshop or crafting circle, because these materials are available in great quantity and with similar quality. However, the possibility that a certain workshop owned some of the smaller quarries or worked with a quarry through a longer period should not be underestimated, so the frequency of white limestone usage could also be indicative, if it is proven from a sufficient amount of samples.

5 MATULIĆ 2011, 167-170.

6 PARICA 2012, 345-353.; POPOVIĆ 2012; KATIĆ 2009; BUZOV 2009, 628, 629; DONELLI *et al.* 2009; ZANI-NOVIĆ 1997, 37-45.



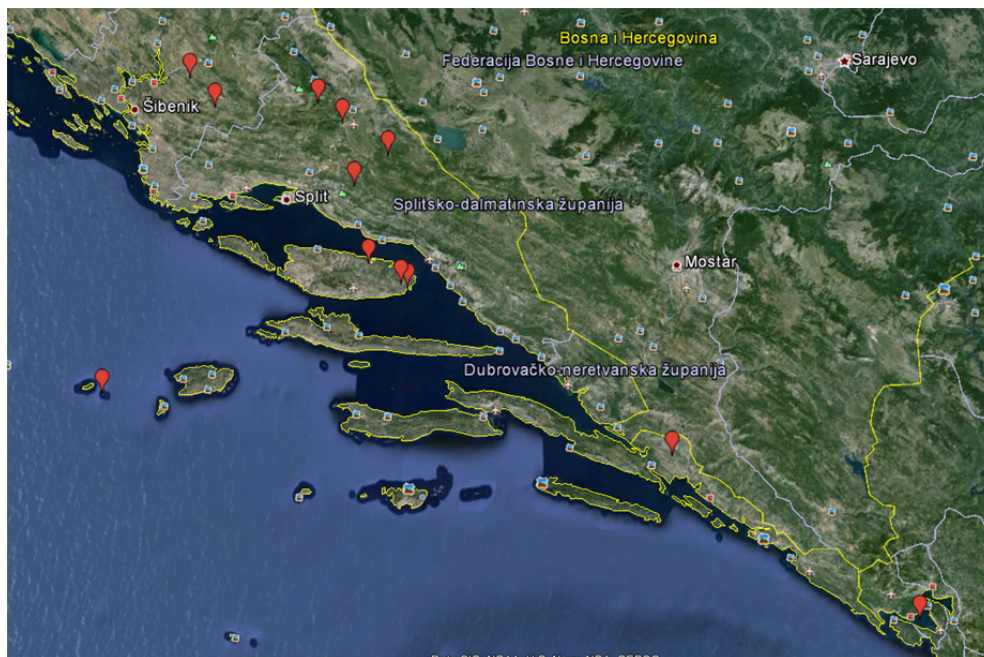


Fig. 2.  
Distribution of the  
relevant quarries  
in the former Roman  
province of Dalmatia

Following the study on the works carried out by the Salonitan mosaic workshop, it is especially interesting to study the Diocletian Palace mosaics. Decorating a building of such significance could not have been entrusted to just any workshop, and by the end of the 3<sup>rd</sup> century, the Salonitan workshop has already established a notable reputation.<sup>7</sup>

Apart from the obvious reasons, it is important to mention that just a small portion of the excavated mosaics attributed to the Salonitan school is available to the public today. Besides two of the major mosaics within Diocletian's palace, mosaics exhibited at the Archaeological Museum, and some of the mosaics visible at the sites, the rest of them have been reburied, not presented, and thus are unavailable for sampling.

It is unquestionable that all the mosaics produced for Diocletian's Palace have not been saved, especially when it is borne in mind that archaeological campaigns have often found only piles of tesserae, or small, sporadic remains. Such remains survived at the dome of Vestibul, two of which were strapped and conserved at the Archaeological Museum store in 1898 by Don Frane Bulić.<sup>8</sup>

At the intersection of Bulićeva Street with the ancient decumanus, the remains of a building that had a courtyard and a portico have been discovered. Recent research assumed that the building was a part of a vast *thermae* complex, and when the ancient mosaics within were uncovered, a lot of scattered, gilded glass paste tesserae were found, probably a part of a wall or vault decoration. Today, only a part of the preserved mosaic is presented, since the adjacent buildings cover the rest (as shown by the original research).

Not far from this mosaic, right next to the Vestibule on the eastern side, lies a mosaic from the same period, excavated in 1905, and re-excavated in 1963. The latter research recognized the mosaic as a part of the courtyard, that is, a porticus surrounding an ancient building from three sides, completely paved with mosaic. Today, only a part of the northern pavement is presented, the western being disrupted by a medieval street then then continuing in the ground floor of a Roman house, where a part of the southern pavement is also visible.<sup>9</sup>

Since both of the mosaics are visible (exposed

7 Some examples of their executions would be a mosaic depicting the Nine Muses, found in the remains of Roman baths covered by a complex of Christian edifices. Other such examples would be a mosaic depicting Orpheus, which is dated to the 3<sup>rd</sup> century, mosaics with the image of Triton and Apollo as well as mosaics in Stari Grad on Hvar, found in Srednja ulica (Srinjo kola).

8 JELIČIĆ - RADONIĆ 1999/2000, 62; MATULIĆ 2005, 228.

9 MATULIĆ 2005, 228, which is referring to BULIĆ 1908, NIEMANN 1910, HEBRARD-ZEILLER 1921, BULIĆ - KARAMAN 1927; MARASOVIĆ - MARASOVIĆ 1965; MARASOVIĆ 1967; MARASOVIĆ - MARASOVIĆ 1968; MARASOVIĆ *et al.* 1972., JOVANOVIĆ 1974, SMITH 1979, MEDER 1980; ČREMOŠNIK 1984; BUZOV 1985; BUZOV *et al.* 1987; MARASOVIĆ 1989; MARIN - KIRIGIN 1989; BUZOV 1991; MARASOVIĆ 1994; CAMBI 1994; KOLARIK 1994; MATULIĆ 1994/1995; BELAMARIĆ 1997; MEDER 2003.



Fig. 3. Laboratory sample No. 19853 (photo: D. Mudronja)



Fig. 4. Laboratory sample No. 19856, variety A (photo: D. Mudronja)

to the public view), it is necessary to undertake regular maintenance, and conservation campaigns. This also enables study and research on them to take place, mainly undertaken by the Croatian Conservation Institute, while the Arts Academy Section for conservation-restoration participates occasionally.

Sampling and petrographic - mineral analysis of the black, red and green tesserae, a specific type of material present in both of the mosaics, started with the sampling of both mosaics. This method was selected because of its availability at the moment, being the only suitable to estimate the potential of this pioneering attempt of cataloguing and mapping. In the following phases (which will, it is hoped, occur in the near future) it will be necessary to include other nuclear and spectroscopic techniques of analysis, and also to form a public information base for dissemination of the research data.

Quarries with similar materials that were assumed to be active during Antiquity were sampled along with them, and the material found was mainly not widely spread over the province, but specific to a certain area (to microlocations). Such quarries are Dolac, where Zeleni Jadran green stone is still quarried, a quarry in the village of Velić, near the Roman castrum of Tilurium, from where the rough black, low quality building stone was quarried up to a recent date, and the small quarry of Kamenari in Montenegro, near Boka Kotorska, where a red stone is excavated and used mainly for masonry.

Petrographic-mineral analysis was undertaken by macroscopic observation, and the observation of the ground samples under polarizing light. It is important to mention that the results of only six samples are now published, while analysis of the complete mosaic material of the available mosaics is planned, as a part of a wider project dealing with the creation of a reference catalogue of materials and their distribution over mosaics within the province.

### Samples

LAB. NUMBER	SAMPLING LOCATION	COLOUR	CODE
19853	Dolac Donji quarry	Green	DOLAC_Z_1
19854	Mosaic, Buličeva Street	Black	BUL_C_1
19855	Mosaic, Arhidakonova Street	Red	ARC_CR_1
19856	Mosaic, Arhidakonova Street	Green	ARC_Z_1
19857	Velić quarry	Black	VELIC_C_1
19858	Kamenari quarry	Red	BOKA_CR_1

### Analysis results

#### Sample lab. No. 19853 (Fig. 3)

Homogenous, grainy structure, made of well-sorted particles, dominantly bioclastic; strong reaction with diluted HCl – which implies limestone composition

Description of the microscopic sample - examination of the microscopic sample identified a homogenous, grainy structure, made of thickly packed bioclasts. Bioclastic material dominates its composition, and is mainly made of benthic foraminifera fragments (*Discocyclina* sp., *Operculina* sp., *Rotalia* sp., *Nummulites* sp.), fragments of red algae, bryozoa, and a smaller amount of shells. Plankton foraminifera appear sporadically (*Globigerinatheka* sp.). Completely preserved foraminifera appear sparsely, and are mostly



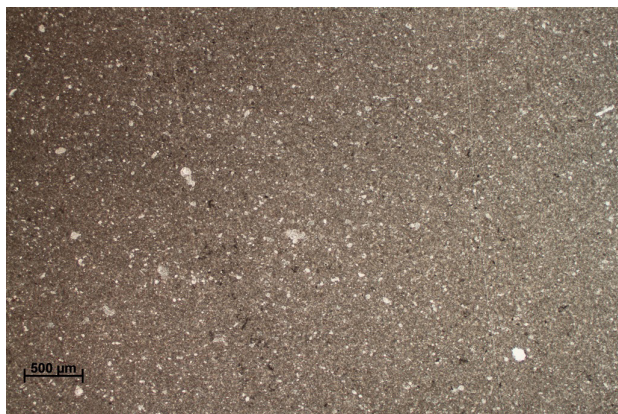


Fig. 5. Laboratory sample No. 19858 (photo: D. Mudronja)

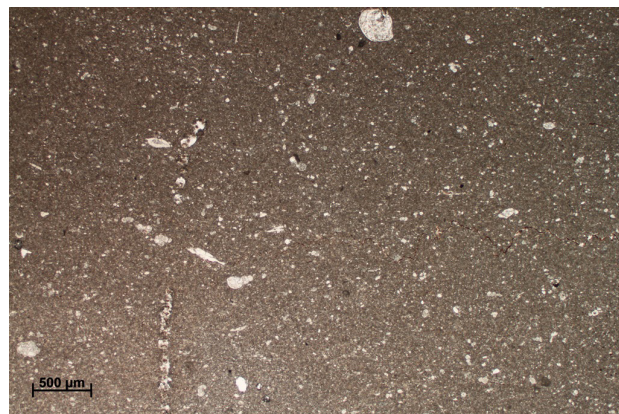


Fig. 6. Laboratory sample No. 19855 (photo: D. Mudronja)

fragmented, which suggests their redistribution at some point. Among non-skeletal particles, pelloid grains have been noted. Size of the clast is within the interval of coarse-grained sandstone. Considering the noted characteristics of the composition and the structure, the sample can be determined as bioclastic (foraminifer) limestone, originating from the Eocene, most likely a part of the flysch formation.

Based on its characteristics, the sample was defined as bioclastic foraminiferic limestone, from the geological age of Eocene.

#### Sample lab. No. 19856

Seven mosaic tesserae, all of which cause a strong reaction with diluted HCl – limestones;

After examination of all of the seven tesserae, two varieties of grainstone packstone, with smaller and bigger grains, were selected for sample preparation.

Variety A: bioclastic material made of thickly packed, mostly fragmented bioclasts of Eocene benthic foraminifera (*Discocyclus* sp., *Operculina* sp., *Rotalia* sp., *Nummulites* sp.), echinoderms, shells, Briozoi, and sporadically planktonic foraminifera (*Globigerinatheka* sp.) Based on all of the observed characteristics, the sample was identical to sample 19853, identified as bioclastic foraminiferic limestone, from the geological age of Eocene. (Fig. 4)

Variety B features a fine-grained, homogenous structure, made of calcite particles (most likely skeletal karst), peloid in its grainy support. Angular grains of quartz, uniformly darkened, appear sporadically. According to particle size, this is classified as a fine-grained sandstone. The sample was identified as biocalcareneite.

#### Sample lab. No. 19858 (Fig. 5)

Brownish, strong reaction with diluted HCl – limestone; predominantly small grained micritic material, with significant traces of bioturbation; broken surface is convex –concave, without gloss.

Within the micritic material (base), there are some (sporadically) scattered planktonic foraminifera, preserved and fragmented, most likely the Upper Cretaceous group of planktonic foraminifera. Material was defined as biomicrite wackestone.

#### Sample lab. No. 19855 (Fig. 6)

Seven small tesserae, from among which two brownish varieties were extracted: a strong reaction with diluted HCl is present in all of them – limestones.

One of the varieties was characterised with a micrite base within rarely distributed planktonic foraminifera. Few of them were completely conserved (mostly fragmented in tiny calcite particles). Based on its characteristics, this variety is an exact match with sample 19858.

The material can be defined as biomicrite wackestone.

#### Sample lab. No. 19857 (Fig. 7)

Dark, black sample, strong reaction with diluted HCl – limestone; a sugary-looking fracture – most likely the result of recrystallization, the sawn and polished surface reveals a nonhomogeneous structure formed as irregular clasts, originating from *in situ* clastic sedimentation.

Clasts are of centimetre dimensions, slightly rounded but irregular, while interstices are filled with tiny grained grainstone – packstone material (grey coloured).

A homogenous, finely crystalline structure, made of anhedral calcite crystal can be noticed. Sporadically, nests filled with quite large sparite crystals can be perceived (most likely the sparite fillings of the cavities, occurring during the meltdown in diagenesis, suggesting recrystallization with destruction of primary limestone structure. Material is defined as recrystallized limestone. (Fig. 9)

#### Sample lab. No. 19854 (Fig. 8)

Five tesserae, all of which are limestones, reacted intensively with diluted HCl, prevalently tiny grained packstones to wackstones. Observing the microscopically



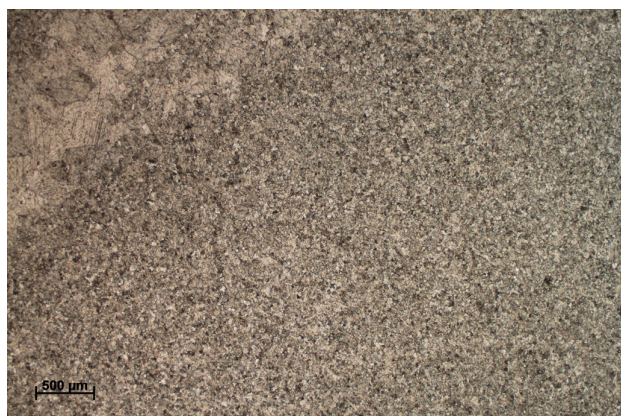


Fig. 7. Laboratory sample No. 19857 (photo: D. Mudronja)



Fig. 9. Laboratory sample No. 19857, magnified (photo: D. Mudronja)



Fig. 8. Laboratory sample No. 19854 (photo: D. Mudronja)

specimen a mostly tiny-grained but non homogeneous structure due to bioturbation was noticed. The base is made of micritic material mixed with tiny calcite particles. Elongated, straight to slightly bent bioclasts are spread all over the base (most likely the remains of tiny shells and echinoderms). The material went through the process of bioturbation (hence its non-homogenous structure). A small portion of the specimen is characterised by more micritic material, without tiny calcite particles, also filled with elongated skeletal remains of shells, and by all odds, echinoderms. A microsparite component with a significant amount of brown limonite matter is present within some regions. Based on all of its characteristics, the material is defined as biomicritic packstone to wackstone.

## Conclusion

As for the properties of the materials, the analysis of the samples suggested the following

Green tesserae of the Arhidakonova street mosaic (19856) are made of two varieties, one of which is identical to a Dolac Donji quarry, while the other is not similar (marked as variety A).

Red tesserae of the Arhidakonova Street mosaic (19855) are also made of two varieties, one of which is identical to a Boka quarry sample (marked as variety B). Black tesserae samples (19854) are not similar to the Velić quarry.

The analysis done was just a test to discover if it was plausible to assume that most of the materials used by the Salonitan mosaic workshop were local. Determining and connecting the well known quarries from Salona's area of influence to its mosaic materials would, however enable a wider project. Forming a catalogue, and/or mapping the materials used would, of a necessity, require the use of further petrographic mineral, nuclear and spectroscopic identification methods. Once the base of the materials used takes shape, it will be easier and more accurate (combined with previous methods of identification) to assign a certain mosaic to a certain workshop and period.

Material bases are a prerequisite for many other studies of the crafts from Antiquity. So far, we do not have any usable material databases for the study of ancient mosaics in Croatia. Furthermore, we also do not have material bases to compare to similar databases largely made abroad. The first step to that goal was taken in this research, which can be described as a pioneering but obviously deficient attempt towards cataloguing and mapping the stones used in Salona during antiquity. Nevertheless, if we manage to emphasise the need for such a project, and spark the interest of scientific disciplines working towards the same purpose within Croatia's scholarly and professional network, then no effort will have been in vain.

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