Characteristics of Early Iron Age pottery from north-eastern Slovenia through the prism of ceramic technology and petrography

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ABSTRACT – *Pottery technology in the Early Iron Age remains understudied in Slovenian archaeology; especially in the use of description on a macroscopic level combined with the petrographic thin section analysis, taking in consideration also relevant stratigraphical information. In this study, we focus on the pottery technology of vessels from two recently excavated contemporaneous Early Iron Age sites in north-eastern Slovenia, Poštela near Maribor and Novine near Šentilj. We characterised the inclusions based on macroscopic observation on whole and reconstructed vessels. In addition, vessel typology, surface treatment, decoration techniques, and firing atmosphere were established. Based on these results, a petrographic analysis was conducted on pottery samples. At both sites, we looked at the different contexts, comparing pottery from settlements,* i.e. *hillforts, to pottery found in the adjacent cemeteries. The results show that potters from the two settlements produced similarly shaped vessels using different pottery recipes from locally available raw materials. The use of grog as a possible chronological marker in the Early Iron Age is also discussed.*

KEY WORDS – *pottery; technology; petrography; Early Iron Age; NE Slovenia; Poštela near Maribor; Novine near Šentilj*

Značilnosti starejšeželeznodobne lončenine v severovzhodni Sloveniji skozi prizmo keramične tehnologije in petrografije

IZVLEČEK – *Lončarska tehnologija starejše železne dobe ostaja v slovenski arheologiji slabše raziskana. To velja predvsem za uporabo makroskopskega opisa, združenega z dodatnimi petrografskimi preiskavami keramičnih zbruskov, ki upoštevajo tudi stratigrafske podatke najdb. V članku se osredotočamo na tehnologijo lončenih posod z dveh sodobno raziskanih starejšeželeznodobnih najdišč v severovzhodni Sloveniji, s Poštele pri Mariboru in z Novin pri Šentilju. Na zbiru celih in rekonstruiranih posod smo opisali sestavine lončarskih mas na makroskopskem nivoju. Poleg tega smo izdelali tipologijo posod, opisali obdelavo površine in izdelavo okrasa ter določili atmosfero žganja. Na podlagi teh rezultatov smo izbrali vzorce za petrografsko analizo. Značilnosti tehnologije izdelave posod smo na obeh najdiščih opazovali znotraj različnih arheoloških kontekstov, saj smo primerjali lončenino iz naselbin (gradišč) in tisto z bližnjih grobišč. Rezultati kažejo, da so lončarji iz obeh naselbin izdelovali podobne oblike posod, vendar so pri izdelavi uporabljali različne lončarske recepte iz lokalnih surovin. V članku opozorimo še na uporabo groga v lončarskih receptih kot morebitno kronološko občutljivo značilnost lončenine v starejši železni dobi.*

KLJUČNE BESEDE – *lončenina; tehnologija; petrografija; starejša železna doba; SV Slovenija; Poštela pri Mariboru; Novine pri Šentilju*

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Introduction

Pottery represents a series of different physical properties of clay and additional raw materials that we observe with the aid of archaeometric analyses. But alongside the physical properties, ceramic vessels are products of a series of decisions made by potters in the past. These decisions and choices span from the procurement and preparation of raw materials, to tools, manufacturing techniques, sources of energy *etc*. These technological choices are related to the local environment and the availability of raw materials, as well as to potters' perception of the suitability of these materials, the politics of who controls these resources, the abilities and experience of potters, and cultural traditions (*Sillar, Tite 2000.7–9*). In all pottery analyses, we should strive to understand the environmental, technological, economic, social, political, and ideological contexts in which these products are embedded (*Stilborg 2001.401*). In particular, the choice of temper, which is by definition the substance added to clay by potters in order to modify its physical properties (*Rice 1987. 408–410*), can be besides the most obvious functional aspects also associated with social, political, or ideological aspects (*Stilborg 2001.398; Tite, Kilikoglou 2002.4; Tite* et al. *2001.321–322*). Pottery techniques are considered traditional inside their communities, and potters learn them from other potters in a form of apprenticeship, but the techniques used in one community present only some of all the possible technological solutions for making a clay vessel (*Sillar, Tite 2000.10*), and the unavailability of certain raw materials only rarely limited the manufacture of pottery (*van der Leeuw 1993.239*). Traditions can therefore be seen as the main unit of cultural evolution and change, and there is a correlation between culture and traditional activities, and as Elisabeth DeMarrais (*2004.13*) states, "*archaeology deals mostly with material traces of repeated activities*".

The technological choices of potters relate closely to the performance in manufacture and use in accordance with the intended function of the finished product. Potters control the shape and size of their products, the paste or pottery recipe, the surface treatment, as well as the firing conditions and techniques to create vessels that need to perform certain roles (*Skibo 2013*). Therefore, it is important to observe the paste's characteristics and other pottery manufacturing techniques on large sample assemblages to make better assessments of the intended role and function of vessels in a community. Although typology and chronology remain fundamental to pottery research, the analysis of pottery characteristics forms an important basis for our understanding of pottery production, as well as the social and physical environment of potters in the past.

Macroscopic analysis and descriptions of vessels remain the fastest method for processing large pottery assemblages, which is especially important in long-term projects, including excavations. It provides important fundamentals for further petrography sampling, as the results of thin section analysis can be extrapolated to the whole assemblage, which is virtually impossible if no data on macroscopic characteristics of pottery are provided (*Whitbread 2017*).

Ceramic petrography is an integral part of this analysis, especially for prehistoric pottery assemblages, as the observation, description, and interpretation of petrographic thin sections is central in understanding past technologies and production techniques (*Rice 1987; Whitbread 1995; Reedy 2008; Quinn 2015*). In petrography, we focus on pottery manufacture, such as collecting and preparing raw materials, the addition of temper, and the shaping, drying, and firing of vessels. This allows for a better understanding of how potters acted in the past, and what choices they made about pottery making. Furthermore, petrography and macroscopic descriptions of larger assemblages form the basis for understanding the operational sequence or the 'life cycle' of a vessel (*Lemmonier 1993*).

Our main focus in this study is pottery technology in the Early Iron Age, *i.e.* Hallstatt period (late 9th–mid. 6th century BC), specifically in the north-eastern region of Slovenia, which is an integral part of the broader Eastern Hallstatt circle and closely connected to the broader south-eastern Alpine and the north-western Pannonian regions. We analysed the composition of the ceramic material, as well as surface treatment, decoration, and firing techniques, and describe the pottery typology in the pottery assemblages from two Early Iron Age sites, Poštela near Maribor and Novine near Šentilj. The sites are similar in some ways: in the position of the settlement and presence of a flat cremation cemetery, as well as having barrow cemeteries outside the hillforts.

Within these complex sites, we also looked at the different contexts of sampled finds, comparing pottery from settlements to pottery from cemeteries outside the hillforts. Whole or reconstructed vessels were used as the main source of information for both sites, and were described firstly on a macroscopic level. In the next step, thin sections of samples were prepared and analysed with an optical polarising microscope. As this is one of the first studies focusing on pottery technology for the Early Iron Age in Slovenia (*Žibrat Gašparič, Dolenec 2015*), especially using the combination of macroscopic and petrographic analysis, we will try to demonstrate the similarities and differences in pottery production and use between two contemporary sites, Poštela and Novine, first with an analysis within both individual sites and their various contexts, and then in comparison between them.

Archaeological background

Poštela is an Early Iron Age hillfort located above Maribor in north-eastern Slovenia that has been researched since the 19th century (*Teržan 1990.13, 59–78, 256–339; Teržan* et al. *2012; Mušič* et al. *2014.19*). In recent years, the hillfort was extensively researched in the course of interdisciplinary research projects of the Department of Archaeology at the University of Ljubljana. The projects included the interpretation of ALS data, geophysical research, geochemical mapping, as well as trial trenching and excavations (*Mušič* et al. *2014.42*).

The hillfort is located on the south-eastern ridge of the Pohorje Hills and covers approx. 6ha (Fig. 1). It is surrounded by a monumental rampart, while the interior has three smaller ramparts of a younger (post Early Iron Age) date and terraces (*Teržan* et al. *2012.26*). The settlement has a funerary area on the Habakuk plateau just below the hillfort, with a flat cremation cemetery, two groups of barrows (southern and northern group), and a so-called ritual ground located on the eastern edge of the southern barrow group. Individual barrows extend over the ridges to the south-east into the Drava River plain and towards the towns of Pivola and Spodnje Hoče near Maribor (*Mušič* et al. *2014.32–35, Fig. 16*).

In the present analysis, we included pottery from trenches excavated at the hillfort (trench 27), from the flat cremation cemetery (trenches 14 and 24), from the barrows (trenches 25 and 26), and from the ritual ground near the southern barrow group (trenches 1, 33 and 34), all of them located on the Habakuk plateau. The archaeological finds from the flat cremation graves and the earliest settlement layers date to the beginning of the Early Iron Age (Ha C0), whereas finds from the later settlement layers span to the developed Early Iron Age (Ha C1–C2/D1) and also to the Late Iron Age (Lt D). The finds from the so-called ritual ground and from the barrows seem to be dated only to the developed Early Iron Age (Ha C1–C2/D1).

The main trench excavated at the settlement (trench 27) shows two periods of occupation, the first form the Early Iron Age and the second from the Late Iron Age. The earlier can be further subdivide into three phases, representing different building activities or uses of the area (Fig. 2). The first phase is represented by two pits with a fireplace (phase Ia), which can be dated to the Ha C0. The following phase is characterised by extensive alteration of the excavated area by terracing (phase Ib). Later, a pit was dug through the accumulated layers (phase Ic), which held large amounts of pottery. Both of these phases are dated to the broader Ha C1–C2/D1 period, without a subdivision possibility in the present

Fig. 1. Poštela on lidar-derived shaded DTM, with the position of the settlement, the so-called ritual ground, flat cremation and barrow cemetery and trial trenches.

Fig. 2. Eastern cross-section of trench 27 at the Poštela hillfort showing the position of layers and interpreted periods/phases.

state of research. The second period, *i.e.* fourth building phase (phase II), dated to the Late Iron Age (Lt D), yielded a kiln with some additional contexts.

Novine (Ger. Bubenberg/Hoarachkogel) has a dominant position above the Mura valley (*Gaberz* et al. *2015.127*).[1] The hillfort, covering approx. 6ha, is situated on a small ridge on the right bank of the Mura River, and is divided by the modern Slovenian-Austrian state border (Fig. 3). The settlement is located on the northern part of the ridge and is fortified with ramparts on the western, southern and eastern side, whereas the northern part is protected by a precipice above the river. Intertwined holloways, *i.e.* ancient paths, lead from the hillfort to the south, passing a flat cremation cemetery and groups of barrows, but also additional elements of fortification. The complex ends to the south with the largest barrow on an elevated spur that overlooks the whole ridge (*Gaberz* et al. *2015.139*). In our analysis, we included pottery finds from the settlement (trenches 2 and 5), the flat cremation (trench 6) and the barrow cemetery (trench 1), as well as from the rampart shielding the central part of the cemetery (trench 3).

Most of the material comes from trench 5, which shows two different periods of occupation, the first form the Early Iron Age and the second from the Late Iron Age. The earlier can be further subdivide into four phases, representing different building activities or uses of the area (Fig. 4). The oldest phases are represented by two buildings (phases Ia and Ib), dated to the beginning of the Early Iron Age (Ha C0). They are followed by an occupational hiatus, marked by a levelling layer without building activities (phase Ic), which may, however, be merely a local phenomenon which cannot be extrapolated to the whole site. The fourth phase was marked by a stone pavement (Id) dating to the developed Early Iron Age (Ha C1–C2/D1). The youngest phase, dates already to the second occupational period (phase II) in the Late Iron Age (Lt D) (*Vinazza* et al. *2015.177–181, 183–184*).

Geological background

The Pohorje Hills, where Poštela is located, are part of Eastern Central Alps, and are composed of characteristic regionally metamorphosed rocks, with metamorphic rocks as the predominant type in the south-eastern part. The central and western parts of Pohorje are composed mainly of igneous rocks (*Mioč, Žnidarčič 1989*). Poštela and its surroundings are built

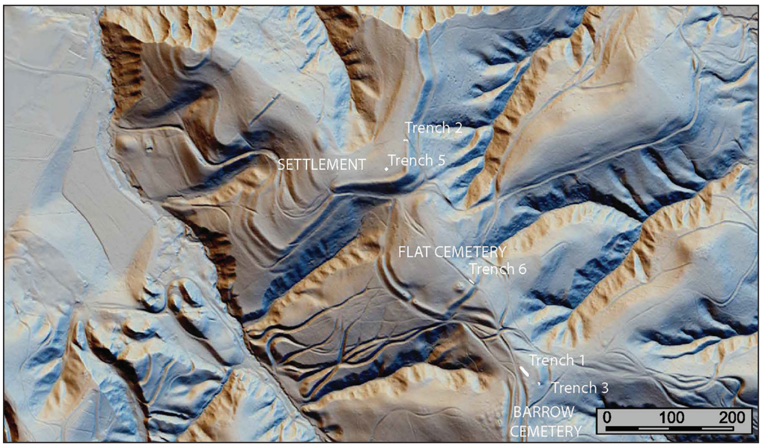

Fig. 3. Novine on lidar-derived shaded DTM, showing the position of the settlement, flat cremation and barrow cemetery, and trial trenches (modified after* Vinazza *et al.* 2015.sl. 1*).

1 The site recently came into focus, as it was one of the nodal locations for a bilateral Slovenian-Austrian project (*Črešnar, Mele 2015.9–10; Mušič* et al. *2014.41–42*).

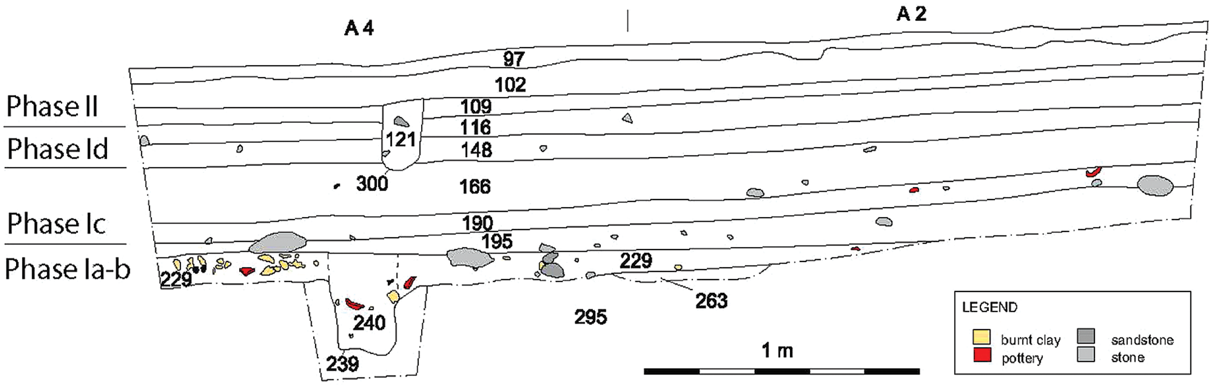

Fig. 4. Northern cross-section of trench 5 at Novine hillfort, showing the position of layers (after Vinazza *et al.* 2015.sl. 37*).*

on metamorphic rocks, such as muscovite-biotite gneiss, amphibolite, schist, and quartzite (Fig. 5). The gneiss often has lenses of brown to light grey and dark green amphibolite rock. The plains below the hillfort are composed of plio-quaternary sediments, with predominantly sand, sandy clays, and gravel. These sediments include grains of igneous, metamorphic, and sedimentary rocks and include heavy minerals (*e.g.*, garnet, rutile, epidote, zircon, zoisite, kyanite, and hornblende) (*Hinterlechner Ravnik 1971; 1973; 1974; Mioč, Žnidarčič 1989*).

Novine hillfort is located in the western part of the Slovenske gorice hills, which are characterised by sedimentary clastic Miocene rocks (Fig. 5). The surrounding hills are composed of sandstones and marls, with many microfossils, sands, and clay (*Rijavec 1976.56–58*). The gravel is composed of igneous, metamorphic, and sedimentary rocks with heavy minerals (*e.g.*, garnet, rutile, tourmaline, apatite). The sediments were deposited in marine basins, with the source material originating from the land masses of the Pohorje and Kozjak hills to the southwest and south of Novine, meaning that the igneous and metamorphic gravel found in the sandstones in Slovenske gorice came from parent rocks from Pohorje and Kozjak (*Mioč, Žnidarčič 1989*).

Analytical methods and sampling

For the present study, we analysed 832 ceramic vessels from Poštela and 405 vessels from Novine using macroscopic description and focusing on whole or reconstructed vessels that were excavated in different archaeological contexts. The Poštela samples come from the settlement, the flat cremation cemetery, the barrow cemetery and the ritual ground, all located on the Habakuk plateau below the hillfort (Fig. 1). We obtained the samples from Novine from inside the hillfort, and only a small number from graves, *i.e.* from the flat cremation and the barrow cemeteries (Fig. 3).

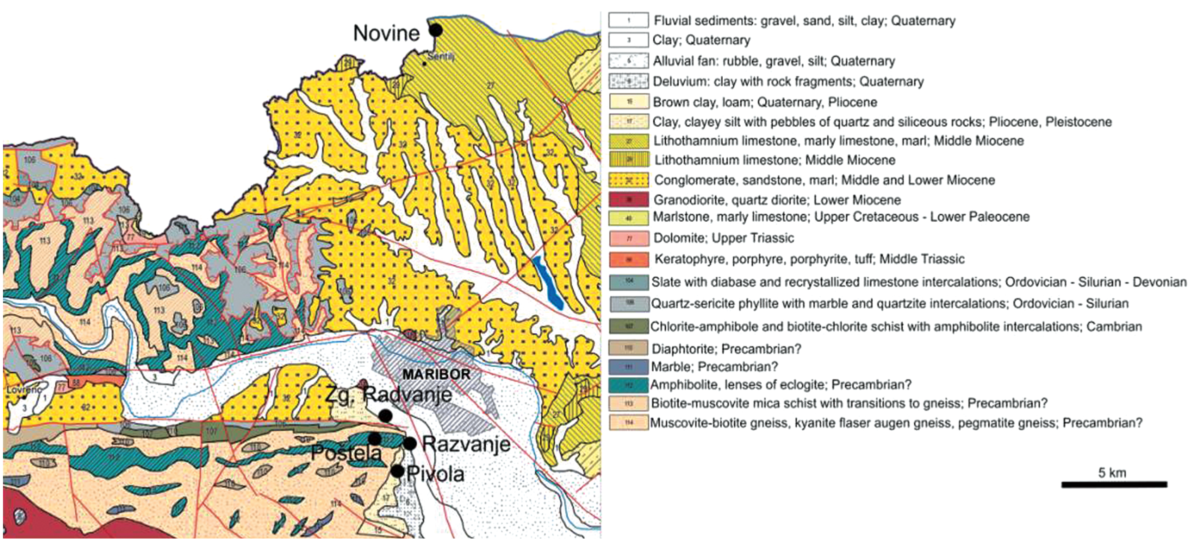

Fig. 5. The geological background of Poštela and Novine (adapted after Buser 2009*).*

Macroscopic description by means of a hand lens is still the most effective method for describing and analysing larger sets of samples. Macroscopic observation of pottery is relatively fast, offers adequate discrimination between vessels, can be done with minimal equipment, and forms the most suitable basis for petrographic sampling, as the acquired data can always be related back to the whole assemblage (*Whitbread 2017.217*). The main characteristics that we described on a macroscopic scale consist of the type of inclusions and their size, the size and shape of voids, forming techniques, surface treatment, decorating techniques and motifs, and the different firing techniques (*Horvat 1999; Rice 1987.113–310*). Using a hand lens and diluted hydrochloric acid, we determined the visible types of inclusions in a fresh cross-section of the pottery (approx. 1cm^2 surface), and we treat most as naturally occurring inclusions, with the exception of grog. We could identify additional inclusions as temper in petrographic analysis; therefore, we describe these results in the mineralogical/petrographic section of the paper.

In the following step, we chose samples for ceramic petrography analysis on the basis of the macroscopic results. Ceramic petrography was chosen, as it increases the identification of inclusions and allows for direct comparisons with the regional geology (*Rice 1987.415; Quinn 2015*). We sampled 23 vessels from Poštela and 15 vessels from Novine. We also collected locally available clays and sediments from the settlements and below the hillforts (Fig. 3). The clay samples were formed into 3 x 4cm tiles and fired in a modern kiln under oxidising conditions at 700 and 800°C and were also prepared as thin sections. The goal is to better understand potters' choices regarding the procurement of raw material in this region.

The selected samples were prepared as polished thin sections, 30μm thick, mounted on glass slides. These were then analysed under a polarising light microscope, Nicon Eclipse E600 POL, using standardised descriptions (*e.g., Whitbread 1995; Reedy 2008; Quinn 2015*). The thin sections were sorted into fabric groups based on the clay matrix and inclusions. On the basis of compositional, microstructural, and textural criteria, we identified the presence of specific techniques, such as the procurement of raw materials, the addition of temper, vessel forming, and the atmosphere and firing temperatures (*Reedy 2008.146–148, 173–189; Whitbread 1986; 1995.393–394; Quinn 2015.83–93*).

Results

Poštela

Pottery typology and technology

During the 2012 to 2015 fieldwork at Poštela, more than 68 000 pottery sherds were recovered, and of these, 1689 could be reconstructed into 980 vessels. We analysed the technological characteristics of 832 whole and fragmented vessels from different contexts: the settlement (trench 27), the flat cremation cemetery (trenches 14, 24), the barrow cemetery (trenches 25, 26) and the so-called ritual ground (trenches 1, 33, 34, Figs. 1 and 2). Most of the material originates from the ritual ground, where a larger deposit of pottery alongside cremated animal bones was excavated. Other trenches were omitted due to their size (trenches less than 2m^2), the very small number of vessels (< 10), or mixed material with no clear stratigraphy. Accordingly, we analysed 173 vessels from the settlement, 554 vessels from the ritual ground, 55 vessels from the flat cemetery, and 50 vessels from the barrow cemetery.

We identified the following types of vessels at Poštela: bowls (conical, rounded, spherical, round-bellied), pots (oval, spherical, round-bellied), storage

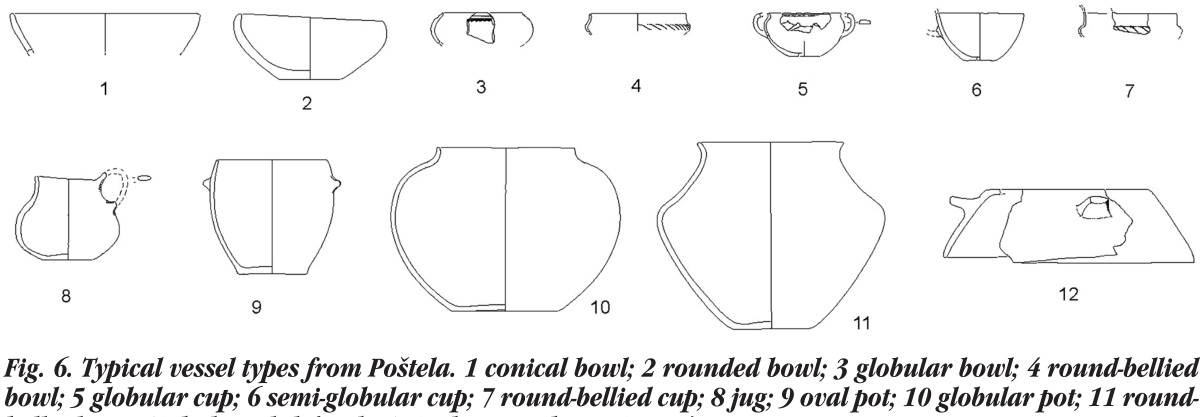

Fig. 6. Typical vessel types from Poštela. 1 conical bowl; 2 rounded bowl; 3 globular bowl; 4 round-bellied bowl; 5 globular cup; 6 semi-globular cup; 7 round-bellied cup; 8 jug; 9 oval pot; 10 globular pot; 11 round-bellied pot; 12 baking lid (scale 1: 8; drawing by D. Oman).

jars, urns, lids (conical, shallow), backing lids (conical, rounded), jugs, cups (spherical, semi-spherical, round-bellied), small cups, and miniature vessels (round-bellied, biconical) (Figs. 6 and 7). Vessel types could be identified in 61% of the analysed material. The most common types are various bowls (60%), followed by pots (24%), while other types comprise less than 20% of the assemblage. Bowls are the most common type in the settlement, the ritual ground, and in the barrow, whereas pots predominate in the flat cremation graves.

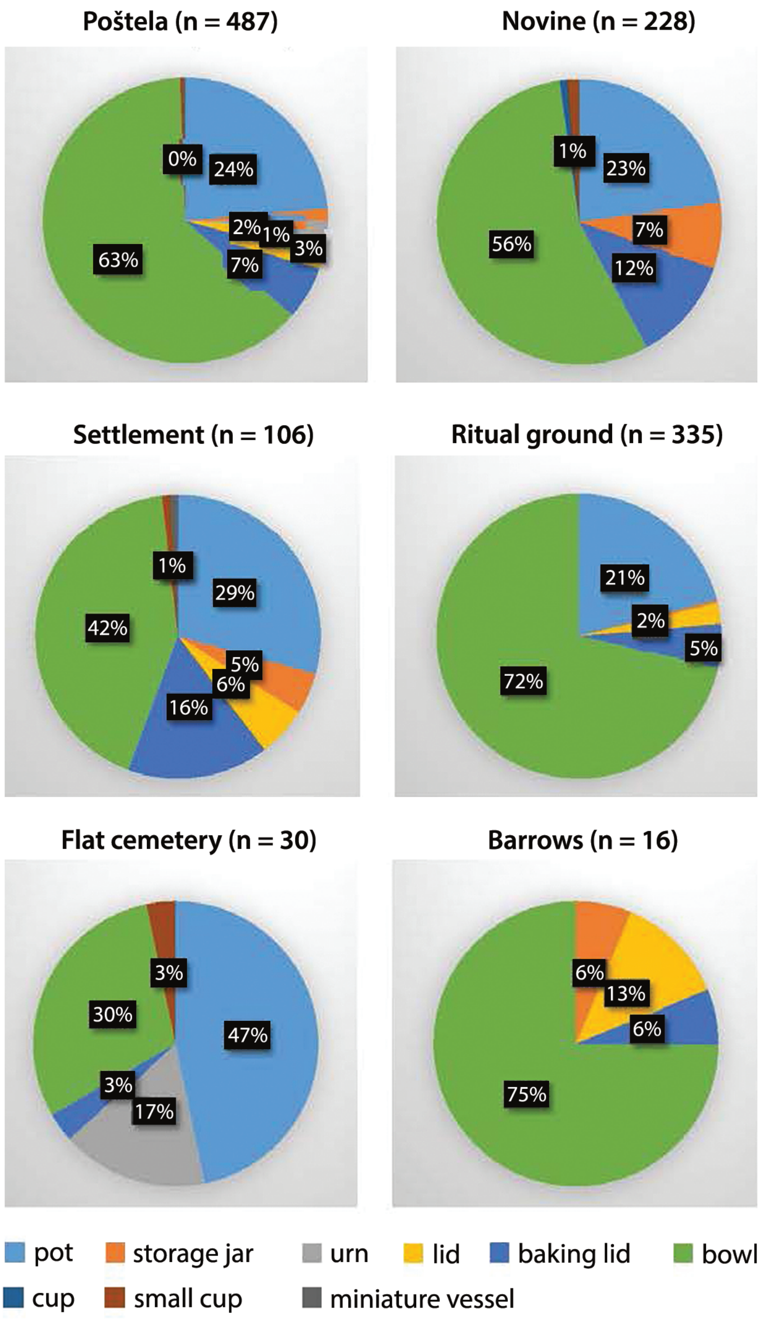

Fig. 7. Ratios of vessel types from Poštela in total and according to context, as well as from the Novine assemblage.

The macroscopically determined inclusions are quartz, mica, organic matter, iron oxides, clay pellets, and grog in various combinations (Tab. 1). All of the samples contain quartz and mica inclusions; the main difference is in the presence of organic matter, iron oxides, clay pellets, and grog. Vessels with only quartz and mica inclusions predominate in the assemblage (20%), although vessels with additional organic matter and grog are also common (in approx. 15%). The majority of vessels from the settlement, the ritual ground, and the barrows contain only quartz and mica inclusions, whereas the vessels from the flat cremation cemetery have organic matter and grog added to the quartz and mica inclusions. Grog especially is more common in vessels from the flat cemetery than other locations (70% of vessels contain grog inclusions in contrast to the 30% to 45% of vessels excavated at the settlement, ritual ground, and the barrows) according to the results of the macroscopic description.

Most of the inclusions are in the medium sand size (0.26 to 0.5mm) in approx. 50% of the analysed vessels; some 30% of the vessels contain inclusions predominantly of coarse sand (0.5 to 1mm), 16% fine sand, and less than 1% in the fine gravel size (more than 1mm) (Fig. 8). The fine gravel inclusions were present only in vessels from the settlement and the ritual ground, whereas vessels from the flat cemetery and the barrows contain inclusions only in the sand size. Most of the shapes (*i.e.* pots, lids, baking lids, and bowls) contain inclusions in the medium sand size, although only baking lids contain inclusions in the fine gravel size. A third of the pots from the settlement and the ritual ground were made with inclusions in the coarse sand size, but only a fifth of pots from the flat cremation graves were made with such inclusions. Bowls are made mostly of medium sand size, although fine sand sized inclusions predominate in the bowls from the barrows.

Inclusions	Poštela (n = 832)	*settlement* (n = 173)	*flat cemetery* (n = 55)	*ritual ground* (n = 544)	*barrows* (n = 50)	Novine (n = 405)
Q, M	27,8%	38,2%	16,4%	23,1%	56,0%	4,5%
Q, M, Cp	0	0	0	0	0	14,2%
Q, M, Cp, G	0,2%	1,2%	0	0	0	17,0%
Q, M, G	16,5%	17,3%	30,9%	14,8%	16,0%	8,2%
Q, M, Io	5,9%	1,7%		8,3%	0	0,5%
Q, M, Io, Cp	0	0	0	0	0	0,7%
Q, M, Io, G	2,3%	2,3%	3,6%	2,3%	0	0,2%
Q, M, Om	16,8%	11,0%	12,7%	19,3%	14,0%	9,0%
Q, M, Om, Cp	0,1%	0,6%	0	0	0	7,7%
Q, M, Om, Cp, G	0,1%	0,6%	0	0	0	20,1%
Q, M, Om, G	15,9%	24,9%	34,5%	11,4%	14,0%	16,7%
Q, M, Om, Io	12,3%	2,3%	1,8%	17,5%	0	0,2%
Q, M, Om, Io, Cp	0	0	0	0	0	0,7%
Q, M, Om, Io, Cp, G	0	0	0	0	0	0,2%
Q, M, Om, Io, G	2,2%	0	0	3,2%	0	0

Tab. 1. Types of inclusions as observed by macroscopic analysis from Poštela, in total as well as from different contexts (settlement, flat cemetery, ritual ground, barrows), and from Novine (in total). The inclusions are abbreviated as: Q quartz, M mica, Cp clay pellets, G grog, Io iron oxides, Om organic matter.

Hand-forming techniques were used to form the vessels into various shapes from these clay pastes[2]. The surfaces were smoothed with various surface treatment techniques, the most common being smoothing, burnishing, and polishing. For smoothing, potters use soft tools (*e.g.*, cloth, leather) to smooth out any irregularities on the surface of the vessel after forming. In burnishing, the surface of the vessel is treated with a hard but smooth object such as a pebble or bone, which are easily recognisable by the streaky lustre and incomplete coverage of the surface. Polishing is executed on a dry surface, and gives the vessels a uniform lustre (*Rice 1987.124–140*). The surfaces of most of the vessels from Poštela were treated with smoothing and burnishing; only rarely was polishing used (on less than 5% of the analysed vessels).

Decoration of the vessels was not common. Most of the pottery assemblage has no decoration, and a mere 10% of the vessels from the flat cremation cemetery and up to 30% of the vessels from the settlement, barrows, and ritual ground were decorated. The decoration techniques identified in the Poštela assemblage are incisions (*e.g.*, incisions, grooved incisions, fluted incisions, and piercing), impressed decorations (*e.g.*, with fingertips, fingernails, awl, cord and stamp), applied decorations (*e.g.*, cordon, handmade appliqués, barbotine), and combinations of these techniques. The most common technique in the vessels from the settlement and the barrows are incisions (approx. 40 to 60%). Impressions predominate in the flat cremations cemetery vessels (approx. 60%), and most of the vessels from the ritual ground also have a combination of an applied cord with awl impressions (approx. 35%).

The motifs (Fig. 9) are mostly simple lines executed in different decoration techniques (incisions, impressions, appliques, or a combination of techniques) or circular ornaments (especially as appliqués). Less than 5% of the decorated vessels have other types of motifs: hatched triangles on vessels recovered

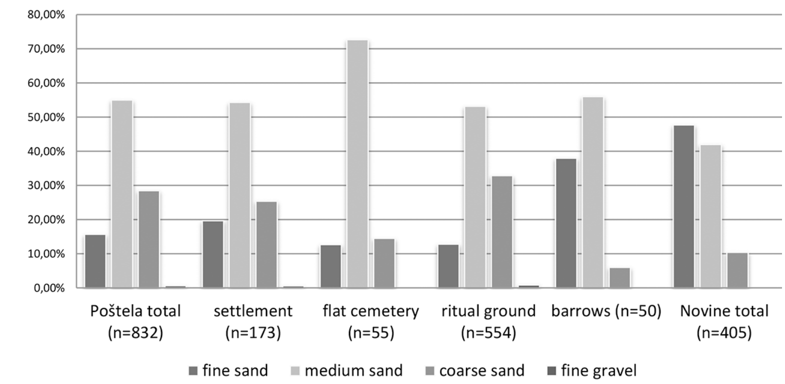

Fig. 8. Average grain sizes of inclusions in pottery from Poštela, in total and from different contexts, and Novine (in total) as observed on the macroscopic scale.

2 The results of this aspect of production will be published separately, as it is an extensive subject and is outside the scope of this paper.

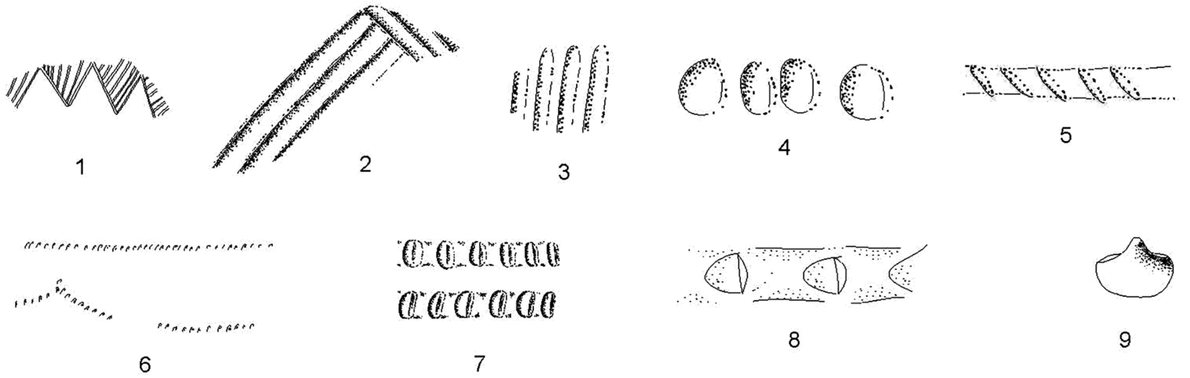

Fig. 9. Decoration techniques with different motifs at Poštela. 1 hatched incised triangles; 2 incised triangle; 3 incised lines; 4-6 impressed lines; 7-8 appliqué with impressions in a line; 9 simple appliqué.

from the settlement, the ritual ground and the barrows, zigzag motifs from the ritual ground and the settlement, concentric circles, and a rhomb motif arranged in a line.

An incomplete oxidising firing atmosphere predominates in the majority of prehistoric vessels fired in open fire pits, as the firing temperature and atmosphere were not easily controlled by potters (*Rice 1987.109*). Nevertheless, we know from other sites in the region that kilns were used for firing pottery at least from the Bronze Age (*Kossack 1995.Abb. 33; Črešnar 2006.115*). The use of both techniques can be assumed at Poštela (Tab. 2), where half of the vessels show traces of incomplete oxidation, while the remainder of the vessels bear traces of firing in a more controlled atmosphere, perhaps in a kiln. By looking at the contexts at Poštela, we could observe many differences in the firing atmospheres of the pottery (Tab. 2).

If we look more closely into the pottery assemblage from trench 27 at the Poštela hillfort, we can see that the excavations yielded a stratigraphy with occupation spanning from the beginning of the Early Iron Age until the Late Iron Age (Fig. 2). In the oldest phase (Ia), dating to the Ha C0 period, vessels were made both with and without grog inclusions in a similar ratio (51% *vs.* 49%). The inclusions are in the medium sand size in 60% of the vessels, and the vessels were fired in an incomplete oxidising and oxidising atmosphere in 35% and 25% of vessels, respectively. Firing with an oxidising atmosphere at the beginning and a reducing atmosphere at the end of firing (with a typical light coloured core and dark surface of vessels) was evidenced only in vessels from this phase. In terms of typology, the most common vessel types are bowls, pots, and baking lids, with occasional appearance of storage jars, lids, a small cup, and a miniature vessel. Almost half of the vessels were decorated with a combination of an appliqué with impressions, while the rest were decorated with incisions, impressions, and appliqués.

The inclusions in vessels from the second and third phase (Ib, Ic; Ha C1–C2/D1) consist predominantly of quartz and mica inclusions, whereas grog was identified in less than half of the samples (approx. 42%). The inclusions are in the medium sand size in some 40% of the vessels, and they were fired in an incomplete oxidising and reducing atmosphere at around 48% and 25%, respectively. Less than 10% of

Firing / atmosphere	Poštela (n = 832)	*settlement* (n = 173)	*flat cemetery* (n = 55)	*ritual ground* (n = 544)	*barrows* (n = 50)	Novine (n = 405)
oxidising	26.6%	16.8%	14.5%	32.1%	12.0%	21.2%
reducing	13.0%	20.8%	14.5%	8.1%	38.0%	23.0%
uncontrolled	8.8%	15.0%	7.3%	7.2%	6.0%	0
oxidising with reducing conditions at the end	1.3%	1.8%	0	1.4%	0	3.2%
reducing with oxidising conditions at the end	2.3%	0.6%	3.6%	2.3%	6.0%	11.1%
incomplete oxidising	48.0%	45.1%	60.0%	48.6%	38.0%	37.0%
series of alternating atmospheres	0.1%	0	0	0.2%	0	0.2%
overfired	0	0	0	0	0	4.2%

Tab. 2. Firing atmosphere of Poštela, in total and from different contexts, and Novine pottery (in total).

vessels from these phases were fired in a complete oxidising atmosphere. The other type of firing, exclusively identified in these phases, is firing in reducing conditions with an oxidising atmosphere at the end of the process (recognised by a typically dark-coloured core and light-coloured surface of vessels). These layers yielded bowls and pots as the most common types of vessels, with rare storage jars, lids, and cups; however no baking lids have been identified. Vessels were decorated with a wider variety of techniques, although more than half had incised decoration; other types of decoration are less frequent.

Ceramic petrography

For the petrographic analysis, we sampled 19 vessels from the Poštela settlement (9 samples from trench 27, one from trench 32), as well as from trenches below the hillfort: four samples from the ritual ground and five from the flat cremation cemetery (Tab. 3). The analysis revealed the presence of four main fabric groups (A, B, C, D) according to the presence of different inclusions, use of temper and composition of the clay matrix (Tab. 4; Figs. 10 and 11). All the fabrics are made of non-calcareous clay with aplastic and rare plastic inclusions, *i.e.* organic matter. The most common inclusions are monocrystalline quartz, mica (muscovite, biotite), metamorphic rock fragments (quartzite, amphibolite), opaques or 'amorphous' concentration features, and accessory minerals (epidote, clinozoisite, hornblende, plagioclase feldspars, rutile, and sphene) (more details in *Žibrat Gašparič, Dolenec in prep*). The pottery samples all show an optically active clay matrix in the petrographic analysis, which is indicative of lower firing temperatures (max. 800°C) for these vessels (*Grimshaw 1971.221–227; Cultrone* et al. *2001*).

Some of the samples contained temper intentionally added to the clay; metamorphic rocks (fabrics A, B1-2, C1-3, D1) were the most common, but other types of temper are also present, such as igneous rocks (fabric C3), grog (fabrics B2, D2), organic matter (fabrics B3, D3), and mica (fabric C1). Only two fabric sub-groups contained no temper added to the clay (fabrics B4, C4).

Fabric group A is an amphibolite tempered fabric determined by the size, sorting, and frequency of amphibolite, hornblende, and clionozoisite grains in the matrix. The fabric was found in an urn from the flat cremation cemetery on the Habakuk plateau dating to the Ha C0 period (Fig. 10.A1).

Sample No.	Vessel type	Trench	Context	Fabric	Description of fabric
149	cup	1	ritual ground (SU 1006)	C4	quartzite & hornblende fabric
449	urn	14	flat cremation cemetery (SU1605)	A1	amphibolite temper
453	small cup	14	flat cremation cemetery (grave N. 19)	B2	grog, quartzite & amphibolite temper
454	bowl	14	flat cremation cemetery (grave N. 19)	B3	organic, quartzite & amphibolite fabric
451	pot	24	flat cremation cemetery (grave N. 24)	D1	quartzite & garnet temper
452	bowl	24	flat cremation cemetery (grave N. 24)	B4	quartzite & amphibolite fabric
510	pot	27	settlement (SU 2725)	C2	quartzite temper
1023	pot	27	settlement (SU 2727)	D2	grog temper
808	bowl	27	settlement (SU 2739)	C2	quartzite temper
732	small cup	27	settlement (SU 2747)	D3	organic temper
738	pot	27	settlement (SU 2745)	C1	quartzite & mica temper
755	pot	27	settlement (SU 2745)	B2	grog, quartzite & amphibolite temper
788	bowl	27	settlement (SU 2745)	B2	grog, quartzite & amphibolite temper
733	lid	27	settlement (SU 2751)	B1	quartzite & amphibolite temper
745	pot	27	settlement (SU 2751)	C3	quartzite & granodiorite temper
659	bowl	32	settlement	B4	quartzite & amphibolite fabric
844	bowl	34	ritual ground (SU 3403)	B1	quartzite & amphibolite temper
866	bowl	34	ritual ground (SU 3403)	B1	quartzite & amphibolite temper
868a	decorated vessel	34	ritual ground (SU 3402)	B1	quartzite & amphibolite temper
Razvanje 1	clay, fired to 700°C		east of Poštela hillfort		
Razvanje 2	clay, fired to 700°C		east of Poštela hillfort		
Zg. Radvanje	clay, fired to 700°C		north of Poštela hillfort		

Tab. 3. List of petrography samples from Poštela.

Fabric	Description of fabric	Sample No.	quartz	mus-covite	bio-tite	hem. agreg.	quartzite	amphi-bolite	horn-blende	clino-zoisite	sphene	epi-dote	granodi-orite	gar-net	orga-nic	grog	other minerals (<2% total)
A1	amphibolite temper	449	25	20	5	15		1	20	10	5	5					chlorite, plagioclase, K-feldspars,rutile
B1	quartzite & amphibolite temper	733, 844, 866, 868a	30–35	30–40	10–15	2–5	<0.5	0.5–1	1–2	2–5	2–5	<0.5	<0.5	<0.5			chert, chlorite, plagioclase, rutile
B2	grog, quartzite & amphibolite temper	453, 755, 788	35–45	20–30	2–5	15	1–2	<0.5	1–2	2–5	0.5–1	0.5–1		<0.5	1–2	1–2	chlorite, plagioclase, rutile
B3	organic, quartzite & amphibolite fabric	454	35	35	1–2	2–5	<0.5	0.5–1	2–5	2–5	<0.5	<0.5			10		chlorite, plagioclase, rutile
B4	quartzite & amphibolite fabric	452, 659	35–40	35–40	5	15	0.5–1	<0.5	0.5–1	0.5–1	<0.5	0.5–1					chlorite, plagioclase, rutile
C1	quartzite & mica temper	738	35	25	20	10	2–5		0.5–1	0.5–1	<0.5	1–2					chlorite, rutile
C2	quartzite temper	510, 808	40–50	20–35	10	10	2–5		0.5–1	0.5–1	<0.5	0.5–1		1–2			chlorite, plagioclase, K-feldspars,rutile
C3	quartzite & granodiorite temper	745	40	20	15	15	1–2		0.5–1	<0.5	<0.5	<0.5	1–2				chert, plagioclase, K-feldspars,rutile
C4	quartzite & hornblende fabric	149	40	20	2–5	25	<0.5		0.5–1	1–2	<0.5	2–5					chlorite, K-feldspars, rutile
D1	quartzite temper & garnet inclusions	451	30	25		25	2–5					<0.5		10			chert, chlorite, rutile
D2	grog temper	1023	35	35	2–5	15	1–2			0.5–1		1–2				1–2	chert, chlorite, plagioclase, K-feldspars, rutile
D3	organic temper	732	50	25	2–5	5	1–2			0.5–1		1–2		<0.5	10		chlorite, plagioclase, rutile
clay	clay, fired at 700°C	Razvanje 1	35	20	15	10	<0.5	<0.5	2	0.5–1	<0.5	0.5–1		<0.5			plagioclase, rutile
clay	clay, fired at 700°C	Razvanje 2	40	20	15	5	<0.5	<0.5	5	<0.5	<0.5	1–2		<0.5			chlorite, plagioclase, rutile
clay	clay, fired at 700°C	Zg. Radvanje	35	20	15	5	<0.5	<0.5	10	<0.5	0.5–1	0.5–1		<0.5			chlorite, plagioclase, K feldspars, rutile, zircon

Tab. 4. The results of ceramic petrography of the Poštela pottery samples. Numbers are in %.

Fabric group B also contains metamorphic rocks as inclusions, but here quartzite is present in the clay alongside amphibolite. The various subgroups of this fabric include samples with quartzite and amphibolite added as temper (fabric B1), quartzite, amphibolite, and grog temper (fabric B2) or quartzite, amphibolite temper with added organic matter (fabric B3). Fabric B4 has only fine-grained quartzite and amphibolite fragments, which form part of the naturally occurring inclusions in the clay (Fig. 10.B1–B4). The different types of temper were identified on the basis of the size, sorting, and frequency of these grains in the clay matrix.

Fabric group C differs from the other samples, as the fabric has only quartzite inclusions, but no amphibolite. The subgroups differ according to the added temper, which is only quartzite temper (fabric C2), quartzite and muscovite and biotite mica temper (fabric C1), quartzite and igneous rocks temper (fabric C3), and fabric with only naturally occurring quartzite fragments (fabric C4) (Fig. 10.f; 10.C1–C4).

Fabric group D has only rare quartzite fragments, which occurs naturally, give their size, sorting, and frequency inside the matrix. The samples in this group contain quartzite temper and a higher frequency and size of garnet inclusions (fabric D1), grog temper (fabric D2), and organic temper (fabric D3) (Fig. 10.D1–D3).

The distribution of the fabric groups in the different contexts shows that samples from the settlement are more diverse in composition, as the majority of fab-

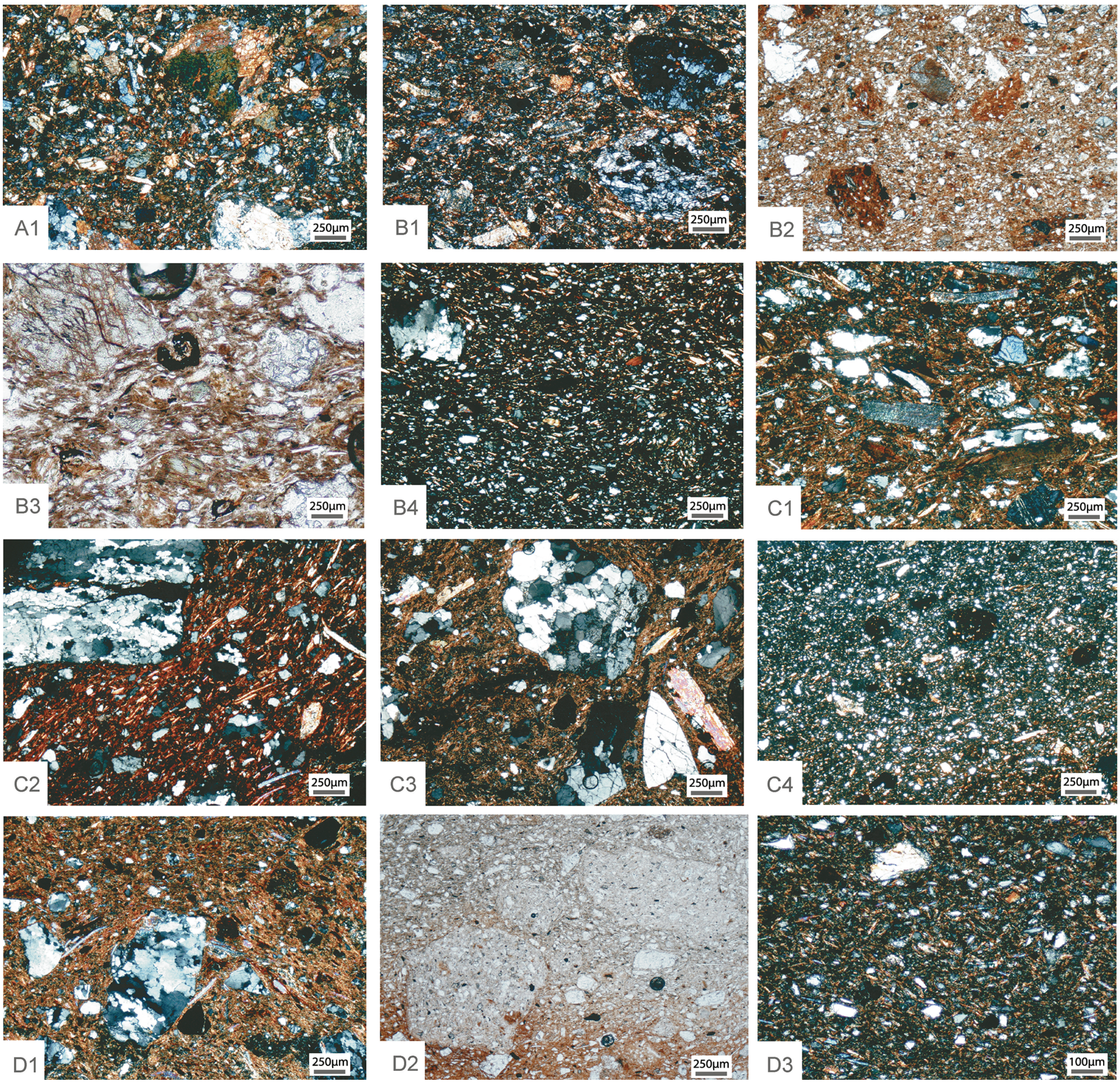

Fig. 10. Photomicrographs of the Poštela fabrics (A1 to D3). Photos B2, B3, D2 taken in parallel polars, all other photos taken under crossed polars.

ric groups and subgroups were identified here. That includes fabric groups B, C and D, whereas vessels with quartzite temper (fabric groups C1-C3) were identified in trench 27 exclusively. Fabric group B with added amphibolite and quartzite temper (fabric B1) and with added grog (fabric B2) was found only in the oldest Ha C0 phase, on the other hand groups C and D were found in all Early Iron Age occupation phases in this trench (Fig. 2).

In addition to the pottery samples, we obtained three locally available clays from the plains approx. 1.5km to the east (location Razvanje) and north of the Poštela hillfort (location Zgornje Radvanje) for a complementary provenance analysis (Tabs. 3 and 4). Here, regional clays are mostly secondary clays with an illite-chlorite composition and many other aplastic inclusions, depending on the local geology (*Rokavec 2014*). The three clay samples have a similar mineralogical composition, with quartz, muscovite and biotite mica, opaque minerals and clay pellets, as well as metamorphic rock inclusions (quartzite, amphibolite) and accessory minerals (plagioclase feldspars, hornblende, clinozoisite, sphene, epidote, rutile, and garnet) (for details see *Žibrat Gašparič, Dolenec in prep.*).

The two Razvanje clays are composed of a fine-grained non-calcareous reddish brown clay matrix with frequent (30%) aplastic inclusions in the clay matrix. The metamorphic (quartzite, amphibolite) rock fragments are sub-angular inclusions in fine to coarse sand size (0.05 to 1mm). The clay sample from Zg. Radvanje is composed of a fine-grained non-calcareous reddish-brown clay matrix, with abundant (40%) aplastic inclusions, such as quartzite and amphibolite; additionally, in comparison to the Razvanje clays, there was a higher content of hornblende, while clay pellets were absent.

The composition of the analysed clay samples is comparable to the pottery fabric groups B1–B4. The main difference in the composition is the presence of temper in the pottery fabrics. Fabric groups A1 and C1–C4 share some similarities with the local clays, but were obtained from a different source, since they contain different amounts of amphibolite and quartzite grains from the analysed clays (Tab. 4). Fabric groups D1–D3 have no amphibolite or hornblende inclusions; they could be made from raw materials not available at Poštela. The closest rocks with a similar composition can be found some kilometres south-west of the settlement, where the local geology shows significantly fewer amphibolite rocks than at the hillfort (*Mioč, Žnidarčič 1989*).

Novine

Pottery typology and technology

At Novine, more than 4500 sherds were recovered from all the trenches, of which 405 vessels were included in the analysis. As the excavated trenches were small, most of the samples come from trenches inside the hillfort (*i.e.* 399 vessels). The comparison between the settlement and the cemetery is therefore limited.

Vessel types could be identified in 228 of the samples (approx. 55% of all the analysed material), and include pots, storage jars, backing lids, bowls, cups, and small cups (Figs. 7 and 11). The most common types are bowls (approx. 55% of the types), which are divided into three groups (Fig. 11.1–5). Bowls are followed by pots, with 23%, which are divided into five groups (Fig. 11.10–14). Another fairly representative group, recognised in 12% of the assemblage, are backing lids (Fig. 11.9). Storage jars, cups and small cups comprise less than 10% of vessels (Fig. 11.6–8).

In the macroscopic analysis, we observed the following inclusions: quartz, mica, iron oxides, clay pellets, grog, organic matter, and graphite. Quartz, mica and grog are present in more than 60% of the samples. Other inclusions could be identified in various combinations (Tab. 1): additional organic matter and clay pellets in 20% of the samples, only organic matter or clay pellets in some 16% of the samples. Vessels without grog have quartz, mica and clay pellets as inclusions, and are present in 15%.

The inclusions are mostly in the fine sand size (up to 0.25mm) in around 47% of the vessels; approx. 42% contain inclusions in the medium sand size (0.26 to 0.5mm), and some 11% contain inclusions, mostly of coarse sand size (0.5 to 1mm) (Fig. 8). At Novine, only storage jars and baking lids contain inclusions, generally in the medium sand size, whereas pots and bowls are mostly made with inclusions of fine sand. Overall, the vessels at Novine have finer inclusions than the Poštela pottery.

The most common surface treatment of the Novine assemblage is smoothing, in more than 65% of the vessels, followed by burnishing in around 27%, and only some vessels were polished (about 4%).

Most vessels at Novine were undecorated; only some 14% had decoration. The most common techniques used are incisions (incisions, grooved and fluted incisions, and combed decorations), impressions (fingertip and fingernail impressions, awl impressions,

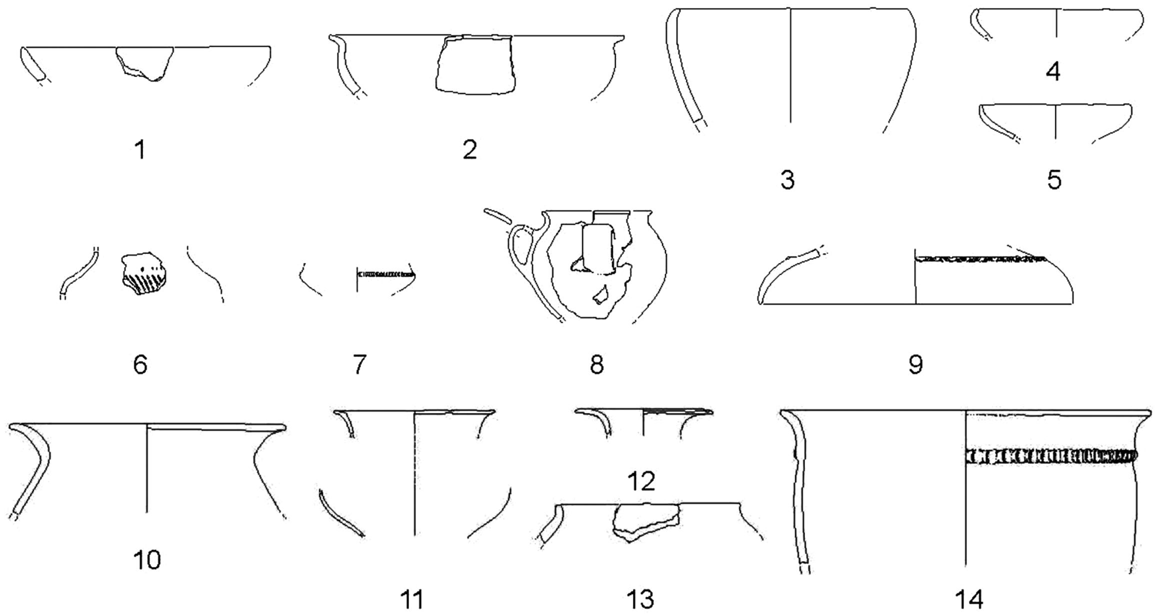

Fig. 11. Typical vessel types from Novine. 1 conical bowl; 2-5 rounded bowl; 6-8 cups; 9 backing lid; 10-11 round-bellied pot; 12 pot with high funnel-shaped neck; 13 globular pot; 14 oval pot (scale 1:8; drawing by D. Oman).

stamped, and roller-stamped decoration), applied decoration (a cordon, handmade appliqué, and a matrix-made relief), and a combination of impressions and applied decorations (the most common is an applied cord with awl impressions). Incised decorations were recognised in approx. 34% of the decorated samples, impressions in around 16%, and applied decorations in around 18% of the samples. The combination of appliqués with awl impressions could be seen in a third of the samples.

The most common motifs are simple horizontal, vertical, or oblique lines made with different techniques (incisions, impressions, appliqués, or a combination of these techniques). Other motifs are rare, and include perpendicular lines, a band of oblique lines, a band of (hatched) triangles, and semi-circles.

The firing techniques identified in the Novine assemblage show that most of the vessels (approx. 39%) were fired in incomplete oxidising conditions in an open fire (Tab. 2), and some 20% of the samples were fired either in a reducing or oxidising atmosphere. Other types of firing were less common. Some vessels (less than 4%) show signs of over-firing; these signs include some bloating, higher porosity and hardness.

The earliest phases at Novine date to the Ha C0 period, and vessels from these phases were mostly made with quartz, mica, organic matter, and grog inclusions. Vessels with grog from the earliest layers (phases Ia, Ib) comprise around 67% of the whole assemblage. The most common firing technique was in an incomplete oxidising atmosphere (in approx. 32%), but firing in an oxidising and reducing atmosphere inside a kiln is also common (approx. 25% for each). More than 10% of vessels were fired in an oxidising atmosphere at the beginning and a reducing atmosphere at the end of firing (with a typical light-coloured core and dark surface of vessels), which is a rare technique in the later phases. Typologically, most of the vessels are bowls and pots (approx. 30% each), but baking lids and storage jars are also common. The vessels were mostly decorated with a combination of an appliqué with impressions, although incisions and appliqués are also common (around 20% each).

The later occupational phases, dating to Ha C1–C2/D1, include vessels with predominantly quartz, mica, organic matter, clay pellets, and grog inclusions. Vessels with added grog predominate, but in a lower percentage than in the previous phases (only approx. 53%). The firing atmosphere was predominantly not completely oxidised (approx. 49% of vessels), although firing in oxidising and reducing conditions are also common (around 13% to 23%, respectively). The other common firing technique is in reducing conditions with an oxidising atmosphere at the end (recognised by the typical dark-coloured core and light-coloured surface of vessels) in some 12% of vessels. The order is the exact reverse of the firing atmosphere that occurred in the older phases. These phases have similar types of vessels, although different subtypes of bowls predominate in the assemblage, with approx. 72%. Only approx. 15% of vessels were pots, with the remainder being storage jars and baking lids. The decorations remain similar to the previous phases.

Pottery from both the Ha C0 and the Ha C1–C2/D1 phases was made mostly with the addition of grog temper, although the share of vessels with grog is lower in the later phases (around 53% to 67%, respectively). We could also observe differences in firing of vessels and the types, whereas the size of inclusions and decoration were not subject to change.

Ceramic petrography

The petrography of 14 pottery samples from Novine showed the presence of six fabrics that differ according to composition and temper (Tabs. 5, 6; Fig. 12). Most of the samples come from trench 5 from the settlement at Novine, and show many similarities in their composition. Two samples come from trench 3, excavated through the rampart at the central part of the cemetery, and one from trench 6 in the flat cremation cemetery in front of the settlement.

The pottery is made of non-calcareous clay with aplastic inclusions and rare organic inclusions. The most common aplastic inclusions are monocrystalline quartz, mica (muscovite, biotite), metamorphic rocks (quartzite), chert, opaques or 'amorphous' concentration features, argillaceous rock fragments and rare accessory minerals (plagioclase and K-feldspars, garnet). Generally, the samples have an optically active clay matrix in the petrographic analysis, which is indicative of lower firing temperatures (max. 800°C) for these vessels (*Grimshaw 1971.221–227; Cultrone* et al. *2001*). Only four samples show a darker clay micromass, with weak optical activity, which could point to a higher firing temperature for these samples, between 800 and 900°C (*Cultrone* et al. *2001.624–628*).

Most of the fabrics had temper added to the clay, such as grog (fabrics N3, N4, N5), rock fragments (fabrics N4, N5, N6), and organic matter or chaff (fabric N5). Fabrics with added grog are most common, and were recognised in 11 samples from Novine, whereas lithic temper (quartzite) is present in just four samples. Other fabrics with temper are represented by one sample each. Two fabrics have no added temper to the clay matrix, but are made from different clays: one is a clay matrix with rare quartz and mica inclusions (fabric N1), and the other has quartz, mica, metamorphic rocks, feldspars, and amphiboles as natural inclusions (fabric N2).

For the complementary provenance analysis (Tabs. 5 and 6), we sampled three locally available clays and sediments from Novine (No. 1004, 1005, 1006). The clays in this region are mostly secondary clays, with an illite-chlorite composition and aplastic inclusions, depending on the local geology (*Rokavec 2014*). The clay samples from Novine have a very similar composition; they are all of non-calcareous clay with predominantly quartz inclusions. The main difference between the samples is in their quartz grain size distribution (for details, see *Žibrat Gašparič,*

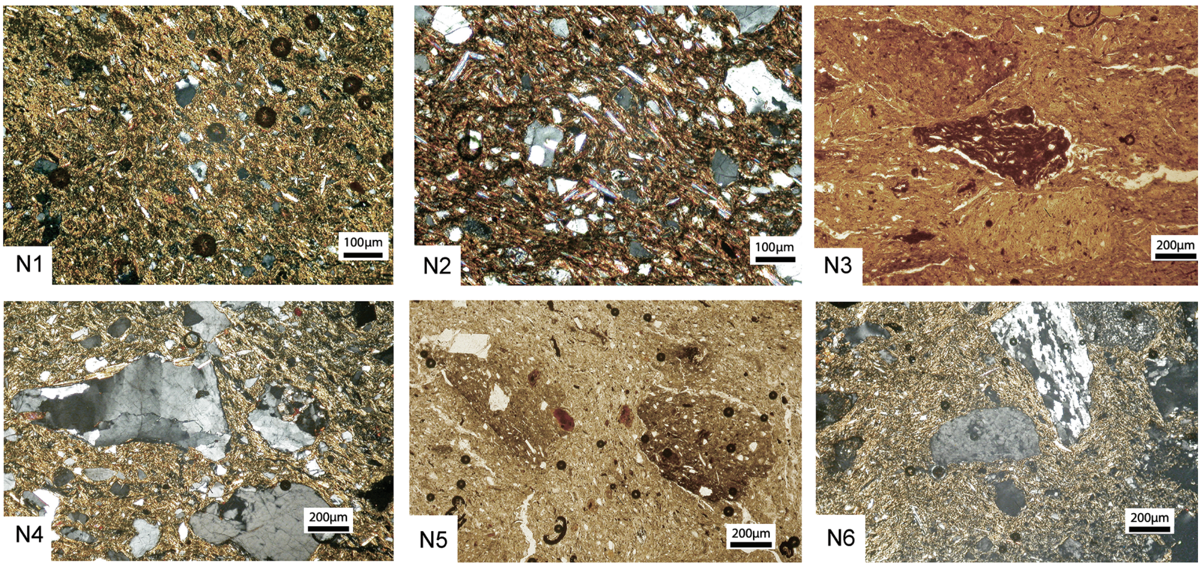

Fig. 12. Photomicrographs of the Novine fabrics (N1–N6). Photos N1, N2, N4, N6 taken under crossed polars, photos N3, N5 taken in parallel polars.

Dolenec 2015). All of the samples are light yellow-brown (Munsell 2.5YR 6/4), which turned into reddish yellow after firing (Munsell 5YR 6/6). The Novine clay samples 1004 and 1005 are fine-grained non-calcareous clays, and sample 1006 is coarse grained non-calcareous clay. The samples contain up to 30% aplastic inclusions, mostly monocrystalline quartz, muscovite and biotite mica, opaque minerals, and rare rock fragments (quartzite, chert) and other accessory minerals (feldspars, amphibolite, and garnets).

Discussion

Comparison of the macroscopic results

The macroscopic description of the Poštela and Novine samples showed significant variation in the composition of the ceramic paste between the two contemporary sites. At Poštela, vessels were made predominantly with quartz and mica inclusions, although vessels with additional organic matter and grog are also common. It is important to note that the vessels with grog temper come mostly from the flat cremation cemetery below the settlement, which is dated to the Ha C0 period. Vessels with added grog were also more common in the first occupation phase (Ia) as recognized in trench 27 in the settlement.

At Novine, two thirds of vessels were made with quartz, mica inclusions and grog temper, although clay pellets are also common inclusions in the pottery. Vessels with only quartz and mica inclusions are rare, comprising around 10% of the samples. Analysing further the samples from trench 5 from the Novine settlement, we can observe again that the samples from older stratigraphic layers (phases Ia and Ib) have mostly grog temper added to clay, whereas other types of temper occur in vessels from younger layers (*i.e.* phases Ic and Id, layers above stratigraphic unit 195; see *Vinazza* et al. *2015.180, Sl./Abb. 37, 38*).

An important difference between the two sites in their respective pottery production is therefore the use of grog as temper. At Novine, this is the most common temper in the clay paste and comprised approx. 60% of the samples, whereas at Poštela, less than 40% of the samples contain grog. Similarly to Poštela, the ratio of vessels with added grog at Novine is higher in the earlier occupation phases, and drops in the subsequent phases (67.5% compared to 53.5% of vessels with grog in trench 5). The results from trench 27 at Poštela and trench 5 at Novine are evidence of a more distinctive preference for the use of grog temper in the oldest occupation layers (Ha C0). Therefore, it seems likely that these technological changes can also be related to chronological phases.

Grog is fired ceramic material intentionally crushed and added to clay during the pottery manufacturing process and is a common type of inclusion in prehistoric pottery. Grog is a suitable tempering material, since its physical properties (such as coefficient of expansion) are similar to those of clay (*Rye 1976. 115; Rice 1987.229; Reedy 2008.146*), and it was commonly used in the Late Bronze Age and Early Iron Age, as was demonstrated by macroscopic observation at other contemporary sites in north-eastern Slovenia (*Črešnar 2010.10–11; Mele 2009*) and

Sample N.	Vessel type	Trench	Context	Fabric	Description of fabric
NOV14	storage jar	5	settlement (SU 215)	N3	grog temper
NOV39	storage jar	5	settlement (SU 229)	N3	grog temper
NOV45	baking lid	5	settlement (SU 289)	N3	grog temper
NOV58	baking lid	5	settlement (SU 195)	N1	chert fabric
NOV118	storage jar	5	settlement (SU 229)	N3	grog temper
NOV123	storage jar	5	settlement (SU 229)	N3	grog temper
NOV195	bowl	5	settlement (SU 223)	N5	grog, organic matter and rock temper
NOV232	decorated vessel	5	settlement (SU 158)	N4	grog and rock temper
NOV240	storage jar	5	settlement (SU 220)	N3	grog temper
NOV248	decorated vessel	6	settlement (SU 138)	N3	grog temper
NOV339	bowl	5	settlement (SU 195)	N3	grog temper
NOV347	bowl	5	settlement (SU 102)	N2	quartzite fabric
NOV362	pot	5	settlement (SU195)	N4	grog and rock temper
NOV417	decorated vessel	3	settlement (SU 80)	N6	rock temper
1004	clay, fired to 800°C	3	cemetery (SU 118)		
1005	clay, fired to 800°C	5	settlement (SU 258)		
1006	clay, fired to 800°C	5	settlement (SU 294)		

Tab. 5. List of petrography samples from Novine.

Fabric	Description of fabric	Sample No.	quartz	musco-vite	bio-tite	opaq. min.	quartzite	amphi-bolite	horn-blende	clinozoi-site	grano-diorite	organic	grog	other minerals (<2%)
N1	chert fabric	NOV58	40	40	5	5								chert, garnet
N2	quartzite fabric	NOV347	45	45		5	<1%		<1%			<1%		plagioclase, K-feldspars
N3	grog temper	NOV14, NOV39, NOV45, NOV118, NOV123, NOV240, NOV248, NOV339	30–45	30–40	5	10–20	<1%		<1%			<1%	3–5	chert, garnet, plagioclase, K-feldspars
N4	grog and rock temper	NOV232, NOV 362	50	30	2–5	5–10	<1%	<1%		<1%	<1%		1	chert, garnet, plagioclase, K-feldspars
N5	grog, organic matter and rock temper	NOV195	35	25	0,5	10	<1%					10	1	chert, garnet, plagioclase, K-feldspars
N6	rock temper	NOV417	40	50	1	5	1				1	1		chert, garnet, plagioclase, K-feldspars
	fired clay samples	1004, 1005, 1006	50–55	20–25	5–10	15–20	<1%	<1%						chert, plagioclase, garnet

Tab. 6. The results of ceramic petrography of the Novine pottery samples. Numbers are in %.

Austria (*Hellerschmid 2006.112–113; Sauer 2006*). In addition to its physical properties, grog can be regarded as a symbolic improvement of clay, as seen in some ethnoarchaeological examples (*Quinn, Burton 2009.288; Gosselain, Livingstone Smith 2005. 41*).

At Poštela, the most common surface treatment of the vessels include smoothing and burnishing, with polishing present in less than 5%. In the settlement, the ritual ground, and in the barrows, different types of bowls predominate in the assemblages; on the other hand, pots are the predominant type of vessels in the flat cremation cemetery. At Novine, smoothing of vessels surfaces is more common than burnishing, whereas polishing can be considered a rare surface treatment technique.

Most of the vessels were fired in an incomplete or complete oxidising atmosphere; at Poštela in more than 70% and at Novine in around 60% of samples (Tab. 2). A reducing atmosphere was used in less than 15% at Poštela, and some 25% of vessels at Novine. The combination of a reducing atmosphere with an oxidising atmosphere at the end of firing is at Novine also more common than at Poštela (10% compared to 2% of samples). As it can be concluded after the petrographic analysis, the vessels at Poštela and Novine were fired in similar temperature ranges (at max. 800°C). We conclude that firing was done in open fire pits, as well as in a more controlled atmosphere, perhaps inside a structure, *i.e.* a pottery kiln.

Although there are many differences in clay paste selection and preparation, in surface treatment, and firing of vessels between Poštela and Novine, the forms of vessels show many parallels. Similarly shaped bowls and pots are the most common types at both sites, followed by baking lids, lids, cups, and small cups (Fig. 7). Although the forms are comparable, vessels of the same type were made from different fabrics. For example, pots are made with fabrics without grog temper at Poštela, but more than 70% of Novine pots contain grog temper. The same holds for bowls and cups. Only baking lids were predominantly made with grog temper at both Poštela and Novine.

Besides pottery forms, it is also the decoration techniques that show many similarities. The most common techniques are incisions, followed by impressions and appliqués in combination with impressions. The motifs are mostly simple horizontal, vertical, or oblique lines made in different techniques, with rare motifs occurring at each of the sites.

The petrography of Poštela and Novine samples

The petrography of pottery samples from Poštela shows a variety of fabrics that were made with different types of locally available raw materials. Most (*i.e.* 67%) of the analysed vessels contain crushed metamorphic rocks of local origin added as temper. Other types of temper were added rarely, and include igneous rocks, mica, garnet and organic matter. At Poštela, crushed pottery or grog added as temper was recognised in around 20% of the petrographic samples, although a higher share (about 35%) was observed during the macroscopic analysis. None of the other samples contained temper added to the clay.

Rock temper is commonly added to clay to improve the workability of the raw material when forming vessels (*Rye 1981; Reedy 2008.133–141*). This type of temper was commonly used by Bronze and Iron Age potters at sites in western Hungary and Austria (*Gherdan* et al. *2002; Sauer 2006*). The most common temper at Poštela – quartzite – is a metamorphic silicate rock found locally (*Hinterlechner Ravnik 1971*), which includes several accessory minerals that were also found in the pottery samples (mica, feldspars, opaques, garnet). The natural bedrock at Poštela (*Hinterlechner Ravnik 1971*) is amphibolite, a metamorphic rock that is easily recognisable by its dark green colour. Amphibolite is composed mostly of hornblende, but also includes other minerals (*i.e.* quartz, feldspars, epidote, clinozoisite, sphene). All these minerals were identified in the pottery samples from Poštela.

Two samples from the oldest layer at the Poštela hillfort (from trench 27, samples 733, 745) contained igneous rock inclusions (granodiorite), which were part of the raw material or even added as temper additionally to the metamorphic rock grains. Granodiorite is common in the central Pohorje massif, and can be found about 10km west of Poštela; it is composed mostly of feldspars, quartz and biotite mica, with other accessory minerals (*Mioč, Žnidarčič 1989; Zupančič 1994/1995*).

Most of the petrography samples come from the settlement, and only a smaller amount from the flat cremation cemetery and the ritual ground. Nevertheless, some differences in the fabrics from the different contexts can be seen. At the flat cemetery, the vessels were quite diverse and only two fabrics (B2, B4) were also found in other analysed Poštela contexts. Here we identified a vessel with amphibolite temper (fabric A1), quartzite and amphibolite temper with grog (fabric B2), quartzite and amphibolite temper with organic matter (fabric B3), and a vessel with no temper and only naturally occurring quartzite and amphibolite inclusions (fabric B4), as well as a vessel with quartzite and garnet inclusions (fabric D1). The samples from the ritual ground, on the other hand, are similarly made and belong mostly to one fabric with added quartzite and amphibolite temper (fabric B1), while one sample was made without temper (fabric C4) and was not found in any other context. Due to the large amount of pottery excavated from this context and based on the results of the macroscopic description, we expected greater diversity in these samples, but as only four samples were analysed from this context, it will be necessary to include more samples from the ritual ground for future petrographic analysis. All the other samples come from trenches inside the hillfort, where the pottery was made from a variety of fabrics (groups B, C, and D). The vessels of fabrics groups C and D were appearing predominantly in the settlement and were not identified in the flat cremation cemetery or the ritual ground. Based on the results of the macroscopic and petrographic analyses, we presume that the Poštela potters made vessels that were intended for different uses (funerary, ritual, or domestic) from different fabrics.

If we compare the petrography results with the macroscopic description, we can observe that the main groups of inclusions display greater diversity when viewed under the microscope, which is to be expected, as petrography gives a more detailed insight into the mineralogical composition of the fabrics. However, we could ascertain that the recognition of grog inclusions in macroscopic analysis was not correct in one third of the samples, as fragments of iron-rich pellets and amorphous concentration features as well as rock fragments were mistakenly interpreted as grog in the fabrics. As the recognition of grog is sometimes difficult even in thin section (*Whitbread 1986*), this result is not surprising, but does indicate that the amount of pottery with grog temper could be lower than estimated in the macroscopic analysis. This will have to be studied in more detail with new petrographic samples.

At Novine, pottery was made predominantly with grog temper, found in more than 60% of the samples in the petrographic as well as in the macroscopic analysis. The samples from trench 5 at the settlement show that fabric N3 with grog was found only in the earlier phases (Ia and Ib), whereas other types of temper can be found also in the later phases (Ic and Id). Metamorphic rocks and organic matter were rarely added to the clay, and just two samples were without added temper (fabrics N1, N2). Rock temper was identified in less than a third of the samples from Novine, and in most samples was added alongside grog (fabrics N4, N5); only one fabric had rock temper exclusively (fabric N4). The most common rock found in the samples is quartzite, a metamorphic silicate rock that forms lenses inside other types of rocks (phyllite, schist, amphibolite, and gneiss) on the Pohorje Massif and the Kobansko area some 10 to 15km to the south and south-east of Novine, although larger pebbles of quartzite could also be procured by prehistoric potters from the alluvial deposits below the settlement (*Mioč 1978; 1983; Mioč, Žnidarčič 1989*).

Uniquely to Novine, one fabric showed the presence of charred organic remains that were identified as chaff under the polarising microscope (Fig. 12.N5). Chaff is husks of cereals and other seeds that are separated from grains by threshing, and is often mixed with clay in pottery preparation (*e.g., Mariotti Lippi, Gonnelli, Pallecchi 2011; Kreiter* et al. *2013*) as this increases the plasticity and dry strength of sandy clays (*Rice 1987.78*). This was common practice at least from the Neolithic period (also in Slovenia, see *Tolar, Veluščček 2016*), and its use could also be confirmed for the Early Iron Age at Novine. Chaff temper is related to seasonality in pottery production, as chaff as an agricultural waste product occurs at the end of harvesting (*Rye 1981*). Thus with the use of chaff we can directly relate pottery production to agricultural activities, which has a temporal character and is a seasonal activity, much like pottery production that often happens in the drier parts of the year (*Arnold 1985.77*). We understand the use of chaff as a part of material culture and an active part in the structuring of social actions incorporated in pottery. The connection manifests itself in the way that pottery is used for the storage, preparation, and consumption of agricultural products, as much as how agricultural by-products are connected to the raw material of the vessels (*Kreiter* et al. *2013. 139*).

The grain size of the inclusions is also different at the two sites (Fig. 8). At Poštela, the grain size distribution shows that the mean value of the inclusions is mostly between 0.25 to 0.5mm, with a third of the samples containing inclusions between 0.5 to 2mm. On the other hand, at Novine most of the samples containing inclusions in sizes less than 0.25mm. These differences in grain size can also be observed in the clay samples, as the clays from Razvanje and Zg. Radvanje contain inclusions between 0.05 and 1mm, whereas the clays from Novine contain inclusions up to 0.6mm in size. The differences in the size distribution of inclusions in the clays can be attributed to the local geology, whereas the differences in the size of inclusions in pottery is also connected to the use of temper.

Although the forms and decoration of these Early Iron Age vessels from both sites are similar, we could observe important differences in the pottery composition and firing. The analyses of local clays show a strong correlation between the locally available raw materials and the ceramic fabrics. We conclude that Early Iron Age potters from Poštela and Novine used local raw materials to produce comparable vessels intended for similar purposes. The differences in the procurement of raw materials and paste preparation are therefore more connected to the availability of clays and temper than to the desired physical properties of the finished vessels.

Conclusions

The results of the analysis show that potters from the contemporaneous sites of Poštela and Novine made similarly shaped vessels with similar decorations, using different pottery recipes with locally available raw materials. At Novine, grog was the main temper used, in addition to a fine-grained clay paste, and at Poštela metamorphic rocks (mostly amphibolite and quartzite), rocks forming the bedrock at the sites, were used as temper, as well as forming a large part of natural inclusions in the clay paste.

The use of grog, as identified on the macroscopic level, can be connected to the oldest occupation phases, as vessels with grog predominate in both the Poštela and Novine settlement assemblages in the Ha C0 period. This is supported by the results of petrographic analysis, which show a shift towards added rock temper in the later phases, *i.e.* Ha C1–C2/ D1.

The differences in pottery composition can be associated with the naturally available raw materials, as metamorphic rocks are readily available at Poštela, but rare in the Novine area, where limestone and sandstone predominate in the geological structure. On the other hand, differences in the use of temper can also be linked to different choices and pottery traditions inside these communities. This can be especially demonstrated with the addition of grog, as the practice of adding old ceramics to new clay paste can be associated with change and the past (*Quinn, Burton 2009.288; Gosselain, Livingstone Smith 2005.41*).

We also established that there are certain differences in pottery technology according to the context of the vessel placement at Poštela: the settlement, flat cremation cemetery, barrow cemetery or the so-called ritual ground. The results indicate that vessels placed inside the flat cremation graves were made differently from vessels discarded inside the settlement. This is less surprising, as the use of pottery inside the settlement and in the graves is linked to different functions – this is also demonstrated by the predominance of vessels made for cooking or storage inside the settlements (pots, lids, baking lids, storage jars) and the lack of these inside the graves (especially the lack of lids and baking lids). Additionally, vessels discarded at the so-called ritual ground have many similarities to vessels from the settlement, and less with pottery from the graves, as cooking vessels are also very common in this context. On the other hand, bowls are the most prevalent type of vessel found in the ritual ground, their number far exceeding the number of bowls in other contexts. Bowls, from small to large forms, are open-shaped vessels that are usually used in the serving and consumption of food, and can be linked to feasts and communal activities (*e.g., Arthur 2002; Hayden 1996; Mlekuž* et al. *2013*).

Petrographic analysis shows that the Poštela pottery was made with a variety of fabrics and contained mostly added rock temper. These results were compared to locally available clays below the Poštela hillfort, which showed that Early Iron Age potters used local clays and other types of raw materials for temper, although not always from the same source. At Novine, the petrography showed that the most common fabrics had grog or crushed old pottery added as temper. Other inclusions added as temper included rock fragments (mostly quartzite) and chaff. Again, locally available clays were used, but the provenance of the rock temper is not yet clear; it could have come from the alluvial deposits below Novine or from geological regions nearby, the Kobansko and Pohorje Hills to the southeast of the site.

The comparison of the results of the Poštela and Novine samples show that the Early Iron Age pottery in north-eastern Slovenia was made using similar forming and firing techniques, but made with different fabrics and different tempers, using mostly locally available raw materials. This confirms that potters were connected to their environment in their production, and that potters had different views when selecting the most suitable material for making pottery.

The present work is the first step in comparing Early Iron Age sites and their pottery production in the region. However, the work is being extended to broader regional and transregional levels, as well as over multiple chronological phases. In this way, more in-depth knowledge about technological changes and other decision-making factors about pottery in the Early Iron Age will be produced.

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back to contents