RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

The materiality of social identity: Interdisciplinary insights into Roman Period pottery production in the Kietrz/Nowa Cerekwia micro-region (Upper Silesia, Southern Poland)

Materialita sociální identity: Interdisciplinární poznatky o výrobě keramiky doby římské v mikroregionu Kietrz/Nowa Cerekwia (Horní Slezsko, jižní Polsko)

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The research analyses the production and distribution of ceramics from the Kietrz 7 site, a cemetery dating back to phase C of the Roman Period, located in the Kietrz/Nowa Cerekwia micro-region in Upper Silesia, Poland. The Kietrz 7 site is distinguished by the fact that approximately 20% of the vessels are wheel-thrown. This technology, foreign to the Przeworsk culture at this stage, indicates a significant share of imports and cultural links, especially with the Rhine-Weser region. It is assumed that the concept of advanced production arrived with the new community. Interdisciplinary studies of 33 ceramic samples were conducted to verify the location of production. It has been established that, despite foreign technological influences, local raw materials were most likely used— Miocene clays and abundant loess, available in the Głubczyce Upland. Although no local centre has been identified in Kietrz, non-imported vessels may have come from nearby workshops known from the literature. While the social organisation of production remains open to discussion, the distribution of pottery kilns may reflect shared communal practices rather than individualised production, suggesting that ceramic output primarily served broader community functions.

Roman Period – Barbaricum – Upper Silesia – pottery – petrography – economic factor – raw material management

Výzkum analyzuje výrobu a distribuci keramiky z lokality Kietrz 7, pohřebiště datovaného do fáze C doby římské, nacházejícího se v mikroregionu Kietrz/Nowa Cerekwia v Horním Slezsku v Polsku. Lokalita Kietrz 7 je výjimečná tím, že přibližně 20 % nádob bylo vyrobeno na hrnčířském kruhu. Tato technologie, v této fázi przeworské kultuře cizí, naznačuje významný podíl importů a kulturních vazeb, zejména s porýnsko-vezerskou oblastí. Předpokládá se, že koncept pokročilé výroby přišel spolu s novou komunitou. Za účelem ověření místa výroby byly provedeny interdisciplinární analýzy 33 keramických vzorků. Bylo zjištěno, že navzdory cizím technologickým vlivům byly s největší pravděpodobností používány místní suroviny – miocenní jíly a hojně dostupná spraš, přítomné v Hlubčické pahorkatině. Ačkoli v Kietrzi nebylo identifikováno žádné lokální výrobní centrum, neimportované nádoby mohly pocházet z blízkých dílen známých z literatury. Ačkoli sociální organizace výroby zůstává předmětem diskuse, rozmístění hrnčířských pecí může odrážet sdílené komunitní praktiky spíše než individualizovanou výrobu, což naznačuje, že keramická produkce sloužila především širším komunitním funkcím.

doba římská – barbarikum – Horní Slezsko – keramika – petrografie – ekonomický faktor – management surovin

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Introduction

The research presented in this article was conducted on artefacts from the Kietrz 7 site, a cemetery whose chronology is attributed on the basis of artefacts to the 3rd century AD (*Godłowski 1973*, 285; *Błażejewski 1998*, 87–88, 186). In the chronological framework relating to the Roman Period, this corresponds to phase C, more precisely B2/C1, C1, and C2 (*Godłowski 1970*, 91–93; *Kaczanowski – Przychodni 2014*, 140–142). The Kietrz 7 site and the micro-region in which it is located are situated on the Głubczyce Plateau, which is part of the northern foothills of the Moravian Gate (*Fig. 1*). In the literature, this area is classified as part of the Przeworsk culture settlement zone (*Godłowski 1973*, 285; *1977*, 57–63, 75; *Błażejewski 1998*, 87–88), which is largely confirmed by archaeological material. However, it is a borderland between two similar cultural circles: the Przeworsk and the Bohemian-Elbe region (*Jílek 2009*, 251–258; *Droberjar 2019*).

The 3rd century AD in the Barbaricum area, as well as in the Moravian Gate region, is characterised by marked diversity and an increased dynamics of social structures (*Godłowski 1984*, 122–127; *Strzelczyk 1992*, 31–32). Numerous cultural changes can be observed, such as highly diversified funeral rites and progressive social stratification (*Olędzki 2008*, 67–90), as well as technological changes, including the spread of the potter's wheel and the improvement of metallurgical techniques (*Dobrzańska 1980*; *Orzechowski 2013*, 178–183). In general, significant changes in the functioning of communities can be observed during this period, as they began to operate more as integrated and largely self-sufficient economic organisms.

Pottery production processes are deeply embedded in community traditions, particularly in prehistoric societies, where they function as established patterns of practice. This craft can arguably be placed on par with religion in terms of cultural significance (*Gosselain 1999*, 209–211; *Stark 2003*, 202–204; *Gosselain et al. 2005*, 41; *Rice 2015*, 186; *Volf et al. 2024*, 5–7). Each stage of production likely followed inherited customs, ranging from sourcing suitable raw materials to the careful selection of fuel for firing (*Sillar – Tite 2000*, 13–14; *Rice 2015*, 35, 166–167). This was especially evident in household pottery, where individual families may have developed their own rituals associated with the process. However, when examined from a regional or microregional perspective, these traditions likely exhibited subtle variations, shaped by differences in how knowledge was transmitted. It appears that each interconnected community had access to a designated area for sourcing high-quality clay, with the appropriate proportion of non-plastic and clay materials (*Arnold 2000*, 121–122; *Neupert 2000*; *Rice 2015*, 129). This paper hypothesises that the economy of barbarian societies was fundamentally egalitarian, where key means of production, such as pottery kilns, functioned as collective assets rather than instruments for individual capital accumulation. It is further assumed that the production process was primarily oriented toward fostering communal prestige and ensuring universal access to goods, thereby defining this system as a 'human-centred economy' distinct from market-driven logic (*Gralak 2022*).

The study of production patterns and their ethnographic parallels has a long-standing tradition in archaeology. These patterns are often conceptualised as *chaînes opératoires* (*Roux 2017*), which enable us to examine pottery production not only through technical or quantitative data, but also as a sequence of culturally embedded actions. While such data is essential, it is equally important to interpret it in the context of community practices.



Fig. 1. Location of the Kietrz 7 archaeological site against the backdrop of the river landscape on the Polish-Czech border and the scope of the Przeworsk culture in yellow (after *Kaczanowski – Kozłowski 1998*, 298, modified).

The availability of suitable raw materials (clay, but also bog iron ore, wood, fertile soils, water) appears to have been a key factor in the location of settlements (*Orzechowski 2013*, 30–40; *Dobrzańska – Kalicki 2024*). A prime example is the presence of Miocene clays and tills, which, when combined with loess, abundant on the Głubczyce Plateau, yielded good-quality ceramic products. This constitutes the first element of the production puzzle: easy access to raw materials. The next essential component is fuel, specifically wood, required for firing (*Sillar – Tite 2000*, 13–14).

The presented research focuses on pottery excavated from graves in Kietrz 7. Petrographic studies were made, which allow for more in-depth information than that obtained solely from comparative analyses. In this case, the research question concerned the provenance of the analysed vessels, and particularly the possibility of their local production.

The literature on the subject tends to classify wheel-thrown pottery, especially from the early 3rd century AD, as imports (from other parts of the Barbaricum), since no specialised workshop has been documented in the given area (*Dobrzańska 1980*, 133–134; *2008*, 192–199; *Błażejewski 2007*, 87; *Domański 2008*, 151–160). The aim of this research is to challenge this assumption and to show that pottery made on a potter's wheel did not necessarily have to be produced exclusively in specialised production centres. Only 12 pottery kilns from the Silesian region are known in the literature, and the amount of wheel-thrown pottery far exceeds the production capacity of these facilities (*Pazda 2008*, 268, fig. 1, tab. 1). This raises some doubts as to whether the basic form of a pottery kiln for this area has been identified. Its production could also have been *ad hoc*, as one of the seasonal

crafts (the concept of cross-craft, *McGovern 1989*; *Costin 2005*; *Brysbaert – Vetters 2010*). It should be emphasised that this is a hypothesis that requires further verification, in particular in the course of future field research.

The cemetery in Kietrz itself is a clear cultural mix. In addition to numerous Roman imports, such as *terra sigillata*, glass vessels, and weighing scales (*Godłowski 1977*, 57–63, 75; *Błażejewski 1998*, 87–88, 186; *Stawiarska 1999*; *Tyszler 1999*), artefacts characteristic of several Germanic groups were also discovered. These include elements typical of the Przeworsk culture (brooches A.158 and A.162, pottery; *Almgren 1923*, 71–85; *Godłowski 1973*; *Błażejewski 1998*; *Olędzki 2008*, 20–24), the Elbe region group (brooches A.193, A.207, wheel-thrown pottery; *Almgren 1923*, 91–95; *Droberjar 2002*; *2019*, 267–276) and the Rhine-Weser group (layered graves, pottery; *Błażejewski 2007*, 57–61). For this reason, one of the key research problems from the very beginning of work with the archival material was the question of the provenance of this population group.

The study involved a petrographic analysis of ceramic fragments from various graves. The results were compared with locally available raw materials to verify their suitability for use in the production of vessels. Next, a spatial analysis of the immediate surroundings of the site was performed, which resulted in the identification of a micro-region, designated as Kietrz/Nowa Cerekwia.

Unfortunately, this micro-region is known mainly from surface surveys. Nevertheless, the conducted analyses made it possible to identify a probable settlement or place of pottery production, potentially a workshop. In the next stage, an attempt was made to reconstruct the functioning of the entire micro-region by assigning hypothetical functions to its individual zones.

Ceramic artefacts are undoubtedly the most abundant finds at Roman Period sites, and the same holds true for Kietrz 7. However, what distinguishes this assemblage is not its quantity, but its form. Notably, approximately 20% of the vessels are wheel-thrown, which clearly exceeds the typical share for the Przeworsk culture (*Olędzki 2008*, 20–24, fig. 3). Although the site is dated to phases C1–C3 of the Roman Period, traditional models link the widespread distribution of wheel-throwing technology to phase C2 (e.g. *Błażejewski 1998*, 186). However, the earliest occurrences in the Przeworsk culture are already documented from stage C1a onwards (*Dobrzańska 1980*, 91, 133–137; *Godłowski 1984*, 90; *Rodzińska-Nowak 2006*, 175; *2010*, 82). Given the site's location near the Moravian Gate, it is highly plausible that this region also played a key role in the transmission of wheel-throwing technology into the Przeworsk culture sphere. Nevertheless, since no traces of pottery production (workshop, kilns) have been found within the micro-region around Kietrz 7, wheel-thrown pottery should be considered imports from another micro-community (*Dobrzańska 1980*, 133–134; *Błażejewski 2007*, 186; *Domański 2008*, 151–160). The substantial quantity of ceramic material provides valuable insights into cultural connections, particularly with the Rhine-Weser and Elbe region zones. Several distinctive decorative motifs are present, including nipple-like ornament imitating glass vessels, stamped designs, meanders, nail impressions, engraved lines, grooves, and relief strips. These vessels are also distinguished by their light colour, use of the pottery wheel, and high firing quality (*Błażejewski 2007*, 87). Everything mentioned in this paragraph suggests that up to 20% of the sherds came from imported pottery items. While such a high portion of imports is striking, we decided to conduct interdisciplinary research and test whether the wheel-thrown pottery is genuinely local.

Ceramic vessel forms analogous to those from Kietrz 7 have been identified at sites such as Opočno in Northwest Bohemia (*Pleinerová 1995*) and Holasovice, Neplachovice or Opava-Kateřinky in Czech Silesia (*Loskotová 2009*). Nonetheless, the Kietrz assemblage also includes forms characteristic of local ceramic traditions. This phenomenon is entirely natural, as neighbouring human groups engage in trade and other forms of interaction. However, it appears that the general concept of ceramic production technology may have arrived alongside the users of the cemetery. Thus, it cannot be ruled out that the vessels were produced locally, although the potters, or the technological knowledge itself, were likely newcomers from another part of Barbaricum or even the Roman Empire. It is well established that the Przeworsk cultural environment underwent significant differentiation during the late Roman Period, making it difficult to clearly distinguish between local and external patterns (*Pazda 1984*, 193). It is also important to consider the significant movements of Germanic tribes during this period, which began in the time immediately preceding and following the Marcomannic Wars.

Archaeological context

Site no. 7 in Kietrz was discovered during riverbed regulation works along the Troja River and excavated in 1933–1934 by Georg Raschke and Franz Ullrich. The recovered materials were initially transferred to the Racibórz Museum and are currently housed at the Museum of Opole Silesia in Opole. Unfortunately, the finds have never been fully analysed or published; the site is only briefly referenced in broader regional syntheses and thematic studies (*Szydłowski 1964*, 31, 54, 114; *Godłowski 1973*, 285; *1977*, 57–63, 75; *Błażejewski 1998*, 87–88, 186). Due to the frequent relocation of the collection, only the administrative documentation from the original excavations conducted by the German archaeologists has been preserved. Regrettably, the drawings mentioned in this documentation, which are essential for reconstructing the spatial arrangement of the investigated features and their stratigraphy, are missing. In this case, the location of archaeological features could only be reconstructed based on written descriptions and analysis of the recovered materials. This approach led to the identification of the site as a stratified cemetery, or one containing stratified graves, dated to phase C1–C2 of the Roman Period.

The cemetery is located directly above the Troja River, a tributary of the Psina, which in turn flows into the Oder River, placing the site within the Oder River basin (*Mierzwiński 1992*, 60; *Zipser 2024*, 68–69). It lies in the floodplain zone, on the Głubczyce Plateau, which forms part of the southeastern Silesian Lowlands. The area is underlain by loess deposits, resulting in fertile soils (*Zipser 2024*, 70–72).

The 25 features discovered at the site were initially interpreted as disturbed cremation graves. The cemetery is undoubtedly linked to the aftermath of the Marcomannic Wars (166–180 AD), as the burial practices observed differ from the established norms of the Przeworsk culture. Known analogies within Polish territory are the so-called Dobrodzień group (*Szydłowski 1974*) and cemeteries along the Barycz River dated to phase C2 (*Błażejewski 2007*). Neither of these analogies is geographically close to the Kietrz site, as they are separated by hundreds of kilometres in different (NW and NE) directions, and they also date from a later period. The site yielded an unusually large quantity of animal bones, which is atypical compared to most assemblages associated with populations inhabiting

the present-day territory of Poland. These include numerous remains of horses, dogs, and cattle. Bones of pigs, wild animals, and poultry are also present, though in significantly smaller numbers. Fragments of *terra sigillata* were also found and are dated to the reigns of emperors Antoninus Pius through Septimius Severus (*Tyszler 1999*, 29–30, 32, 38, 42). These originated from provincial Roman workshops in Lezoux and Rheinzabern. Taken together, the evidence suggests that the population buried at Kietrz may have had direct contact with the Roman world.

Geological background

The surroundings of the archaeological site are dominated by Pleistocene loess and loess loam, covering c. 75–80% of the area (*Fig. 2*). Less commonly, redeposited sediments enriched in clay with subordinate sand grains occur (*Badura et al. 1996*, 9; *Trzepla 2005*, 7). Holocene alluvial soils, riverbed sands, and gravels are found in stream valleys cutting through the loess cover. Small exposures of Odranian till, rich in quartz, and lithic grains from Scandinavian crystalline rocks, as well as fluvioglacial sands and muds, emerge in erosion cuts (*Badura et al. 1996*, 23–24; *Trzepla 2005*, 11–12). Pliocene gravels and kaolinitic clays of the Gozdnica series are rare (*Badura et al. 1996*, 21–22; *Trzepla 2005*, 9–10). They contain quartz, subordinate muscovite flakes, and occasional mudstone or sandstone grains. Between Kietrz and Dzierżysław (a neighbouring village south of Kietrz), small outcrops of middle Miocene grey or blue-grey clays contain fine sand, silt, and intercalations of mud, sand, and gypsum (*Fig. 2*; *Trzepla 2005*, 8–9).

Materials and methods

A multi-analytical approach was applied to characterise the ceramic assemblage from the Kietrz site and to identify the raw materials and technological practices involved in their production. It involved petrographic microscopy, SEM-EDX analysis, thermal analysis, X-ray diffraction, and experimental firing.

A total of 33 samples (*Tab. 1*), representing just a small part of the total assemblage of approximately 6,000 sherds, were subjected to these analyses. The deliberate selection was meant to represent technological diversity. The set includes both wheel-thrown and hand-built vessels, which exhibited a range of colours (*Fig. 3*). Some fragments contain coarse-grained inclusions visible to the naked eye, while others feature very fine inclusions undetectable at the macroscopic level.

In order to attempt an identification of the raw material used in the preparation of the ceramic body, reference sedimentary rock samples were collected near the archaeological site (*Fig. 2*). Sampling locations were selected based on prior geological survey (see above). All samples were taken from surface or subsurface exposures: sample A – loess loam (0.3 m depth); sample B – loess loam (1.4 m depth); sample C – Miocene clay; sample D – glacial till. Experimental firing of these samples was performed under controlled conditions to study the mineral behaviour of the same raw materials that were likely used in the preparation of ceramic paste for the production of the analysed ancient pottery. The firing procedure was conducted in an oxidising atmosphere using an SNOL 4/1100 LSC01 electric

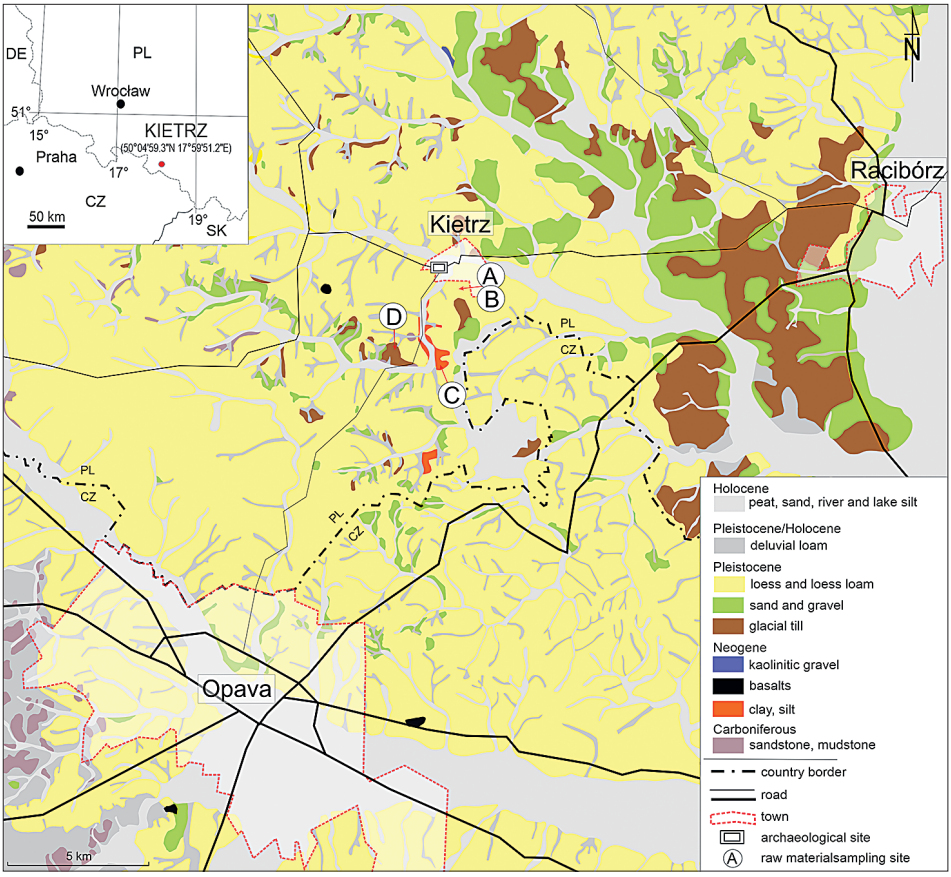


Fig. 2. Geological map of the study area with location of raw material samples (after PGI-NRI Detailed Geological Map of Poland 1:50 000 and Czech geological survey, Geovědní mapy 1:50 000).

furnace equipped with an E5CC controller. The temperature was increased at a rate of approximately 1.5°C per minute. After reaching 700°C, the ceramics were soaked at this temperature for about two hours. Subsequently, the temperature was reduced from 700°C to ambient conditions at a controlled cooling rate of approximately 1°C per minute.

Petrographic characterisation of the samples was conducted using polarised light microscopy (PLM). Analyses were performed with a Zeiss Axiolab microscope on standard petrographic thin sections (35–40 µm thick), prepared using the method described by *Quinn* (*2013*, 23–33). Modal composition was determined using JMicroVision software (*Roduit 2007*, 84–87) and a series of photomicrographs of the thin sections, applying the point-counting method. The longest Feret diameter (Feret max) of 500 grains per thin section intersected by a grid of parallel lines superimposed on the micrographs was measured using JMicroVision. The results were analysed with the Gradistat grain size distribution and statistics package (*Blott – Pye 2001*, 1240), and descriptive parameters were calculated using the method from *Folk* and *Ward* (*1957*, 6; *Folk 1954*, 347). The roundness of particle inclusions was assessed using a visual comparison chart (*Powers 1953*, 118).

Sample no.	Description	Petrographic group & subgroup
1	handmade pot fragment with linear ornament	1b
2	wheel-thrown pot fragment (grey ware)	1a
3	wheel-thrown pot fragment (grey ware)	1a
4	wheel-thrown pot fragment (grey ware)	1a
5	handmade pot fragment	1b
6	wheel-thrown pot fragment (grey ware)	2
7	wheel-thrown pot fragment	1a
8	wheel-thrown pot fragment (grey ware) with ornament	1a
9	wheel-thrown pot fragment, light grey/beige colour	1a
10	handmade pot fragment, rough exterior	1b
11	bottom of wheel-thrown pot, with linear ornament	1a
12	handmade pot fragment	2
13	wheel-thrown pot fragment (grey ware)	1a
14	bottom of wheel-thrown pot	1a
15	bottom of wheel-thrown pot; light grey/beige	1b
16	wheel-thrown pot fragment; scorching visible inside	1b
17	wheel-thrown pot fragment; scorching visible inside	1a
18	wheel-thrown pot fragment (grey ware)	1a
19	handmade pot fragment	1b
20	handmade pot fragment	2
21	wheel-thrown pot fragment (grey ware)	1a
22	handmade pot fragment	1b
23	wheel-thrown pot fragment, light grey/beige colour	1a
24	bottom of handmade pot	2
25	wheel-thrown pot fragment; orange colour	1a
26	wheel-thrown pot fragment (grey ware)	1a
27	wheel-thrown pot fragment; light grey/beige, with plastic strip	1a
28	handmade pot fragment, with stabbed ornament	1b
29	wheel-thrown pot fragment, light grey/beige colour	1a
30	handmade pot fragment	1b
31	wheel-thrown pot fragment (grey ware)	1a
32	handmade pot fragment, with dish holder	1b
33	wheel-thrown pot fragment (grey ware)	1a

Tab. 1. Summary of the ceramic samples included in the analysis.

SEM-EDX analysis was carried out using a JEOL JSM IT-100 microscope (JEOL, Akishima City, Tokyo, Japan) equipped with an energy-dispersive X-ray spectrometer. The analyses were performed on fresh fracture surfaces of the ceramic sherds, oriented perpendicular to the exterior vessel surfaces, in order to examine unweathered microstructural and compositional features. Samples were examined in backscattered electron (BSE) mode under low vacuum conditions (~25–35 Pa) at an acceleration voltage of 14 kV, without the application of a conductive coating. In addition to point analyses, EDS spectra were collected from a set of small areas of the clay matrix to determine chemical composition.

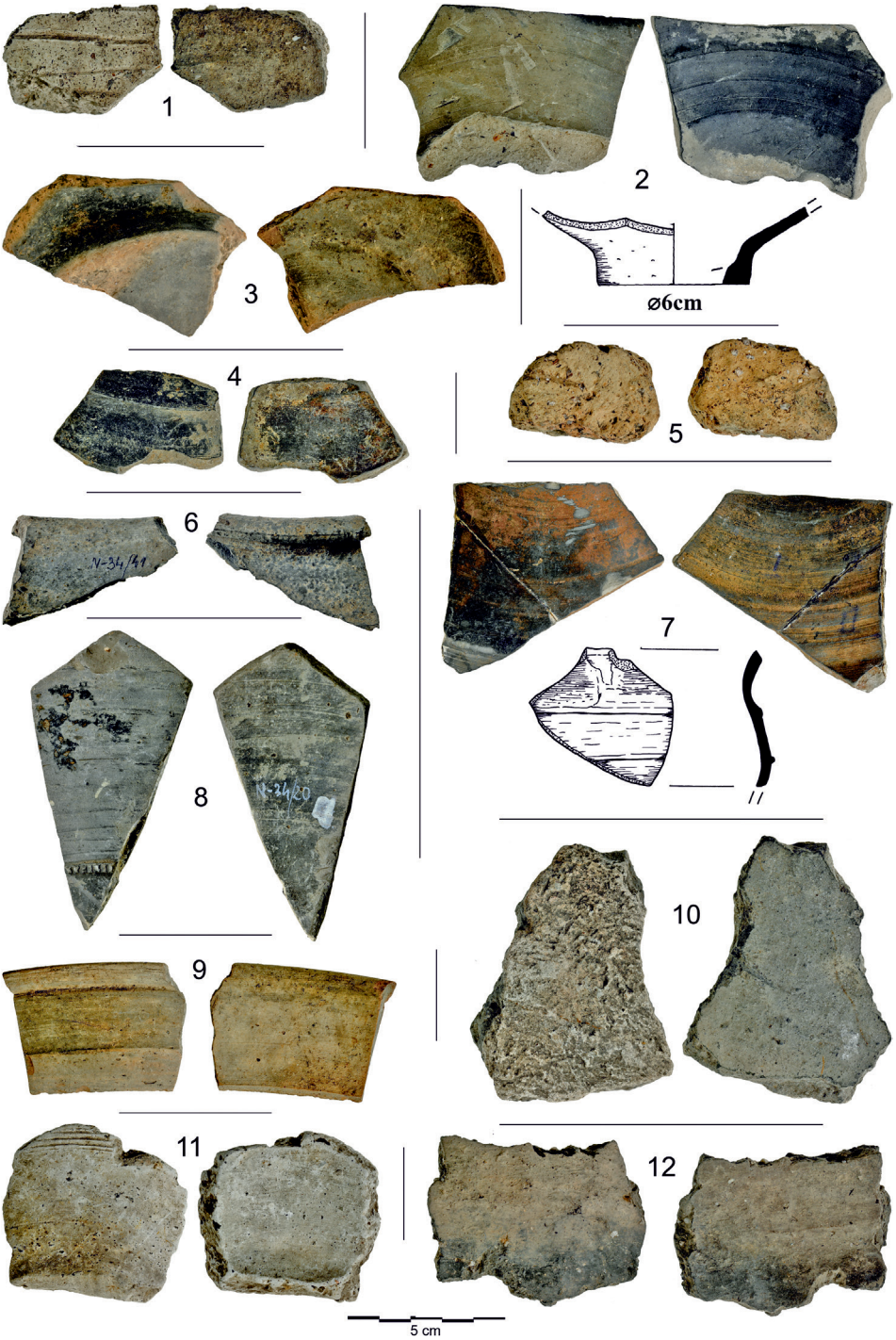


Fig. 3A. Sampled pottery finds (drawings by Krzysztof Dołbizno).

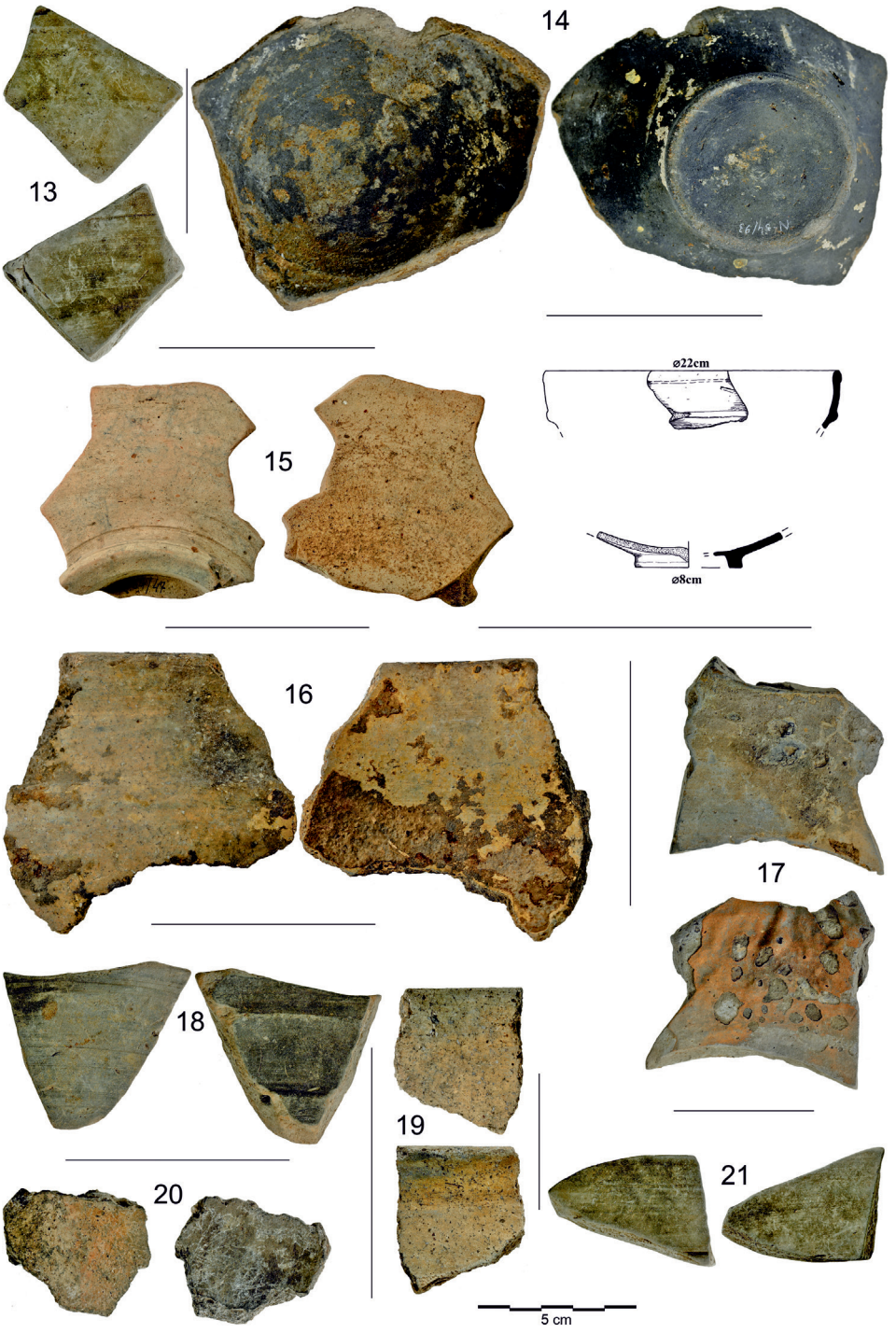


Fig. 3B. Sampled pottery finds (drawings by Krzysztof Dołbizno).

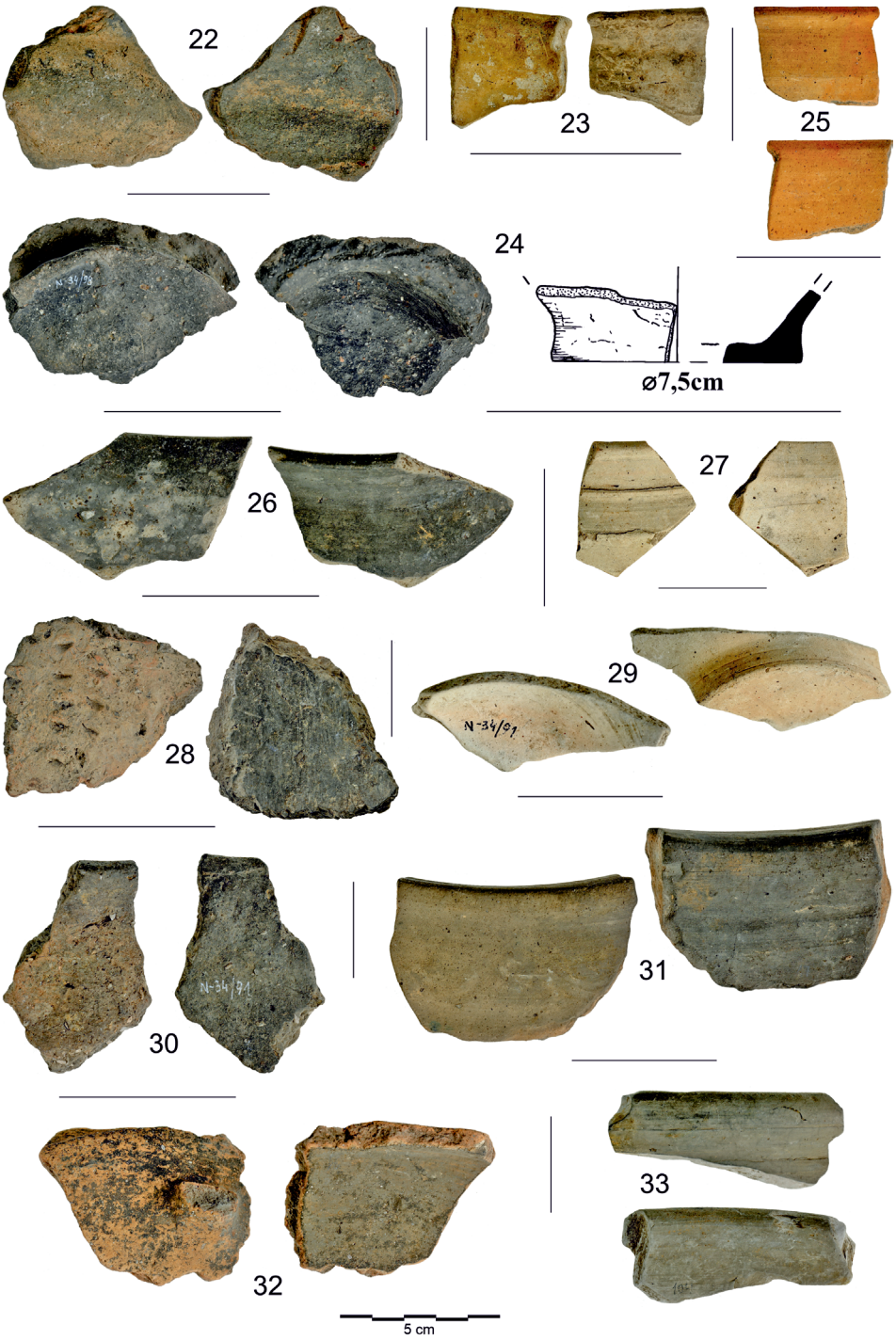


Fig. 3C. Sampled pottery finds (drawings by Krzysztof Dołbizno).

Differential scanning calorimetry–thermogravimetric analysis (DSC-TG) was conducted using a PerkinElmer STA6000 calorimeter with an Al_2O_3 sample pan, in the temperature range of 40–999°C, at a constant heating rate of 15°C/min. under a nitrogen atmosphere. Data interpretation was carried out using PYRIS software.

Powder X-ray diffraction (PXRD) patterns were obtained with a Bruker D8 Advance diffractometer operating at 40 kV and 40 mA, using CuKα radiation. Measurements were performed in the 2θ range of 4° to 75°, with a step size of 0.01° and a scan time of 2 s per step. Unprocessed raw material samples were also studied to determine the mineral composition of their clay-sized fraction. Samples were suspended in 500–700 ml of distilled water for gravitational separation (~12 h; *Środoń 2006*, 766–767). The obtained suspension was centrifuged and used to prepare three oriented mounts: (1) saturated with ethylene glycol; (2) heated for 1 h at 550°C; and (3) untreated. The measurements were taken in the 2θ range of 3–35. The results were compared with standard reference patterns from the ICDD database (*ICDD 2003*).

Results

Ceramic sherds

The petrographic results presented below make it possible to differentiate two ceramic groups – Group 1 and Group 2, which differ in the proportion and grain-size characteristics of their non-plastic inclusions. Mineralogical analysis shows that the samples consist of a clay matrix with randomly distributed inclusions, predominantly quartz (*Tab. 2*; *Fig. 4*). Feldspars (alkali feldspar and plagioclase) and lithic fragments are rare. Accessory components include muscovite flakes, opaques, and other minor phases like biotite, epidote, zircon, amphibole, zoisite, garnet, and rutile. These constituents are very small, typically <0.05 mm, and rarely exceed 0.1 mm.

According to *Folk* (*1954*, 347), inclusions are classified as poorly to moderately sorted sediments. Most grains are subangular to angular, with fewer subrounded forms (*Powers 1953*, 118). Despite shared features, the analysed samples differ notably in grain-size distribution (*Fig. 4*; *Fig. 5*). Based on the *Folk* and *Ward* (*1957*) descriptive classification, the majority of ceramic samples (1–8, 10, 11, 15, 16, 17, 19, 22, 23, 25, 27–30, and 32) contain inclusions corresponding to very coarse or coarse silt. A smaller subset of samples (9, 13, 14, 18, 21, 26, 31, and 33) exhibits inclusions classified as medium silt. In contrast, samples 12, 20, and 24 contain inclusions of the very fine sand category. The statistical distribution of the ceramic samples was evaluated using principal component analysis (PCA), which revealed clear compositional groupings (*Fig. 6*).

A key distinguishing feature of the samples is the pronounced variability in the proportion of non-plastic components relative to the clay matrix. Notably, samples 1–5, 7–11, 13–19, 21–23, and 25–33 (Group 1) exhibit a high content of inclusions. Within this group, most samples (e.g. 2, 3, 4, 7–9, 11, 13–14, 17–18, 21, 23, 25–27, 29, 31, 33), classified as subgroup 1a, exhibit very fine-grained inclusions (silt fraction), while others (samples 1, 5, 10, 15–16, 19, 22, 28, 30, 32) assigned to subgroup 1b, show a slight enrichment in coarser grains (sand fraction), including quartz, rare crystalline rock fragments, and feldspars, with varying degrees of roundness. Their clay matrix, in most cases locally, contains

Sample	Qz	Fs	Lithic grains (leucocratic rocks)	Lithic grains (claystone)	Ms	Ep	Zrn	Amp	Zo	Rt	Bt	Grt	Biocl	Fe-agg.	Opaques	Others
1	+++	+	+		+									+	+	
2	+++	+	?		+									+	+	
3	+++	+	?		+	+	+	+	+	+				+	+	calcite
4	+++	+	?	+	+	+								+	++	calcite
5	+++	+	+[1]		+	+								+	+	
6	+	+	+		+										++	
7	+++	+	?		+		+	+		+	+				+	
8	+++	+	?	+	+										+	calcite
9	+++	+	?		+						+				+	calcite
10	+++	+	?	+	+		+	+				+		+	++	
11	+++	+	+		+									+	+	
12	+	+	+		+										++	
13	+++	+	?		+		+					+			++	
14	+++	+	?		+	+	+	+	+					+	+	
15	+++	+	+		+									+	+	
16	+++	+	+		+									+	+	
17	+++	+	?		+										+	
18	+++	+	?	+	+										++	
19	+++	+			+		+								+	
20	++	+	+		+										+	
21	+++	+	?		+									+	++	
22	++	+	+		+								++		+	calcite
23	+++	+		+	+		+	+						+	++	
24	+	+	+		+									+	+	
25	+++	+	?		+	+	+							+	+	
26	+++	+	?	+	+									+	+	
27	+++	+	?		+									+	+	
28	++	+	+	+	+			+						+	+	
29	+++	+	?		+										++	
30	+++	+	+	+	+									+	+	
31	++	+	+		+									+	+	
32	++	+	?		+										+	
33	+++	+	?		+										+	

[1] large, angular grains

Tab. 2. Summary of microscopic PLM observations. Abbreviations after *Warr* (*2021*): Qz – quartz; Fs – feldspar group; Ep – epidote; Zrn – zircon; Amp – amphibole; Zo – zoisite; Rt – rutile; Bt – biotite; Grt – garnet; Biocl – bioclasts; Fe.agg. – Fe-aggregates. Quantification: +++ – very abundant; ++ – abundant; + – rare; ? – trace amounts/probably present.

well-preserved flakes of primary clay minerals. It appears yellowish beige to rusty-brown in plane-polarised light and shows strong birefringence under crossed polars (*Fig. 4*). Lenticular voids (0.5–1.0 mm), aligned parallel to the vessel rim, are common in several samples, though overall microporosity is low. Moreover, in samples 3, 4, 8, 9, and 22,

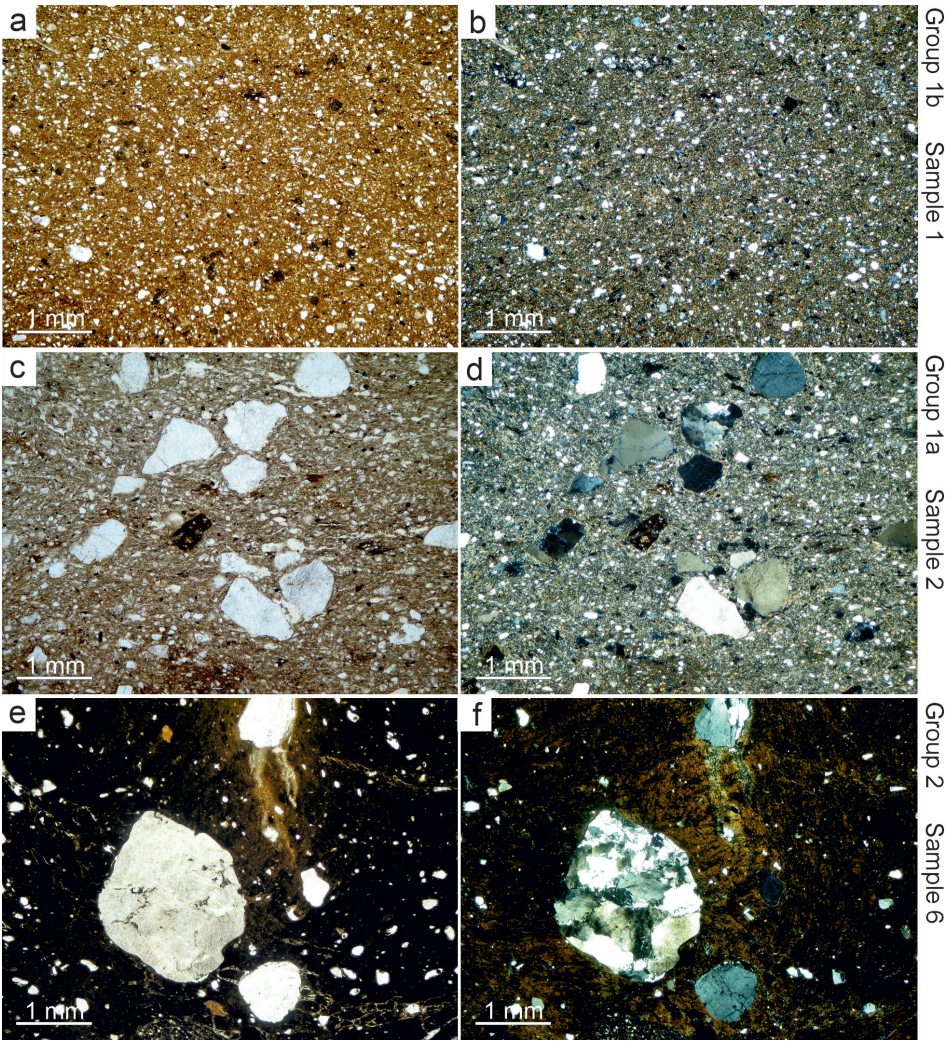


Fig. 4A. Photomicrographs of representative samples taken in plane-polarised light (left column) and cross-polarised light (right column): a, b – sample 1 (Group 1b); c, d – sample 2 (Group 1a); e, f – sample 6 (Group 2);

microcrystalline carbonate aggregates ($\leq$1 mm) occur, mostly as micrite and occasionally as sparite (*Tab. 3*). The shape does not allow a classification of calcite as primary or secondary. Additionally, sample 22 contains small structures ($\leq$1 mm) with sickle-like shapes (*Fig. 4B*), composed of microcrystalline, strongly birefringent material, likely calcium carbonate (*Tab. 3*). These may represent bioclasts (e.g. mollusc and foraminifera shell fragments) or secondary carbonate infills of voids formed by decomposed organic matter (possibly plant-derived).

In some samples (4, 8, 10, 18, 23, 26, 28, 30), rounded, lens-shaped clusters of parallel-oriented clay flakes, interpreted as claystone fragments, are present (*Fig. 4*). Additionally,

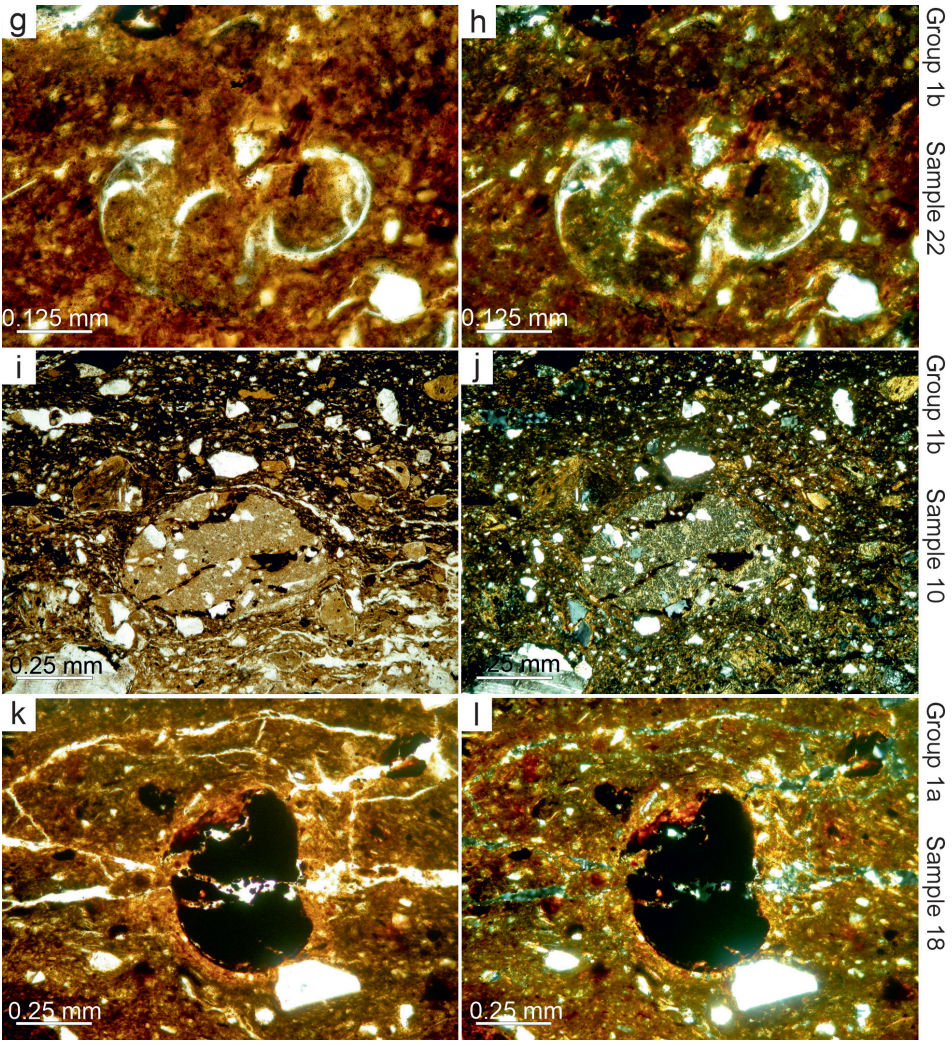


Fig. 4B. Photomicrographs of representative samples taken in plane-polarised light (left column) and cross-polarised light (right column): g, h – sample 22 (Group 1b) with foraminifera bioclast; i, j – sample 10 (Group 1b) with claystone fragments; k, l – sample 18 (Group 1a) with Fe-bearing aggregate.

cryptocrystalline Fe-bearing aggregates occur as oval lenses (<1.0 mm; *Fig. 4*) or discontinuous laminae within the clay matrix, extending up to 5–6 mm. These aggregates are inclusion-poor and composed of a rusty-brown cryptocrystalline substance (goethite; *Tab. 3*) with minor clay content.

In contrast, samples 6, 12, 20, and 24 (Group 2; *Fig. 4*) differ markedly from Group 1 sherds; they are dominated by the clay matrix and contain only sparse non-plastic inclusions, consisting primarily of quartz, with occasional feldspars and fragments of leucocratic crystalline rocks. Accessory minerals, mainly opaques, are scarce (*Tab. 2*). Some are with rusty, translucent rims, likely representing weathered iron minerals. Occasional

Sample	Qz	Kf	Pl	Spl	Px	Hem	Mul	Crs	Ilt/Ms	Kln	Sme	Cal	Brt	Jrs	Amp	Ant	Gp	Gth
1	+++	+	++						++									
2	+++	+	tr						++			tr						
3	+++	+	+						+						tr			
4	+++	+	+						+									
5	+++	++	++						++									
6	+++	+	+						+									
7	+++	+	+						+									
8	+++	+	+	+	+							+						tr
9	+++	+	++	+	+			+										
10	+++	+	+						+						tr			
11	+++	+	+						+				tr					
12	+++	+	+						+									
13	+++	+	+						+									tr
14	+++	+	+				?		+	tr				tr				
15	+++	++	++	?	+	+												
16	+++	+	tr				+					+						
17	+++	+	++	+	+													
18	+++	+	+						+	+	?							
19	+++	tr														tr		
20	+++	+	tr						+								tr	
21	+++	+	+						+									
22	+++	+	+						+			tr						tr
23	+++	+	+						+									
24	+++	++	++						+									
25	+++	+	+						+									
26	+++	+	+						+									
27	+++	+	+				+		tr									
28	+++	+	+						+						tr			
29	+++	+	+				?		tr								?	
30	+++	+	+						+									
31	+++	+	+						+									
32	+++	++	+		+	+												
33	+++	+	+						+									

Tab. 3. List of crystalline phases identified through X-ray diffraction analysis. The following abbreviations are used: Qz – quartz; Kf – alkali-feldspar; Pl – plagioclase; Spl – spinel; Px – pyroxene; Hem – hematite; Mul – mullite; Crs – cristobalite; Ilt – illite; Ms – muscovite; Kln – kaolinite; Sme – smectite; Cal – calcite; Brt – baryte; Jrs – jarosite; Amp – amphibole; Ant – anatase; Gp – gypsum; Gth – goethite (*Warr 2021*, 292, 294–295, 297, 301–304, 308, 311–312, 314). Quantification: +++ – abundant component; ++ – subordinate component; + – accessory component; tr – trace component; ? – component whose presence is uncertain.

muscovite flakes are also present. The clay matrix has a light beige to brown colour, occasionally appearing brown-black in plane-polarised light, with a translucent, rusty-red hue. In cross-polarised light, it may be optically inactive or nearly isotropic in darker samples, but more commonly shows strong birefringence, with simultaneous extinction in clay mineral aggregates. Elongated pores, aligned parallel to vessel margins, can reach several millimetres in length.

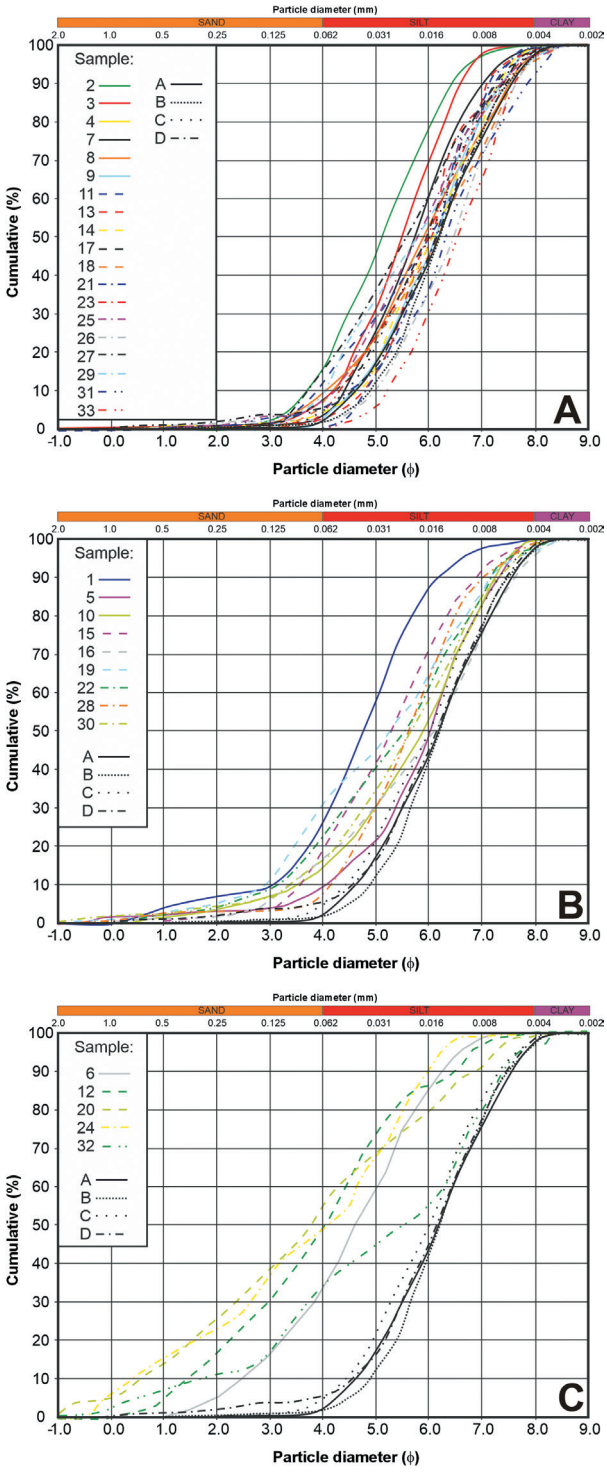


Fig. 5ABC. Comparison of cumulative grain size curves illustrating the granulometric characteristics of the ceramic samples and the raw material samples.

Sample	Temperature range						Total mass loss/ mass gain
	40–120°C	120–200°C	200–400°C	400–600°C	600–650°C	650–999°C	
2	0.64	0.61	0.95	1.03 570°C qz	0.24 cal	0.52 675°C cal 920°C exo?	3.99
3	1.53	1.55	1.38	1.02 570°C qz	0.10	0.09 910°C exo?	5.67
4	0.35	0.41 230°C viv	1.05	0.23 570°C qz	0.01	0.24 msc>1000°C	2.29
5	1.58	2.07	1.83	1.06 570°C qz	0.09	0.17 910°C exo?	6.8
6	1.09	1.1	1.41	1.37 570°C qz	0.20	0.67 msc>1000°C	5.84
7	0.61	0.45	0.74	0.68 570°C qz	0.09	0.04	2.61
8	0.29	0.26	0.88	0.31	0.13	0.43 m.l. 675°C. cal/0.38 m.g.	2.30
9	0.17	0.22	0.73	0.23	0.04 635°C. cal	0.33 m.g.	1.39
10	1.34	1.28	1.42	1.24 570°C qz	0.18	0.47 msc? 920°C exo?	5.93
11	0.30	0.31	0.89	0.47 570°C qz	0.01	0.25 m.g.	1.98
12	1.89	1.42	2.34	2.72 570°C qz	0.36	1.09 930°C exo?	9.82
13	0.28	0.23	0.69	0.20 570°C qz	0.02 m.g.	0.31 m.g.	1.4
14	0.40	0.30	0.96	0.51 570°C qz	0.02	0.14 msc>1000°C	2.33
15	0.49	0.37	0.59	0.37 570°C qz	0.13 cal	0.22 m.l. 665°C. cal/0.07 m.g.	2.17
16	0.26	0.29	0.94	0.46 570°C qz	0.16 cal	0.87 m.l. 710°C. cal 985°C exo?	2.98
17	0.21	0.19	0.76	0.18 570°C qz	0.02 m.g.	0.40 m.g.	1.34
18	1.64	1.39	1.72	1.56 570°C qz	0.14	0.42 900°C exo?	6.87
19	0.19	0.29 220°C viv	0.84	0.23 570°C qz	0.02	<0.01	1.57
20	1.85	2.00	1.95	1.68 570°C qz	0.20	0.89 980°C exo?	8.57
21	0.11	0.19	0.65	0.21 570°C qz	<0.01	0.16 m.g.	1.16
22	1.80	2.09	1.87	1.09 570°C qz	0.23 cal	1.05 700°C cal	8.13
23	0.07	0.12	0.45	0.12 570°C qz	<0.01	0.18 m.g.	0.76
24	2.83	3.4	2.97	1.82	0.26	0.60 msc>1000°C	11.88
25	0.15	0.18	0.57	0.18 570°C qz	<0.01	0.07 m.g.	1.08
26	1.43	1.37	1.26	0.83 570°C qz	0.07	0.11	5.07

27	0.04	0.25 210°C viv	0.68	0.07 570°C qz	0.02	0.17 m.g.	1.06
28	1.83	1.52	2.38	2.19 570°C qz	0.28	1.21 msc>1000°C	9.41
29	0.06	0.23 215°C viv	0.77	0.13 570°C qz	<0.01	0.23 m.g.	1.19
30	2.11	1.17	2.04	1.91 570°C qz	0.27	0.49 msc>1000°C 910°C exo?	7.99
31	0.89	0.81	1.12	0.93 570°C qz	0.15	0.40	4.3
32	0.30	0.29	0.87	0.22 570°C qz	0.16	0.20 m.g.	1.84
33	0.42	0.34	0.63	0.38 570°C qz	<0.01	0.18 m.g.	1.77

Tab. 4. Summary of thermal analysis results expressed as weight loss [% by weight] (unless otherwise noted) within selected temperature ranges (after *Moropoulou et al. 1995*, 747), corresponding peak temperature of endo/exothermic effect, and identified mineral phase. Abbreviations used: qz – quartz, ilt – illite, cal – calcite, viv – vivianite, msc – muscovite (*Warr 2021*, 295, 303, 308, 312, 317), m.l. – weight loss, w.g. – weight gain.

In most samples, PXRD peaks attributed to illite and/or muscovite were identified (*Tab. 3*). The relative intensity of the reflections of these phases varies. As the degree of firing increases, the intensity of the main illite/muscovite peak decreases, eventually disappearing completely, which corresponds to the total destruction of the crystalline structure (as supported by the TG-DTA curves in *Online Supplementary Material 1*). According to various authors, this peak persists up to approximately 800–950°C (*Rathossi et al. 2004*, 321; *Maritan et al. 2006*, 6–7). Notably, reflections of these commonly occurring minerals were not observed in samples 8, 9, 15, 16, 17, 19, and 32, while in samples 27 and 29, their main reflection was barely distinguishable from the background noise. PXRD analysis also revealed the presence of several high-temperature mineral phases formed during firing, including spinel, pyroxenes, hematite, mullite, and cristobalite (*Tab. 4*; *Online Supplementary Material 1*). The formation of these phases occurs over a broad but mineral-specific temperature range, as reported in the referenced experimental studies. Hematite begins to form at approximately 750–850°C and becomes well crystallised above ~1000°C (*Uğurlu Sağin – Böke 2013*, e75; *Manoharan et al. 2011*, 21). Calcium-rich pyroxenes develop between ~800 and 900°C (*Uğurlu Sağin – Böke 2013*, e75; *Molera et al. 1998*, 199). Spinel-type phases appear at temperatures around 900–1000°C (*Maritan et al. 2006*, 7; *Manoharan et al. 2011*, 21–22). Mullite nucleation typically begins near 950–1000°C, simultaneously with the formation of cristobalite (*Manoharan et al. 2011*, 21–22). The occurrence of these phases in samples 8, 9, 14–17, 27, 29, and 32 is therefore consistent with firing temperatures exceeding ~900°C.

Rare phases with very low intensity peaks, such as baryte, amphibole, and anatase (*Tab. 4*; *Online Supplementary Material 1*), are accessory components derived from the raw materials used in ceramic production. Other secondary phases, including gypsum, jarosite, and goethite, are related to post-depositional processes during burial in soil layers. Calcite may represent a secondary phase, but it can also be of primary origin, as indicated by the presence of preserved carbonate bioclasts in at least one sample.

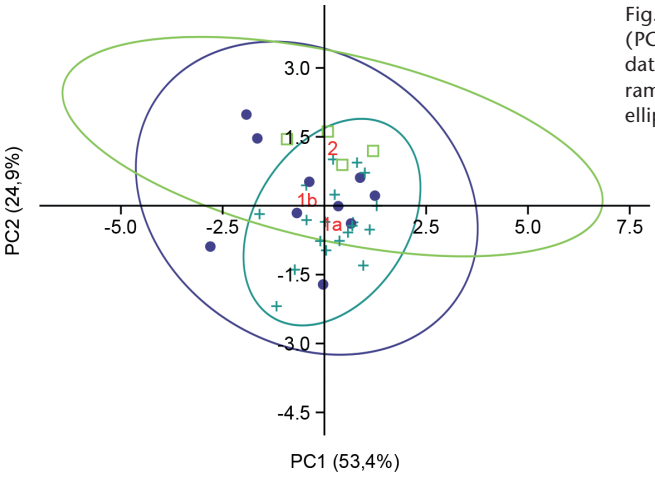


Fig. 6. Principal component analysis (PCA) of the chemical composition data, showing the distribution of ceramic samples and 95% confidence ellipses for groups 1a, 1b, and 2.

SEM–EDS observations, supported indirectly by the low total mass loss recorded in the TG curves (Tab. 4, SM1), indicate that most ceramic samples reached an advanced firing stage. The strongest evidence for high-temperature firing comes from vessels 8, 9, 15–17, 21, 23, and 25, which display well-developed vitrification: a dominant glassy matrix and abundant fine bloating pores (~5 µm) (*Fig. 7*; *Maniatis – Tite 1981*, 68).

A second group of sherds, i.e. samples 6, 13, 14, 19, 20, 24, and 27–29, exhibits initial vitrification. These specimens contain partially homogenised glassy areas with fewer bloating pores, while remnants of clay-mineral structures are still recognisable.

In contrast, samples 1–5, 7, 10–12, 18, 22, 26, 30–31, and 33 show no signs of vitrification. Their microstructures are characterised by well-preserved clay flakes and, in some cases, primary textures such as kaolinite booklets and micro-laminations, indicating firing temperatures insufficient to initiate vitrification. These sherds also exhibit the highest total mass loss, resulting in part from the thermal decomposition of preserved clay-mineral relics.

The SEM-EDS analysis indicates that the ceramic matrix consists primarily of silicate and aluminosilicate phases, with minor contributions from iron-bearing components, while trace amounts of potassium, magnesium and calcium are also present (*Tab. 5*). Most elemental concentrations remain relatively stable across samples, whereas calcium and phosphorus exhibit notable variability; minor quantities of titanium, sodium and occasionally sulphur are likewise detected.

Raw material

In all sedimentary rock samples collected around the Kietrz 7 site, the primary non-plastic component is detrital quartz (*Fig. 8*). Most grains are fine, typically smaller than approximately 0.05 mm, although a few larger grains, reaching up to several tenths of a millimetre, are present in samples B (loess loam) and D (glacial till). Feldspar grains, including both alkali feldspar and plagioclase, occur only rarely in comparison with quartz and thus form a subordinate component. Additionally, grains of polycrystalline quartz and lithic fragments composed of leucocratic minerals (quartz and feldspars), presumably of granitic origin and smaller than about 1.0 mm, were observed in samples B and D.

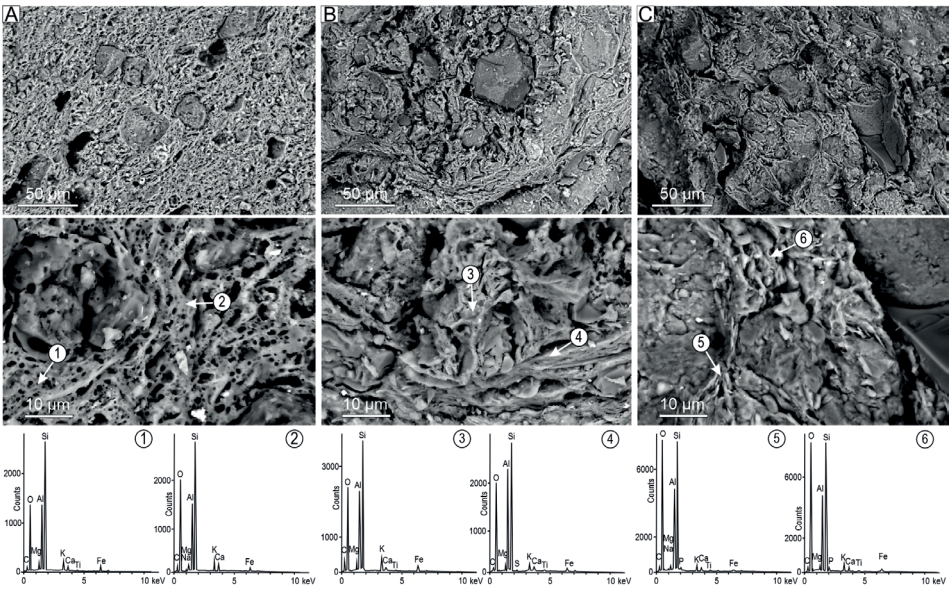


Fig. 7. SEM-BSE images of pottery: A – sample 9 (group 1a); B – sample 19 (group 1b); C – sample 1 (group 1b), with representative EDS spectra.

A notably greater diversity of non-plastic components is observed among the accessory constituents. In samples A and B (both loess loam), these occur as small grains, typically less than 0.01 mm in size, occasionally reaching up to approximately 0.05 mm. They are relatively common and likely include zircon, biotite, rutile, epidote, amphibole, and opaque minerals (e.g. magnetite, ilmenite). Sample C (Miocene clay) differs from A and B by its clay-dominated matrix and low content of non-plastic components, including accessory minerals. They include muscovite flakes, typically smaller than 0.05 mm and only occasionally reaching 0.2–0.3 mm, along with opaque minerals and irregularly shaped, cryptocrystalline, rust- to dark-brown intergrowths, likely composed of iron oxide-hydroxide phases such as goethite or lepidocrocite.

Sample D (glacial till), like samples A and B, contains a mineralogically diverse assemblage of accessory components. These are abundant and appear slightly more frequently than in the other two samples. Most grains are smaller than approximately 0.05 mm and are predominantly represented by muscovite flakes. Less common constituents include biotite, epidote, zircon, opaque minerals (oxides and/or sulphides), and possibly zoisite, amphibole, tourmaline, or garnet.

Grain size analysis of the detrital components indicates that all samples are dominated by silt-sized particles (*Fig. 5*), including coarse, medium, and fine silt fractions (*Folk 1954*, 347). Very coarse and very fine silt grains are present only in trace amounts. Sand-sized grains form a subordinate part of the assemblage and are primarily represented by very fine sand; larger sand grains are rare. Cumulative grain size curves (*Fig. 5*) show that sample D is slightly enriched in sand-sized particles compared to samples A, B, and C. Aside from this distinction, no significant differences in grain size distribution are observed among the samples.

	1	2	3	4	5	6	7	8	9	10	11
SiO_2	63.1	58.2	56.3	58.0	46.6	60.5	63.5	57.9	57.7	58.9	55.3
Al_2O_3	25.1	28.6	21.8	21.1	19.7	28.6	21.3	21.7	23.8	23.2	28.8
FeO	3.9	4.5	9.1	8.9	17.1	2.7	7.5	7.4	5.5	6.0	6.2
MnO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MgO	1.1	1.2	1.2	2.2	1.7	1.3	0.9	2.1	2.8	1.2	1.6
CaO	2.6	1.3	3.3	3.5	5.7	1.8	1.5	3.9	3.6	3.2	1.4
Na_2O	0.4	0.0	0.0	0.5	0.0	0.0	0.1	0.5	0.6	0.0	0.0
K_2O	2.7	3.4	1.8	3.2	4.6	2.2	4.0	2.7	4.2	3.1	3.8
P_2O_5	2.4	0.0	4.2	0.0	4.5	2.0	0.0	0.0	0.0	1.8	0.7
TiO_2	0.7	0.7	0.0	0.8	1.2	0.0	1.12	0.0	0.0	1.2	0.8
SO_3	0.0	0.0	0.0	0.0	0.0	0.8	0.00	0.0	0.0	0.0	0.0

	12	13	14	15	16	17	18	19	20	21	22
SiO_2	54.2	59.6	57.80	51.0	59.6	54.1	61.2	53.4	57.2	59.5	47.0
Al_2O_3	28.8	23.2	21.30	19.8	28.5	25.4	23.1	27.1	27.1	23.6	25.2
FeO	4.5	6.7	9.05	5.4	6.0	8.4	6.4	8.8	4.9	9.1	7.6
MnO	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MgO	1.1	1.6	1.80	3.9	1.4	2.3	2.1	1.1	1.4	1.7	2.1
CaO	2.5	0.8	0.85	15.3	1.4	3.9	2.2	2.0	1.9	1.2	9.4
Na_2O	0.0	0.6	0.20	1.2	0.4	0.7	0.0	0.0	0.0	0.6	0.0
K_2O	2.6	5.4	2.75	2.1	2.1	3.4	2.3	3.5	3.1	3.4	2.5
P_2O_5	2.3	0.0	0.00	0.0	0.0	0.0	1.7	0.0	2.3	0.0	4.6
TiO_2	0.0	0.6	0.40	0.0	0.7	0.6	0.7	1.4	0.8	0.3	0.4
SO_3	0.8	0.0	4.25	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.2

	23	24	25	26	27	28	29	30	31	32	33
SiO_2	62.3	51.2	62.5	50.7	59.3	60.7	54.5	54.7	60.9	59.8	54.1
Al_2O_3	24.4	26.9	23.9	20.7	28.1	22.7	20.9	23.4	23.2	21.3	19.3
FeO	3.6	7.5	6.1	11.2	4.3	6.0	12.4	10.4	6.5	12.8	15.5
MnO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MgO	1.9	1.7	1.7	1.6	1.2	1.7	0.0	2.2	1.7	1.2	0.9
CaO	1.1	4.7	0.7	4.2	0.7	2.1	0.7	3.2	2.1	1.7	1.1
Na_2O	0.8	0.0	0.8	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.3
K_2O	2.9	2.2	2.2	2.9	3.5	3.4	4.7	2.4	3.5	2.9	7.5
P_2O_5	0.0	4.9	0.0	5.6	0.0	1.5	0.0	3.3	0.8	0.0	0.1
TiO_2	0.6	0.0	0.6	0.0	0.8	0.7	1.2	0.3	0.5	0.1	0.7
SO_3	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Tab. 5. Summary of the chemical composition of the matrix (reported values represent average weight percentages for each sample calculated based on five 5 μm^2 surface areas scans).

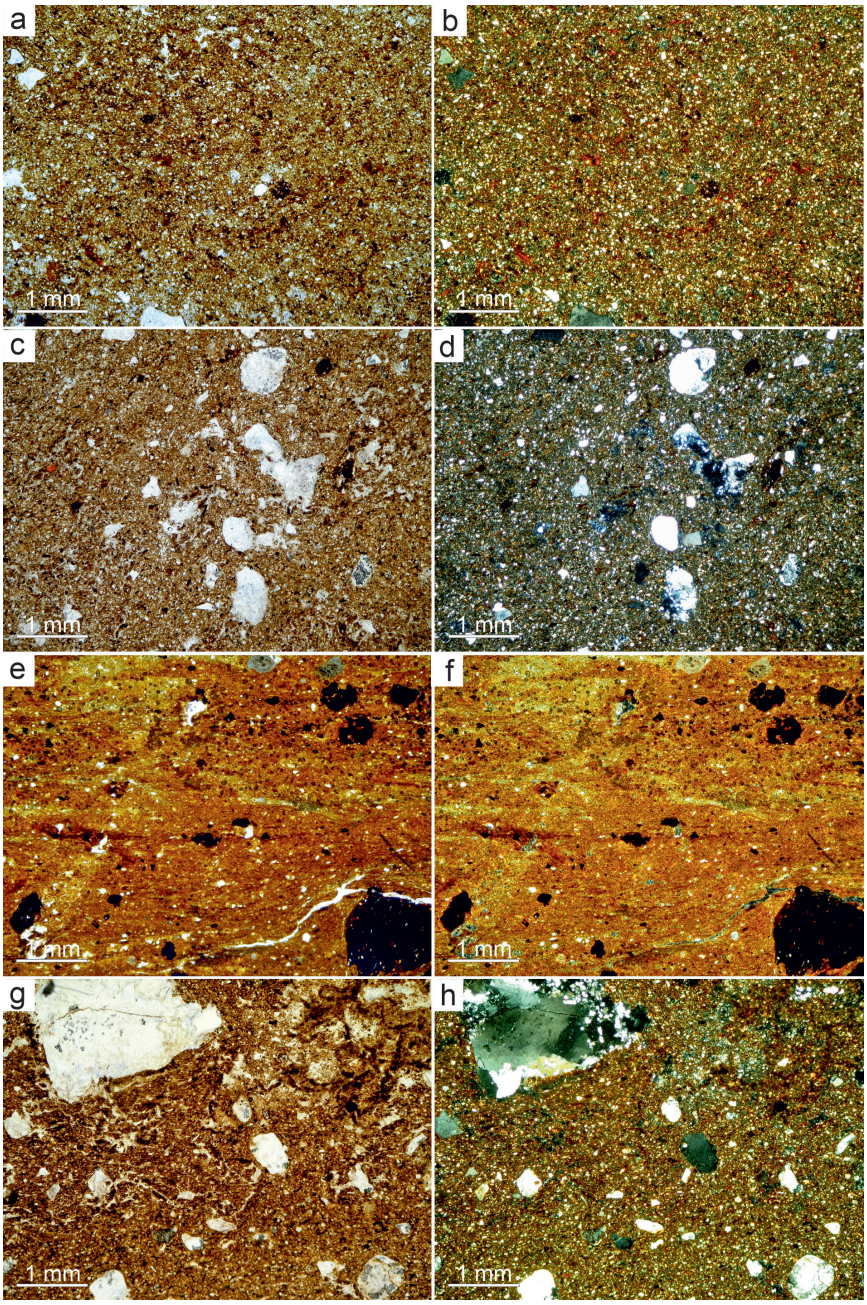


Fig. 8. Photomicrographs of raw-material samples taken in plane-polarised light (left column) and cross-polarised light (right column): a, b – sample A (Pleistocene loess loam); c, d – sample B (Pleistocene loess loam); e, f – sample C (Neogene clay); g, h – sample D (Pleistocene glacial till). The photomicrographs illustrate the textural variability of the raw materials: a, b – well-sorted loess loam; c, d – moderately-sorted loess loams with abundant coarse quartz inclusions; e, f – laminated Neogene clay with brown iron-oxide aggregates; g, h – poorly sorted glacial till containing quartz, feldspar, and lithic clasts.

	A	B	C	D
SiO_2	62.88	61.76	51.99	57.91
Al_2O_3	20.99	18.00	20.71	17.74
Fe_2O_3	7.25	8.84	7.96	12.90
MnO	0.00	0.09	0.00	0.00
MgO	1.86	1.60	2.15	2.03
CaO	0.83	3.71	12.56	2.93
Na_2O	0.93	1.08	0.09	0.69
K_2O	4.35	4.14	3.99	3.89
P_2O_5	0.00	0.00	0.00	0.00
TiO_2	0.90	0.74	0.53	1.11
SO_3	0.00	0.05	0.00	0.00

Tab. 6. Summary of the chemical composition of the clay matrix (reported values represent average weight percentages for each sample calculated based on five 5 μm² surface areas scans).

	Sample			
Constituent	A	B	C	D
Main	Ilt/Ms, Kln & Mnt/Non or Mnt-Chl	Ilt/Ms, Kln & Mnt/Non or Mnt-Chl	Ilt/Ms, Kln, Mnt/Non	Ilt/Ms, Kln, Mnt-Chl(?)
Accessory	Qz, Kf, Pl	Qz, Kf, Pl, Cal	Qz, Kf, Cal(?)	Qz, Kf, Pl

Tab. 7. Summary of results obtained from PXRD analysis for separated clay fractions. Mineral abbreviations: Qz – quartz; Cal – calcite; Pl – plagioclase; Kf – alkali feldspar; Ilt/ms – illite/muscovite; Kln – kaolinite; Mnt – montmorillonite; Non – nontronite; Chl-Mnt – chlorite–montmorillonite mixed-layer mineral. Abbreviations after *Warr* (*2021*, 292, 295, 296, 303, 304, 308, 309, 311, 312).

The fired raw material samples show evidence of moderate thermal alteration of the clay matrix. In all cases, residual flakes are clearly visible, accompanied by numerous micropores. Occasionally, well-preserved aggregates of stacked kaolinite platelets forming characteristic booklets can also be observed. The chemical composition of the clay matrix in all samples is dominated by silica, followed by lower concentrations of aluminium, iron, and potassium (*Tab. 6*). Samples C and D contain slightly less silica compared to samples A and B. Magnesium, as well as titanium and sodium, are present in minor amounts. Notably, magnesium content is somewhat higher in samples C and D. The greatest variability is observed in calcium content: it appears only in trace amounts in sample A, increases slightly in samples B and D, and reaches its highest concentration in sample C.

Analysis of the separated clay-sized fraction revealed some variation in the composition of clay minerals (*Tab. 7*). Samples A and B are dominated by kaolinite and a mineral with an illite and/or muscovite structure. In contrast, smectites (montmorillonite or nontronite) are the principal clay minerals in samples C and D. Regarding subordinate minerals, an inverse proportion is observed: smectites and kaolinite occur in samples A and B, whereas kaolinite and illite and/or muscovite are present in samples C and D. Accessory components identified in the clay fraction include quartz and feldspars, which are common to all samples, and calcite, which was found exclusively in sample C.

Thermal analysis revealed a series of thermal events and associated weight losses. Below 100°C, all samples exhibit the loss of unbound (hygroscopic) water. Between approximately 95 and 130°C, illite undergoes dehydration, followed by smectite (montmorillonite) in the 130–200°C range (*Földvári 2011*, 76, 83). Thermal decomposition of iron

hydroxide minerals (goethite/lepidocrocite) occurs between 200 and 300°C (*Földvári 2011*, 64–65). The 400–600°C interval corresponds to the dehydroxylation of illite. However, the magnitude of mass loss in this range suggests the presence of an additional thermally active phase—most likely kaolinite—which also undergoes dehydroxylation alongside illite (*Földvári 2011*, 68).

At around 570°C, a distinct endothermic peak is observed, corresponding to the thermal transformation of quartz (*Földvári 2011*, 55). This effect is clearly visible in the thermograms of samples A, B, and D, but is weak in sample C, indicating a significantly lower quartz content in the latter. Mass loss between 600 and 800°C is primarily attributed to the dehydroxylation of smectites and the thermal decomposition of calcium carbonates (*Földvári 2011*, 108). In this temperature range, the highest mass loss (5.59 wt.%) is recorded in sample C, which also shows the highest CaO content (*Tab. 6*). XRD observations confirm the presence of calcite exclusively in sample C. Therefore, in samples A, B, and D, mass loss in the range of 600–800°C must be attributed solely to smectite dehydroxylation, whereas in sample C, it most likely reflects a combined effect of smectite dehydroxylation and calcite decomposition. The final thermal event is a sharp exothermic peak above 900°C, without a corresponding mass change, associated with the formation of mullite from residual kaolinite (*Földvári 2011*, 68).

Spatial analysis

In order to determine the significance of the location of the cemetery, which did not function in isolation from the surrounding settlement landscape, spatial analyses were carried out. To examine site-to-site connectivity and territorial patterns, a settlement triangulation was applied (*Valde-Nowak 1995*, 90–95; *2001*; *Connoly – Lake 2006*; *Chmiel-Chrzanowska – Adamczyk 2022*, 119–125). In this framework, triangulation functions as a network-based method where settlement units and contemporary sites are connected into a geometric graph to model direct spatial relationships, inter-site distances and the central or peripheral placement of the site within the local community. Beyond triangulation, the spatial workflow incorporated site-density mapping, buffer analysis around key settlement features, and an evaluation of environmental variables, such as local topography and distance to watercourses (*Wheatley – Gillings 2002*, 148–162). Settlement points known from archival materials, most of which were identified during surface surveys, were used as a database. Only sites dating from the same chronological phase as Kietrz 7 were included in the analysis, which allowed for interpretative consistency and reduced the risk of anachronistic comparisons.

The broad label ‚Roman Period' was used for sites lacking sufficient diagnostic material for more detailed chronological phasing, but the author of this study decided, after examining the pottery, that they should be treated as dating from the late Roman Period (*Tab. 8*). The approach used is in line with landscape archaeology, in which space is treated not as a neutral background for events, but as an active element that co-creates the social structure (*Kuna et al. 2004*, 465). The analysis of the relationships between settlement points was aimed at capturing the network of connections that could have organised the functioning of the micro-region. In this context, triangulation allows not only for the identification of geometric relationships, but also for the modelling of potential communicative, economic or symbolic relationships (*Neustupný 2010*, 146).

No.	Site	Chronology	Dating basis	Source
1	Kietrz 7	C1–C2	25 graves	MŚO w Opolu; *Godłowski 1973*, 285; *Błażejewski 1998*, 87–88, 186
2	Kietrz 11	C2–D	11 graves	*Kaczanowski 1970*; *Godłowski 1973*, 285
3	Kietrz 1	C1–D	7 graves	*Gedl 1988*; *Błażejewski 1998*, 186
4	Kietrz 79	RP	pottery	WUOZ Opole
5	Kietrz 81	RP	1 sherd	WUOZ Opole
6	Kietrz 19	C1–C2	pottery, coins; other metal artefacts; settlement features	*Godłowski 1973*, 286; *Ciołek 2008*, 110–111
7	Kietrz 162	C1–D	14 sherds	WUOZ Opole
8	Kozłówki 6	C1–D	75 sherds	*Godłowski 1973*, 286; WUOZ Opole
9	Kietrz 34	RP	19 sherds	WUOZ Opole
10	Kozłówki 1	RP	pottery	WUOZ Opole
11	Kozłówki 17	C1–D	6 sherds	WUOZ Opole
12	Kozłówki 18	RP	3 sherds	WUOZ Opole
13	Kozłówki 26	RP	1 sherd	WUOZ Opole
14	Księże Pole 14	RP	pottery	*Godłowski 1973*, 287
15	Nowa Cerekwia 1	B2–C/D	pottery; coins; settlement features (fire places, well)	*Pescheck 1936*, 254–260; *Godłowski 1973*, 287–289
16	Nowa Cerekwia 16	RP	pottery; spindle whorl	*Godłowski 1973*, 290
17	Nowa Cerekwia 23	C1–D	2 sherds	WUOZ Opole
18	Nowa Cerekwia 25	RP	pottery	*Godłowski 1973*, 290
19	Nowa Cerekwia 40	C1–D	1 sherd	WUOZ Opole
20	Nowa Cerekwia 35	RP	1 sherd	WUOZ Opole
21	Nowa Cerekwia 103	RP	2 sherds	WUOZ Opole
22	Nowa Cerekwia 44	C1–D	48 sherds	WUOZ Opole
23	Nowa Cerekwia 104	RP	1 sherd	WUOZ Opole
24	Kietrz 167	RP	11 sherds	WUOZ Opole
25	Kietrz 149	RP	16 sherds	WUOZ Opole
26	Kietrz 148	RP	2 sherds	WUOZ Opole
27	Kietrz 151	RP	9 sherds	WUOZ Opole
28	Kietrz 67	RP	1 sherd	WUOZ Opole
29	Kozłówki 20	RP	1 sherd	WUOZ Opole
30	Kozłówki 21	RP	9 sherds	WUOZ Opole
31	Nowa Cerekwia 68	RP	pottery	WUOZ Opole
32	Nowa Cerekwia 9	C1–D	pottery; settlement features	*Godłowski 1973*, 290
33	Nowa Cerekwia 4	C1–D	pottery, coins	*Godłowski 1973*, 289–290
34	Nowa Cerekwia 7	C1–D	pottery	*Godłowski 1973*, 290
35	Nowa Cerekwia 11	C1–D	pottery	*Godłowski 1973*, 290
36	Nowa Cerekwia 78	RP	pottery	WUOZ Opole
37	Rogożany 19	RP	2 sherds	WUOZ Opole
38	Rogożany 21	RP	1 sherd	WUOZ Opole
39	Nowa Cerekwia 33	RP	2 sherds	WUOZ Opole
40	Nowa Cerekwia 51	RP	26 sherds; spindle whorl	WUOZ Opole
41	Nowa Cerekwia 5	C1–D	175 sherds	*Godłowski 1973*, 290
42	Nowa Cerekwia 19	RP	19 sherds	*Godłowski 1973*, 290
43	Chróścielów 41	RP	1 sherd	WUOZ Opole
44	Nowa Cerekwia 34	RP	39 sherds	WUOZ Opole

No.	Site	Chronology	Dating basis	Source
45	Chróścielów 43	C1–D	1 sherd	WUOZ Opole
46	Rogożany 33	RP	1 sherd	WUOZ Opole
47	Chróścielów 54	C1–D	1 sherd	WUOZ Opole
48	Chróścielów 27	RP	pottery	WUOZ Opole
49	Chróścielów 28	RP	33 sherds	WUOZ Opole
50	Nasiedle 22	RP	4 sherds	WUOZ Opole
51	Nasiedle 16	RP	3 sherds	WUOZ Opole
52	Nasiedle 2	RP	pottery	WUOZ Opole
53	Lubotyń 48	RP	49 sherds	WUOZ Opole
54	Lubotyń 49	RP	145 sherds; spindle whorl	WUOZ Opole
55	Lubotyń 50	RP	24 sherds	WUOZ Opole
56	Dzierżysław 126	RP	pottery	WUOZ Opole
57	Dzierżysław 93	C1–D	4 sherds	WUOZ Opole
58	Dzierżysław 83	RP	1 sherd	WUOZ Opole
59	Dzierżysław 76	RP	14 sherds	WUOZ Opole
60	Dzierżysław 35	RP	22 sherds	WUOZ Opole
61	Dzierżysław 75	RP	202 sherds	WUOZ Opole
62	Dzierżysław 45	RP	15 sherds	WUOZ Opole
63	Dzierżysław 2	RP	24 sherds	WUOZ Opole
64	Dzierżysław 74	C1–D	56 sherds	WUOZ Opole
65	Dzierżysław 28	C1–D	pottery	*Godłowski 1973*, 285
66	Dzierżysław 26	B2/C1?	coin	*Godłowski 1973*, 285
67	Kietrz 80	RP	4 sherds	WUOZ Opole

Tab. 8. List of sites included in the research. The number corresponds to the number on the map (*Fig. 9*). List of abbreviations: RP – Roman Period; MŚO – Museum of Opole Silesia; WUOZ – Provincial Office for the Protection of Monuments; pottery – unknown number of sherds.

Within the micro-region under study, it has been possible to distinguish its internal zones, including the area with the highest concentration of points, which can be interpreted as a potential central location. Referring to the theory of the central place, such a concentration may indicate the existence of a centre performing integrating functions (economic, social or ritual) in relation to the surrounding settlements (*Christaller 1963*; *Kobyliński 1987*, 39–42). The cemetery in Kietrz 7, analysed in this context, ceases to be an isolated object and begins to appear as part of a broader organisational structure.

The results of the analyses revealed certain patterns visible in the spatial distribution of the sites, presented on the map (*Fig. 9*) and discussed later in this paper. This approach goes beyond petrographic analyses of ceramics, which focuses on raw materials and technology. The attempt to create a spatial model (still hypothetical) allows for the interpretation of the studied complex in terms of a dynamic network of relationships. This introduces a perspective in which a set of points is transformed into a social landscape, reflecting the ways in which space was organised and perceived by the communities of the time.

The AZP surface survey (a project involving the search for, recording and mapping of archaeological sites, carried out throughout Poland since 1978; *Jaskanis 1996*) and archive excavations identified settlement points on the north side of Troja River indicated

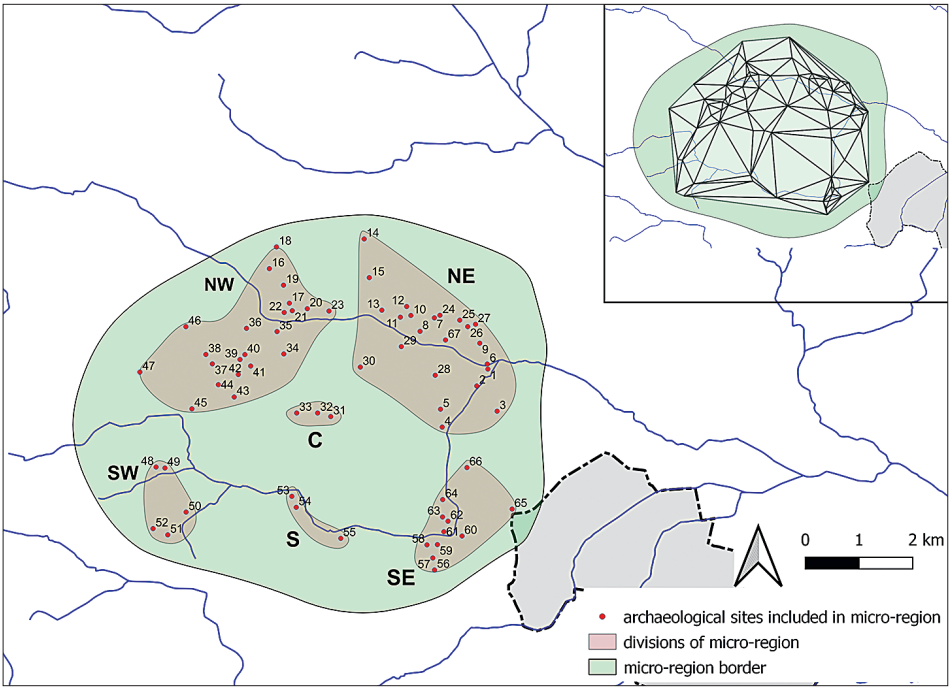


Fig. 9. The Kietrz/Nowa Cerekwia micro-region is divided into zones with each site included in it and triangulation in the corner. Divisions symbols: NE – northeastern division; NW – northwestern division; C – central division; SE – southeastern division; S – southern division; SW – southwestern division.

by numerous pottery fragments and settlement features (*Fig. 9*: divisions NW, NE, 6, 15, 32; *Tab. 8*: 6, 15, 32). Unfortunately, no excavation projects are available that could show what the spatial structure of these settlements looked like. At this point, we can only conceptualise the functions of certain parts of the micro-region (*Fig. 9*). However, this remains a hypothesis. It can be assumed that the settlement points originate from the same phase as the cemetery under investigation (*Tab. 8*). The question is whether the entire micro-region functioned as a single organism, i.e. whether a given part served as a residential area, another as a production area, etc. Recent research on prehistoric communities indicates that specialised manufacturing was integrated into daily life, with individuals engaging in specific tasks during certain times of the year. Various factors likely influenced this, including weather conditions, the availability of raw materials and fuel, or simply the absence of other obligations (*Orton – Hughes 2013*, 23–35; *Duistermaat 2017*, 135–136; *Eramo 2020*, 2, 4).

Sites at the foot of Gipsowa Hill (SE part of the micro-region, *Fig. 9*) contained substantial quantities of pottery fragments and daub (*Tab. 8*, 56–64). Given the proximity to raw material outcrops, it is plausible that a pottery workshop was located there. However, this hypothesis remains open due to the current state of research. From a regional perspective, these elements appear to be interconnected. The geographical context of the region should also be considered. Situated in the northern foreground of the Moravian Gate, along the Amber Road, the inhabitants' daily activities likely included trade or trade-related

responsibilities. This is evidenced by the abundance of *terra sigillata* and glass vessel fragments, as well as the quality of the metalwork.

Discussion

Petrographic analysis revealed two distinct ceramic groups, differing in grain size distribution and clay matrix content. Group 1 comprises samples which contain a high proportion of non-plastic inclusions compared to the clay matrix. Group 2 comprises samples abundant in clay matrix and containing sparse, relatively large non-plastic inclusions. These include moderately to poorly rounded quartz grains and fragments of crystalline rocks.

In several samples assigned to Group 2, the clay matrix preserves relics of structures closely resembling primary sedimentary stratification. Although similar features are less common and more weakly expressed in Group 1, several sherds contain lens-shaped claystone clasts with clear internal lamination (*Fig. 4*). Archaeometric literature shows that primary sedimentary features within claystone-like clasts can survive paste preparation when the plastic raw material is introduced in a semi-consolidated form and only partially disaggregated during kneading, leaving identifiable clay lenses or clasts ('clay pellets') and inherited textural domains in thin section. This persistence and its recognition criteria are well documented in ceramic petrography handbooks and reviews (e.g. *Quinn 2013*, 168–171; *Ben-Shlomo 2025*, 9). Such inherited features are especially expected where raw materials of contrasting plasticity and granulometry are combined, limiting homogenisation efficiency and favouring the survival of laminated claystone fragments in the fired body. Accordingly, the laminated claystone clasts in our material are best interpreted as remnants of a highly plastic component (i.e. Miocene clay) that was not fully disaggregated during mixing and working, a reading fully consistent with established petrographic criteria and *chaîne-opératoire* reconstructions (*Quinn 2013*).

The clay mixing and/or addition of a naturally granular temper to adjust plasticity, workability and drying behaviour is a standard technological solution (*Quinn 2013*; *Eramo 2020*, 3; *Ben-Shlomo 2025*, 5). We therefore interpret most Group 1 vessels (rich in non-plastic inclusions) as made from a deliberately mixed paste combining a highly plastic Miocene clay with weakly plastic loess, which is widespread in the surrounding landscape and characteristically rich in fine silt- and sand-sized particles while relatively poor in clay. The grain-size spectrum of the inclusions in our sherds matches what would be expected from a loess, and in several samples, semi-consolidated claystone clasts petrographically indistinguishable from the Miocene clay persist as relics. At the same time, a small subset of Group 2 specimens characterised by a high matrix-to-inclusions ratio but containing large angular quartz, feldspar and granitoid grains likely represent an alternate recipe dominated by Miocene clay tempered with coarse mineral sand rather than loess.

Accessory minerals provide additional insight into the provenance of the raw materials. Group 2 samples, characterised by an abundant clay matrix, contain a limited suite of accessory minerals, primarily muscovite and iron-rich aggregates, similar to those occurring in the Miocene clay. In contrast, Group 1 samples, which contain abundant non-plastic inclusions, display a more diverse mineral assemblage, closely resembling that of loess.

Another indication supporting the use of local loess in the manufacture of the ceramic paste employed in producing the analysed vessels is the presence of foraminiferal bioclasts

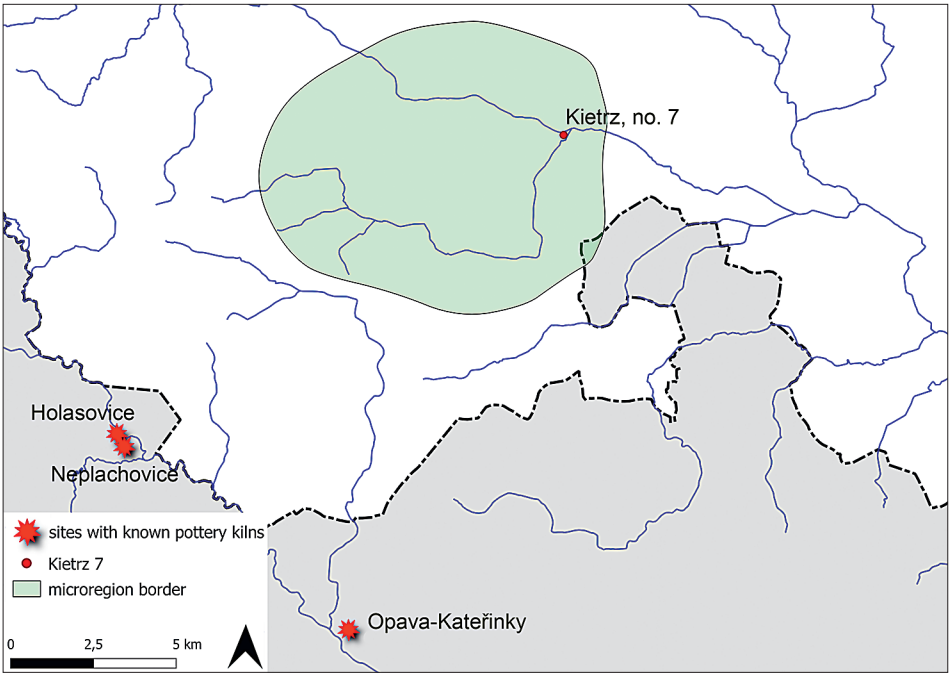


Fig. 10. Sites with pottery kilns located closest to the Kietrz/Nowa Cerekwia region.

in sample 22. These remains are most likely analogous to those described from the loess deposits of the Głubczyce Plateau, including the vicinity of Kietrz (*Paruch-Kulczycka et al. 2003*). Although such bioclasts were encountered only rarely, we nonetheless infer that loess was widely used in ceramic production. Their scarcity is readily explained by the fact that the calcium carbonate composing the foraminiferal tests would have undergone thermal dissociation during firing, thus preventing their preservation in most of the ceramic samples.

All raw materials contain illite/muscovite, kaolinite, montmorillonite, and calcite. The latter is particularly relevant to the firing process due to its influence on the sintering temperature. By comparing the thermal decomposition temperatures of clay minerals and the formation temperatures of new crystalline phases with PXRD results, the firing temperatures can be estimated. Kaolinite begins to dehydroxylate at approximately 450–600°C, forming metakaolinite through a multi-step process, while complete breakdown of the kaolinite structure is typically reported at ~530–590°C, depending on material and conditions (*Földvári 2011*, 68; *Ptáček et al. 2011*, 20; *Stevenson – Gurnick 2016*, 55). Weak kaolinite peaks observed in samples 14 and 18 may therefore suggest that the firing temperature for these two specific sherds did not exceed ~600°C. However, kaolinite can be partially rehydroxylated (or of secondary origin), which may yield weak basal reflections even if the original firing temperature was higher; this possibility is documented in rehydroxylation studies of archaeological ceramics (*Stevenson – Gurnick 2016*, 55). Consequently, such a temperature limit should be treated with caution. On the other hand, sample 18 retained traces of montmorillonite, which dehydroxylates at around ~700°C. This observation

indirectly supports the interpretation that samples 14 and 18 likely experienced relatively low firing temperatures (i.e. below the full dehydroxylation threshold of smectites). This inference is further supported by our SEM observations, several sherds show strong vitrification, whereas sample 14 exhibits only initial vitrification and sample 18 shows no vitrification. Such a pattern is consistent with lower firing temperatures for samples 14 and 18 and, crucially, with the primary (non-rehydroxylation) origin of their kaolinite. Other samples were fired at significantly higher temperatures (>700°C), as no kaolinite or montmorillonite peaks were detected. Illite was identified in most samples, and although its crystal structure begins to break down at around 550°C, the basal reflection may persist up to 950°C (*López-Arce et al. 2003*, 46; *Rathossi et al. 2004*, 321). However, under pit-firing conditions, complete illite decomposition is estimated to occur at approximately 800°C (*Maritan et al. 2006*, 6–7). The ~10 Å basal reflection may partly arise from overlapping contributions of illite and mica; nonetheless, this effect is minor in our assemblage. Biotite shows no thermal reaction below 1000°C, whereas muscovite undergoes dehydroxylation at ~820–920°C (*Földvári 2011*, 82). Consistently, our DSC-TG data register a mass-loss event attributable to muscovite dehydroxylation clearly only in a few sherds (e.g. 4, 14) and very weakly in several others (6, 10, 12, 20, 28), while it is absent in the majority of samples. Consequently, we interpret the observed ~10 reflection primarily as related to illite.

The absence of illite peaks in several samples (8, 9, 15, 16, 17, 19, 32) indicates firing temperatures above ~900°C. SEM observations show advanced sintering and partial vitrification, while PXRD patterns display high-temperature phases – mullite, spinel, pyroxene, and cristobalite – characteristic of firing above 900°C (*Molera et al. 1998*, 189; *Özkaya – Böke 2009*, 997; *Uğurlu Sağin – Böke 2013*, e75). Although the ceramic sherds are generally Ca-poor, the presence of small amounts of calcite—locally documented, for example, by preserved carbonate bioclasts (foraminifers) in one sample—may have promoted pyroxene crystallisation by releasing calcium upon decomposition (>600°C), simultaneously consuming iron and contributing to the light colour of the fired bodies.

Based on the current state of research, it is reasonable to assume that the non-imported wheel-thrown vessels found at the Kietrz 7 site were produced in workshops known from Neplachovice, Holasovice, and Opava-Kateřinky (*Fig. 10*; *Loskotová 2009*). This hypothesis should be upheld, given the location of these workshops and their proximity to the micro-region under study, from which the raw materials originated. It is most reasonable to assume that such a workshop was located within the micro-region. However, as we currently lack archaeological evidence, this must be regarded as a hypothesis. On a macro scale, these vessels have numerous analogies. The sites are separated by only 15 km in a straight line, a distance that could be covered within a few hours even by Roman-period communities. More than a dozen kilns were discovered there, capable of supplying this community on a micro-regional scale. This interpretation may change as our knowledge of this population expands. However, it is highly likely that the inhabitants maximised their use of the environment, exploiting fertile loess soils, establishing residential settlements along rivers, and utilising locally available clay deposits.

Micro-regional layout and economy

It should be noted that the site under discussion is not an isolated entity. It was used by a community that most likely had organised social structures. It seems logical that every

element essential to the functioning of the community had its designated place in both time and space. Pottery was an integral part of daily life in every past society (*Roux et al. 2017*; *Volf et al. 2024*, 5–7). In this case, we are not referring solely to household production, but possibly to a larger societal framework. The manufacturing process can be reconstructed by examining all its attributes. It involves many stages, beginning with the collection of raw materials and ending with firing and usage (*Roux 2017*, 102–105; *Volf et al. 2024*, 6–7). Archaeological sources indicate that the selection of raw materials was usually limited. Potters preferred resources located approximately 1 km from their homes (*Rice 2015*, 52). Occasionally, depending on specific conditions, this distance could be within or exceed 7 km (*Hein – Kilikoglou 2020*, 10).

In the analysed micro-region, winds typically blow from the west, suggesting that the placement of workshops on the southeastern side was intentional (*Fig. 9*: divisions SE, S). Conversely, the western and northern parts of the micro-region most likely served as residential zones (*Fig. 9*: divisions NE, NW, SW), with a central place (possibly a centre of power or cult) located near site 4 in Nowa Cerekwia (*Fig. 9*: division C, 33). It is important to note that this was the central settlement of the population occupying the area during the Late La-Tène period (*Dulęba 2019*, 140; *Rudnicki 2014*). However, this does not imply the existence of a similar settlement during the Roman Period, as current findings do not support this. Nevertheless, the large number of Roman coins suggests the uniqueness of the location (*Godłowski 1973*, 290; *Ciołek 2008*). According to Tacitus, Germanic (barbarian) populations tended not to inhabit large or complex settlements, instead valuing space between farms (*Tacitus*, *Germania*, 17: *Hammer 2004*). This likely explains the gaps between clusters visible on the maps (*Fig. 9*). It is essential to view the entire micro-region as a living organism, where every element had its place and time. The distribution of residential settlements, likely uninhabited production sites, and central places (not necessarily linked to larger settlements) reflects specific relationships discussed in the text.

The egalitarian nature of society, often described by Tacitus, is also noteworthy. This primarily refers to their approach to private property, or the lack thereof. Consequently, in the context of pottery production, it is inappropriate to interpret a kiln as a symbol of capitalism. Instead, it should be seen as a communal asset of the local population (*Gralak 2022*, 53–57). This is further supported by our findings from Kietrz. Although the site yielded abundant evidence of active trade networks and numerous genuine imports, our compositional analysis revealed that several prestigious vessels initially suspected to be non-local were actually manufactured using local raw materials. This indicates that alongside a thriving exchange in pottery, local potters actively produced high-status vessels or local imitations of desirable styles rather than relying solely on imported goods. It appears that even the most skilfully crafted vessels were not produced for individual profit or sale, but rather for the benefit and prestige of the community. This supports the notion that barbarian communities operated within a human-centred economy (*Gralak 2022*, 71). Such a system ensured that all members had access to essential goods. The goal was not to accumulate wealth, but to continuously produce, repurpose, and transform items into new configurations for human use.

It should be emphasised, however, that the above considerations regarding the economic system, egalitarianism, and the communal nature of pottery production are hypothetical in nature. The concept of a people-centred economy and the interpretation of the pottery kiln as a common good are based primarily on an analysis of the relevant literature

and theoretical analogies, rather than on direct field evidence from the micro-region under study. Although this model effectively integrates petrographic data with the cultural context, its full validation requires targeted excavations and also multi-faceted archaeological analyses that would allow for unequivocal confirmation of ownership structures and the organisation of labour within local workshops.

Conclusion

This study aimed to reinterpret archaeological data in the context of existing views on manufacturing technologies, economic organisation and the social structures of the Przeworsk culture communities functioning in the Barbaricum zone. The main research issue was to verify the origin of wheel-thrown vessels, which in the literature—especially in the absence of identified pottery workshops—are often interpreted as imports. A total of 33 samples of pottery (both wheel-thrown and hand-made) and samples of local raw materials, including loess, Miocene clays and boulder clays, were analysed. The results of petrographic and technological studies indicate that the ceramic masses used correspond to local raw material resources, which supports the local production of vessels. Within the studied group, two basic technological traditions can be distinguished, differing in the composition and preparation of the ceramic mass, but both based on local raw materials. Mineralogical analyses (PXRD) and thermal studies suggest that the firing process took place under conditions requiring significant control of technological parameters, e.g. the use of a kiln.

An examination of the material strongly suggested that the site in question was a burial ground associated with people who were possibly connected with the area, but not with the typical Przeworsk culture of the time, due to strong foreign influences. The aim of this research was to use interdisciplinary methods to study the origin of the artefacts produced by the local community, in this case ceramic vessels, in order to examine their provenance. At the same time, radiocarbon dating and strontium isotope analysis of human bones were performed. The results indicate that the buried individuals were local, and the chronology should be moved closer to the beginning of the 3rd century, as established by ongoing data processing and analysis currently being prepared for publication.

The material analyses were supplemented by the development of a spatial model of the micro-region based on archival data and the results of surface surveys. The use of spatial analyses and triangulation made it possible to capture the relationships between sites dating from the same chronological phase. As a result, an image emerged of a diverse but internally connected settlement and production system, in which it is possible to identify areas with a predominance of manufacturing functions, settlement zones and a place with a potential integrating role in the Nowa Cerekwia area. These interpretations are model-based and remain open to further verification, but they allow us to view the cemetery in Kietrz 7 as part of a broader landscape structure.

The obtained results prompt a cautious revision of the established identification of wheel-thrown pottery with imports. It seems possible that advanced technological solutions were locally adapted in the micro-region under study, which can be linked to the transfer of knowledge, the mobility of craftsmen or broader processes of intercultural contact, which intensified in the 3rd century AD. This does not rule out the presence of actual imports but suggests that the image of exchange was more complex than previously assumed.

The Kietrz/Nowa Cerekwia micro-region, located in the Moravian Gate area, appears to be an area with significant interactive potential, where the influences of various cultural environments intersect. The presence of Roman artefacts testifies to participation in extensive networks of contacts, but the simultaneous use of local raw materials and developed manufacturing facilities indicate a significant degree of organisational and technological independence.

In light of the performed analyses, the communities functioning in this area can be seen as groups capable of effectively managing local resources and adapting and processing external cultural impulses. The research does not redefine the image of the Barbaricum, but rather elaborates it, showing that the level of socio-economic organisation and craftsmanship may have been higher than suggested by simplified models of dependence on the Roman world.

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