

Stone Objects from Vindobona (Austria) - Petrological Characterization and Provenance of Local Stone in a Historico-Economical Setting

Rohatsch, Andreas; Kronberger, Michaela; Insulander, Sophie; Mosser, Martin; Hodits, Barbara

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CONTENT

PRESENTATION	15
NECROLOGY: NORMAN HERZ (1923-2013) by Susan Kane	17
1. APPLICATIONS TO SPECIFIC ARCHEOLOGICAL QUESTIONS – USE OF MARBLE	
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 th C.) and the Basilica of San Lorenzo (5 th 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 nd C. Bc – Late 1 st C. Ad) <i>Stefan Ardeleanu</i>	155
<i>Amethystus</i> : Ancient Properties and Iconographic Selection <i>Luigi Pedroni</i>	167
2. PROVENANCE IDENTIFICATION I: (MARBLE)	
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 th And 17 th 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 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>Marmorata</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
3. PROVENANCE IDENTIFICATION II: (OTHER STONES)	
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
4. ADVANCES IN PROVENANCE TECHNIQUES, METHODOLOGIES AND DATABASES	
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
5. QUARRIES AND GEOLOGY	
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
6. STONE PROPERTIES, WEATHERING EFFECTS AND RESTORATION, AS RELATED TO DIAGNOSIS PROBLEMS, MATCHING OF STONE FRAGMENTS AND AUTHENTICITY	
Methods of Consolidation and Protection of Pentelic Marble <i>Maria Apostolopoulou, Elissavet Drakopoulou, Maria Karoglou and Asterios Bakolas</i>	749
7. PIGMENTS AND PAINTINGS ON MARBLE	
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
8. SPECIAL THEME SESSION: „THE USE OF MARBLE AND LIMESTONE IN THE ADRIATIC BASIN IN ANTIQUITY”	
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
INDEX OF AUTHORS	1009

STONE OBJECTS FROM VINDOBONA (AUSTRIA) – PETROLOGICAL CHARACTERIZATION AND PROVENANCE OF LOCAL STONE IN A HISTORICO-ECONOMIC SETTING

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Abstract

The interdisciplinary project *Stone Monuments and Stone Quarrying in the Carnuntum – Vindobona Area* aims to acquire new knowledge about Roman economic and settlement history, art, quarrying and infrastructure through the analysis of archaeological and geological data collections. Based on macroscopic examination of Roman stone objects as well as the analysis of historical maps and airborne laser scans, potential quarrying regions were selected and samples taken.

The main quarrying areas were located near Perchtoldsdorf (Lower Austria) and in Vienna. It seems that after the installation of the Roman legionary garrison, the building material was quarried from the eastern margin of the Eastern Alps, including the Vindobona vicinity. Additionally, it was possible to prove the origin of Neogene algal limestones from the *Leitha Mountains*, which played an important role in sculptured stone monuments.

All investigated lithotypes from the mentioned regions belong to the Austrian stratigraphic stages from Neogene sedimentary rock formations of the Central Paratethys.

Keywords

Vindobona, Roman time monuments, lithological investigation

Introduction, questions and methodological approach

The interdisciplinary project „Stone monuments and Stone Quarrying in the Carnuntum – Vindobona Area“ (FWF P 26368-G21; <<http://www.oeaw.ac.at/antike/figindex.php?id=390>>) investigates the stone monuments in the larger area of the two legionary fortresses of Carnuntum (Petronell/Bad Deutsch-Altenburg in Lower Austria) and Vindobona (ancient Vienna) in the north western part

of the Roman province of Pannonia Superior.¹ The aim is to provide an archaeological evaluation of the stone objects and to investigate their geological composition as well as the origin of the rock. The presented paper focuses on the stone monuments from the Vindobona area dating from the 1st to the beginning of the 5th century AD. Since the Roman period, the urban territory of Vienna has been subject to a process of transformation, lasting almost 2000 years. This entailed the continuous reuse of stone objects as valuable construction material – thus it is not surprising that they have been constantly reduced in quantity in the course of time. Nevertheless, about 370 stone monuments originating from Vindobona's sphere of influence are preserved in different collections, especially the Wien Museum.

For an interdisciplinary project, however, this small number can be seen as an opportunity. It allows the historic-cultural classification of more or less all the stone monuments of Vindobona. Specifically chosen case examples from the different object groups can be thus subjected to a more precise geological examination. Thus, in addition to inscription stones, sculpture and architectural ornamentation, it is also possible to explore simpler architectural elements, parts of the infrastructure, building material as well as stone tools with respect to the origin of the stone raw material.

The mapping of the stone inventory in a GIS system and the attempt to reconstruct the ancient terrain enables the visualisation of the individual find-spots of the Roman stone objects as well as their allocation to different historical settlement areas of the legionary base according to object groups (Fig. 1).

During the last years almost 180 archaeological objects of the Vindobona area were examined to get an overview of the preferred lithotypes used for Roman stone objects. An important requirement, deriving also

1 KREMER, KITZ 2016, p. 75–82; KRONBERGER, MOSSER, INSULANDER 2016; ROHATSCH *et al.* 2016.

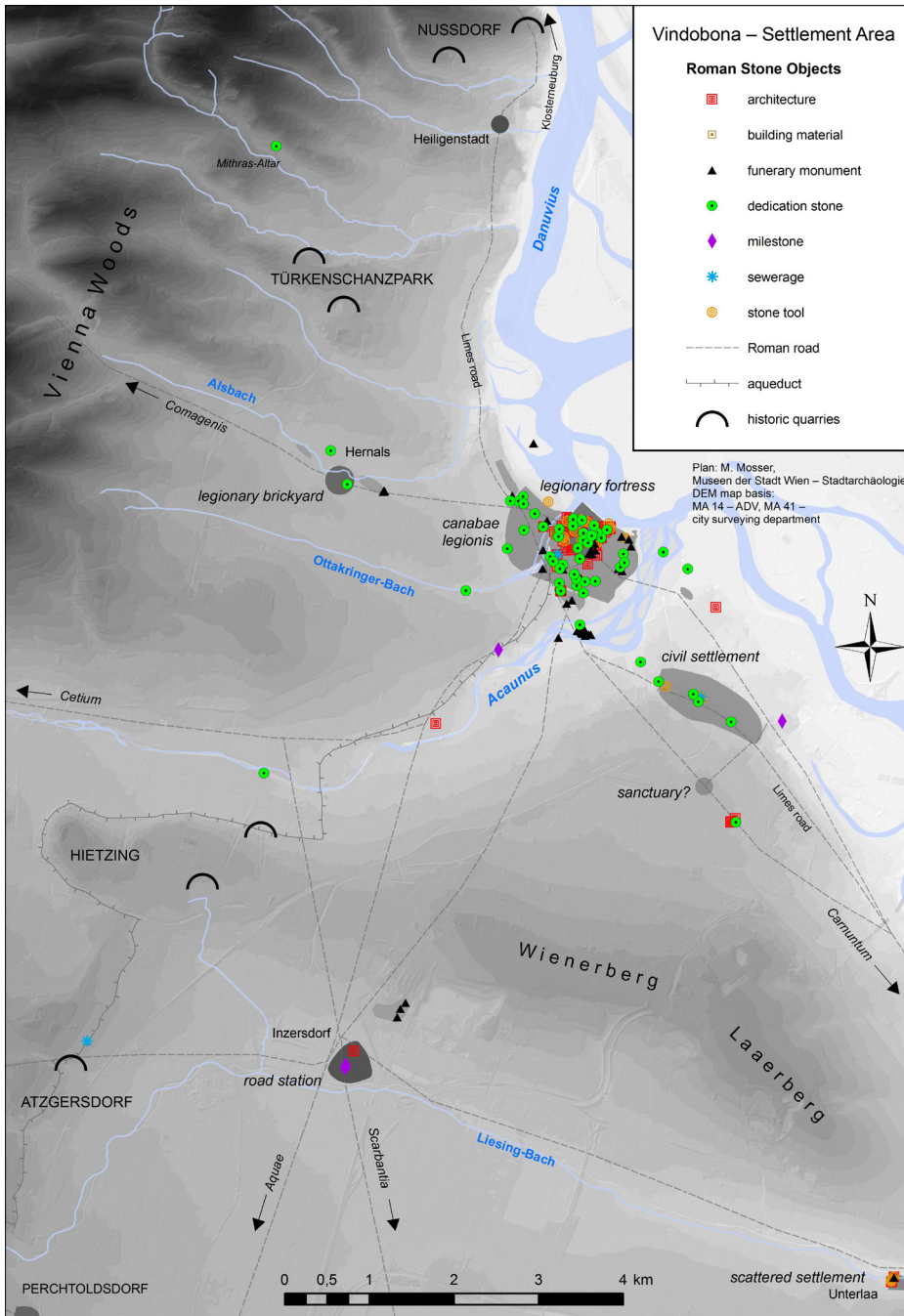


Fig. 1. Mapped stone objects within the settlement area of Vindobona (plan: M. Mosser, Museen der Stadt Wien – Stadtarchäologie, DEM map basis: MA 14 – ADV, MA 41 – city surveying department, ancient course of the River Danube after ENVIEDAN project [Environmental History of the Viennese Danube 1500-1890])

from the archaeological point of view, is that all investigated objects should be well described, dateable and should be assigned the scientific context of their respective archaeological origin. Only if these fundamental preconditions are fulfilled can a meaningful interpretation of trading connections, economic history and social history be achieved. This constitutes the basis for further questions, such as the localisation of quarries, routes of transportation, chronology, workshops and economic relations.

Corresponding with the topic of the project, the geoscientific focus of this multidisciplinary research is placed on deciphering the petrology and carbonate facies made of Miocene sedimentary rocks on one hand, and on

comparing them with the strata outcropping in abandoned quarries on the other. The targeted quarries and pits are especially distributed on the western marginal zone of the *Vienna Basin* and in the north-eastern *Leitha Mountains* within a 45 km radius (= 30 Roman miles) from Vindobona. The about 300 quarries that were exploited in the last 2000 years indicate the importance of these rocks for architecture and sculpture. Nowadays only three active quarries are left: St. Margarethen, Mannersdorf and Aflenz near Leibnitz.

The selection of the quarries for detailed documentation was based on topographical evaluation with emphasis on historical maps from the 18th and 19th

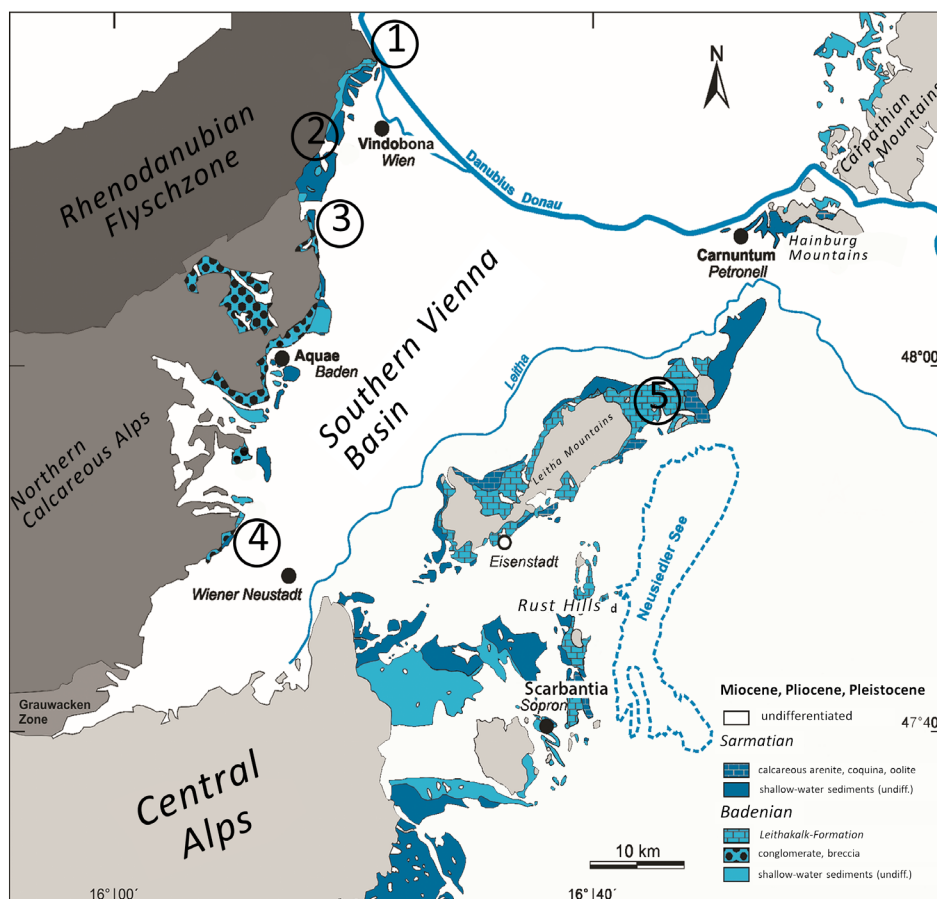


Fig. 2. Sketch map of the distribution of stones for sculptures, decorations and buildings from the Miocene of the southern Vienna Basin and the adjacent Pannonian Basin in Austria, which are relevant for Vindobona; locations: 1 – Nussdorf, 2 – Hietzing, 3 – Perchtoldsdorf, 4 – Bad Fischau, 5 – Winden, Jois, Bruckneudorf (plan: modified from Rohatsch, Draganits 2014)

centuries, geological maps and on high resolution airborne laser scans. The archaeological evidence of Roman settlements supplemented the prospection.

In these selected quarries lithological profiles were recorded and representative samples for microscopic, petrophysical, and geochemical analysis were taken. The lithological descriptions, microfacies analyses, determinations and denominations of the samples were carried out with the use of common macroscopic and microscopic methods.²

Geological and petrographic fundamentals

Sedimentary rocks from the *Middle Miocene* up to the lower *Late Miocene* (*Langhian* – *Serravallian* – *Tortonian*) ranging from about 15.97 to 7.25 my BP³ can be found in many places in the marginal areas of the *Vienna Basin* as well as in the *Eisenstadt Basin*.⁴ The *Vienna Basin* is an important geological element between the

Austrian Eastern Alps and the *Western Carpathians*. The subsidence of the basin along strike slip faults in connection with a pull-apart mechanism⁵, due to the final uplift of the *Eastern Alps* and the *Carpathians* started in the Miocene regional stage of the Lower *Badenian* accompanied by the transgression of the *Paratethyan Ocean*. The relevant stratigraphically regional stages in Austria span then the *Badenian*, *Sarmatian* and *Pannonian* stages. The lithological inventory includes calcareous arenites, sandstones, limestones, conglomerates and breccia. One of the most common lithotypes, the *Leithakalk*⁶, comprises the *Badenian* coralline red algae (*Corallinaceae*) dominated limestones of shallow water carbonate platforms from the *Western Central Paratethys*⁷, distributed around the *Leitha Mountains*, the *Rust-Hills* and other parts of the *Vienna Basin* (Fig. 2).⁸ It comprehends the *Leithakalk* faciostratotype of the *Badenian* regional stage with its

2 DUNHAM 1962; FLÜGEL 2004; FOLK 1959; PETTI-JOHN *et al.* 1973; TUCKER, WRIGHT 1990.

3 PILLER *et al.* 2004; GRADSTEIN *et al.* 2012, 183.

4 HÄUSLER *et al.* 2015, 475–493; SCHMID 1968.

5 DECKER *et al.* 2005, 307–322.

6 KEFERSTEIN 1824.

7 KOVÁČ *et al.* 2007; HARZHAUSER, RÖGL 2011; DECKER *et al.* 2005.

8 MOSHAMMER *et al.* 2015; WESSELY *et al.* 2006; SCHÖNLAUB 2005.

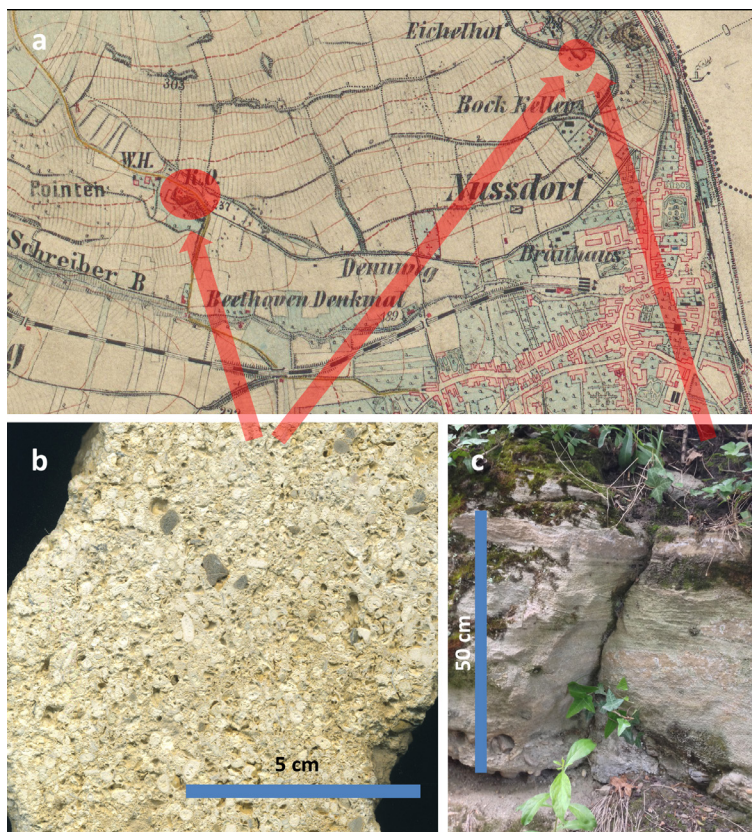


Fig. 3.

Abandoned quarries beyond Nussdorf:

a: detail from the historical map of the 3rd geodetic survey of Austria from 1872 (https://commons.wikimedia.org/wiki/File:Aufnahmeblatt_4657-3c_Heiligenstadt,_Floridsdorf,_Strebersdorf.jpg)

b: sample of Badenian detrital *Leithakalk* (rudstone, biosparite) from the former quarry at the Eichelhof; this type of rudstone mainly consists of debris from coralline red algae beneath debris of Bryozoa, foraminifers, echinoids; pebbles of quartz-arenites from the *Flyschzone* are common (photo: B. Hodits)

c: cross-bedded medium to coarse grained siliciclastic arenite: mainly consisting of angular quartz grains beneath additional debris of coralline red algae and foraminifers; on the bottom of the sandstone sometimes layers of conglomerate, consisting of pebbles from the *Flyschzone* are included (photo: A. Rohatsch)

lateral equivalents of near-shore calcareous sandstones, breccia and conglomerates.⁹

The so-called *detrital Leithakalk* which is an informal name for calcareous arenites and rudstones consisting mainly of debris from coralline red algae comprises the Sarmatian and Pannonian regional stages. Sarmatian oolitic limestones, coquinas and immature sandstones without veritable algal debris content are comparable with the Holíč-Formation and the Skalica-Formation¹⁰. All these lithotypes have been used extensively as building stones and ornamental stones since at least the late Bronze Age in eastern Austria.

Rock sources of the stone objects in Vindobona – first results

About 180 archaeological objects in the storage place of the *Wien Museum*, the *Römermuseum* and the *Kunsthistorisches Museum* in Vienna, such as gravestones, dedication monuments, architectural parts and milestones have been identified as *detrital Leithakalk* from local quarries along the western border of the *Vienna Basin* as well as from further afield in the *Leitha Mountains*.

The geological hinterland of Vindobona contains a greater variety of natural stone resources and the catchment area for rock used in Vindobona appears to have extended southwards along the Alpine margin via Perchtoldsdorf as far as Bad Fischau. Badenian algal rudstones with or without pebbles of quartz-arenites from the *Rhenodanubian-Flyschzone* and cross-bedded quartz-arenites with accessory debris of coralline algae and foraminifers originate from abandoned quarries near *Nussdorf* in the north of Vienna (Fig. 3).

Very important for the extraction of stones for architecture was the Sarmatian Skalica-Formation which delivered the so called *Atzgersdorfer Stein* and was used for large amounts of building blocks from Roman times to the end of the 19th century. Quarries in Hietzing, Vienna's 13th district, and in Atzgersdorf (23rd district) were exploited for several hundred years. Gastropod- or bivalve coquinas, oolitic limestones and immature, hybrid arenites are characteristic and simply determinable lithotypes of this formation (Fig. 4).

In order to provide an insight into the current state of research, different case examples, which illustrate the problematic nature of the research as well as showing preliminary tendencies of results, will be presented below.

9 ROHATSCH 2005; STEININGER, PAPP 1978.

10 e.g. HARZHAUSER, PILLER 2004, 65–86; PILLER *et al.* 2004; PILLER, HARZHAUSER 2005, 450–455.

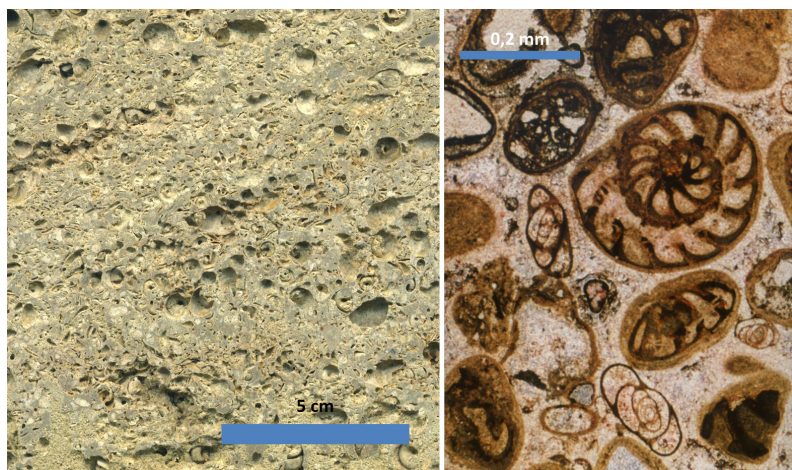


Fig. 4.

Samples from the abandoned quarry of Hietzing (Vienna, 13th district; photos: A. Rohatsch):

a: coquina consisting mainly of endocasts of the Sarmatian gastropods *Pirenella sp.* (rudstone – floatstone, poorly washed biosparite)
 b: the thin section (grainstone, biosparite) reveals the embedding fine to medium grained calcareous arenite dominated by foraminifers of the order Miliolida (e.g. *Quinqueloculina sp.* is very common) beneath ooids and siliclastic detritus from the *Flyschzone*; multi-phase diagenetic cementation with dog-tooth calcite and sparry calcite

Example 1: Building material from the Vienna Woods

Starting in 98 AD, the 13th and 14th legion began the construction of the legionary fortress in the area of present Vienna's city centre.¹¹ There exists a sample of about 30 architectural elements belonging to the fortifications which can be allocated to this period. To these belong a number of facing ashlars and building inscriptions from the fortification wall as well as the profiled base of the *porta principalis sinistra*.¹² According to the petrographic analysis these were made out of rocks predominantly originating from the eastern foothills of the Vienna Woods in the municipal area of present day Vienna, which can be found, for example, in the surroundings of Hietzing, in the Türkenschanzpark and on the Nussberg (Fig.1). This shows the tendency to use nearby quarrying areas with short routes of transportation to bring construction material to the settlement centre.

Example 2: Infrastructural features

According to the current state of research, typical uses of different rock types for various different infrastructural features are already becoming apparent. The massive sewers of the legionary fortress, as high as 2 m, were demonstrably built at the beginning of the legionary camp's construction period at the end of the 1st century AD.¹³ This is proved by the continuous use of tiles of the 13th legion for the sewers – the legion which was the first one to work on the legionary fortress. The sewers were covered by manhole cover stones with characteristic drain holes, of which



Fig. 5. Restored Roman manhole cover stone from the sewer of the legionary bath of Vindobona. Wien Museum, Inv.-Nr. MV 93.196/1. (photo: M. Mosser)

seven examples have been found in Vienna (Fig. 5).¹⁴ Five of them were definitely produced from stones extracted along the western border of the *Vienna Basin*, because the breccias predominantly consist of debris of Mesozoic dolomite (*Hauptdolomit*) and limestone (*Dachsteinkalk*). Therefore the *Northern Calcareous Alps* can be assumed as geological hinterland. The predominance of *Hauptdolomit* and *Dachsteinkalk* suggest a northernmost region of the *Northern Calcareous Alps* with a catchment area of the *Frankenfelsler-* and *Lunzer Nappe*.¹⁵ Provided that the manhole covers were, in fact, fabricated during the construction period of the legionary fortress, this can be taken as evidence for the early exploitation of quarries south of Vienna, probably from the area of Perchtoldsdorf (see below).

11 KRONBERGER, MOSSER 2015, 242.

12 KAT. VINDOBONA 1978, 172–175 S5–S8; S13–S15; Wien Museum, Inv.-Nr. MV 643. 719. 720. 1703; Kunsthistorisches Museum (KHM) Inv.-Nr. III 1205; MOSSER 2011, 167–183.

13 GIETL, KRONBERGER, MOSSER 2004, 49 tab. 3, Abb. 12.

14 KAT. VINDOBONA 1978, 175 S 16–S 17; Wien Museum, Inv.-Nr. MV 723. 2049. 11937/291. 38060/90. 71531. 93196/1.

15 WESSELY 1983, 27 – 68.

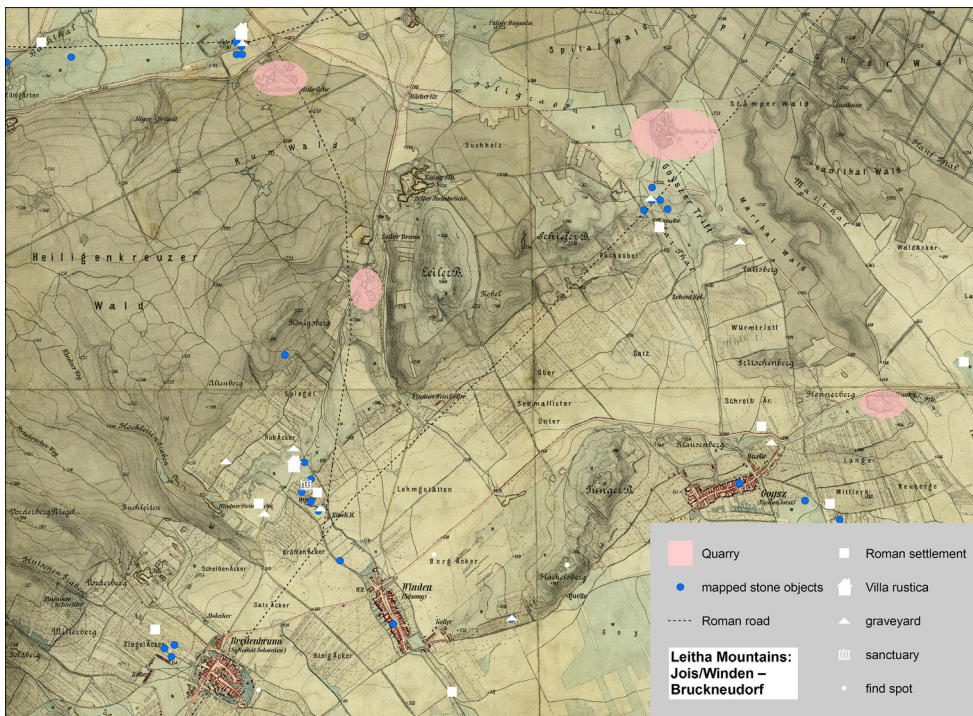


Fig. 6. Roman settlements (e. g. Edit B. Thomas 1964, 152 ff., 201 ff., René Ployer 2012a, 2012b) and nearby quarries, which were probably used since Roman times (map source: detail from the 3rd geodetic survey of Austria 1873; upload from: http://commons.wikimedia.org/wiki/File:Aufnahmeblatt_4857-2b_Jois_Winden_Breitenbrunn.jpg)

Example 3: Gravestones and altars

For certain types of stone monuments, like tombstones and dedication monuments, it has been proved that there were a large number of imports from quarries in the Leitha Mountains. From those approximately 80 examined objects around one-half was extracted there. One reason for this could be that the Leitha limestone with its finer structure was more suitable for the sculpting of reliefs and inscriptions than the local rocks. But undecorated sarcophagi also have their origin in the *Leitha-Mountains*. So another possibility for these imports could be pre-existing workshops in the *Leitha-Mountains* region or the Carnuntum area whose market extended to Vindobona.

Ancient quarries in the *Leitha Mountains* – first results

Objects made of Sarmatian and Pannonian *detrital Leithakalk* were delivered from ancient quarries in the *Leitha-Mountains*, probably situated in the region between Winden, Jois and Bruckneudorf, and are very similar and comparable to the lithotypes which were used in Carnuntum. Due to the petrographic and geological investigations of the last years¹⁶ the region be-

tween Winden, Jois and Bruckneudorf in the northern part of the *Leitha Mountains* is assumed to be an important source area for stones used in Roman architecture, for tombstones and sacred monuments. Some of the quarries are obviously situated near Roman settlements (Fig. 6).¹⁷ The probability that the exploitation of building blocks occurred during Roman times is therefore very high, although antique tool marks are generally not visible in the different extraction walls. The reason for this circumstance is the continuing use of the stone pits up to the early 20th century. The lithological inventory of the regional Miocene stages *Badenian*, *Sarmatian* and *Pannonian* in this region includes detrital limestones with different grainsize distributions (grainstone to rudstone/floatstone), degrees of sorting (very well to poor), porosities and strength. All the lithotypes consist predominantly of debris from coralline red algae (*Corallinaceae*), beneath Bryozoans, echinoids and foraminifers (Fig. 7).

Summary: Monument types and quarrying areas

To sum up, the following picture emerges: architectural elements and infrastructure components, which were mostly documented in the legionary fortress area of Vindobona, originate predominantly from local quarries or the western margin of the *Vienna Basin*.

16 e. g. DRAGANITS *et al.* 2008; ROHATSCH 2005; ROHATSCH 2012; ROHATSCH, DRAGANITS 2014; WIEDL *et al.* 2012; WIEDL *et al.* 2013; WIEDL *et al.* 2014.

17 e. g. THOMAS 1964, 152 ff.; 201 ff.; PLOYER 2012a, 2012b.

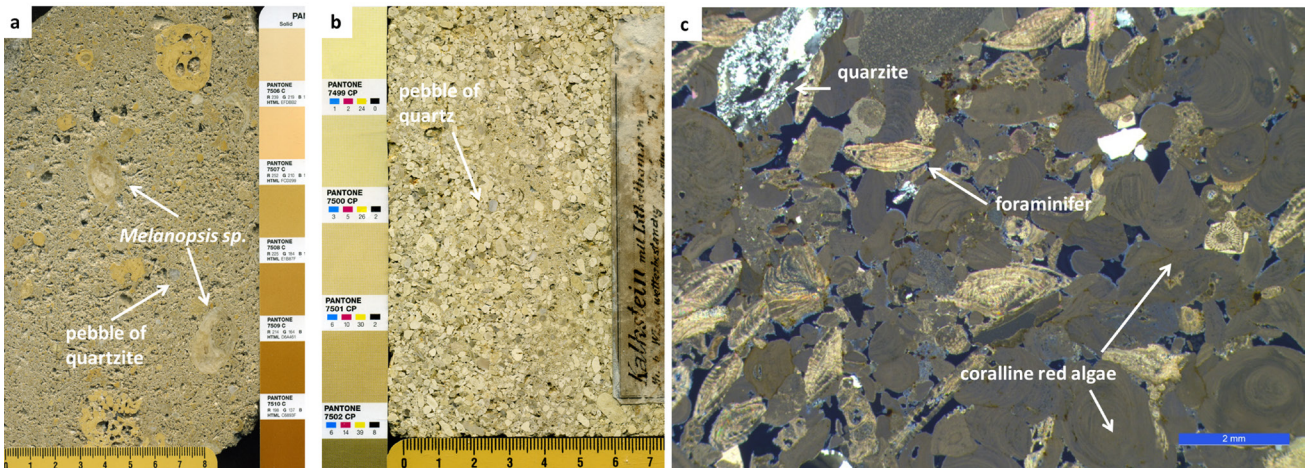


Fig. 7. a: Pannonian detrital Leithakalk (grainstone – packstone, biosparite) predominantly consisting of debris from coralline red algae and foraminifers from an abandoned quarry near Winden with reworked rhodolithes, freshwater gastropods (*Melanopsis sp.*) and pebbles of Quartz and Quartzite (photo: B. Hodits)
 b: coarse grained detrital Leithakalk (rudstone, biosparite,) mainly consisting of well-rounded debris from coralline red algae and sporadically pebbles of Quartz and Quartzite (photo: B. Hodits)
 c: thin section of b consisting of debris from coralline red algae, foraminifers (e.g. *Amphistegina sp.*); furthermore debris of echinoids, bryozoans and pebbles quartzite are observable (photo: A. Rohatsch)

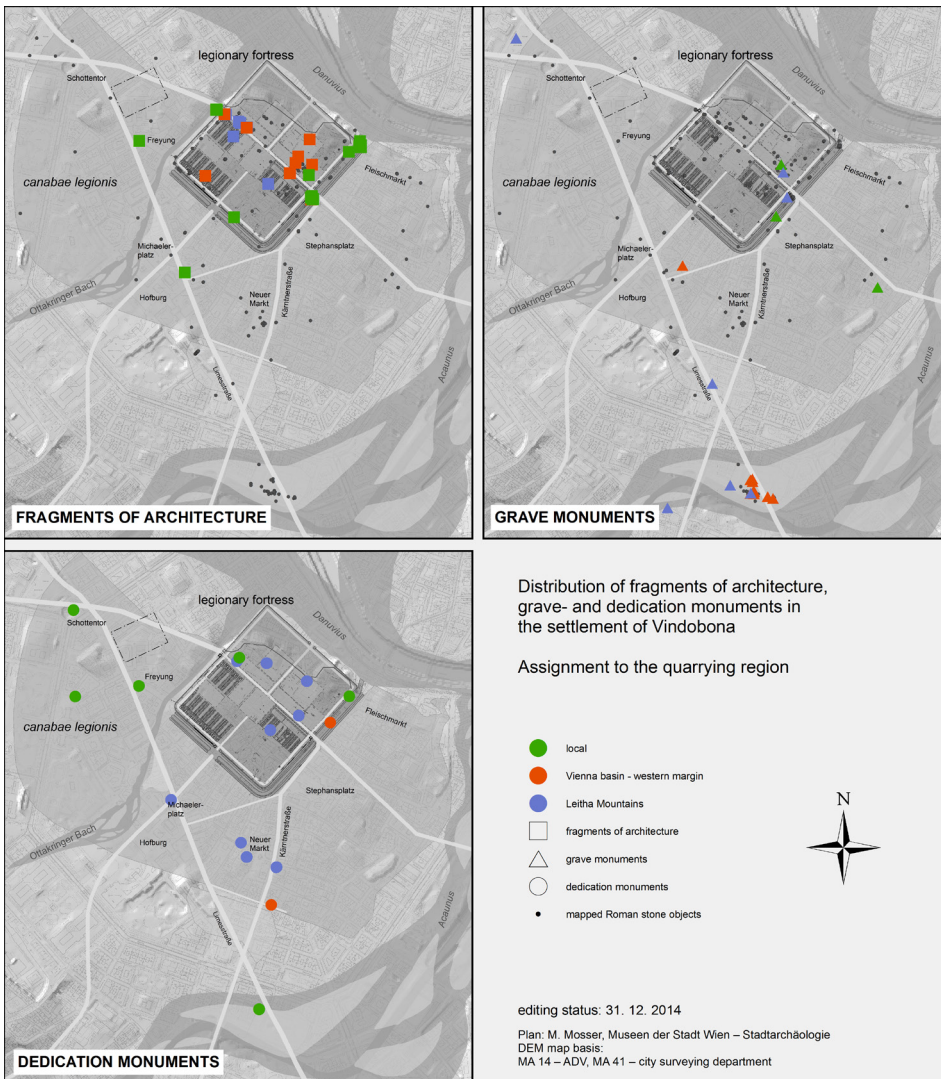


Fig. 8. Distribution of architectural fragments, dedication monuments and gravestones within the Roman settlement centre of Vindobona. The term “local” designates the quarries of Nussdorf, Türkenschanze and Hietzing. (plan: M. Mosser, Museen der Stadt Wien – Stadtarchäologie; DEM map basis: MA 14 – ADV, MA 41 – city surveying department)

For certain types of stone monuments, like dedication monuments and tombstones, a considerable proportion of imports from quarries in the *Leitha Mountains* can be proved. Rocks from the western margin of the *Vienna Basin* play a lesser role for these types of monuments (Fig. 8).

Analysis by linking various data sources

Petrological characterization offers the possibility of defining quarrying areas for stone monuments on a large scale. However, it is more difficult to locate the actual ancient quarries or the routes of transportation, which were essential for infrastructure. Here a connection of archaeological, geological as well as historical data is needed and therefore constitutes a crucial part of our project. The localisation and verification of Roman find-spots in the surrounding area of potential stone quarries are of great importance. It must be assumed that quarries of significance were established and operated by certain legions, which requires an infrastructure of military nature. The presence of military, then, can be proved through the existence of respective finds in the relevant collections, whose inspection is part of the project. For this purpose all published Roman sites were integrated in a GIS-map of the *Vienna Basin* region as a starting point to enclose the quarry region in question.¹⁸

Example 4: Verification of a quarrying area

The area surrounding Perchtoldsdorf, 13 km (9 Roman miles) away from Vindobona (Fig. 1) at the western margin of the *Vienna Basin* meets all the requirements concerning the location of an assumed Roman quarry region. It is situated in the vicinity of a Roman arterial road leading to Vindobona and distinct signs of settlement have been detected.¹⁹ The finding material in the collections, such as tile stamps of all three legions garrisoned in Vindobona or the tombstone of a veteran, is indicative of military context.²⁰ All these factors make ancient quarrying a possibility.

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18 Important basic literature: TALAA, HERRMANN 2004; PLOYER 2007; PLOYER 2013.

19 TALAA, HERRMANN 2004, 14–76; KRONBERGER, MOSSER 2013, 113–116.

20 KAT. VINDOBONA 1978, 207 S 119; TALAA, HERRMANN 2004, 46–48 Abb. 17.

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