

# The Use of Limestone in the Roman Province of Dalmatia

---

**Lozić, Edisa; Rižnar, Igor**

*Source / Izvornik:* **ASMOSIA XI, Interdisciplinary Studies on Ancient Stone, Proceedings of the XI International Conference of ASMOSIA, 2018, 915 - 923**

**Conference paper / Rad u zborniku**

*Publication status / Verzija rada:* **Published version / Objavljena verzija rada (izdavačev PDF)**

<https://doi.org/10.31534/XI.asmosia.2015/08.10>

*Permanent link / Trajna poveznica:* <https://um.nsk.hr/um:nbn:hr:123:502928>

*Rights / Prava:* [In copyright](#)/[Zaštićeno autorskim pravom.](#)

*Download date / Datum preuzimanja:* **2024-11-21**



*Repository / Repozitorij:*

[FCEAG Repository - Repository of the Faculty of Civil Engineering, Architecture and Geodesy, University of Split](#)



# ASMOSIA XI

Interdisciplinary Studies on Ancient Stone

## PROCEEDINGS

of the XI ASMOSIA Conference, Split 2015

Edited by Daniela Matetić Poljak and Katja Marasović



Interdisciplinary Studies on Ancient Stone  
Proceedings of the XI ASMOSIA Conference (Split 2015)

Publishers:

ARTS ACADEMY IN SPLIT  
UNIVERSITY OF SPLIT

and

UNIVERSITY OF SPLIT  
FACULTY OF CIVIL ENGINEERING,  
ARCHITECTURE AND GEODESY

Technical editor:  
Kate Bošković

English language editor:  
Graham McMaster

Computer pre-press:  
Nikola Križanac

Cover design:  
Mladen Čulić

Cover page:

*Sigma shaped mensa of pavonazzetto marble from Diocletian's palace in Split*

ISBN 978-953-6617-49-4 (Arts Academy in Split)

ISBN 978-953-6116-75-1 (Faculty of Civil Engineering, Architecture and Geodesy)

e-ISBN 978-953-6617-51-7 (Arts Academy in Split)

e-ISBN 978-953-6116-79-9 (Faculty of Civil Engineering, Architecture and Geodesy)

CIP available at the digital catalogue of the University Library in Split, no 170529005

Association for the Study of Marble & Other Stones in Antiquity

# ASMOSIA XI

## Interdisciplinary Studies of Ancient Stone

Proceedings of the Eleventh International Conference of ASMOSIA,  
Split, 18–22 May 2015

Edited by  
Daniela Matetić Poljak  
Katja Marasović



Split, 2018

**Nota bene**

All papers are subjected to an international review.

The quality of the images relies on the quality of the originals provided by the authors.

# 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 Silentary, 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 Ruppiniè 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 Brillì 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. Peréx 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 Barancsuk, 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 Previato 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 Denктаş</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 Previato</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 LIMESTONE IN THE ROMAN PROVINCE OF DALMATIA

Edisa Lozić and Igor Rižnar

Ljubljana, Slovenia (edisalozic@gmail.com; igor.riznar@telemach.net)

## Abstract

The primary objective of this study is to present the methodological approach used in an attempt to determine possible provenience areas (quarries) of the stone material used for the stonemasonry production of the funerary monuments (dated between 1<sup>st</sup> and 3<sup>rd</sup> century AD) in the interior of the Roman province of Dalmatia. To illustrate this methodological approach, we have decided to present the results of three regional case studies. The results of the study reveal the possible existence of Roman quarries in the interior of the province of Dalmatia.

## Keywords

Roman province Dalmatia, provenance study, limestone

## 1. Introduction

This paper examines the stone supply used for the stonemasonry production of the funerary monuments in the interior of the Roman province of Dalmatia (today's BiH and parts of Croatia, western Serbia, Montenegro). Even though the number of funerary monuments is small compared to the coastal area of the province of Dalmatia they still provide ample evidence of rich stone masonry production and reveal an existing demand for stone.

In the past, many studies were devoted to different archaeological aspects of the funerary monuments from the interior of the province of Dalmatia, focusing on stylistic groupings, typological development and art history.<sup>1</sup> However, provenance analysis and mechanisms for the distribution of stone material are still in their infancy.

The present research aims to fill this gap by using a specific methodological approach in attempt to locate appropriate (possible) provenience areas (quarries) of the stone material.

There are three basic questions that need to be answered:

1. What type of stone material (in geological terms) was used for production of the stone monuments and are there any (micro) regional differences in the use of stone?
2. Is it possible to locate stone material source area(s)?
3. Is it possible to identify stone material transport routes?

Therefore, the work was organized in three different phases: (i) the first phase aimed at identifying what type of stone material (in geological terms) was used for the production of the stone funerary monuments, (ii) the second phase was devoted to determining the potential locations from which the stone material might have originated i.e. the possibility of locating appropriate quarries, (iii) the third phase was aimed at identifying possible routes of transport.

## 2. Methods of work

Here the methodological approach used in the study is outlined.

The aim of the first phase was to identify the types of stone material (in geological terms) used for production of the stone funerary monuments from the interior of the province of Dalmatia. To this end, macroscopic petrographic analysis was conducted on 177 funerary monuments curated at the National Museum of Bosnia and Herzegovina as this is the most representative corpus of the funerary monuments from this geographic area. The stone artefacts were macroscopically analysed using a hand lens and lithotypes (described below) were defined on the basis of the petrographic analysis. In addition, the archaeological analysis of the monuments was conducted, in which their cultural – historical background was defined.

The next step was to determine provenance, i.e. the potential locations from which the stone material could have been quarried. Using the finding-site location as the starting point, the lithotype of each monument has enabled comparison with the geology within a 30 km radius.<sup>2</sup> Data from the 1:100,000 scale basic geologic map

1 PAŠKVALIN 2012; ZOTOVIĆ 2003; ČREMOŠNIK 1963, 105-125.

2 Research has shown that transportation distance for building stone between larger urban centres and quarries was not larger than 30 km (*cf.* RUSSELL 2014).



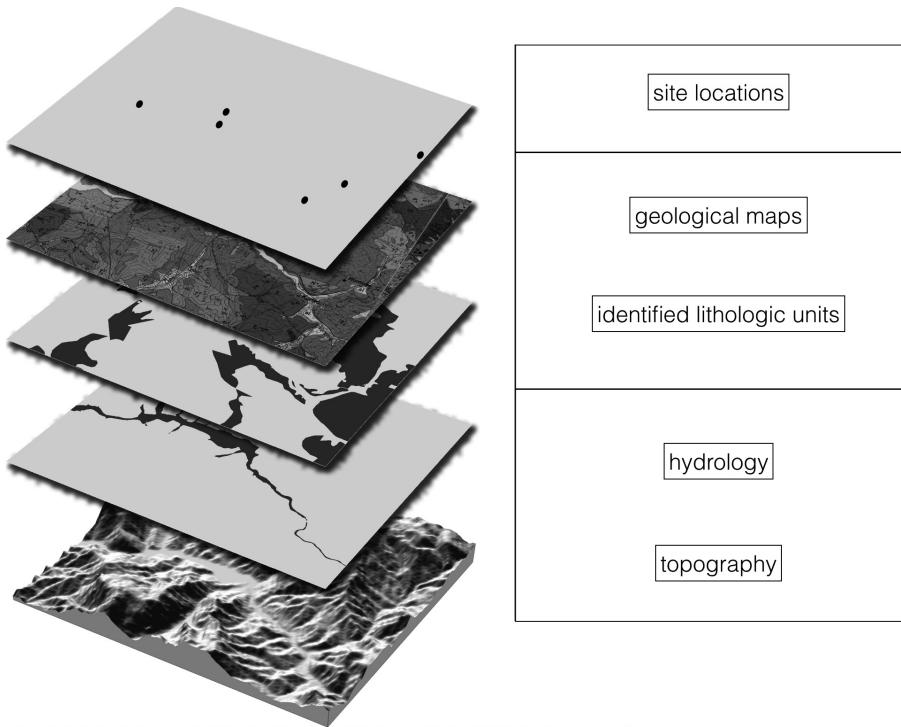


Fig. 1.  
Graphic representation  
of GIS analysis workflow

of SFR Yugoslavia (maps and explanatory text) were used for this comparison. Using GIS-analysis enabled us to analyse spatial associations between archaeological (site location) and geological datasets (relevant lithostratigraphic units). The output was a series of maps of the (micro) regions with identified lithostratigraphic units from which particular stone material could have been acquired.

Since the logistics of stone supply within each (micro) region, highly depends on terrain characteristics and the possibility of water transport; we have also taken in account the topographical and the hydrological situation.<sup>3</sup> For this purpose the digital elevation model (DEM) with a 25 m spatial resolution<sup>4</sup> was used and hydrological data digitized from 1: 50, 000 maps. GIS- tools has allowed us to overlay data layers obtained and to identify the existence of potential locations for the quarry and possible routes of transport.

It should be pointed out that this is an initial phase of the study where a basic insight into the material from the artefacts is acquired with a non-destructive method, and in which basic information regarding potential provenance of the lithotypes is defined. In the second phase, the artefacts will be sampled, petrographically and paleontologically analysed, and compared to the exposures of relevant rock formations in the field.

To summarize: the collected datasets consist of the three main data layers: archaeological (site locations), geological (identified relevant lithostratigraphic

unit) and spatial data (topographic and hydrological situation) (Fig. 1). By overlaying data layers we were able to obtain the result in form of topographic maps of the micro-regions (a series of maps). The map presents the stone material available in the immediate vicinity of the sites. Based on these maps the possible provenance area and the potential transport corridors were recognised.

### 3. Case studies

For illustration purposes of this methodological approach, the results of three regional case studies are presented. The areas have been chosen based on the high concentrations of the site locations in which the numerous stone funerary monuments were encountered (Fig. 2).

#### 3.1. Bihać

The first study area is located in the Bihać area in the northwest of Bosnia and Herzegovina, where several archaeological sites with high concentration of stone funerary monuments are located (Fig. 4). Archaeological analysis has shown that the entire corpus (dated between the 1<sup>st</sup> and the 3<sup>rd</sup> century) of the funerary monuments from this area exhibits great typological diversity (cinerary urns, lids in the form of simple sloped roofs, stelai, aediculae etc.).<sup>5</sup> In a typological sense two types of funerary monuments prevail: most cinerary urns and lids in the forms of simple

3 *cf.* RUSSELL 2014, 78.

4 EU-DEM25.

5 LOZIĆ 2013.



Region	Number	Archeological site	Inventory number	Item	height (cm)	width (cm)	depth (cm)	Identification number	Type of stone	Lithotype
Bihać	1	Brekovica	96	stela	152	63	20	103	Limestone	A
	2	Čavkići	1501	cinerary urn	13	8	5	2	Limestone	A
	3	Čavkići	1333	cinerary urn lid	15	29	8	3	Limestone	A
	4	Čavkići	1337	cinerary urn lid	20	22	9	18	Limestone	A
	5	Čavkići	1338	cinerary urn lid	15	30	10	19	Limestone	A
	6	Doljani	1331	cinerary urn	38	16	12	7	Limestone	A
	7	Doljani	249	cinerary urn	55	71	72	130	Limestone	A
	8	Golubić	1322	cinerary urn	32	20	14	6	Limestone	A
	9	Golubić	50	edicula	170	50	15	22	Limestone	A
	10	Golubić	421	stela	77	83	15	23	Limestone	A
	11	Golubić	246	stela	200	67	17	35	Limestone	H
	12	Humačka Glavica	1318	cinerary urn	10	7	7	1	Limestone	A
	13	Humačka Glavica	1346	cinerary urn	38	30	29	17	Limestone	A
	14	Pritoka	1345	cinerary urn lid	20	56	57	12	Limestone	A
	15	Pritoka	1445	cinerary urn lid	15	55	47	15	Limestone	A
	16	Pritoka	1343	cinerary urn lid	15	48	46	20	Limestone	A
	17	Pritoka	408	cinerary urn lid	12	55	20	21	Limestone	A
	18	Pritoka	1446	cinerary urn lid	14	60	54	53	Limestone	A
	19	Pritoka	unknown	cinerary urn lid	49	40	10	112	Limestone	A
	20	Pritoka	unknown	edicula	38	77	27	31	Limestone	A
	21	Ribić	589	cinerary urn	52	101	97	131	Limestone	A
	22	Ribić	1827	cinerary urn	42	78	25	132	Limestone	A
Konjic	23	Brčani	49	stela	174	78	30	174	Limestone	BD
	24	Homolje	55	stela	178	68	26	94	Limestone	BD
	25	Homolje	57	stela	149	70	28	169	Limestone	BD
	26	Homolje	52	stela	170	85	29	172	Limestone	BD
	27	Lisičići	1824	stela	123	70	26	96	Limestone	BD
	28	Lisičići	161	stela	169	67	29	170	Limestone	BD
	29	Lisičići	264	stela	138	63	25	171	Limestone	BD
	30	Ostrožac	56	stela	159	70	23	155	Limestone	BD
	31	Radešine	58	stela	144	62	26	93	Limestone	BD
Srebrenica	32	Mihaljevići	267	stela	117	69	26	77	Limestone	C
	33	Sase	161	stela	140	65	23	83	Limestone	C
	34	Sikirići	1826	funerary altar	77	66	51	104	Limestone	C
	35	Skelani	1839	stela	114	45	18	82	Limestone	C
	36	Skelani	unknown	stela	26	29	21	121	Limestone	C
	37	Skelani	unknown	stela	32	33	17	122	Limestone	C
	38	Tegare	266	stela	124	60	24	62	Limestone	C
	39	Tegare	265	stela	170	61	24	85	Limestone	C
	40	Tegare	262	stela	91	66	23	105	Limestone	C
	41	Tegare	1831	stela	74	67	22	173	Limestone	C

Fig. 2. List of the funerary monuments from the case study areas on which the macroscopic petrographic analysis was conducted

sloped roofs that were, according to the epigraphic sources, produced for the local population.

Macroscopic petrographic analysis of the material was conducted on the 22 funerary monuments from the Bihać area (Fig. 2). Results of the macroscopic petrographic analysis have shown that funerary monuments from the Bihać area are made of two distinct limestone lithotypes (defined as A and H). The limestone of lithotype A was identified on 21 funerary monuments. The only exception is the funerary stela from Golubić (Fig 2: No. 11) made of the lithotype H limestone.

#### Description of the lithotypes and their possible provenance area

Lithotype A is white to rarely yellowish porous limestone. Allochems are well-sorted medium to well-rounded spherical grains 0.1 – 0.2 mm in size. Internal structure of the grains could not be established by macroscopic observation. In parts where the sorting is better, the lithotype resembles oolitic limestone but it seems that the spherical

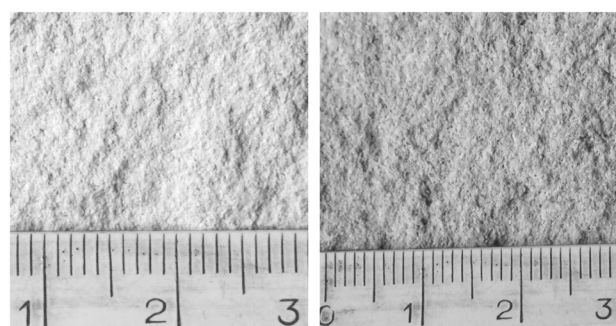


Fig. 3. The figure provides a comparison of macro-photos of lithotype A (Fig. 2: No. 13, on left) and the “bihacit” from the modern quarry (photo: I. Rižnar)

grains are bacterial in origin as the internal structure resembles travertine. According to a sarcophagus (exhibited in front of the Museum), which is the largest artefact made of this lithotype, it is clear that the limestone is massive- to thick-bedded with poorly expressed sedimentary structure. Poorly expressed bedding is manifested as subtle

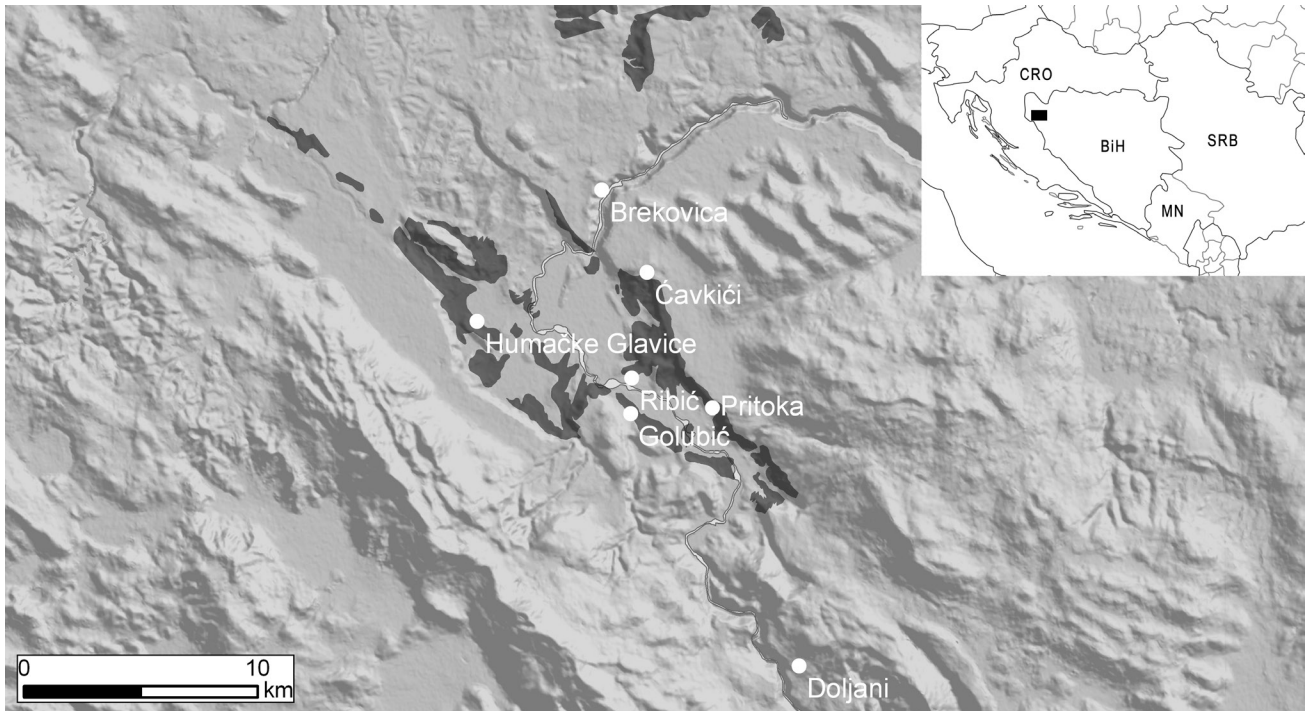


Fig. 4. Locations of the corresponding lithostratigraphic unit identified on the geological map Bihac (2M2) and archaeological sites referred to in this case study

changes in roundness, sorting and size of the grains. Regarding the porosity and general resemblance with other Neogene rocks of the Central Paratethys, it is clear that the limestone is of Neogene age. Due to its high porosity, lithotype A is much lighter than marble and the Mesozoic limestones from the Dinarides that underwent deep burial. High porosity, homogeneity and isotropy are important characteristics that make the limestone easy to work with, while the very fine grains enable an excellent workability even for the most delicate ornaments.

This kind of limestone is described in explanatory booklets of the geological maps of the area as “travertine-like” fresh water limestone. These rocks are present in the area in several stratigraphic units mapped as “Oligomiocene”, and the Upper and Middle Miocene.<sup>6</sup>

The limestone of lithotype A corresponds to the limestone from the modern day quarry in the vicinity of Bihac town where it is known under commercial name “bihacit.” From an archaeological point of view the most important characteristic of “bihacit” stone is its high porosity which enables excellent workability and easy extraction (fresh blocks of it can be cut or sawn); in addition, its deposits are very shallow, ca 1–1.5 m under the surface.

All the Neogene limestones that do not belong to the well distinguished Lithotype A are classified into lithotype H. In general lithotype H can be described as brownish to

yellowish fine-grained porous limestone without macrofossils. In some artefacts limonitized terrigenous grains are present. No sedimentary structures are present in the artefacts. The degree of cementation varies among the artefacts. The fine-grained structure and porosity of lithotype H allows elaboration of very fine details. According to geological maps of the area, lithotype H can be expected among the Oligomiocene succession in the base of the coal series.<sup>7</sup>

The lithotypes are very similar to each other. That is why we are confronted with a frequent problem in identification of the potential source of limestone: geological mapping is not precise enough to identify the differences between the two. This could only be achieved with field testing. This is why we were only able to determine areas, which correspond to potential sources of both.

Based on the geological map of the Bihac area and the descriptions of interpreters geological maps we were able to identify the lithostratigraphic unit (<sup>2</sup>M<sub>2</sub>) as the corresponding geological formation in which both lithotypes of the limestone occur.<sup>8</sup> The potential source area of the stone material is therefore present in the major part of the Bihac area (Fig. 4).

7 POLŠAK *et al.* 1977; POLŠAK *et al.* 1978.

8 In order to be able to identify the geological formation for each lithotype (in lithostratigraphic unit <sup>2</sup>M<sub>2</sub>) more detailed outcrop mapping will be required.

6 POLŠAK *et al.* 1977; POLŠAK *et al.* 1978.

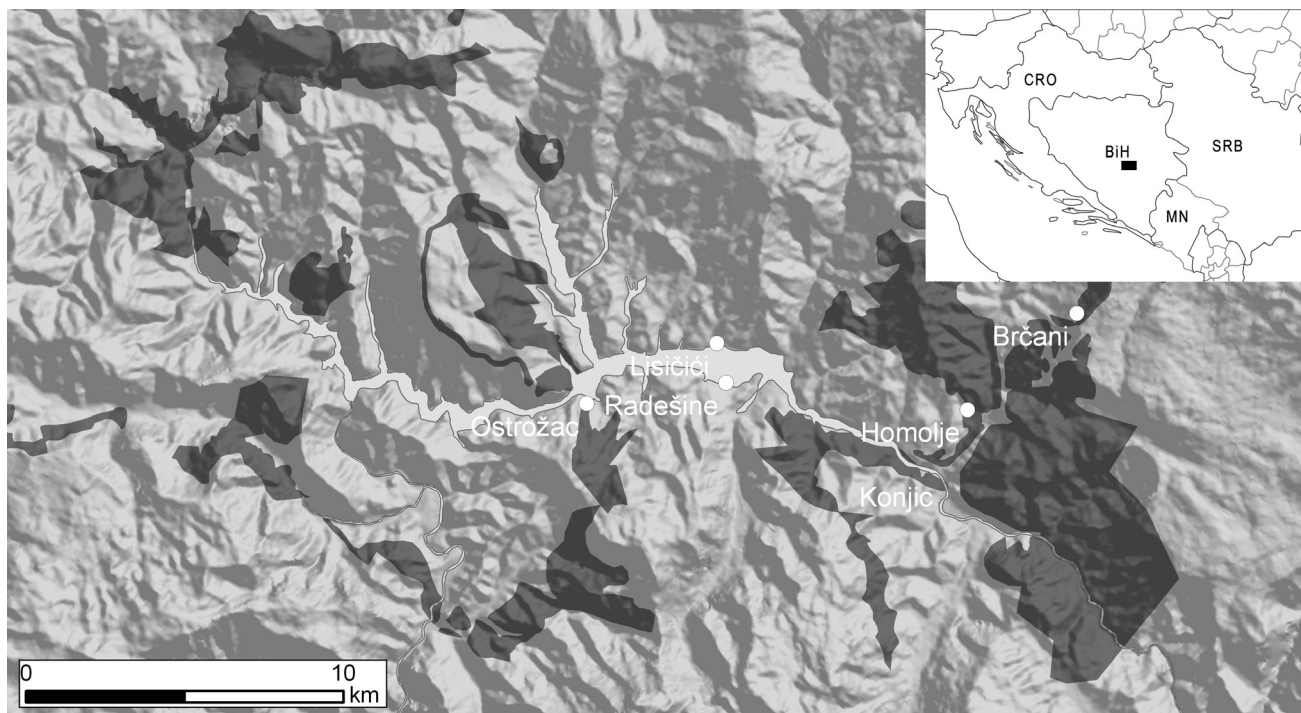


Fig. 5. Locations of the corresponding lithostratigraphic unit identified on the geological maps Prozor ( $T_2$ ;  $T_{2,3}$ ,  $T_3$ ;) Mostar ( $T_3$ ,  $T_2^1$ ,  $1 T_2^1$ ); Kalinovik ( $aT_3^{2,3}$ ,  $cT_3^{2,3}$ ), Sarajevo ( $T_{2,3}$ ,  $T_3$ ) and archaeological sites referred to in this case study

## Results and discussion

The results have shown that all finding sites of stone monuments are located within a 1 km radius of a potential source area of the stone material. The only exception is the cinerary urn (Fig. 2: No. 7) from the site of Doljani, which is located the furthest from the possible potential source of the limestone, ca 5 km. Numerous easily accessible surface limestone exposures near the site location lead us to conclude that in the Bihac area we could perhaps expect the existence of numerous small locations from which limestone was obtained. The existence of a large quarry or quarries (at least for the needs of production of the funerary monuments) does not seem likely. However, in order to be able to detect the exact locations of these small-scale, local Roman quarries, systematic terrain surveys are needed.

### 3.2. Konjic

The second study area is located 59 km southwest of Sarajevo in northern Herzegovina. Numerous archaeological sites with high concentrations of stone funerary monuments are located within 10 km of Konjic town (Fig. 5). The preferred type of funerary monuments on the territory of the Konjic area, during the 2<sup>nd</sup> and beginning the 3<sup>rd</sup> century AD, was the stela. The typological and stylistic analysis of the stela from the Konjic area has revealed that they were probably produced in

local stonemasonry workshops.<sup>9</sup> The epigraphic data and women's clothing depicted on the stela suggest that the clients were local people.<sup>10</sup>

Macroscopic petrographic analysis of the stone material was conducted on 9 funerary monuments (Fig. 2). Results of the analysis have shown that all funerary monuments from the Konjic area are made of the same type of limestone, defined as lithotype B.

### Description of the lithotype and its possible provenance area

The lithotype B is white detrital, bioclastic, partially dolomitized limestone with a "grainstone to packstone" texture. Fragments of shells, echinoderms, and other mollusc fragments are recognizable. The rock is composed of large rhomboidal dolomite crystals. Crystals range in size from 0.2 to 1 mm (0.5 mm on average). The matrix between dolomite crystal reacted to 10% hydrochloric acid demonstrating that partially dolomitized limestone samples prevail and that completely dolomitized samples are very rare. According to the geological maps in the Konjic area the dolomitized white limestone occurs among Middle and Upper Triassic rocks. These have been identified on the basic geological

9 LOZIĆ 2013.

10 LOZIĆ 2013.





Fig. 6. The figure provides a macro-photo of the limestone lithotype C (photo: I. Rižnar)

map on a scale of 1:100,000, Sheet Prozor (T2, T2,3, T3)<sup>11</sup>, Sheet Mostar (T3, T2, 1; 1T2, 1)<sup>12</sup>, Sheet Kalinovik (aT2, 3; cT3, 2,3)<sup>13</sup>, Sheet Sarajevo (T2, 2; T3)<sup>14</sup>. The corresponding lithostratigraphic units (i.e. potential source area of the stone material) are also presented in the Upper Neretva valley (Fig. 5).

### Results and discussion

The results have shown that all finding sites are located within a 3 km radius of the potential source area of the stone material. According to the geological analysis alone we cannot determine whether the material used for the stonemasonry production of the funerary monuments was sourced in a single large quarry or several smaller ones. However, the very small-scale production of the funerary monuments, produced in a relatively short time period would suggest the existence of a single quarry. The geological map and the transportation conditions narrowed the choices of potential locations for such a quarry to two possibilities (Fig. 5). The first is the outcrop of the limestone near the site Ostrožac under the assumption that the Neretva River was used for transport to the Lisičići, Radešine and Konjic. The second possibility is in the Konjic area at the junction of the Neretva valley and the known Roman road before it crosses over the Ivan pass to the Sarajevo area. Other source areas do not seem suitable since they are located on mountainous

and inaccessible locations. However, in order to be able to confirm one or the other quarry systematic terrain surveys are needed.

### 3.3. Srebrenica

The third study area is located 75 km northeast of Sarajevo in eastern Bosnia and Herzegovina. The archaeological sites at which stone funerary monuments were found are located within 20 km of Srebrenica town (Fig. 7). In the Roman period this region was an important mining territory, with *Domavia* (Gradina near Srebrenica) as the most significant municipal and administrative centre in the eastern part of the Roman province of Dalmatia. Epigraphic analysis has revealed that in the area of *Domavia* lived not only local people but also those from different parts of the Roman Empire such as Romans, Greeks, and people from Orient.<sup>15</sup> This is also reflected in the typological and stylistic heterogeneity of the funerary monuments in this region. However, the preferred type of funerary monuments on the territory of the Srebrenica area, during the end 2<sup>nd</sup> and the 3<sup>rd</sup> century AD, was the stela with a portrait medallion. The macroscopic petrographic analysis of the material conducted on the 10 funerary monuments revealed that they were all made from the same type of limestone, defined as lithotype C.

### Description of the lithotype and its possible provenance area

Lithotype C is a light grey to white limestone breccia of presumably Middle to Upper Triassic age. The breccia clasts are poorly sorted and are measuring from a few mm to 15 cm. The breccia has no matrix; the clasts are separated by stylolithe (pressure solution) seams in which the breccia clasts were partially dissolved. The breccia clasts are cut by a few millimetre thick calcite veins (arranged in conjugate pairs), ending at stylolitic seams. The breccia clasts are composed of light grey to almost white limestone, mudstone to rudstone type with rare, completely recrystallized shells, brachiopods (up to 2 cm) and algae. Lithotype C is a monomictic breccia, composed of angular clasts belonging to only one formation. However, some clasts appear to be brecciated as well. (Fig. 6).

The corresponding lithostratigraphic units have been identified on the basic geological map : 100,000, Sheet Ljubovija (T<sub>2</sub>)<sup>16</sup> and Višegrad (T<sub>2</sub>)<sup>17</sup> (Fig. 7).

11 SOFILJ, ŽIVANOVIĆ 1979; SOFILJ *et al.*, 1980.  
12 MOJIĆEVIĆ, LAUŠEVIĆ 1971; MOJIĆEVIĆ, LAUŠEVIĆ 1973.  
13 MOJIĆEVIĆ, TOMIĆ 1981; MOJIĆEVIĆ, TOMIĆ 1982.  
14 JOVANOVIĆ *et al.* 1977; JOVANOVIĆ *et al.* 1978.

15 ZOTOVIĆ 2003, 19.  
16 KUBAT *et al.* 1976; KUBAT *et al.* 1977.  
17 OLUJIĆ, KAROVIĆ 1986.

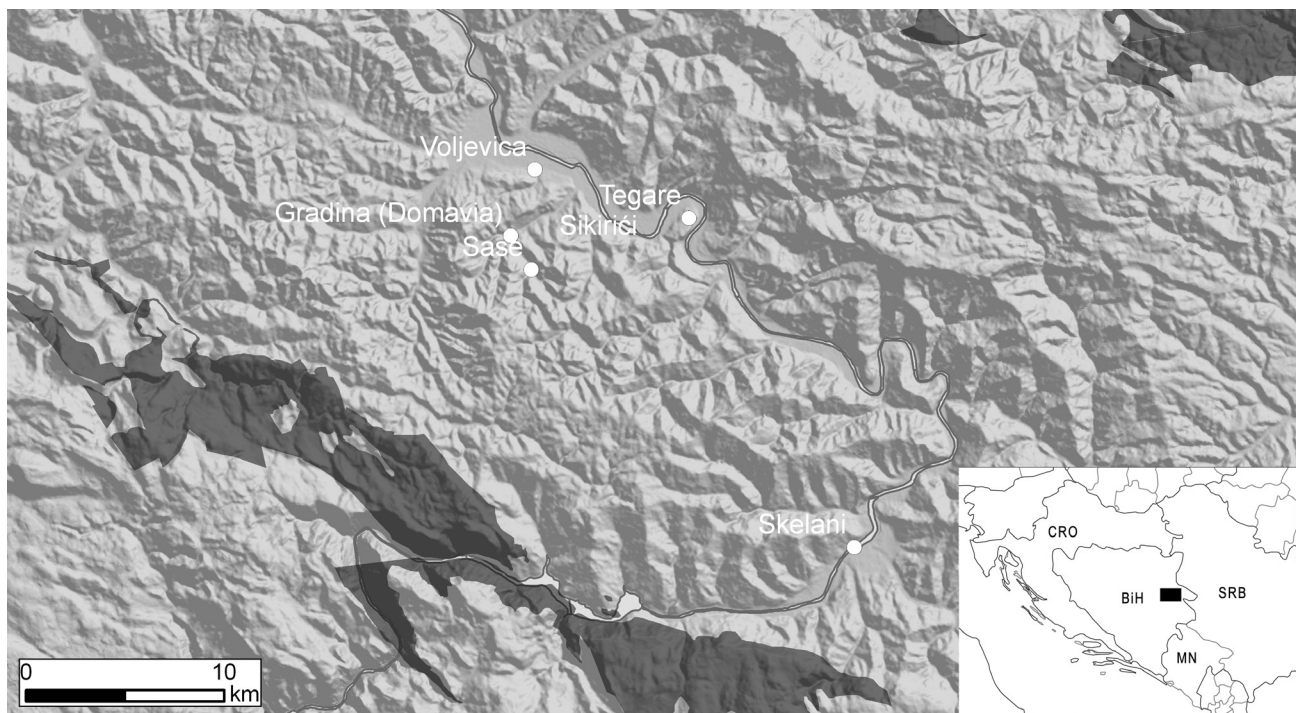


Fig. 7. Locations of the corresponding lithostratigraphic unit identified on the geological maps Ljubovija (sheet T<sub>2</sub>) and Višegrad (T<sub>2</sub>) and archaeological sites referred to in this case study

## Results and discussion

Geological analysis showed that the entire corpus was made from a single lithotype C, suggesting a single source of the material. However, such stone material is absent in the region. In a geological sense the area around Srebrenica is characterised by Palaeozoic clastites and Neogene igneous rocks. The quality of this stone outcropping near Srebrenica is insufficient for exploitation. This implies that Roman settlements in the Upper Drina valley were faced with a problem regarding stone supply. Especially in *Domavia* (Gradina near Srebrenica), one of the biggest settlements in the area, this must have presented a major infrastructure problem. The nearest potential source of this type of limestone is located about 25 km to the east (Fig. 7). This location does not seem a likely source of the limestone, since it is located in a mountainous region and it is almost inaccessible. Taking into account the limitations of regional topography, underlying geological situation and the transportation conditions the situation permitted only one possible location of suitable material: the area near today's Klotijevac, 55 km upstream from Srebrenica. It seems that the Drina River as a transport route presented the only possible solution. The use of the Drina River for transportation of stone material (from Zvornik — Sirmium) was already confirmed by recent research of the Dardagani quarry.<sup>18</sup>

## 4. Conclusion

The macroscopic-petrographic analysis has revealed that limestone was the first choice for the production of the funerary monuments (dated between 1<sup>st</sup> and 3<sup>rd</sup> century AD) in the interior of the Roman province of Dalmatia. By defining the type of stone material used, we were able to locate the potential source area(s). As it seems, apart from the availability of the stone material it was the terrain characteristics that dictated the quarry location. In the Bihac area, the numerous outcrops of limestone near the site location suggest the existence of small locations on which limestone was procured. In the Konjic area only two possible locations for the quarry site. In the Srebrenica region the geological and topographical situation narrowed the choice to only one possible location for the quarry. Although determining exact locations is not possible without time-consuming additional fieldwork, our results suffice to point out the possible existence of the quarry locations not known previously.

In the case of Srebrenica we were also able to identify the transport route. Results of the material characterisation reveal that stone was obtained locally and each region had its own limestone source areas.

## ACKNOWLEDGEMENTS

This paper is based on unpublished doctoral thesis Archaeological analysis of Roman stone masonry production in the interior of the Roman province of Dalmatia, carried out at the University of Ljubljana. Special thanks go to Prof. Dr. Bojan Djurić.

We also wish to thank the National Museum of Bosnia and Herzegovina, the Konjic Regional Museum, the Travnik Regional Museum.

## REFERENCES

- ČREMOŠNIK I. 1963: "Nošnja na rimskim spomenicima u Bosni i Hercegovini (Trachtendarstellungen auf römischen Denkmälern in Bosnien und der Herzegowina)", *Glasnik Zemaljskog muzeja (Nova serija)* XVIII, 105-125.
- DJURIĆ B., DAVIDOVIĆ J., MAVER A., RIŽNAR I. 2006: "Stone use in roman towns. Resources, transport, products and clients. Case study Sirmium. First report." (Upotreba kamena u rimskim gradovima. Izvori, transport, proizvodi i klienti. Primer Sirmijum. Prvi izveštaj), *Starinar* LVI 103-138.
- DJURIĆ B., DAVIDOVIĆ J., MAVER A., RIŽNAR I. 2007: "Stone use in roman towns. Resources, transport, products and clients. Case study Sirmium. Second report." (Upotreba kamena u rimskim gradovima. Izvori, transport, proizvodi i klienti. Primer Sirmijum. Drugi izveštaj), *Starinar* LVII, 83-100.
- JOVANOVIĆ R., MOJIĆEVIĆ M., TOKIĆ S., ROKIĆ L. 1977: Osnovna geološka karta SFRJ 1 : 100 000. List Sarajevo K34 - 1 (Basic geological map of SFRY 1: 100.000. The Sarajevo sheet). Zavod za inženjersku geologiju i hidrogeologiju Građevinskog fakulteta u Sarajevu (1962-1967), Savezni geološki zavod Beograd.
- JOVANOVIĆ R., MOJIĆEVIĆ M., TOKIĆ S., ROKIĆ L. 1978: Osnovna geološka karta SFRJ 1:100.000. Tumač za list Sarajevo K34 -1 (Basic geological map of SFRY 1: 100.000. Geology of the Sarajevo sheet), Institut za geološka istraživanja Sarajevo (1971), Savezni geološki zavod Beograd.
- KUBATI, RELJIĆ D., VELJKOVIĆ D., STRAJIN V., BEGIĆ F., DIMITROV P., MOJSILOVIĆ S., BAKLAJIĆ D., ĐOKOVIĆ I., VUKANOVIĆ M., NASTIĆ V. 1976: Osnovna geološka karta SFRJ 1 : 100 000. List Ljubovija K34-135 (Basic geological map of SFRY 1: 100.000. The Ljubovija sheet), Institut za geološka istraživanja Sarajevo, Zavod za geološka i geofizička istraživanja Beograd (1959-1963), Savezni geološki zavod Beograd.
- KUBAT I., RELJIĆ D., STRAIN D., BEGIĆ F., DIMITROV P. 1977: Osnovna geološka karta SFRJ 1:100.000. Tumač za list Ljubovija, L 34-135 (Basic geological map of SFRY 1: 100.000. Geology of the Ljubovija sheet), Geološki zavod Sarajevo (1968), Savezni geološki zavod Beograd.
- LOZIĆ E. 2013: Arheološka analiza rimskodobne kamnoseške produkcije v notranjosti rimske province Dalmacije (Archaeological analysis of the Roman stonemasonry production in the interior of Roman province of Dalmatia, Unpublished doctoral thesis), University of Ljubljana.

- MOJIĆEVIĆ M., LAUŠEVIĆ M. 1971: Osnovna geološka karta SFRJ 1:100.000. List Mostar K33-24 (Basic geological map of SFRY 1: 100.000. The Mostar sheet), Institut za geološka istraživanja Sarajevo (1971), Savezni geološki zavod Beograd.
- MOJIĆEVIĆ M., LAUŠEVIĆ M. 1973: Osnovna geološka karta SFRJ 1:100.000. Tumač za list Mostar K33-24 (Basic geological map of SFRY 1: 100.000. Geology of the Mostar sheet). Geološki zavod Sarajevo (1967), Savezni geološki zavod Beograd.
- MOJIĆEVIĆ M., TOMIĆ B. 1981: Osnovna geološka karta SFRJ 1:100.000. list Kalinovik K34-13 (Basic geological map of SFRY 1: 100.000. The Kalinovik sheet). Institut za geološka istraživanja Sarajevo (1965), Savezni geološki zavod Beograd.
- MOJIĆEVIĆ M., TOMIĆ B. 1982: Osnovna geološka karta SFRJ 1: 100.000. Tumač za list Kalinovik K34-13 (Basic geological map of SFRY 1: 100.000. Geology of the Kalinovik sheet). Institut za geologiju Sarajevo, Savezni geološki zavod, Geoinženjering (1981), Beograd.
- OLUJIĆ J., KAROVIĆ J. 1986: Osnovna geološka karta SFRJ 1:100.000. list Višegrad K34-3 (Basic geological map of SFRY 1: 100.000. The Višegrad sheet). Geoinženjering-institut za geologiju Sarajevo i Geološki institut Beograd (1970-1980), Savezni geološki zavod Beograd.
- PAŠKVALIN V. 2012: "Antični sepulkralni spomenici s područja Bosne i Hercegovine (Antique Sepulchral Monuments from Bosnia and Herzegovina)". Djela / Knjiga LXXXIII. Centar za balkanološka ispitivanja. Knjiga 9. Akademija nauka i umjetnosti Bosne i Hercegovine, Sarajevo.
- POLŠAK A., JURŠA M., ŠPARICA M., ŠIMUNIĆ A. 1977: Osnovna geološka karta SFRJ 1 : 100 000. List Bihać L33-116 (Basic geological map of SFRY 1: 100.000. The Bihać sheet). Institut za geološka istraživanja Zagreb (1962 -1967), Savezni geološki zavod Beograd.
- POLŠAK A., CRNKO J., ŠIMUNIĆ A., ŠIMUNIĆ A., ŠPARICA M., JURIŠA M. 1978: Osnovna geološka karta SFRJ 1:100.000. Tumač za list Bihać L33-116 (Basic geological map of SFRY 1: 100.000. Geology of the Bihać sheet). Institut za geološka istraživanja Zagreb (1967), Savezni geološki zavod Beograd.
- RUSSELL B. 2014: The Economics of the Roman Stone Trade. Oxford Studies on the Roman Economy, Oxford.
- SOFILIJ J., ŽIVANOVIĆ M. 1979: Osnovna geološka karta SFRJ 1 : 100 000. List Prozor K33-12 (Basic geological map of SFRY 1: 100.000. The Prozor sheet). Institut za geološka istraživanja Sarajevo (1965 -1971), Savezni geološki zavod Beograd.
- SOFILIJ J., ŽIVANOVIĆ M. 1980: Osnovna geološka karta SFRJ 1:100.000. Tumač za list Prozor K33-12 (Basic geological map of SFRY 1: 100.000. Geology of the Prozor sheet). Institut za geološka istraživanja Sarajevo (1971), Savezni geološki zavod Beograd.
- ZOTOVIĆ, R. 2003, "Romanisation of the population of the eastern part of the Roman province of Dalmatia", *Balcanica* 34, 19-38.