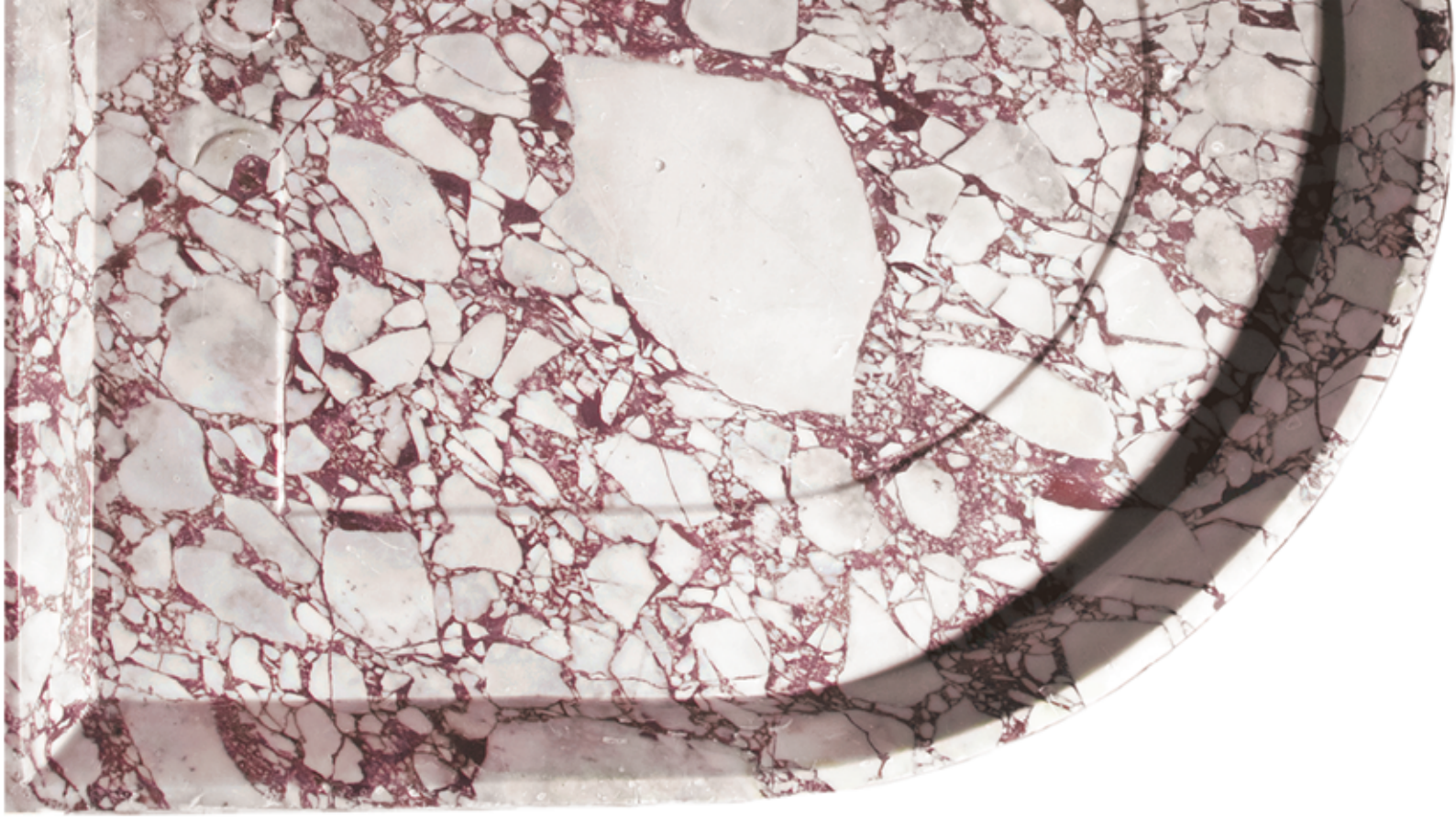
Stone Monuments from Carnuntum and Surrounding Areas (Austria) – Petrological Characterization and Quarry Location in a Historical Context

Kremer, Gabrielle; Kitz, Isabella; Moshammer, Beatrix; Heinrich, Maria; Draganits, Erich



ASMOSIA XI

Interdisciplinary Studies on Ancient Stone

PROCEEDINGS

of the XI ASMOSIA Conference, Split 2015

Edited by Daniela Matetić Poljak and Katja Marasović

ARTS ACADEMY IN SPLIT

UNIVERSITY OF SPLIT,
FACULTY OF CIVIL ENGINEERING,
ARCHITECTURE AND GEODESY

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

DOI: https://doi.org/10.31534/XI.asmosia.2015/03.05

STONE MONUMENTS FROM CARNUNTUM AND SURROUNDING AREAS (AUSTRIA) – PETROLOGICAL CHARACTERIZATION AND QUARRY LOCATION IN A HISTORICAL CONTEXT

Gabrielle Kremer[1], Isabella Kitz[1], Beatrix Moshammer[2], Maria Heinrich[2] and Erich Draganits[3]
[1] Institute for the Study of Ancient Culture, Austrian Academy of Sciences, Vienna, Austria (gabrielle.kremer@oeaw.ac.at; isabella.kitz@oeaw.ac.at)
[2] Department of Mineral Resources, Geological Survey, Vienna, Austria (Beatrix.Moshammer@geologie.ac.at; maria.heinrich@gmx.at)
[3] Department of Prehistoric and Historical Archaeology, Department of Geodynamics and Sedimentology, University of Vienna, Vienna, Austria (Erich.Draganits@univie.ac.at)

Abstract

The currently ongoing project on *Stone Monuments and Stone Quarrying in the Carnuntum – Vindobona Area* (FWF 26368-G21) focuses on petrological and litho-stratigraphic investigations of well-dated Roman stone objects. The majority of the examined monuments are made from local Neogene limestone varieties, sedimentary breccias and sandstones – lithologies widespread in the surroundings of Carnuntum, the edge of the Vienna Basin and the western margin of the Pannonian Basin.
Analyses of historical maps and high resolution airborne laser scans (ALS) are used to detect potential ancient quarry areas, which are ground-checked by geological methods. So far, ancient quarrying areas in the immediate surroundings of Carnuntum and in the Leitha Mountains have been localized, providing deposits of different algal limestones and calcareous arenites.
This interdisciplinary approach promises to provide insight, not only into the provenance of stone material but also into matters of transportation, workshops and economic interaction between Carnuntum, Vindobona and the hinterland.

Keywords
Pannonia, Roman quarries, Neogene

Introduction

Carnuntum is situated on the right bank of the Danube River, on the northern border of the Roman Empire, some 40 kilometers east of Vienna (Roman Vindobona). Carnuntum was the capital of the Roman province of Pannonia Superior. In the middle of the first century AD, a permanent legionary fortress was built, and step by step, Carnuntum became a flourishing metropolis, which existed until the 5th c. AD.[1]

The arrival of the Roman legions involved – among many other things – demand for construction material, including stone, which until then had not been used by the local population.[2] From Carnuntum we have a record of far more than 2000 stone artefacts from Roman times, and the collection is still increasing. This huge number only includes decorated monuments. Over 770 objects related to religion have been published recently in the new volume of *Corpus signorum imperii romani*, including monuments of different types, such as statues, altars, inscriptions or architectural decoration.[3]

About 10 to 16 % of these artefacts are carved in white marble, a material which had to be imported to Carnuntum, mainly from the south-eastern Alpine region, and even from Mediterranean countries.[4]

One of the objectives of our current interdisciplinary project[5] is to learn more about the properties and the provenance of local and regional limestones used in

1 STIGLITZ *et. al.* 1977; JOBST 1983; KANDLER *et al.* 2004; HUMER (ed.) 2006; HUMER, KREMER (eds.) 2011; GUGL *et al.* 2015.

2 MOSSER 2003; KREMER 2013.

3 KREMER 2012.

4 KREMER *et al.* 2009; UNTERWURZACHER *et al.* 2010; UHLIR, UNTERWURZACHER in: KREMER 2012.

5 Austrian Science Fund (FWF) P 26368-21: "Stone Monuments and Stone Quarrying in the Carnuntum – Vindobona Area" (G. Kremer). KREMER 2016; KREMER, KITZ 2016.

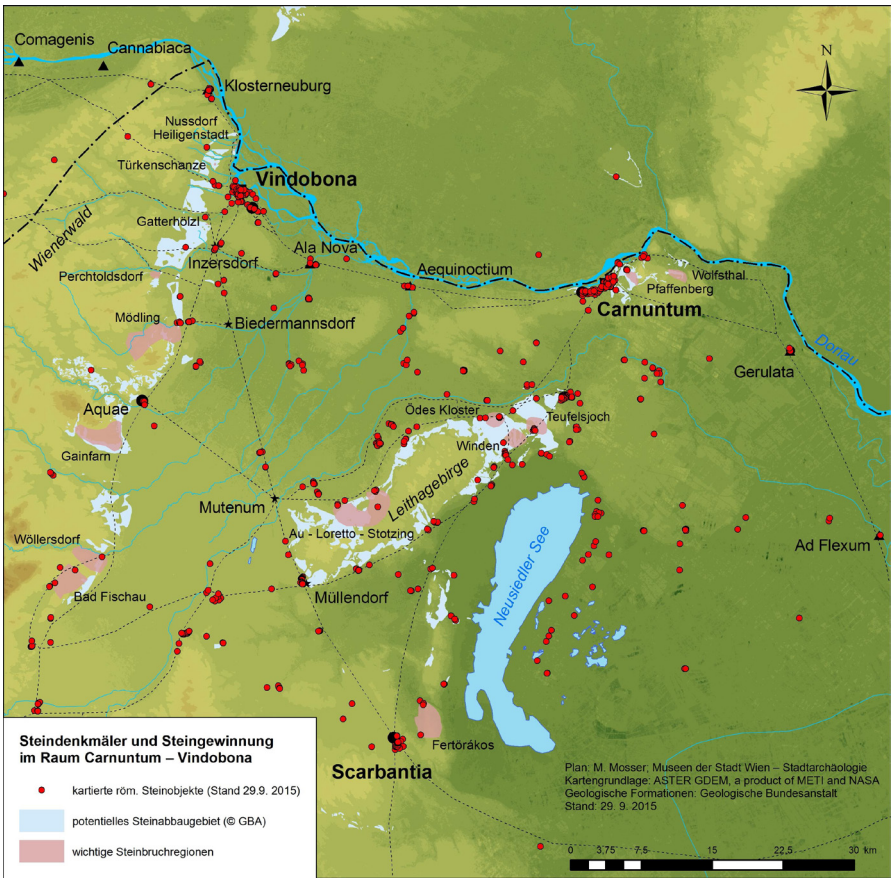


Fig. 1.
Project area with find-spots of Roman stone artefacts and possible quarry areas
(map: M. Mosser)

Roman times, quarried at a distance of less than 50 km from Carnuntum. The corresponding and complementary part of this project, dealing with the stone artefacts from the settlement and legionary fortress of Vindobona/Wien, is presented by Michaela Kronberger *et al.*[6]

The area under investigation is the hinterland of Carnuntum and Vindobona, up to the neighbouring town of Scarbantia (modern Sopron) south of Carnuntum, situated directly on the so-called Amber-Road[7], which connected the North Sea with Italy. Quarry regions and potential quarrying sites are located both to the East and to the West of Carnuntum (Fig. 1). One of our research foci is to compare the materials used in the urban centers Carnuntum and Vindobona with those used in the rural hinterland, to assign the Roman monuments to their respective provenance regions, to possibly identify ancient quarries themselves and to draw historico-cultural conclusions from these data. For these goals we have combined geological and archaeological methods as well as approaches with constant exchange of information and data in progress, aiming for open-minded, interdisciplinary progress in this research.

Geological outline, Neogene sedimentary rocks and quarries

This study investigates Roman building and decorative stones in the northern part of the Roman province Upper Pannonia. The rock types covered by our research are mainly of Middle to Upper Miocene sedimentary rocks comprising fossiliferous red algae limestones, calcarenites of various kinds, different dolomite breccias, various conglomerates and some types of siliciclastic dominated sandstones. They crop out in certain areas on the rim of the southern Vienna Basin and on the former western margin of the Pannonian Basin. These lithologies are also found in several hills within this area (Leitha Mountains, Hainburg Mountains, Rust Hills). Especially on these former islands carbonate platforms developed, reaching maximum thicknesses of some tens of metres. The geological map of the research area in Figure 2 is based on published maps and shows the above-mentioned Neogene deposits. They are known as resources for the extraction of building stones and building material evident from quarries and pits. The localizations of the extraction sites are taken from the quarry archive and database of the Austrian Geological Survey, where information on mineral resources and quarry histories have been collected. This data stock is addressed for

6 See in this volume. KRONBERGER *et al.* 2010; KRONBERGER *et al.* 2016.

7 e.g. DRAGANITS *et al.* 2008a.

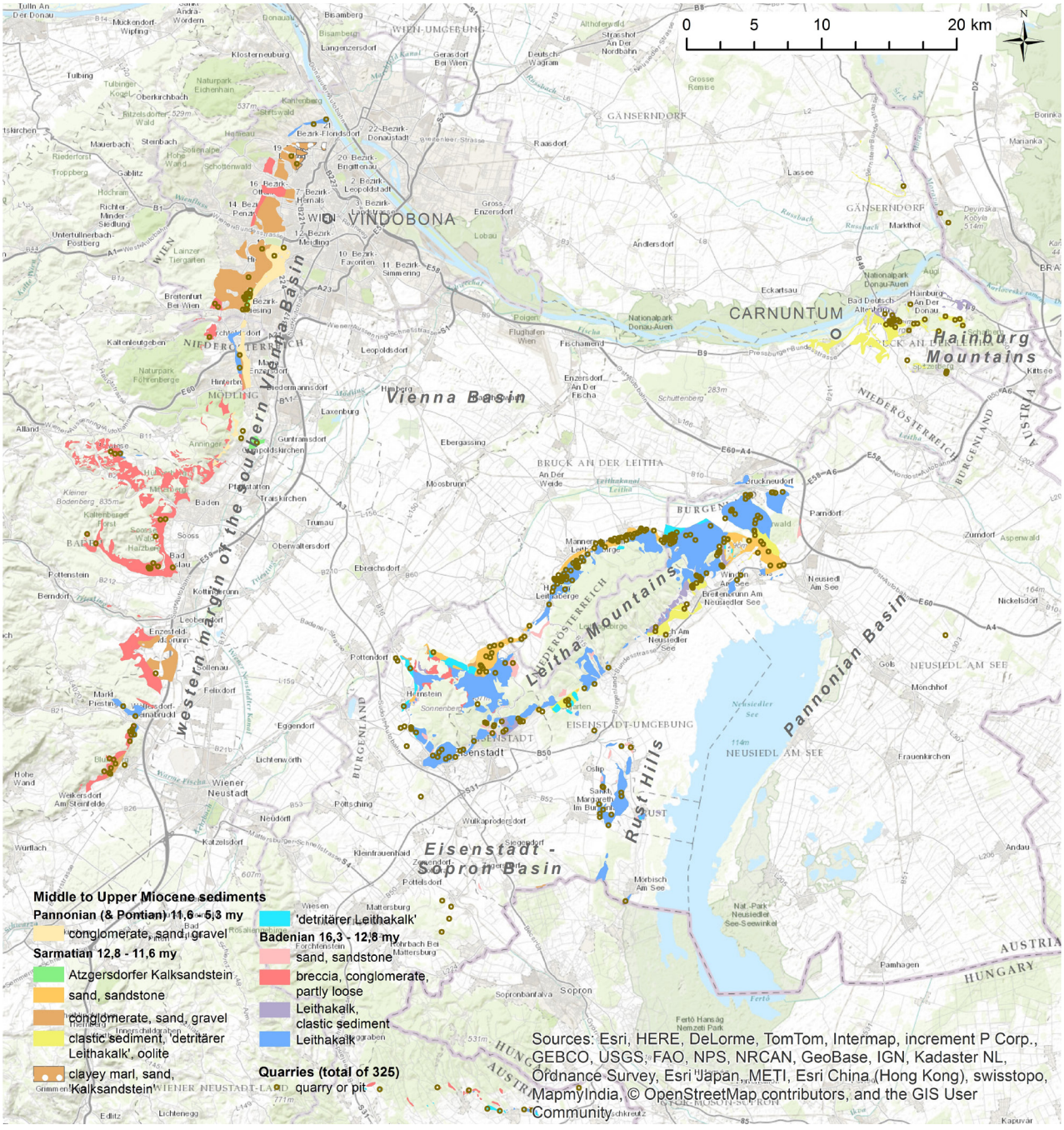


Fig. 2. Targeted geological units and distribution of pits and quarries within the outline of the project area bounded to the north by the Danube (map: B. Moshammer)

selecting quarries with respect to our detailed comparative petrographic analyses of rock types between the samples from the quarries and the investigated stone artefacts.

Among the given sedimentary rocks we are investigating the calcareous algae limestones, the Leitha limestones ('Leithakalk') and related calcarenites ('detritärer Leithakalk') from the Middle to Upper Miocene of Central Paratethys named after their occurrences in the Leitha Mountains (compare Fig. 2). Leitha limestones have proved to be very important resources for building and sculpture stones, exploited since at least Roman time[8]. Today there remains only one active production site for natural building and sculpture stone, which is the huge so-called 'Roman quarry' at St. Margarethen in the Rust Hills. A few other sites with active quarrying in Leitha limestone for other end uses are notable as they incorporated the sites of important historical quarries.[9] One is the large quarry for cement and previous lime

8 MOSHAMMER, ROHATSCH 2015.

9 MOSHAMMER 2013.

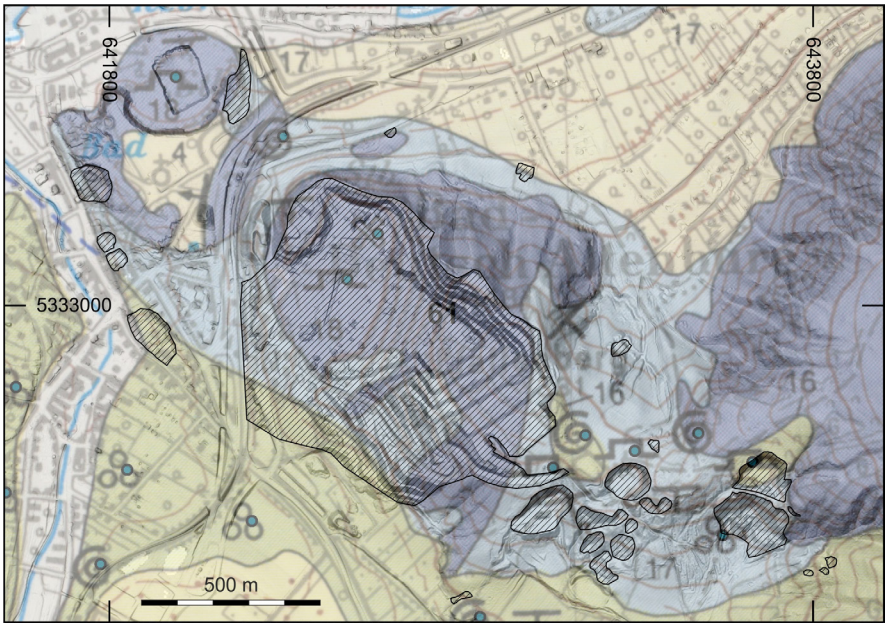


Fig. 3.
Airborne laser scanning topography, and active and abandoned quarries in the area of the north-western part of the Hainburg Mountains (Pfaffenberg); the geological map is taken from FUCHS, WESSELY 1985

Fig. 4.
Example of a weathered quarry face with rare tool marks in the quarry area from figure 3 that could be of possible Roman origin

manufacture at Mannersdorf. Other examples are the former lime, chalk and current filler production quarry at Müllendorf and the large quarry area in the northwestern part of the Hainburg Mountains, which completely removed former Neogene limestone quarries and at present produces dolomite aggregates from the underlying, slightly metamorphous Mesozoic carbonates. For these reasons it is essential to reconstruct the former quarryscapes from various sources. Therefore, airborne laser scanning topographic data, geological maps and historical documents are combined with historical maps and geological field work. Figure 3 shows one result of such a combination for the area of Bad Deutsch-Altenburg on the northwestern boundary of the Hainburg Mountains, near the important Roman army camp and city of Carnuntum. The outlines of the active open mine and the remaining older quarries and spoil heaps are hatched. The Mesozoic meta-limestone and meta-dolomites are indicated in darker blue whereas the sedimentary rocks above are shown in light colours: blue for the Badenian sediments with 'Leithakalk' among others and green for the Sarmatian including 'detritärer Leithakalk'[10]. Field work observations suggest that quarrying started rather in the lower areas of the hills, which means that the older sites are mostly covered by spoil from the ongoing later extractions. In spite of this, traces of very old quarrying might still be preserved. The much weathered vertical tool marks on a rudimentary quarry face in

10 FUCHS, WESSELY 1985.

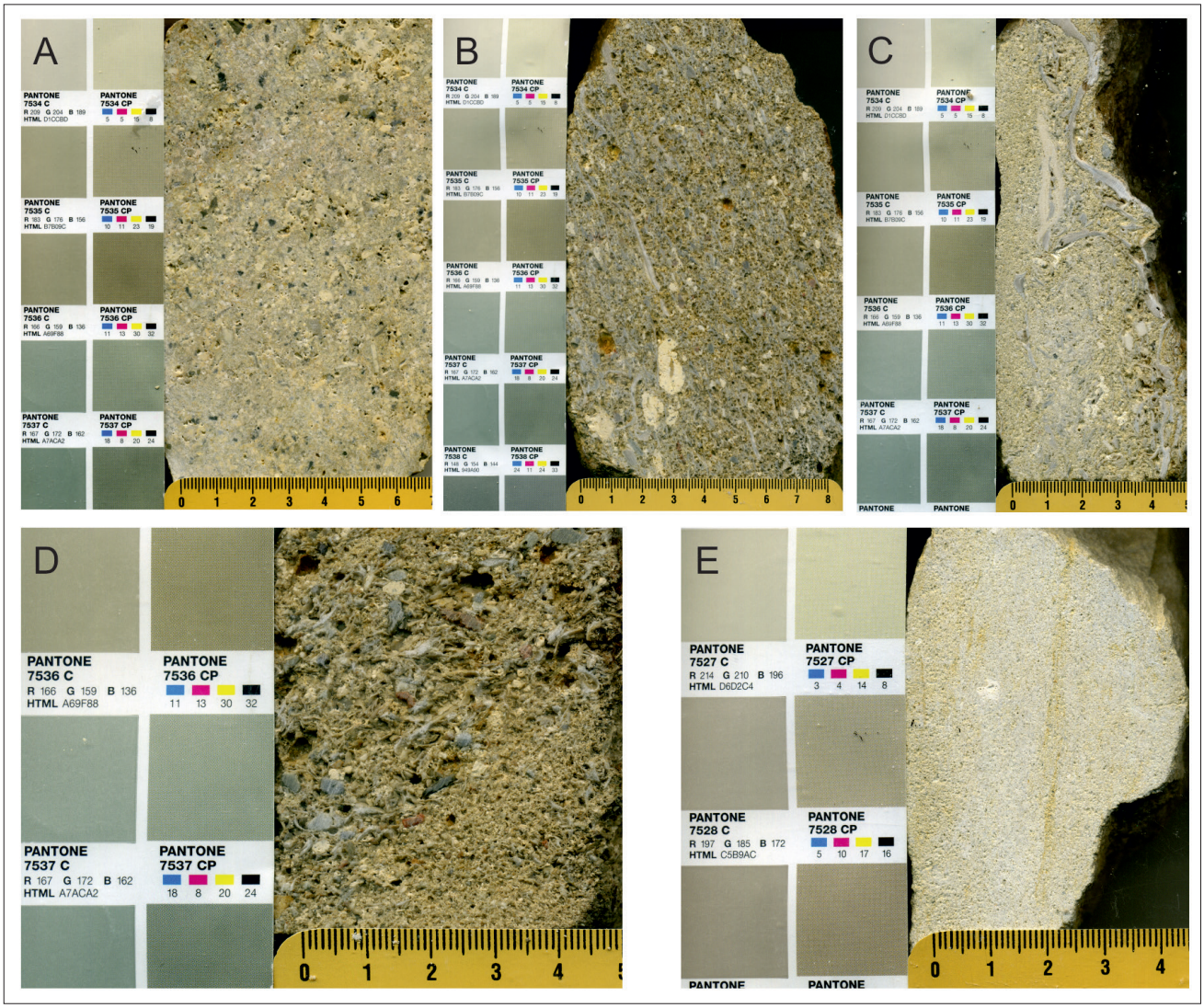


Fig. 5 A-E. Polished slabs of Leitha limestone samples from old quarries of Pfaffenberg area corresponding to stone monuments from Carnuntum; explanations are given in text

this area shown in Figure 4 are such an example. In addition, this outcrop consists of a type of Leitha limestone which is a good match for a couple of stone monuments from Carnuntum.

Methods for stone provenancing, examples of Leitha limestone types near Carnuntum

According to the determined rock types derived from the stone monument investigation, rock samples from relevant quarries are taken and prepared. In accordance with the example from the nearest possible stone resources of Carnuntum given in Figure 3 a choice of polished surfaces of Leitha limestone types sampled in the old quarries is presented in Figure 5. Both sample preparation and pictured scans are provided by team members Barbara Hodits and Andreas Rohatsch from Vienna Technical University. We aim to describe the samples macroscopically as well as on the basis of thin section, geochemical and petrophysical analyses. Stone artefacts made of fine grained sedimentary rocks qualify for analysis with a portable XRF aiming at hints in their chemical compositions. Otherwise the investigation of the Roman stone objects is based mainly on the surficial macroscopic determination. If they show altered or contaminated surfaces the conclusions are limited. Thus it is important to discover distinguishing diagnostic characteristics of the different rock types. The range and definition of the lithotypes from the stone objects is still a work in progress.

The following lithological descriptions of the five samples pictured in Figure 5 give an impression of rock types that are essential as stone materials for the monuments in Carnuntum. Figures 5A–D serve as

Fig. 6.
Building inscription of a *centuria* of the Legio XV Apollinaris, found in the legionary fortress of Carnuntum (CIL III, 13479; Arch. Museum Carnuntinum, Bad Deutsch-Altenburg)

examples of different kinds of Leitha limestone we refer to as 'local types of Leitha limestone' and are supposedly of Badenian age. Although the rock sample in Figure 5E also comes from the same area near Carnuntum, it is not very specific for this area as it crops out for example in the Leitha Mountains as well. The sample of Figure 5E represents a calcarenite supposedly of Sarmatian age.

Figure 5A: Cream to beige-coloured red algae biogenic limestone (rudstone) with prominent dark blue extraclasts (mainly meta-dolomite). The red algae are unattached or of rhodolithic growth forms. Further bioclasts reveal bryozoans, echinoderms, foraminifers and molluscs. The components vary in grain size from coarse sand to fine gravel. A groundmass of fine carbonate sand is present. Sorting and abrasion are weakly developed, stratification is poor. Open pores are particularly related to the coralline algae.

Figure 5B: Cream to beige-coloured oyster bioclastic limestone (rudstone) / coarse coquina. Well aligned elongated oyster shells as well as shells hashed up to coarse sand grain size dominate, followed by strongly abraded red algae fragments, extraclasts of grey and red-coloured carbonates and other bioclastic grains. Pervasive porosity as fine sediment is lacking, sorting and alignment of the components are well developed. That altogether reflects a high energetic depositional environment. The sample was taken from the old quarry face in Figure 4.

Figure 5C: Cream to beige and light blue coloured bioclastic limestone (rudstone to grainstone) with a coarse layer containing broken and unbroken oyster shells. Striking encrustations from bryozoans and some red algae occur, the sediment shows fining upward and is as porous as usual. This coquina is less reworked than the previous example.

Figure 5D: Brownish-grey porous coarse clastic limestone and fine breccia. Its components are similar to 5B, however, among the meta-carbonate extraclasts, the red coloured meta-limestones are enriched. They are an identification criterion for the northwestern Hainburg Mountains.

Figure 5E: Medium sand sized bioclastic limestone (grainstone), ivory-coloured with light rusty banding, The clasts are composed of red algae, foraminifers, bryozoans, echinoderms, molluscs and others. A tiny rhodolith is visible. The well-sorted and -layered sediment has a fine porosity.

Archaeological implications from the ongoing evaluations

The study of the archaeological objects themselves and their comparison with geological samples provides first important results. A representative number of about 100 safely dated objects have been selected, for example funerary monuments erected by members of the legions based at Carnuntum during certain, well-defined periods. Among them, a group of early dated slabs for funerary or other inscriptions were erected for or by soldiers of the 15th legion, and are therefore dated to between the 1st and the early 2nd century AD (Fig. 6).[11] Some of these early funeral slabs comprise an assortment of rock types (compare Figure 5) which indicates a probable provenance from the area of Bad Deutsch-Altenburg – Hundsheimer Berge, only 4 km east-northeast of Carnuntum. There the typical lithologies are porous unsorted clastic limestone to fine breccia composed of mainly coralline algae,

11 MOSSER 2003.

Fig. 7. Funerary slab of Marcus Gavius Cupitus, legionary of the Legio X Gemina (CIL III, 14358/18 a; Arch. Museum Carnuntinum, Bad Deutsch-Altenburg)

Fig. 8. Funerary slab of Matta, from Gols (CIL III, 4392; Burgenl. Landesmuseum Eisenstadt)

characteristic dolomite clasts and minute but specific clasts of a red limestone ('local types of Leitha limestones'). From this geological observation and the scarcity of pre-Roman building stone use we can already conclude that the local quarries in the immediate vicinity of Carnuntum were opened most probably by the Roman military. The rocks of this region east-northeast of Carnuntum are still exploited.

Roman quarries are therefore most likely completely destroyed or covered by spoil. In spite of that, as already mentioned, the location of some pre-Modern quarry sites by geological field-work was possible (Fig. 3, 4). The combination of different generations of historical maps and high resolution airborne laser scanning topography interpretations indicate that the most probable areas for Roman quarry sites are the lower areas directly north and northwest of the Pfaffenberg in Bad Deutsch-Altenburg. Unfortunately, a major part of this area was reshaped for railway and road constructions. Another part is completely covered by vegetation and modern buildings and therefore access has been very limited so far.

Additionally, the lithological types of the funeral slabs of Carnuntum also indicate further quarry regions, which are not in the immediate surroundings of the capital. The 10th legion was based in Carnuntum only for a few years, between 63 and 68 AD, but a group of monuments survived from this period (Fig. 7).[12] They are very similar to each other, not only from a stylistic and typological point of view, but also concerning the rock type which confers to a certain lithotype of Leitha limestone (light, porous grain- and rudstone, predominantly composed of reworked coralline algae, typically with additional quartzite clasts). The material of these slabs can be referred to a region in the northeastern Leitha Mountains, close to the village of Winden, where several quarrying sites are recorded.[13] Therefore the funeral slabs give us information about quarrying activity and probably related workshops in this period, which seem to be closely connected with the military troops.

Another specific group of monuments was erected by the local population and is strikingly different from

12 VORBECK 1980, n. 9–26, 28–30, 262; KRÜGER 1972.

13 ROHATSCH *et al.* 2016.

those from the metropolis, regarding both the figural representations and the technical quality (Fig. 8).[14] They commonly show local Celtic names, and also the characteristic costumes of the region, first of all the representation of women with huge Pannonian caps and their specific jewelry.[15] This population seems to have been concentrated on the western slopes of the Leitha Mountains, where a number of historic quarries are recorded too, and where we assume the existence of several local workshops. Further stone analysis will show whether these observations will be confirmed and if an allocation to specific quarries can be confined.

Anticipated archeological objectives

From the synthesis and evaluation of the recorded data we expect insights into the historico-cultural development of the region, such as the organization and evolution of quarries and stonemason workshops in the Carnuntum – Vindobona region, the development of Roman settlements, infrastructure, transportation links and economy of the region[16]. The exchange between the two legionary forts Carnuntum and Vindobona, as well as their relationship to the so-called hinterland will be investigated. Last but not least we also expect some practical benefits, such as new possibilities for the dating of certain monuments, or new information for the improved detection of forgeries.[17]

14 WEBER-HIDEN 2008; KREMER 2013; KREMER, KITZ 2016.

15 GARBSCH 1965; GARBSCH 1985.

16 Compare with DRAGANITS 2008b.

17 KREMER 2012.

BIBLIOGRAPHY

DRAGANITS E., ZÁMOLYI A., TENTSCHERT E. H., ZALKA T. 2008a: "Einfluß der geologischen und geomorphologischen Verhältnisse auf den Verlauf der Bernsteinstraße im Burgenland", in Die Bernsteinstraße: Evolution einer Handelsroute. Wissenschaftliche Arbeiten aus dem Burgenland 123, Eisenstadt, 26-33.

DRAGANITS E., ROHATSCH A., HERDITS H. 2008b: "Römersteine entlang der burgenländischen Bernsteinstraße", in Spuren römischen Lebens im Burgenland, Wissenschaftliche Arbeiten aus dem Burgenland 124, Eisenstadt, 37-58.

FUCHS W., WESSELY G., mit Beitrag von GRILL R. 1985: Geologische Karte der Republik Österreich 1: 50.000, Bl. 61 Hainburg an der Donau – 62 Pressburg, Geologische Bundesanstalt, Wien.

GARBSCH J. 1965: Die norisch-pannonische Frauentracht im 1. und 2. Jahrhundert, München.

GARBSCH J. 1985: Die norisch-pannonische Tracht, in ANRW II 12, Berlin, 546-577.

GUGL C., RADBAUER S., KRONBERGER M. 2015: "Die Canabae von Carnuntum II. Archäologische und GIS-analytische Auswertung der Oberflächensurveys 2009-2010", RLÖ 48, Wien.

HUMER F. (ed.) 2006: Legionsadler und Druidenstab. Vom Legionslager zur Donaumetropole, Katalog des Niederösterreichischen Landesmuseums N. F. 462, St. Pölten.

HUMER F., KREMER G. (eds.) 2011: Götterbilder – Menschenbilder, Religion und Kulte in Carnuntum, Katalog Niederösterreichische Landesausstellung 2011, St. Pölten.

JOBST W. 1983: Provinzhauptstadt Carnuntum. Österreichs größte archäologische Landschaft, Wien.

KANDLER M., HUMER F., ZABEHLICKY H. 2004: "Carnuntum", in M. ŠAŠEL KOS, P. SCHERRER (eds.): Die autonomen Städte in Noricum und Pannonien, Situla 42, Ljubljana, 11-66.

KREMER G. 2012: Götterdarstellungen, Kult- und Weihedenkmäler aus Carnuntum. Mit Beiträgen von GUGL C., UHLIR C., UNTERWURZACHER M., Corpus Signorum Imperii Romani, Carnuntum Supplement 1, Wien.

KREMER G. 2013: Zu einigen ungewöhnlichen Steindenkmälern aus Carnuntum, Carnuntum Jb 2012, 71-80.

KREMER G. 2016: "Zum Corpus Signorum Imperii Romani Carnuntum – Ergebnisse und Fragestellungen", in G. GRABHERR, B. KAINRATH (eds.): Akten des 15. Österreichischen Archäologentages in Innsbruck 2014, Innsbruck, 129-139.

KREMER G., UHLIR C., UNTERWURZACHER M. 2009: "Kult- und Weihedenkmäler aus Marmor in Carnuntum", in V. GAGGADIS-ROBIN, A. HERMARY (eds.): Les ateliers de sculpture régionaux: techniques, styles et iconographie, Actes du Xe colloque international sur l'Art Provincial Romain à Arles et Aix-en-Provence 21–23 mai 2007, Arles, Aix-en-Provence, 663-681.

KREMER G., KITZ I. 2016: "Steindenkmäler und Steingewinnung. Neue interdisziplinäre Forschungen im Rahmen des CSIR Carnuntum", in F. HUMER, G. KREMER, E. POLLHAMMER, A. PÜLZ (eds.): Akten der 3. Österreichischen Römersteintagung Hainburg 2014, Amt NÖ Landesreg. Abt. Kunst u. Kultur, 71-86.

KRONBERGER M., HEINRICH M., MOSHAMMER B., MOSSER M. 2010: "Preliminary Results of an Interdisciplinary Project on Roman Stone Material and Historic Quarries in Vienna", in Vindobona – Aquincum. Herausforderungen und Ergebnisse in der Stadtarchäologie, Aquincum nostrum 2, 6, Budapest, 61-68.

KRONBERGER M., MOSSER M., INSULANDER S. 2016: "Gesteinsbestimmung an Römersteinen in Vindobona – Lösungsansätze, erste Ergebnisse und Perspektiven aus archäologischer Sicht", in F. HUMER, G. KREMER, E. POLLHAMMER, A. PÜLZ (eds.), Akten der 3. Österreichischen Römersteintagung Hainburg 2014, Amt NÖ Landesreg. Abt. Kunst u. Kultur, 87-99.

KRÜGER M.-L. 1972: Die Reliefs des Stadtgebietes von Carnuntum II: Die dekorativen Reliefs, Corpus Signorum Imperii Romani I 4, Wien.

MOSHAMMER B. 2013: "Neogene pure limestones in eastern Austria for multiple applications", Mineral deposit research for a high-tech world. Proceedings of the 12th Biennial SGA Meeting, Uppsala.

MOSHAMMER B., ROHATSCH A. 2015: "Contribution in support of a Global Heritage Stone designation for the Leitha Limestone s.l. of eastern Austria because of its use in Roman times", Geophysical Research Abstracts, Vol. 17, EGU2015-9020, Vienna.

MOSSER M. 2003: "Die Steindenkmäler der legio XV Apollinaris", WAS 5, Wien.

ROHATSCH A., MOSHAMMER B., HODITS B., DRAGANITS E., HEINRICH M. 2016: "Steindenkmäler und Steingewinnung im Raum Carnuntum – Vindobona: Vorstellung des geologischen Teils eines interdisziplinären Projektes", in F. HUMER, G. KREMER, E. POLLHAMMER, A. PÜLZ (eds.): Akten der 3. Österreichischen Römersteintagung Hainburg 2014, Amt NÖ Landesreg. Abt. Kunst u. Kultur, 177-183.

STIGLITZ H., KANDLER M., JOBST W. 1977: "Carnuntum", ANRW II 6, Berlin, 583-730.

UNTERWURZACHER M., UHLIR C., KREMER G. 2010: "La procedencia de artefactos de mármol de la metrópoli Romana "Carnuntum", Austria", Geología Colombiana 35, 162-174.

VORBECK E. 1980: Militärinschriften aus Carnuntum, Wien.

WEBER-HIDEN I. 2008: "Sprechende Steine – Grabinschriften erzählen", in Spuren römischen Lebens im Burgenland, Wissenschaftliche Arbeiten aus dem Burgenland 124, Eisenstadt 2008, 70-81.