



Provenance analysis of Roman stone artefacts from sedimentary rocks from the archaeological site near Mošnje, NW Slovenia

Določanje izvora rimskih kamnitih artefaktov iz sedimentnih kamnin z arheološkega najdišča pri Mošnjah, SZ Slovenija

Snježana MILETIĆ¹, Sabina KRAMAR², Judita LUX³, Andrej ŠMUC⁴ & Nina ZUPANČIČ⁴

¹Geological Survey of Slovenia, Dimičeva ul. 14, SI-1000 Ljubljana; e-mail: snjezana.miletic@geo-zs.si

²Slovenian National Building and Civil Engineering Institute, Dimičeva ul. 12, SI-1000 Ljubljana, Slovenia; e-mail: sabina.kramar@zag.si

³Institute for the Protection of Cultural Heritage of Slovenia, Regional Office Kranj, Tomšičeva ul. 7, SI-4000 Kranj, Slovenia; e-mail: judita.lux@zvkds.si

⁴University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology, Aškerčeva ul. 12, SI-1000 Ljubljana, Slovenia; e-mail: andrej.smuc@ntf.uni-lj.si; nina.zupancic@ntf.uni-lj.si

Prejeto / Received 18. 3. 2016; Sprejeto / Accepted 31. 5. 2016; Objavljeno na spletu / Published online 11. 8. 2016

Key words: Roman stone artefacts, clastic sedimentary rocks, limestones, microfacies, provenance, Mošnje, Slovenia

Ključne besede: rimske kamnite najdbe, klastične sedimentne kamnine, apnenci, mikrofacies, izvor, Mošnje, Slovenija

Abstract

This study deals with the macroscopic and microfacies characterisation of Roman stone artefacts excavated in 2006 from a Roman villa rustica near Mošnje (NW Slovenia) with the aim of defining their provenance. A total of 28 representative finds (querns, mortars, whetstones, tooled and rounded stones, a fragment of stone slab, mosaic tesserae and two architectural elements - one with a relief) made of clastic and carbonate sedimentary rocks were examined. Comparison was made with rock samples taken from quarries and gravel bars close to the archaeological site, as well as from larger distance to the site. The majority of artefact sampled is composed of Upper Palaeozoic quartz sandstones, which are found as pebbles in gravel bars close to the archaeological site; while 2 samples were from Quaternary coarse grained clastic rocks which can be found in local glacio-fluvial sediments. Other finds were made of four different Mesozoic shallow-water limestones which outcrop in different areas of Central and SW Slovenia. The nearest Lower Jurassic biopelmicritic limestones are found at the western periphery of Ljubljana in Podutik. Cretaceous miliolid limestones and biocalcarenitic limestones with rudists are common in the successions of the Dinaric Carbonate Platform in SW Slovenia (for example, on the Trieste-Komen Plateau), NE Italy and SW Croatia. This indicates that the limestones for architectural elements, stone mortars and tesserae were brought to Mošnje from distant locations. Smaller stone tools are likely to have been made at the location of the archaeological site from material gathered locally, mostly pebbles from clastic rocks, which were accessible and suitable for tooling.

Izvleček

Raziskava obravnava makroskopsko in mikrofaciesno karakterizacijo kamnitih rimskih artefaktov, izkopanih leta 2006 v rimski podeželski vili pri Mošnjah (SZ Slovenija), z namenom določitve njihovega izvora. Pregledali smo 28 reprezentativnih najdb (žrnje, mošnjari, brusi, obdelani in okrogli kamni, odlomek kamnite plošče, mozaične kocke in dva arhitekturna elementa - eden z reliefom) iz klastičnih in karbonatnih sedimentnih kamnin. Kamnite najdbe smo primerjali z vzorci kamnin iz kamnolomov in prodišč v ožji in širši okolici arheološkega najdišča. Večina vzorcev artefaktov je iz zgornjepaleozojskih kremenovih peščenjakov, ki smo jih našli tudi v prodnikih na prodiščih v okolici Mošenj, medtem ko sta dva vzorca iz kvartarnih debeložrnatih klastičnih kamnin, ki se nahajajo v lokalnih ledeniško-rečnih nanosih. Ostale najdbe so izdelane iz štirih različnih mezozojskih plitvovodnih apnencev, ki se pojavljajo na različnih območjih v osrednji in jugozahodni Sloveniji. Spodnjajurske biopelmikritne apnenice najdemo najbližje na zahodnem obrobju Ljubljane v Podutiku. Kredni miliolidi apnenci in biokalkarenitni apnenci z rudisti so pogosti v horizontih Dinarske karbonatne platforme na JZ Slovenije (npr. na Tržaško-Komenski planoti), SV Italije in JZ Hrvaške. Domnevamo, da so apnenice za izdelavo arhitekturnih elementov, mošnjarev ter mozaičnih kock v Mošnje pripeljali z oddaljenih lokacij. Manjša kamnita orodja so verjetno izdelovali na lokaciji najdišča in so uporabili dosegljivi material iz okolice, večinoma prodnike klastičnih kamnin, primernih za obdelavo.

Introduction

During construction of a section of motorway (Vrba–Peračica) in the Gorenjska region NW Slovenia near the village of Mošnje, a Roman *villa rustica* was discovered (Fig. 1). The villa was built in the first half, respectively no later than the middle of the 1st century A.D., and had been used until the end of the 2nd century (LUX & SAGADIN, 2012). The *villa rustica* consisted of five masonry buildings built on the support wall. The largest and best preserved was the easternmost building that contained a residential area with baths. More than six thousand individual artefacts were collected, consisting of tools, jewellery, coins, pottery and other finds; most dating from the period between the 1st and the 4th centuries A.D. (LUX, 2008). Among numerous stone finds are the querns, whetstones, mortars, two architectural elements – one with a relief and one similar to altar, black and white mosaic and other functional and decorative objects. Despite various archaeological finds of Roman stone artefacts within Slovenia there has been only a small number of publications regarding the provenance of the archaeological stone materials. KRAMAR (2009) published a short review of the stone material from this archaeological site, KOŠIR (2011) analysed pyroclastic rocks finds from the Mošnje site, while similar analysis from other parts of Slovenia include stone material from Emona (BRECELJ et al., 1989; RAMOVŠ, 1990; ŠAŠEL KOS, 1990; RAMOVŠ, 2002; RIŽNAR, 2010), studies of querns from Central and Coastal Slovenia (HORVAT & ŽUPANČIČ, 1987) and NE Slovenia (DJURIĆ et al., 2005; DJURIĆ & MÜLLER, 2009; KRAMAR & DOLENEC, 2013).

The aims of the present study were:

- to define and describe the sedimentary rocks used for various artefacts and stone articles found at the *villa rustica* near Mošnje,
- to compare the stone materials with the samples from quarries and gravel bars close to and further away from the archaeological site in order to determine their provenance.

Geological setting

The archaeological site near Mošnje is located in an intramontane basin known as the Gorenjska Basin (VRABEC & FODOR, 2006). Tectonically the basin is located in the northeastern corner of the Adria-Europe convergent margin, situated at the contact between Southern Alps (northern margin) and External Dinarids (southern margin). The geological basement of the basin and its margins is quite complex; composed of mainly clastic Carboniferous-Permian strata, Mesozoic carbonate rocks and Oligocene to Miocene clastic and volcanoclastic rocks (GRAD & FERJANČIČ 1974; GRAD & FERJANČIČ, 1976; BUSER & CAJHEN 1978; BUSER, 1980). The basin itself is filled with Quaternary alluvial and fluvial deposits from the Sava River and its tributaries. Pebbles found in these deposits are mainly composed of Permian Val Gardena sandstones, Lower Triassic conglomerates, Middle Triassic limestones with cherts and sandstones, Upper Triassic Dachstein limestones and Upper Cretaceous reddish marls (JURKOVŠEK, 1986; BUSER, 2004; ŽUPANEC & HERLEC, 2004).

Materials and methods

A total of 28 stone finds were sampled for petrographic analysis (Table 1). Eighteen of these samples were also microscopically examined (Tables 2, 3). Among sampled finds were querns, whetstones, tooled and rounded stones, stone mortars, a fragment of stone slab, two architectural elements – one with relief, the other similar to altar and black and white mosaic tesserae.



Fig. 1. Aerial photograph of the archaeological site near Mošnje (Source: author Jože Hanc, archived by the Institute for the Protection of Cultural Heritage of Slovenia in Kranj)

Table 1. List of analysed archaeological samples.

SAMPLE	ARCHAEOLOGICAL FIND	TYPE OF STONE MATERIAL
ANM 159	quern	laminated grey lithic coarse grained quartz sandstone
ANM 161	quern	laminated grey medium grained mica-quartz sandstone
ANM 163	quern	yellow limonitised grained lithic-quartz sandstone
ANM 164	quern	limonitised yellow-brownish coarse grained lithic-quartz sandstone with transition to fine grained quartz conglomerate
ANM 165	quern	beige pebbly medium grained feldspar-lithic sandstone
ANM 167	quern	laminated light grey pebbly medium grained lithic-quartz sandstone to medium grained quartz conglomerate
ANM 174	tooled stone	limonitised yellowish brown medium grained lithic-quartz sandstone
ANM 179	quern	limonitised laminated grey medium grained mica-feldspar-quartz sandstone
ANM 187	quern	grey pebbly coarse grained quartz sandstone to medium grained conglomerate
ANM 189	fragment of stone slab	limonitised yellowish brown fine to medium grained lithic-quartz sandstone
PN 779	quern	limonitised green greyish fine to medium grained quartz sandstone
PN 1341	rounded stone	medium grey medium grained mica-quartz sandstone
PN 1465	rounded stone	medium grey medium grained mica-quartz sandstone
PN 1514	whetstone	limonitised grey medium grained quartz sandstone
PN 2734	rounded stone	limonitised grey medium grained quartz sandstone
PN 2740	rounded stone	limonitised yellowish brown coarse grained quartz sandstone
PN 4051	whetstone	limonitised light grey medium grained quartz sandstone
PN 6476	whetstone	limonitised grey medium grained quartz sandstone
PN 6497	whetstone	limonitised yellowish brown fine to medium grained mica-quartz sandstone
PN 6569	tooled stone	greenish grey medium grained quartz sandstone
ANM 177	tooled stone	grey medium grained quartz-calcareous conglomerate
ANM 186	quern	dark grey fine grained mica-quartz breccia
ANM 160	stone mortar	medium grey biopelmicritic limestone
ANM 170	architectural element	dark grey pelbiomicritic limestone
ANM 185	stone mortar	white to light grey biocalcarenitic limestone
PN 6178	architectural element with relief	white to light grey biocalcarenitic limestone
ANM 133	white tessera	yellowish white to light grey biomicritic limestone
ANM 133	black tessera	laminated dark grey to black bituminous micritic limestone

In addition, 21 comparative samples, taken from identified potential source areas in vicinity and more distant localities to Mošnje (Tables 4, 5), were used for comparison (Table 6). These potential source areas were determined on the basis of the rock type and the characteristics of the stone artefacts, a detailed review of existing literature on provenance of the Roman stone materials and a review of the geology of the research area (JURKOVŠEK, 1986; BRECELJ et al., 1989; RAMOVŠ, 1990; RAMOVŠ, 2002; BUSER, 2004; ŽUPANEC & HERLEC, 2004; BAVEC, 2008; JURKOVŠEK, 2010; RIŽNAR, 2010).

Potential provenance areas included following localities (Fig. 2, Tables 4, 5):

- in vicinity to the archaeological site pebbles of clastic rocks were taken from the gravel bars of the Sava River near Lancovo (Fig. 2: loc. 1), along with 13 samples of carbonate

rocks from the quarries at Brezovica (Fig. 2: loc. 2), Stara Hleva (Fig. 2: loc. 3), and the exploration area Kodrasti vrh (Fig. 2: loc. 4).

- more distant localities included a limestone quarry in Podutik (Fig. 2: loc. 5) near Ljubljana (3 samples) and an Italian limestone quarry Cava Romana (Fig. 2: loc. 6) near Aurisina/Nabrežina, Italy (15 samples).

For all comparative rock samples thin sections were made and the selected carbonate rocks were coloured with the Alizarin-red S dye. Samples were analysed under an optical microscope - Nikon Eclipse E200 in transmitted light. Digital images were taken with a Nikon Coolpix digital camera. Clastic rocks were classified according to WENTWORTH (1922) and PETTJOHN (1973), while carbonate rocks were classified according to FOLK (1962) and DUNHAM (1962) classifications.

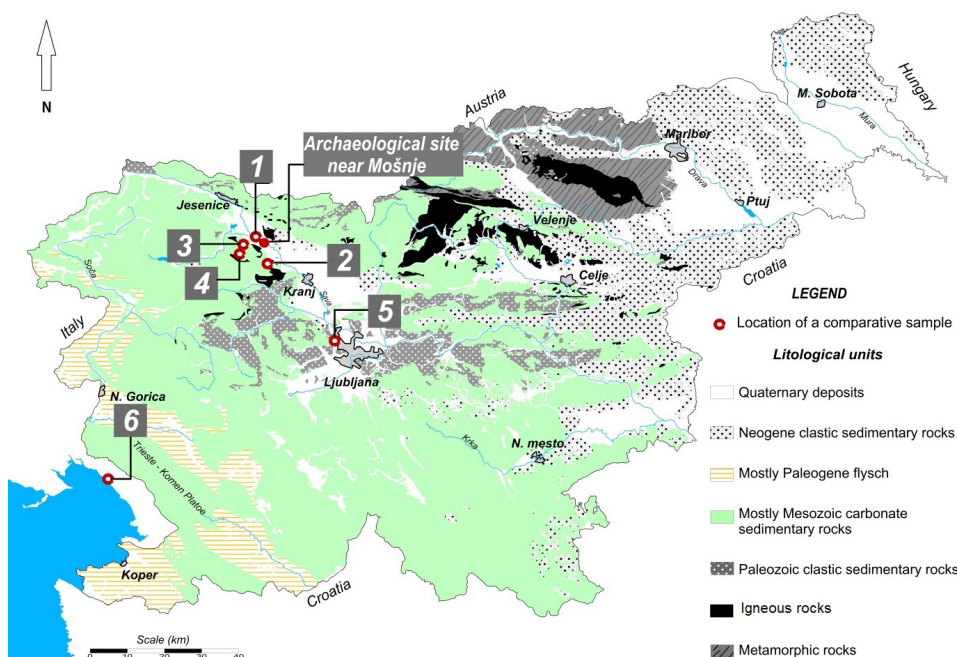


Fig. 2. Locations of comparative samples: 1–Gravel bar Lancovo in Sava River; 2–Brezovica quarry; 3–Kodrasti vrh; 4–Stara Hleva quarry; 5–Podutik quarry; 6–Cava Romana quarry near Aurisina (Geological map after: ŠAJN, 1998).

Results and discussion

Archaeological samples

The results of analyses of samples indicate the use of a diverse variety of rock material. Two major groups were identified: smaller tools, such as querns and whetstones, mostly made of various medium to coarse-grained quartz sandstones, and mosaic tesserae and larger items, such as architectural elements, made of different limestones (Plate 1, figs. 1–8; Plate 2, figs. 9–16; Plate 3, figs. 17–18).

GROUP 1. Clastic sedimentary rocks (Table 2)

Facies 1.A. Medium to coarse grained quartz sandstones: 20 samples (analysed only macroscopically: PN 779 (quern), PN 1341 (rounded stone), PN 1465 (rounded stone), PN 1514 (whetstone), PN 2734 (rounded stone), PN 2740 (tooled stone), PN 4051 (whetstone), PN 476 (whetstone), PN 6497 (whetstone) and PN 6569 (tooled stone). Microscopically analysed: ANM 159 (quern), ANM 161 (quern), ANM 163 (quern), ANM 164 (quern), ANM 165 (quern), ANM 167 (quern), ANM 174 (tooled stone), ANM 179 (quern), ANM 187 (quern) and ANM 189 (fragment of stone slab)).

Macroscopic description—common characteristics: Rock samples are grey to yellowish brown, medium to coarse grained, in places laminated quartz sandstones. Some also contain larger (1–5 mm) grains. Usually these rocks are strongly weathered exhibiting grey-greenish weathered surfaces.

Microscopic description: The rocks structure is mostly heterogeneous, usually composed of 80 % grains and 20 % of matrix. Some are laminated (ANM 159, ANM 161, ANM 167). Grain sizes range

from 0.05 to 0.8 mm, only rarely larger grains (2.5–25 mm) are present (ANM 163, ANM 164, ANM 165, ANM 167, ANM 187). They are poorly sorted, sub-angular to angular and elongated to isometric, and show no visible orientation. Often are coated with red haematite. Contacts between the grains are long and concavo-convex. Grains are represented mainly by mono and polycrystalline quartz grains (45–60 % of all), with irregular edges and undulose extinction. Others are lithic grains (25–45 % of all) mostly of igneous rocks, but also grains of slates, siltstones, limestones, sandstones, and cherts are present. These are rare and present only in some samples: micas (10–30 % of all) in ANM 161, ANM 164, ANM 179, ANM 189, feldspars (5–20 % of all) in ANM 161, ANM 165, ANM 179, ANM 187, Fe minerals in ANM 159, ANM 161, ANM 174, ANM 179, ANM 187, and carbonates in ANM 163, ANM 164, ANM 189. The grains are usually bounded by sericite and quartz-sericite matrix or cemented by quartz and/or carbonate. In some samples (ANM 163, ANM 164, ANM 189) the matrix is strongly limonitised. Clay matrix occurs only rarely (ANM 164, ANM 179, ANM 189).

These sandstones are most likely of Upper Palaeozoic age (Plate 1, figs. 1–8; Plate 2, figs. 9–10).

Facies 1.B. Grey medium grained quartz-calcareous conglomerate: (ANM 177 (tooled stone))

Macroscopic description: Grey conglomerate, clast-supported, composed of well-rounded grains of various compositions up to 3 cm in size. Grains are cemented by highly weathered carbonate cement.

Microscopic description: The rock has a grain supported, heterogeneous structure and consists of 80 % of grains and 20 % of partly weathered carbonate (mostly calcite) cement. The grains

Table 2. Petrographic characteristics of microscopically analysed archaeological samples-clastic sedimentary rocks.

FACIES	SAMPLE MARK	ARCH. FIND	NAME OF ROCK	MINERAL COMPOSITION (GRAINS)				MATRIX OR CEMENT	MATRIX OR CEMENT /GRAINS RATIO	GRAIN SIZE (mm)
				QUARTZ %	LITHIC GRAINS %	MICA %	OTHER %			
1.A Medium to coarse grained quartz sandstones	ANM 159	quern	laminated grey coarse grained lithic-quartz sandstone	60	30	/	Fe minerals 10	carbonates	25/75	0.07-1.05 (0.7)
	ANM 161	quern	laminated grey medium grained mica-quartz sandstone	60	15	20	feldspars 3, Fe minerals 2	sericite, quartz	20/80	0.05-0.45 (0.25)
	ANM 163	quern	limonitised yellow coarse grained lithic-quartz sandstone	45	45	/	calcite 5, plagioclase 5	carbonates (limonitisation)	15/85	0.05-0.9 (0.6), pebbles up to 2.5
	ANM 164	quern	limonitised yellow-brownish coarse grained lithic-quartz sandstone, transition to fine grained quartz conglomerate	45	40	10	carbonates 5	calcite, clay (limonitisation)	20/80	0.19-0.5 (0.1), pebbles up to 5
	ANM 165	quern	beige pebbly medium grained feldspar-lithic sandstone	60	25	/	feldspars 15	sericite, quartz	20/80	0.07-0.7 (0.4), pebbles up to 5
	ANM 167	quern	laminated light grey pebbly medium grained lithic-quartz sandstone to medium grained quartz conglomerate	60	40	/	/	quartz sericite	25/75	0.05-0.45 (0.25), pebbles 10
	ANM 174	tooled stone	limonitised yellowish brown medium grained lithic-quartz sandstone	50	45	in lithic grains	Fe minerals < 5	carbonates	15/85	0.07-1 (0.3)
	ANM 179	quern	limonitised laminated grey medium grained mica-feldspar-quartz sandstone	50	15	10	feldspars 20, pyrite 5	sericite – muscovite, clays	15/85	0.04-0.8 (0.5)
	ANM 187	quern	grey pebbly coarse grained quartz sandstone to medium grained conglomerate	60	25	in lithic grains	Fe minerals < 10, feldspars 5	sericite, quartz, Fe minerals	25/75	0.07-2.5 (0.8), pebbles up to 25
1.B Grey medium grained quartz-calcareous conglomerate 1.C Dark grey fine grained mica-quartz breccia	ANM 189	fragment of stone slab	limonitised yellowish brown fine to medium grained lithic-quartz sandstone	45	40	10	carbonates 5	calcite, clay (limonitisation)	20/80	0.04-0.6 (0.25)
	ANM 177	tooled stone	grey medium grained quartz-calcareous conglomerate	15	83	in lithic grains	feldspars, plagioclase, Fe minerals < 2	carbonates	20/80	0.05-30 (5)
	ANM 186	quern	dark grey fine grained mica-quartz breccia	60	/	35	feldspars 5	sericite, quartz	85/15	0.12-0.8 (0.35), rubble 5

Table 3. Petrographic characteristics of microscopically analysed archaeological samples—carbonate sedimentary rocks.

FACIES	SAMPLE MARK	ARCH. FIND	NAME OF ROCK	BIOCLASTS %	INTRACLASTS %	PELOIDS %	OOIDS %	OTHER	MATRIX OR CEMENT %	MATRIX OR CEMENT /GRAINS RATIO	GRAIN SIZE (mm)
2.A Grey biopelmicritic limestones	ANM 160	stone mortar	grey biopelmicritic limestone	35	5	60	indeterminable	geopetal structures, rounded sparry grains, pyrite	micrite - sparite	35/65 (avg.)	0.03 - 0.45
	ANM 170	architectural element	dark grey pelbiomicritic limestone	20	< 10	15	indeterminable	rounded sparry grains 55 %, pyrite	micrite	70/30 (avg.)	0.03 - 0.15 (0.7)
2.B White to light grey biocalcarenitic limestone	ANM 185	stone mortar	white to light grey biocalcarenitic limestone	30	60	10	/	/	micrite, sparite 60/40	60/40	0.04 - 1 (0.1)
	PN 6178	architectural element with relief	white to light grey biocalcarenitic limestone	30	60	10	/	/	micrite, sparite 60/40	60/40	0.04 - 1 (0.1)
2.C Yellowish white to light grey biomicritic limestone	ANM 133	white tessera	yellowish white to light grey biomicritic limestone	90	some	10	/	/	micrite 70, microsparite 20, sparite 10	70/30	0.1 - 0.9 (0.2)
2.D Laminated dark grey to black limestone	ANM 133	black tessera	laminated dark grey to black bituminous micritic limestone	80	/	/	/	organic matter 10 %, pyrite 10 %	microsparite 90, micrite 10	90/10	0.02 - 0.15

Table 4. Petrographic characteristics of microscopically analysed comparative samples—clastic sedimentary rocks.

PROVENANCE	SAMPLING LOCATION	SAMPLE MARK	NAME OF ROCK	MINERAL COMPOSITION (GRAINS)				MATRIX OR CEMENT %	MATRIX OR CEMENT /GRAINS RATIO	GRAIN SIZE (MM)
				QUARTZ %	LITHIC GRAINS %	MICA %	OTHER %			
Local	Gravel bar Lancovo (Sava River)	P-1	laminated dark green very fine to fine grained mica-quartz sandstone	70	/	30	/	sericite 75, clay 20, carbonates 5	15/85	0.03 - 0.13 (0.07)
		P-2	reddish brown fine grained mica-feldspar-quartz sandstone	60	/	15	feldspars 25	sericite, clay	15/85	0.03 - 0.2 (0.14)
		P-3	grey medium grained feldspar-quartz sandstone	55	< 10	10	feldspars 25	sericite - clay 75, Q 25, traces of carbonates	15/85	0.06 - 0.4 (0.25)

Table 5. Petrographic characteristics of microscopically analysed comparative samples-carbonate sedimentary rocks.

PROVENANCE	SAMPLING LOCATION	SAMPLE MARK	NAME OF ROCK	BIOCLASTS %	INTRACLASTS %	PELOIDS %	OOIDS %	OTHER	MATRIX OR CEMENT %	MATRIX OR CEMENT /GRAINS RATIO	GRAIN SIZE (mm)
Local	Brezovica quarry	Br-1	light grey recrystallised slightly dolomitic pelbiosparite	70	some	20	recrystallised 10	anhidritisation, dolomitisation	sparite 70, microsparite 20, micrite 10, traces of dolomites	70/30	0.02 -0.7
		B-1	light grey recrystallised slightly dolomitic pelbiosparite to pelbiomicrite	70	some	20	recrystallised 10	weak dolomitisation	sparite to micrite, traces of dolomites	70/30	0.02 -0.7
		B-2	light grey recrystallised dolomitic pelbiosparite	70	some	20	recrystallised 10	bioturbations	sparite 70, microsparite 20, micrite 10	70/30	0.02 -0.7
	Kodrasti vrh	KV-1	whitish and reddish recrystallised intrasparitic limestone	/	20	/	/	calcite grains 80 %, stylolites, carstification	sparite 70, micrite 30	80/20	variable, up to 0.5
	Stara Hleva	SH-1	light grey medium grained calcareous dolomite	/	/	/	/	dolomite and calcite grains	/	0/100	variable
	Distant	Quarry in Podutik	P-19	dark grey biopelmicritic limestone	10	< 10	highly variable	indeterminable	rounded sparry grains 30 %, pyrite	micrite, fields of sparite	70/30
P-26			grey biopelmicritic limestone	20	< 10	65	10	rounded sparry grains 5 %, pyrite	micrite, partly recrystallisation (sparite)	40/60	0.02 – 0.2
P-28			dark grey biopelmicritic limestone	10 - 20	< 10	highly variable	indeterminable	rounded sparry grain 10 %	micrite, sparite	70/30	0.5 - 9
Cava Romana (Aurisina)		CR-1	white to light grey biocalcarenitic limestone	30	60	10	/	bituminous substance, pyrite	micrite, sparite	60/40	0.02 – 3 (1)

Table 6. Overview of analysed stone material from the archaeological site near Mošnje and their related rock type and provenance

GROUP OF ROCKS	FACIES	SAMPLE MARK	ARCH. FIND	NAME OF ROCK	GEOL. AGE	PROVENANCE
1. Clastic sedimentary rocks	1.A Medium to coarse grained quartz sandstones	ANM 159	quern	laminated grey lithic coarse grained quartz sandstone	P	gravel bars
		ANM 161	quern	laminated grey medium grained mica-quartz sandstone	C	gravel bars
		ANM 163	quern	yellow coarse grained lithic-quartz sandstone	C	gravel bars
		ANM 164	quern	limonitised yellow-brownish coarse grained lithic-quartz sandstone with transition to fine grained quartz conglomerate	P	gravel bars
		ANM 165	quern	beige pebbly medium grained feldspar-lithic sandstone	P	gravel bars
		ANM 167	quern	laminated light grey pebbly medium grained lithic-quartz sandstone to medium grained quartz conglomerate	P	Sava River terrace
		ANM 174	tooled stone	limonitised yellowish brown medium grained lithic-quartz sandstone	P	gravel bars
		ANM 179	quern	limonitised laminated grey medium grained mica-feldspar-quartz sandstone	C	Quaternary deposits
		ANM 187	quern	grey pebbly coarse grained quartz sandstone to medium grained conglomerate	P	gravel bars
		ANM 189	fragment of stone slab	limonitised yellowish brown fine to medium grained lithic-quartz sandstone	P	gravel bars or Sava River terrace
		PN 779	quern	limonitised green greyish fine to medium grained quartz sandstone	C	gravel bars or Sava River terrace
		PN 1341	rounded stone	grey medium grained mica-quartz sandstone	C	gravel bars
		PN 1465	rounded stone	grey medium grained mica-quartz sandstone	C	gravel bars
		PN 1514	whetstone	limonitised grey medium grained quartz sandstone	C	gravel bars or surrounding deposits
		PN 2734	rounded stone	limonitised grey medium grained quartz sandstone	C	gravel bars
		PN 2740	tooled stone	limonitised yellowish brown coarse grained quartz sandstone	C	gravel bars
		PN 4051	whetstone	limonitised light grey medium grained quartz sandstone	C	gravel bars or surrounding deposits
		PN 6476	whetstone	limonitised grey medium grained quartz sandstone	C	gravel bars or surrounding deposits
		PN 6497	whetstone	limonitised yellowish brown fine to medium grained mica-quartz sandstone	P	gravel bars or surrounding deposits
		PN 6569	tooled stone	greenish grey medium grained quartz sandstone	C	gravel bars
2. Carbonate sedimentary rocks	1.B Grey medium grained quartz-calcareous conglomerate	ANM 177	tooled stone	grey medium grained quartz-calcareous conglomerate	Q	Sava River terrace
	1.C Dark grey fine grained mica-quartz breccia	ANM 186	quern	dark grey fine grained mica-quartz breccia	Upper Pz	Quaternary deposits
	2.A Grey pelbiomicritic limestones	ANM 160	stone mortar	grey biopelmicritic limestone	J1	probably Podutik
		ANM 170	architectural element	dark grey pelbiomicritic limestone	J1	probably Podutik
	2.B White to light grey biocalcarenitic limestone	ANM 185	stone mortar	white to light grey biocalcarenitic limestone	K2	the Trieste - Komen Plateau
		PN 6178	architectural element with relief	white to light grey biocalcarenitic limestone	K2	the Trieste - Komen Plateau
	2.C Yellowish white to light grey biomicritic limestone	ANM 133	white tessera	yellowish white to light grey biomicritic limestone	K2	probably the Trieste - Komen Plateau
	2.D Laminated dark grey to black limestone	ANM 133	black tessera	laminated dark grey to black bituminous micritic limestone	Mz (K2?)	not local

are poorly sorted, size ranging from 0.05 mm to 10 mm. They are rounded to well rounded, with isometric to elongated forms. Contacts between the grains are point to concavo-convex. Pores comprise approx. 10 % of the rock. Most grains (85 % of all) are comprised of various lithic grains (fossiliferous Mesozoic and Paleogene limestones, Ladinian or Oligocene tuffs, quartz sandstones and other types of rocks). The remaining 15 % is comprised of individual grains of quartz. The rock is partly cemented by coarse grained mostly carbonate (calcite) cement.

Grey medium grained quartz-calcareous conglomerate, probably of Quaternary age (Plate 2, fig. 11).

Facies 1.C. Dark grey fine grained mica-quartz breccia (ANM 186 (quern))

Macroscopic description: Fine-grained dark grey matrix-supported breccia with up to 5 mm large quartz clasts, embedded in the dark matrix with mica flakes.

Microscopic description: Breccia is homogeneous, consisting of 85 % matrix and 15 % of grains. The grains range in size from 0.12 to 0.80 mm, are very well sorted, angular to sub-angular and of different shapes. Quartz grains dominate (60 %), while muscovite and weathered feldspars are subordinate. Matrix is of sericite (75 %) and fine-grained quartz (25 %).

Fine grained mica-quartz breccia, probably of Upper Palaeozoic age (Plate 2, fig. 12).

GROUP 2. Carbonate sedimentary rocks (Table 3)

Facies 2.A. Grey to dark grey biopelmicritic limestones: 2 samples (ANM 160 (stone mortar), ANM 170 (architectural element))

Macroscopic description: The rock is a grey bioclastic micritic limestone, in places cut by calcite veins.

Microscopic description: Sample ANM 160 is heterogeneous wackestone to packstone. Grain to matrix ratio is very variable, but on average 65/35. Grains are up to 0.6 mm in size and composed mainly of peloids (around 60 %) and bioclasts (35 %) with some pyrite crystals while intraclasts occur rarely. Bioclasts are of biserial foraminifera and other small foraminifera (*Glomospira?*), algae (*Thaumatoporella?*), mollusc shells and ostracoda. Some are unidentifiable. Also, small rounded sparitic grains are present; some of these are probably ooids. Sample ANM 170 shows similar composition, with average grain to matrix ratio 30/70, however here ostracods (50 %) dominate over other bioclasts, small peloidal grains and micritic intraclasts. The matrix in ANM 170 is micrite, while in ANM 160 micrite and microsparite, in places sparry calcite cement is present.

The observed characteristics indicate shallow-water depositional environment. Absence of age-diagnostic fossils prevents stratigraphic determination of this facies, however, based solely on the microfacies characteristic (cf. OGORELEC, 2011) the rock is tentatively attributed to the Lower Jurassic.

Facies 2.B. White to light grey biocalcarenitic limestone: 2 samples (ANM 185 (stone mortar), PN 6178 (architectural element with relief))

Macroscopic description: White to light grey fine-grained calcarenitic limestone exhibiting shell fragments.

Microscopic description: Limestone is homogeneous packstone to grainstone. Grains are bioclasts of small spherical and biserial foraminifera, sparite-filled rudist shell fragments and echinoderms fragments. They are bounded by micrite to microsparite and in places also by sparite.

Based on the presence of the rudist shells we assigned this limestone to a shallow-water environment of Upper Cretaceous age (Plate 2, figs. 15 & 16).

Facies 2.C. Yellowish white to light grey biomicritic limestone: 1 sample (ANM 133 (white tessera))

Macroscopic description: Yellowish white to light grey homogeneous limestone.

Microscopic description: Limestone is heterogeneous wackestone, composed of 70 % matrix and of 30 % grains. Grains are randomly distributed, without preferred orientation and up to 0.9 mm in size. The majority of grains are miliolid and other foraminifera. Shells, algae fragments and peloids occur rarely. Matrix is micritic and rarely microsparitic. Sparitic infilling of foraminifera moulds is present.

Based on the abundance of miliolids and other shallow-water grains we believe that the limestone was deposited in a shallow water environment and is probably Cretaceous in age (Plate 3, fig. 18).

Facies 2.D. Laminated dark grey to black bituminous limestone: 1 sample (ANM 133 (black tessera))

Macroscopic description: Laminated black to dark grey micritic limestone with transition to homogeneous dark brown micritic limestone. The rock is intersected by 1 mm thick white calcite veins.

Microscopic description: The limestone is homogeneous bioturbated and laminated mudstone. The proportion of matrix approaches 90 %. Lamination is expressed as alternating

bands of 3 mm thick laminae of clear microsparite with 5 mm thick laminae with higher content of organic matter. In some places we noted traces of bioturbation, oriented perpendicular to lamination. Grains are represented by ostracod fragments and rare particles of amorphous organic matter. Small particles of autogenous pyrite are also present. Amorphous organic matter is common and forms streaks and seams roughly parallel to the lamination.

Abundant presence of fine-grained matrix, lamination and high content of preserved organic matter points to the sedimentation in a hydrodynamically quiet anoxic environment. These conditions are typical for sedimentation in restricted lagoonal or deeper-water environments (Plate 3, fig. 17).

Comparative samples

A total of 21 samples with macroscopic petrographic characteristics potentially comparable with artefacts were taken for further examination. Petrographic analyses have shown that 12 of the comparative samples (Plate 3, figs. 19–24, Plate 4, figs. 25–30) from 6 locations (Fig. 2) have certain similarities with the investigated archaeological materials. The results of microscopic analysis of these samples are shown in Table 4 and Table 5, while their significant characteristics are given within the results of comparative analysis in the next subchapter.

GROUP 1. Clastic sedimentary rocks (Table 4)

Samples of local provenance:

Pebbles of quartz sandstone (3 selected samples from the Sava River gravel bars in Lancovo: P-1, P-2, P-3) (Plate 3, figs. 19–21): P-1 is a laminated dark grey to dark reddish brown medium grained sandstone. P-2 is reddish brown homogeneous fine grained sandstone. P-3 is a homogeneous grey to dark greenish grey medium grained sandstone

with light grains of quartz, feldspars and micas. The rocks are of Upper Palaeozoic age.

GROUP 2. Carbonate sedimentary rocks (Table 5)

Samples of local provenance:

Light grey recrystallised limestone (3 selected samples from the quarry Brezovica pri Kropi: BR-1, B-1, B-2) (Plate 3, figs. 22–24) is heterogeneous with carbonate grains of different sizes and numerous parallel calcitic veins, up to 0.5 cm thick. The limestone is a pelbiosparite i.e. wackestone of Upper Triassic age.

Whitish and reddish recrystallised limestone (1 representative sample from the exploration area Kodrasti vrh: KV-1) (Plate 4, fig. 25) with thick white (Note 3) calcitic veins is recrystallised intrasparite i.e. wackestone of Upper Triassic age.

Light grey calcareous dolomite (1 representative sample from the abandoned quarry Stara Hleva: SH-1) (Plate 4, fig. 26) is recrystallised and fractured, with anhedral crystals, cut by thin white veins, with a gradual transition to dolomitic limestone of Triassic age.

Samples of distant provenance:

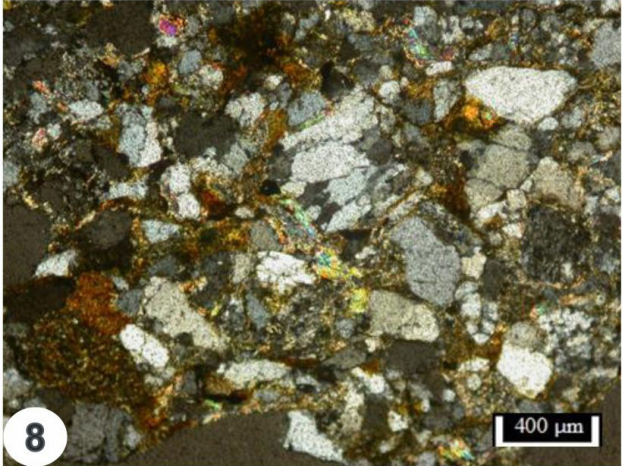
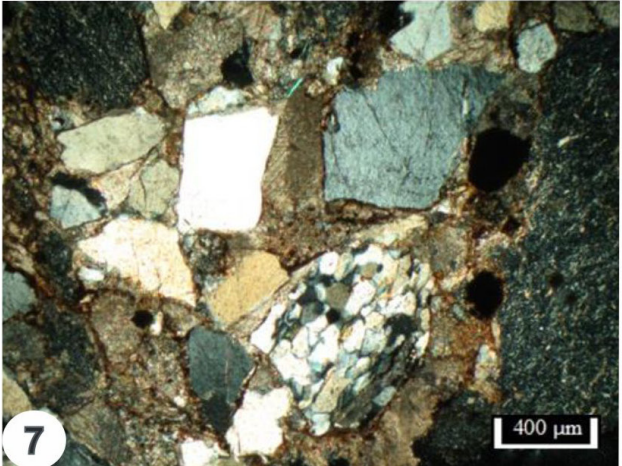
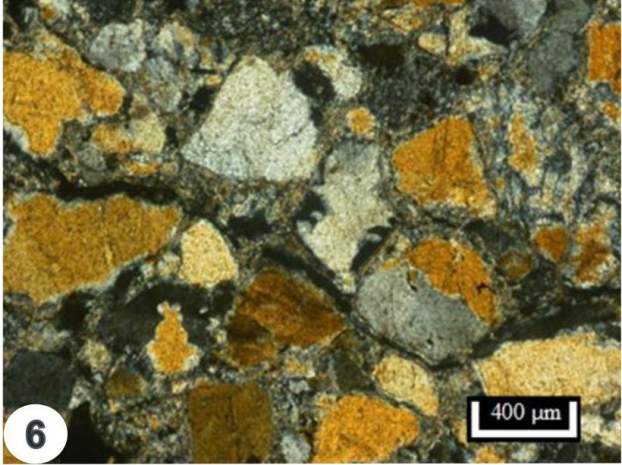
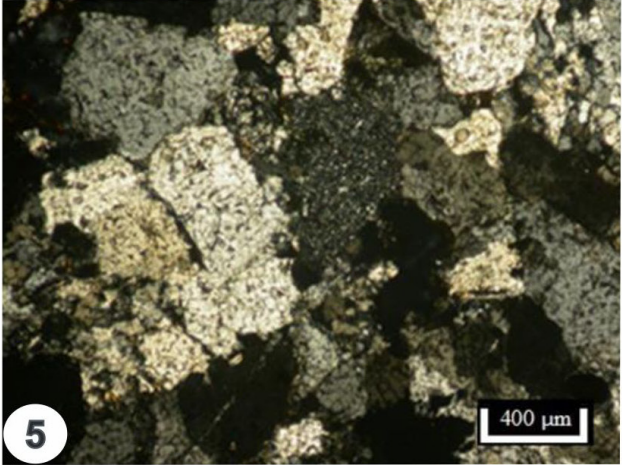
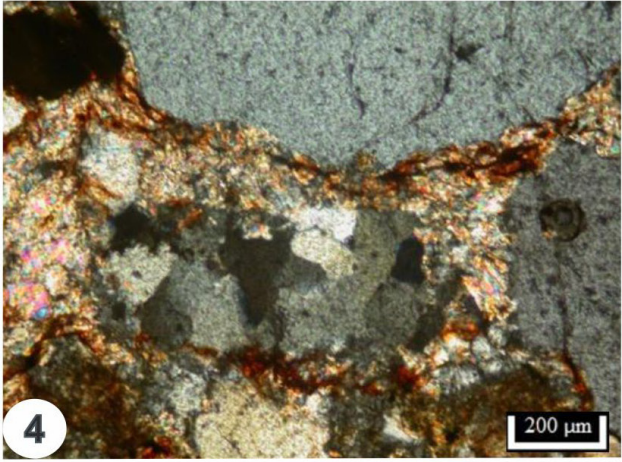
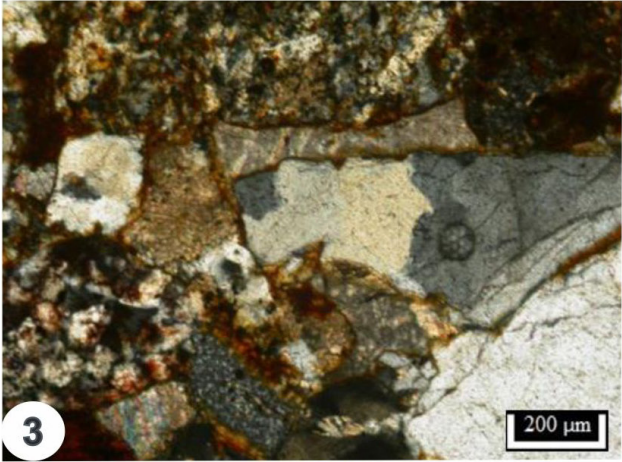
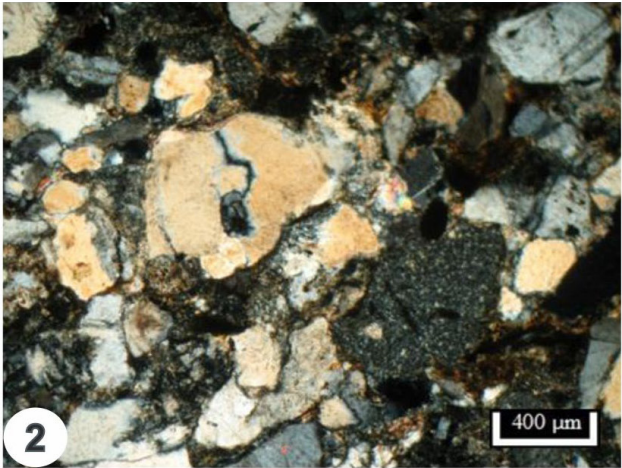
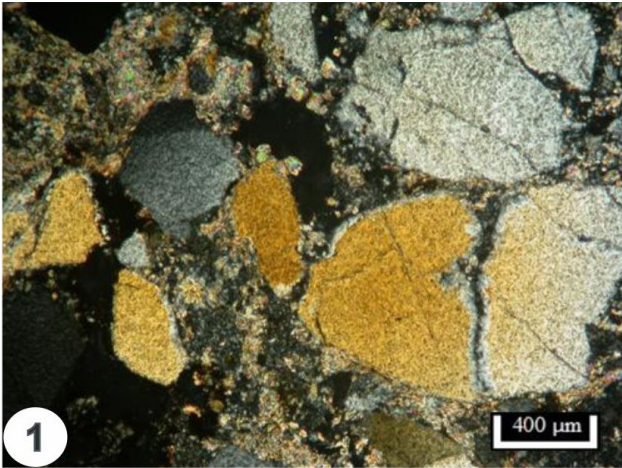
Grey micritic limestones (3 selected samples from an abandoned quarry in Podutik: P-19, P-26 and P-28) (Plate 4, figs. 27 – 29) of varying lighter and darker shades with thin calcitic veins, showing individual fossils, with an average size of 3 mm. The rocks are biopelmicrites i.e. grainstones of Lower Jurassic age.

Light grey biocalcarenitic limestone (1 selected sample from the Roman quarry Cava Romana in Aurisina/Nabrežina: Cr-1) (Plate 4, fig. 30) homogeneous in nature with darker fragmented fossils varying from 1 to 3 mm in size in a lighter coarse grained recrystallised carbonate matrix. The rock is a biointrasparite to biointramicrite i.e. packstone to grainstone of Upper Cretaceous age.

PLATE 1

- 1 ANM 159: limonitised, grey, coarse grained lithic-quartz sandstone: subangular quartz grains connected with fine grained carbonate cement (+A).
- 2 ANM 161: laminated, grey, medium grained mica-quartz sandstone: jagged contacts between quartz and lithic grains in quartz-sericite matrix (+A).
- 3 ANM 163: limonitised, yellow, coarse grained lithic-quartz sandstone: angular lithic and quartz grains are surrounded by limonitised calcitic cement (+A).
- 4 ANM 164: limonitised, yellowish, coarse grained lithic-quartz sandstone with transition to fine grained quartz conglomerate: quartz grains of different sizes bonded with calcitic cement (+A).
- 5 ANM 165: beige, pebbly, medium grained feldspar-lithic sandstone: irregular contacts between quartz and different lithic grains in quartz-sericite matrix (+A).
- 6 ANM 167: laminated, light grey, pebbly, medium grained lithic-quartz sandstone with transition to medium grained quartz conglomerate: quartz and lithic grains with fine grained sericite quartz matrix between them (+A).
- 7 ANM 174: limonitised, yellowish brown, medium grained lithic-quartz sandstone: quartz and lithic grains of different size (+A).
- 8 ANM 179: limonitised, laminated, medium grey mica-feldspar-quartz sandstone: different angular grains in sericite matrix (+A).

PLATE 1



Comparison of archaeological and comparative samples

GROUP 1. Clastic sedimentary rocks

Facies 1.A. Medium to coarse grained quartz sandstones

Finer-grained clastic rocks, from which querns, whetstones, tooled and rounded stones were made (ANM 159, ANM 161, ANM 163, ANM 164, ANM 165, ANM 167, ANM 174, ANM 179, ANM 187, ANM 189, PN 779, PN 1341, PN 1465, PN 4051, PN 4676, PN 1514, PN 2734, PN 2740, PN 6497, PN 6569), show similarity to the Upper Carboniferous–Lower Permian clastic rocks and the Middle Permian Val Gardena formation. Upper Carboniferous and Lower Permian rocks consist of grey siltstones, grey lithic-quartz sandstones and grey quartz sandstones (PLENIČAR et al., 2009), while the Val Gardena formation includes red and grey sandstones, shale and conglomerates (SKABERNE, 1995; BUSER, 2009). These rocks are found at several locations in NW Slovenia in the Gorenjska region, especially in the South Karavanke and at the hills around Škofja Loka (GRAD & FERJANČIČ, 1976; BUSER, 1980). Comparison of the archaeological samples with pebbles collected from gravel bars showed relative similarity in macroscopic characteristics and mineral composition, but they differ in the amount of feldspars (P-2, P-3) and lithic grains. However, due to the rounded shape of some artefacts (Fig. 3) and the presence of even large boulders (of several decimetres in size) of similar sandstones in the surrounding Quaternary fluvial and glacial deposits, we assume that the material for their production was brought from these deposits, located in the close vicinity of the archaeological site. The differences in the composition of the sandstones used to produce the artefacts are considerable and exceed the lateral and vertical facies variations expected in any one quarry, we presume that the material was obtained as pebbles from the gravel bars.

Facies 1.B and 1.C. Medium grained quartz calcareous conglomerate and fine grained quartz breccia



Fig. 3. Quern - medium grained quartz sandstone (ANM 161) (Source: author Aleš Ogorelec, archived by the Institute for the Protection of Cultural Heritage of Slovenia in Kranj)

The sample of conglomerate (ANM 177, tooled stone) contains clasts of limestones with fossils from the Mesozoic and Paleogene, Ladinian or Oligocene tuff and other rocks of different ages. The variety of centimetre-sized clasts in the partly cemented conglomerate clearly indicates post Oligocene erosion and glacio-fluvial transportation. All of the recognised clast lithologies in the conglomerate occur in the catchment area of the Sava River, so the rock most probably originates from Quaternary glacial and fluvial deposits in the vicinity of Mošnje. Fine grained mica-quartz breccia, from which one quern is made (ANM 186), is presumably of Carboniferous age and such cobbles and boulders can be found in the Quaternary fluvial deposits in the vicinity of the archaeological site as well.

GROUP 2. Carbonate sedimentary rocks

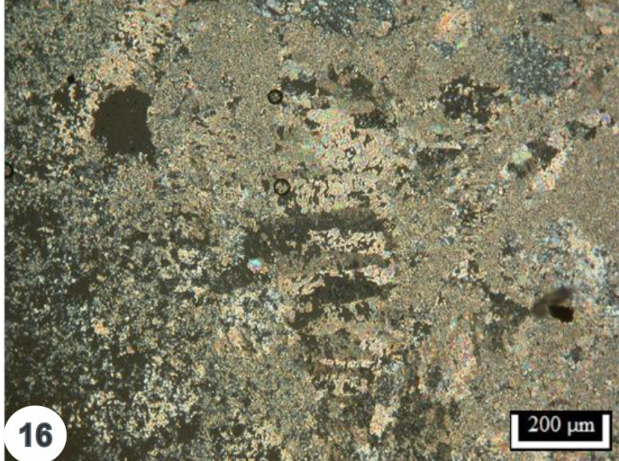
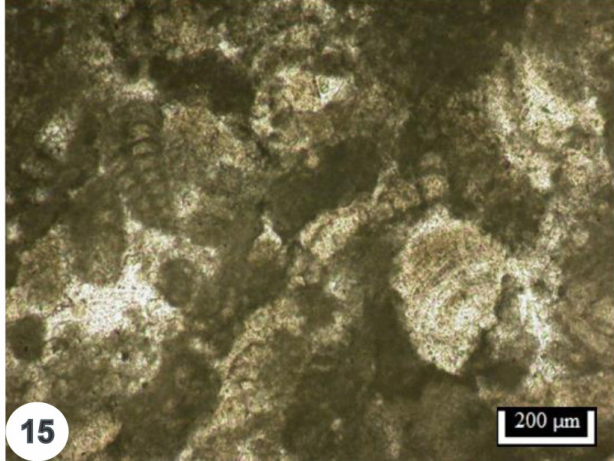
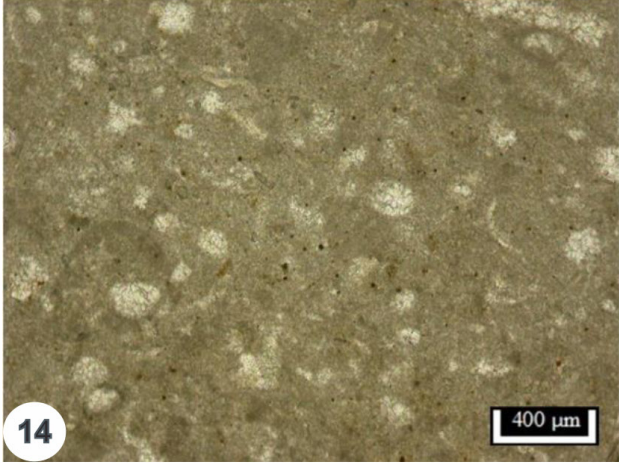
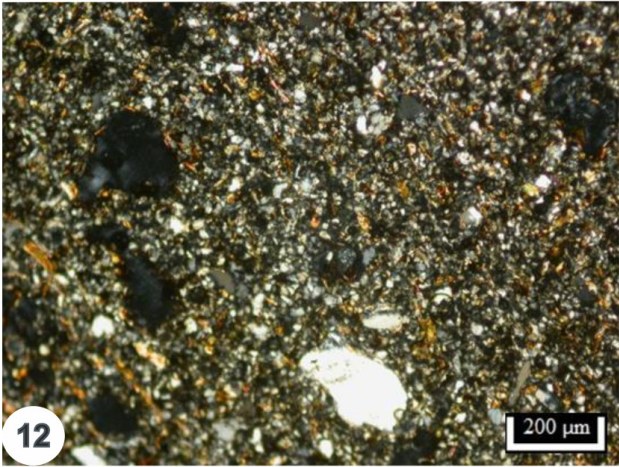
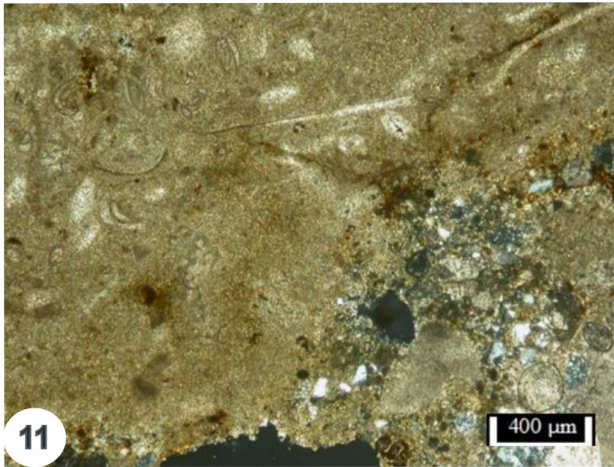
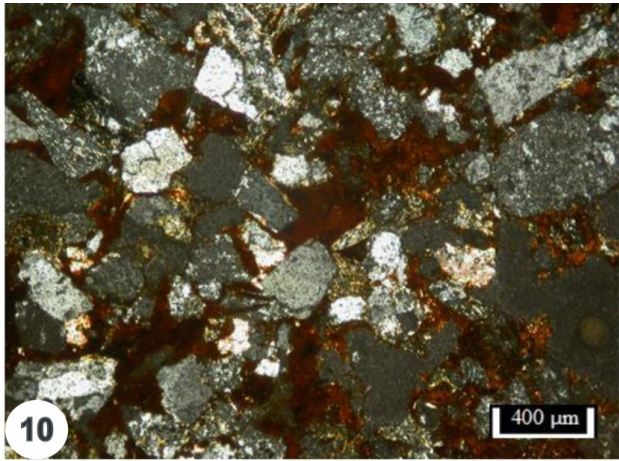
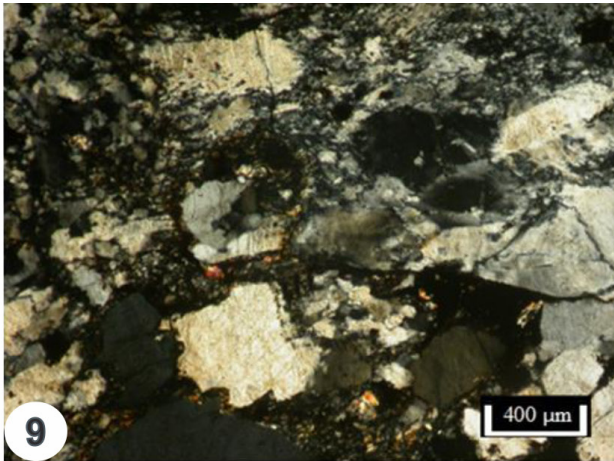
Facies 2.A. Grey pelbiomicritic limestones

The samples of darker grey stone mortar (ANM 160) and architectural element, similar to altar (ANM 170) (Fig. 4), are made of pelbiomicritic limestones. Microscopic analysis showed that these microfacies belong to the subtidal shallow-water environment located on a carbonate platform.

PLATE 2

- 9 ANM 187: grey, pebbly, coarse grained quartz sandstone to medium grained conglomerate: irregular contacts between quartz grains (+A).
- 10 ANM 189: limonitised, yellowish brown, fine to medium grained lithic-quartz sandstone: quartz and lithic grains in limonitised carbonate cement, which replaces sericite matrix (+A).
- 11 ANM 177: grey, medium grained quartz calcareous conglomerate: a rounded lithic grain of biomicritic limestone (+A).
- 12 ANM 186: dark grey, fine grained mica-quartz breccia: smaller quartz grains in fine grained quartz-sericite matrix (+A).
- 13 ANM 160: grey biopelmicritic limestone: peloids and bioclasts (–A)
- 14 ANM 170: dark grey pelbiomicritic limestone: unrecognised bioclasts and small rounded sparitic grains with peloids in micritic matrix (–A).
- 15 ANM 185: white to light grey biocalcarenitic limestone: bioclasts, intraclasts and peloids in micritic-microsparitic matrix (–A).
- 16 PN 6178: white to light grey biocalcarenitic limestone: a shell fragment in micritic matrix (+A).

PLATE 2



According to the geological map of Kranj (GRAD & FERJANČIČ, 1976), shallow-water Upper Triassic and Lower Jurassic limestones exist on the Jelovica Plateau (in the vicinity of the sampling sites of the comparison samples from Kodrasti vrh (KV-1) and Stara Hleva (SH-1)). However they lack any similarity with the investigated artefacts. Furthermore, macroscopic and microscopic characteristics of samples ANM 160 and ANM 170 are in conformance with the samples P-19, P-26 and P-28. The latter were sampled in the vicinity of Podutik near Ljubljana from different Lower Jurassic rock beds, for which such sedimentary depositional environment is proven (NOVAK, 2003). In addition, MÜLLNER (1879) and after him RAMOVŠ (1990) were supposing the existence of ancient quarries and stone masonry workshops at this location.

Facies 2.B. White to light grey biocalcarenitic limestones

The material of the lighter grey stone mortar (ANM 185) and architectural element with relief (PN 6178) is biocalcarenitic limestone containing recrystallised small foraminifera, fragments of rudist shells and echinoderms. The presence of the rudist shells indicates an Upper Cretaceous shallow-water environment of the Dinaric Carbonate Platform. These limestones outcrop in SW Slovenia, NE Italy and SE Croatia. In Aurisina/Nabrežina, near Trieste in Italy, four types of Upper Cretaceous shallow-water limestone from the Dinaric Carbonate Platform are quarried, just as they were in Roman times (BRECELJ et al., 1989; CUCCHI & GERDOL, 1986). The most similar to the Mošnje samples is a variety called *florito*, which is also found in the Cava Romana quarry. Similar horizons are found in Slovenia as well, in the Lipica formation (JURKOVŠEK et al., 1996; RAMOVŠ, 2002).

Facies 2.C. Yellowish white to light grey biomicritic limestones

The white mosaic tessera (ANM 133) is made of yellowish to greyish white micritic limestone with miliolid and other benthic foraminifera and algae.

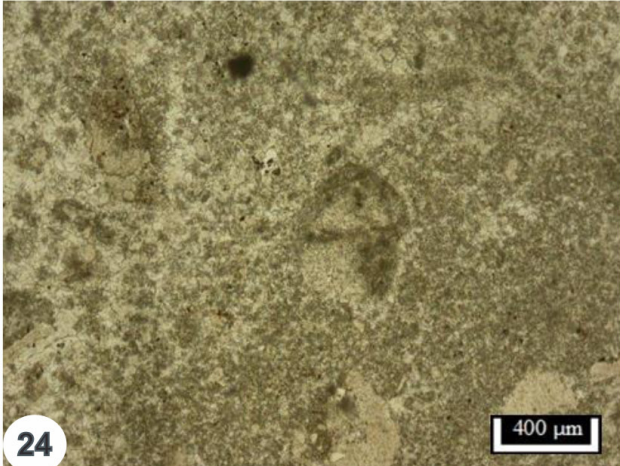
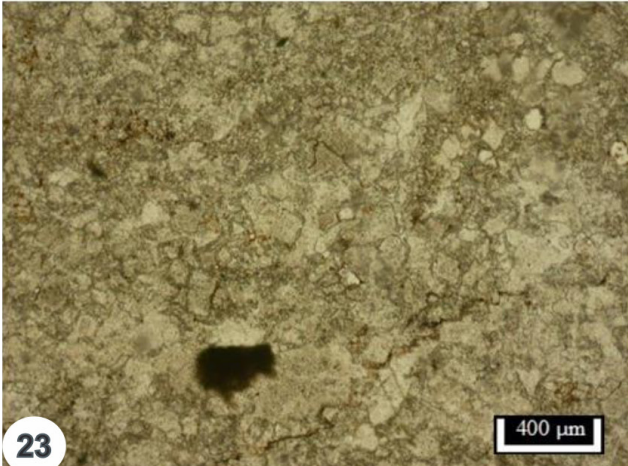
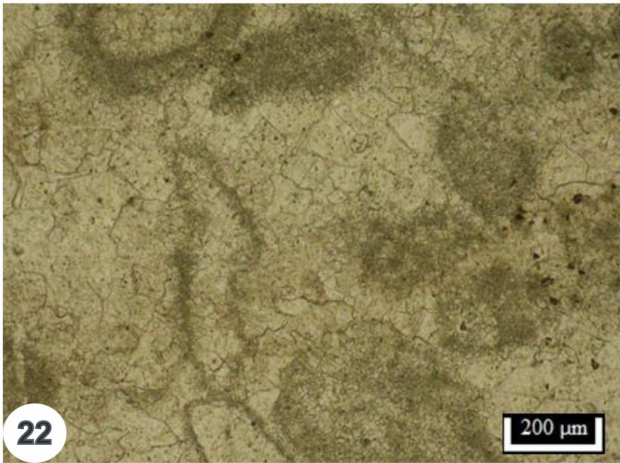
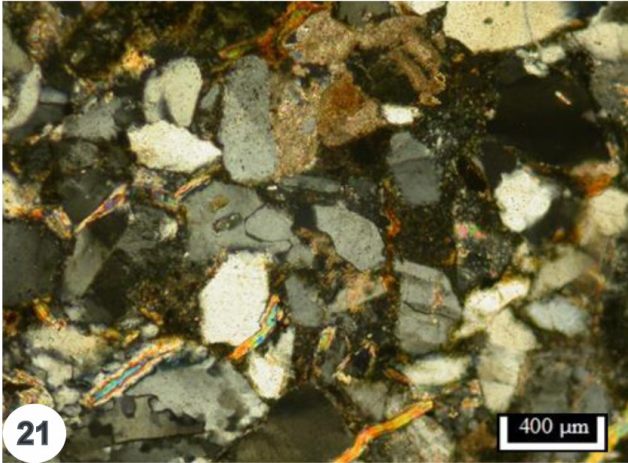
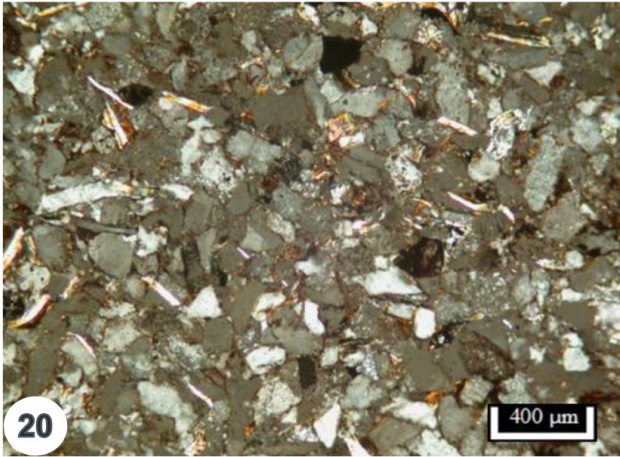
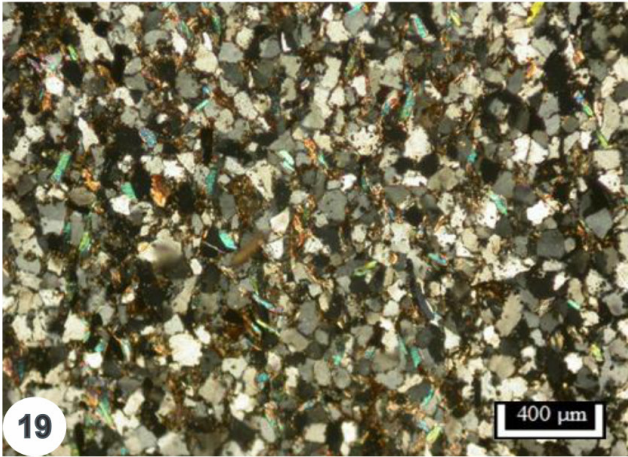
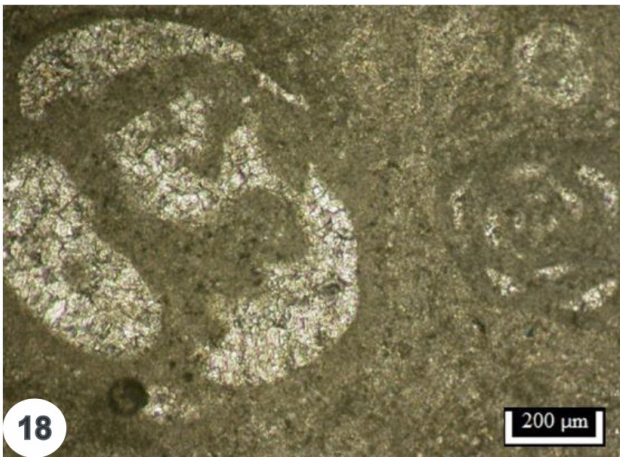
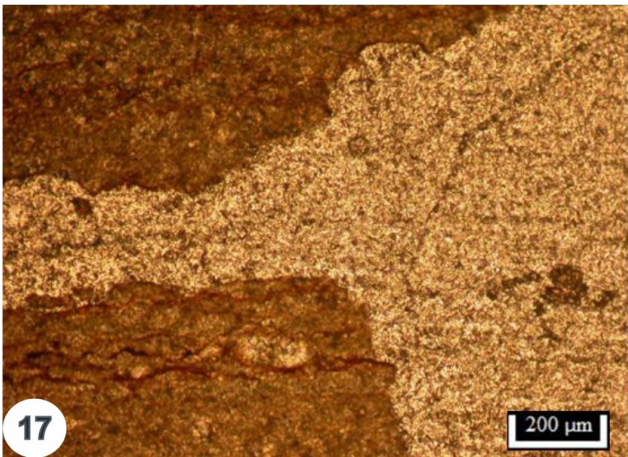


Fig. 4. Architectural element - dark grey pelbiomicritic limestone (ANM 170) (Source: author Aleš Ogorelec, archived by the Institute for the Protection of Cultural Heritage of Slovenia in Kranj)

PLATE 3

- 17 ANM 133 (a black tessera): laminated, dark grey to black, bituminous, micritic limestone: lamination almost parallel with a vein, filled with sparite (+A)
- 18 ANM 133 (a white tessera): yellowish white to light grey biomicritic limestone: miliolids in micritic matrix (+A)
- 19 P-1: laminated, dark green, very fine to fine grained mica-quartz sandstone: small quartz grains and mica flakes (+A)
- 20 P-2: reddish brown, fine grained mica-feldspar-quartz sandstone: angular grains of quartz and feldspar with mica flakes (+A)
- 21 P-3: grey, medium grained feldspar-quartz sandstone: different angular grains of quartz and feldspar with mica flakes in fine grained matrix (+A)
- 22 B-2: light grey, recrystallised dolomitic pelbiosparite: fossil fragments and peloids (-A)
- 23 Br-1: light grey, recrystallised slightly dolomitic pelbiosparite: calcitic crystals and cavities filled with surrounding carbonate material (-A)
- 24 B-1: light grey, recrystallised very slightly dolomitic pelbiosparite to pelbiomicrite: recrystallised limestone with bioclasts and remains of micrite (-A)

PLATE 3



Their abundance and the presence of other benthic shallow-water organisms indicate a shallow-water subtidal environment on a carbonate platform (FLÜGEL, 2004). Miliolids occur over a wide stratigraphic range; however they show highest abundance in Cretaceous shallow-water limestones of the Dinaric Carbonate Platform. These limestones today outcrop in the External Dinarides of Northeastern Italy, Southern Slovenia and Southwestern Croatia.

Facies 2.D. Laminated dark grey to black bituminous limestones

The black mosaic tessera (ANM 133) is of laminated dark grey to black bituminous micritic limestone. Such limestone usually formed in an anoxic-deep or shallow water environment. In the immediate vicinity of the archaeological site we did not find any such rocks. Larger quantities suitable for extraction can be found in the Kras region where shallow-water carbonates containing beds of laminated bituminous limestones with cherts are present within the various Cretaceous formations of Cenomanian–Campanian age (JURKOVŠEK, 2010). ŠRIBAR (1995) has shown that the sedimentary environment for the formation of bituminous limestones in Southwestern Slovenia could also exist in areas of «upwelling» and intertidal coastal areas. However, it must be emphasized that similar sedimentation conditions, optimal for development of the laminated bituminous limestones, existed elsewhere at differing times during the Mesozoic. This wide potential area could be reduced in further research by combining geological with archaeological aspects which assume arrival of a mosaicist to Mošnje from the area of today's Italy bringing tesserae with himself.

Conclusions

The Roman villa near Mošnje in NW Slovenia was discovered during the construction of a section of motorway (Vrba–Peračica). The numerous stone finds from this archaeological site are comprised of differing stone materials. By microfacies analysis of selected samples, we determined the rock type and attempted to establish the provenance of these materials.

The studied stone artefacts can be divided in to two groups dependent on sedimentary rock type: clastic or carbonate.

Small stone artefacts, such as querns, whetstones and tooled stones, including pebbles with tool marks, are made of clastic sedimentary rocks (Facies 1.A to 1.C). The rocks are mainly quartz sandstones, most likely of Upper Palaeozoic age, although there are also coarse grained materials like conglomerates and breccias from local Quaternary deposits of the Sava River. Fieldwork and data from the Basic Geological Map (GRAD & FERJANČIČ, 1976), clearly shows that similar rocks are present in the Sava gravel

bars and terraces, located in immediate vicinity of the archaeological site. Therefore we propose that these small artefacts were most probably produced locally.

Artefacts made of carbonate rocks tell us a different story. Microscopic analysis and comparison with the carbonate samples, taken local to the archaeological site, and with samples from further afield, indicate that the investigated limestone Roman artefacts were not produced locally. The architectural element and grey stone mortar are made of dark grey pelbiomicritic limestone (Facies 2.A), which is tentatively correlated with Lower Jurassic limestones from the vicinity of Podutik near Ljubljana.

The light grey stone mortar and the architectural element with relief are made of white to light grey Upper Cretaceous biocalcarenitic limestone with rudist shells (Facies 2.B). Similar limestones are characteristic for the Upper Cretaceous successions of the Dinaric Carbonate Platform outcropping in the SW Slovenia, NE Italy and SE Croatia. These limestones were quarried in Roman times near Aurisina/Nabrežina in Italy, and are still quarried today. Similar limestones are also typical for the Lipica formation on the Karst in Slovenia. We presume that the two architectural elements were imported to Mošnje from one of these areas, even though an archaeological aspect based on current knowledge favours the Italian extraction site.

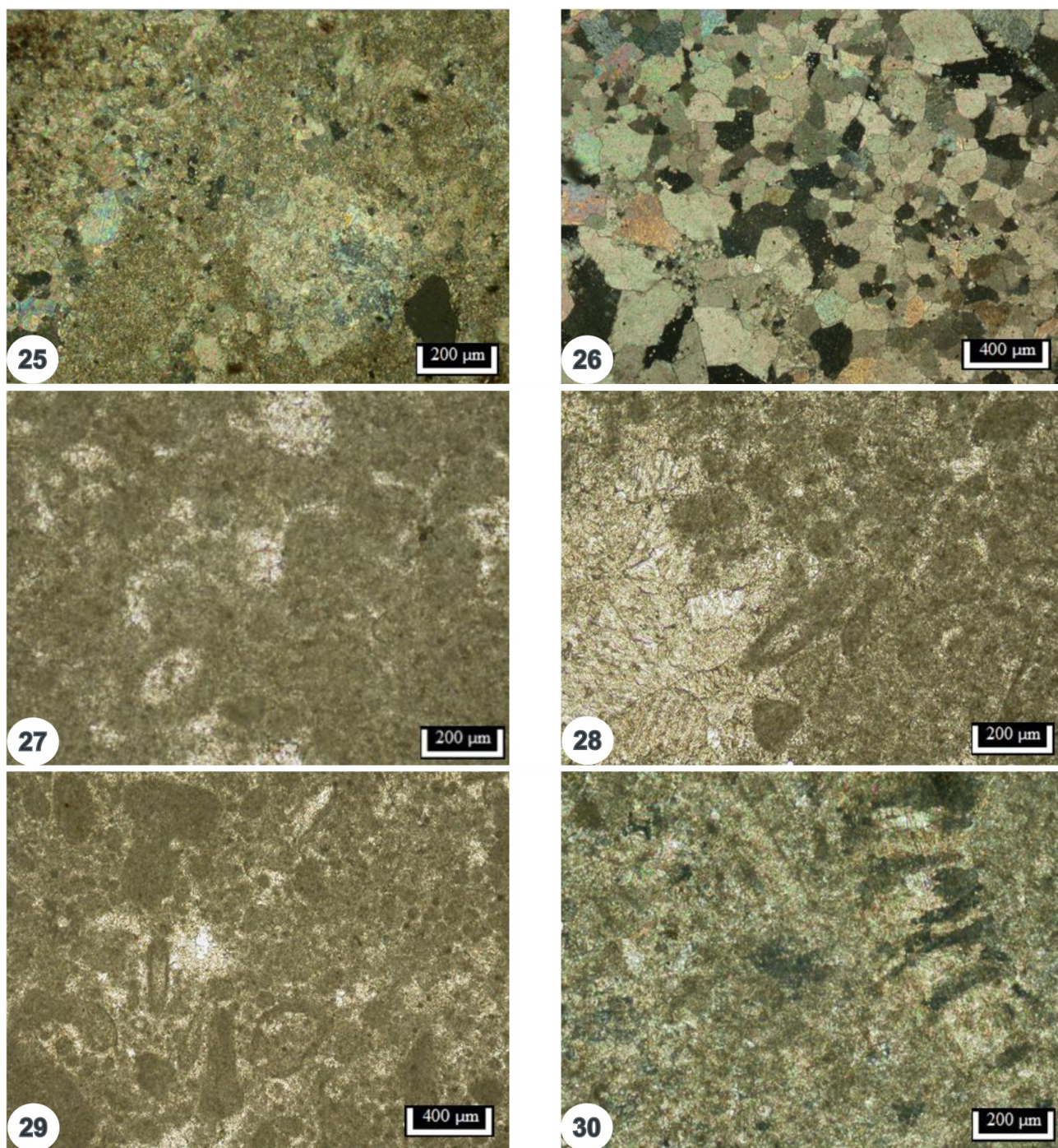
The white and black mosaic tesserae composed of Cretaceous miliolid limestone (Facies 2.C) and dark organic-rich laminated limestone (Facies 2.D), respectively might originate from different horizons of the Cretaceous succession typical for the Dinaric Carbonate Platform. These rocks outcrop on the Trieste–Komen Plateau, but also in some other areas in Slovenia, therefore we cannot unequivocally determine their provenance.

The presented study indicates that in the Roman archaeological site near Mošnje smaller and useful consumable items, such as querns and whetstones, were made from locally sourced materials, easily picked from the ground. Conversely, larger items such as stone mortars, and more prestigious such as architectural elements and tesserae, were obtained by quarrying and imported.

Acknowledgements

For assistance in analysis of the samples we express our gratitude to dr. Dragomir Skaberne, dr. Bogdan Jurkovšek and dr. Matevž Novak. Their opinions, comments and advices were greatly appreciated. For preparation of thin sections and technical assistance we would like to thank the technical staff of the Department of Geology, Faculty of Natural Sciences at University of Ljubljana and to Ivan Mesič from the INA d.d. in Zagreb.

PLATE 4



- 25 KV-1: whitish and reddish, recrystallised intrasparitic limestone with transition to limestone breccia: calcitic crystals of different size in recrystallised limestone (+A)
- 26 SH-1: light grey, medium grained calcareous dolomite: xenotopic and hipidiotopic structure of the dolomite (+A)
- 27 P-19: dark grey biopelmicritic limestone: small rounded sparitic grains in micritic matrix (–A)
- 28 P-28: dark grey biopelmicritic limestone: microfacies modification, variable amount of peloids (–A)
- 29 P-26: grey to dark grey biopelmicritic limestone: bioclasts, intraclasts and peloids (–A)
- 30 Cr-1: white to light grey biocalcarenitic limestone: a shell fragment and intraclasts (+A)

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