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PETROLOGIC STUDIES ON EARLY NEOLITHIC POTTERY FROM VÖRS, SW HUNGARY

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ABSTRACT

This study presents the preliminary results of the petrographic investigation of Neolithic pottery from Southwest Hungary, Vörs. It forms part of a major project on pottery analysis of a multi-period archaeological site. The examined 17 samples analysed so far were chosen by macroscopic examination of fabric and form to represent the most important habitation period of the site, the Early Neolithic Starčevo Culture. Technological studies were based on thin section petrography (temper and paste analysis). In most cases (15 samples) organic material was used deliberately as temper. Other nonplastic inclusions detected involve mineral grains (monocrystalline quartz, feldspars, micas, opaque minerals and accessories) and rock fragments (polycrystalline quartz grains, microcrystalline quartz grains, argillaceous rock fragments, sandstone grains, mica-schist fragments, other metamorphic rock fragments and in one case volcanic rock fragments), clay pellets and in one, stratigraphically debatable case, grog fragments. On the basis of temper composition the pottery could be divided into four groups, each of which represents different pottery-making technology.
Key words: Petrography, Pottery, Neolithic, Hungary

INTRODUCTION

In the past few decades, interest has been drawn to a petrographic type of analysis of ancient ceramics. The important aim of getting to know ceramic production technologies (manufacture, firing) may only be achieved by looking beyond relative chronologies based on vessel-forms and simple models of change, to a detailed analysis of pottery production and consumption. In doing so, scientific analysis plays an important role.

This work is part of an interdisciplinary project to establish a diachronic study of a multi-period habitation site (from the early Neolithic until Medieval times) in Southwest Hungary, Vörs (Fig. 1 and Fig. 2). The approach combines archaeology and archaeometry. Fig. 3 gives an outline of the planned project.

This article presents the preliminary results of the petrographic study of Neolithic ceramics excavated at Vörs. The analysis was based on thin section petrography and the main aim of the authors was to group the pottery samples according to their petrographic properties, compare these groups with the groups defined by macroscopic examinations, and – where possible – make comments on ceramic-making technology.

METHODS

Petrographic analysis is an essential starting point for ceramic studies. The examinations can give information on the texture of the pottery and on the nonplastic material present in the ceramic's body. The nonplastic material can be natural (present in the original clay) or it can be added to the paste by the potter in order to reduce shrinkage and breakage during drying and firing (Maggetti, 1982).

Seventeen samples – chosen by macroscopic examination of fabric and form – were thin-sectioned and examined under the binocular and the polarising microscope. Examinations were based on the method elaborated by Szakmány (1996, 1998), however the authors added some new considerations (e.g. quartz types).

Textural analysis included the examination of fabric (hiatal, serial), grain-size distribution, the measurement of average grain-size and maximum grain-size, as well as the description of the roundness and sphericity of the grains (Pettijohn et al., 1987). The orientation of the grains, the colour and isotropy of the groundmass were also recorded (Whitbread, 1986). Textural analysis was accompanied by the quantitative analysis (volume percent) of the tempering material. The proportion of the pores, groundmass, clay

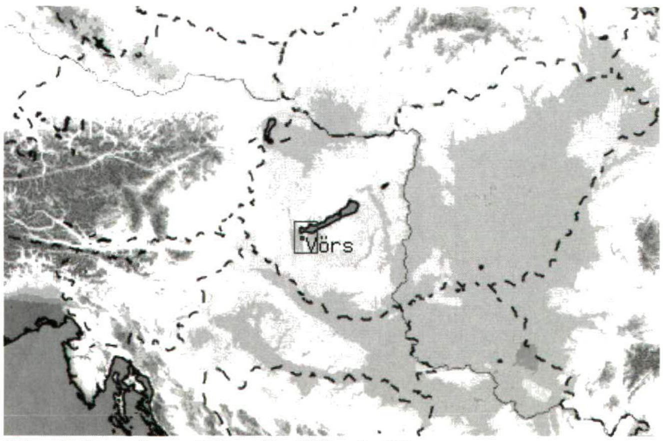

Fig. 1. Location of the site, Vörs in Hungary.

pellets, vegetal material, grog ("Grog" is used in the meaning of pottery grit, as in Maggetti, 1982), rock and mineral fragments was determined.

Archaeological background

Vörs is a small village lying at the eastern margin of the Kis-Balaton („Little Balaton") marshes, very close to lake Balaton (Fig. 2). Sites and finds from various periods from almost all periods of prehistory since the Early Neolithic period were found here, rich till the historical ages. The exceptionally favourable environmental endowments of the site offered an ideal setting for habitation. Archaeological investigations of the region started fairly early and received new impetus from the rescue excavations performed in connection with the reconstruction of the former Kis-Balaton marshes. Archaeological survey and excavations performed between 1989-1991 yielded rich material of an Early Neolithic settlement on the site Máriaasszony-sziget (Aradi, 1992). The significance of the prehistoric finds made the further research of the site necessary (Kalicz et al., 1998). Thus the excavations were renewed and continued in 1999-2000.

The „Máriaasszony-sziget" (Our-lady-Mary Island) is a longish sandy peninsula extending some 1400-1600 m long in northern direction on the eastern margin of the Kis-Balaton marshes, connected to the south-western corner of Lake Balaton. Its highest point is elevated some 3-5 meters above the surrounding marches. On the basis of shallow boreholes drilled in the marshes and the evidence of old maps it can be stated that the peninsula used to be surrounded formerly by the open lake, the water of Lake Balaton itself. The sandy ridge could offer excellent conditions for settlement for the prehistorical communities. According to the results of excavation performed so far, there were elements from the legacy of at least 8 different archaeological cultures and people found here (finds from the Early Neolithic (Starčevo culture, Early Copper Age Lengyel III culture, Middle Copper Age Balaton-Lasinja culture, Late Copper Age Kostolac culture, Early Bronze Age Kisapostag culture, Late Celtic and (Early-) Roman period, Early Mediaeval Árpád-dynasty period).

The immediate antecedents of the present research were the series of rescue excavations performed by the archaeologists of the Somogy County Museum between 1989-1991. On the place of the present observation tower the remains of an Early Medieval church had been spotted by preceding archaeometrical prospection studies. The excavations were primarily directed at opening the church and its surroundings. The excavation report by Aradi (1992) gave an account of, among others, rich Neolithic material found on the excavated surface of cca. 500 m^2 extent. Subsequent research could identify these finds as the heritage of the Early Starčevo culture (Kalicz et al., 1998).

This is one of the northernmost lying settlement of this culture which proved for the first time that the population arriving from the South (direction of the river Drava) reached along the course of lesser rivers the region of Lake Balaton as well. The current research of the site, which has a primary importance for the Transdanubian Early Neolithic became possible in 1999 with the financial support of the Hungarian National Museum and the Somogy County Museum Directorate. The main objective of the new excavations was, apart from getting more material from the Early Neolithic finds of the Starčevo culture, the investigation of settlement features on a large surface and collecting soil samples from closed Early Neolithic units, the scientific investigation of which is of primary importance for the study of the Early Neolithic period (Kalicz et al., 2002).

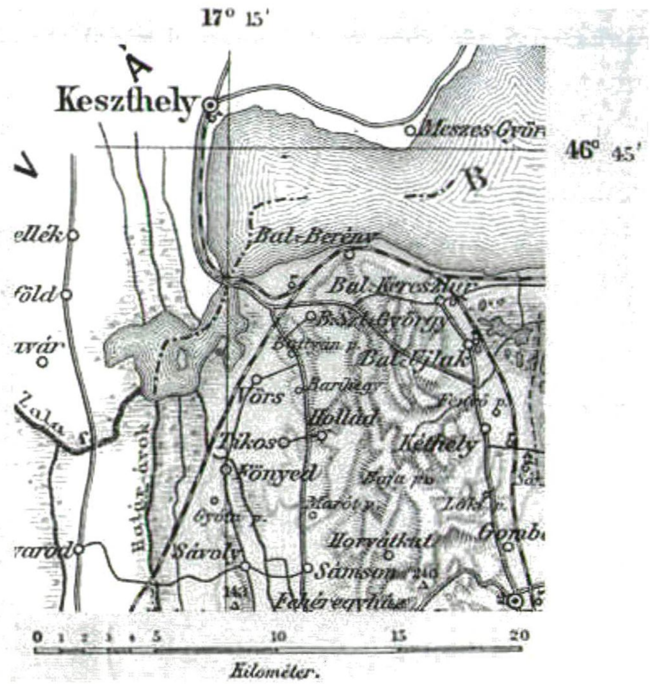

Fig. 2. Immediate environs of the site, Vörs-Máriaaszzonysziget on a map from the beginning of the 20th century.

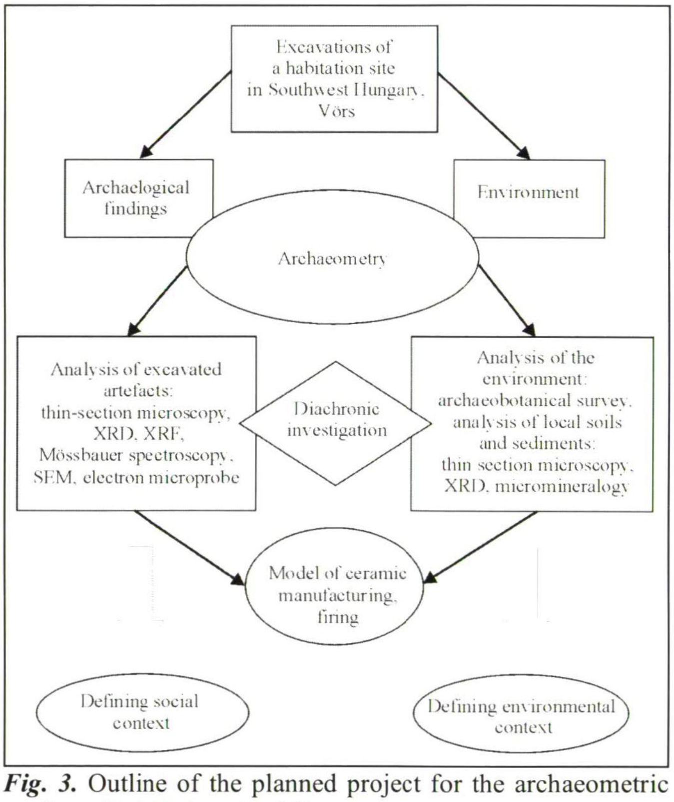

Fig. 3. Outline of the planned project for the archaeometric studies of habitation site, Vörs.

The area of the new excavations could be planted in accordance with the Forestry of the Directorate of West-Transdanubian Water Management. In 1999, a total of some 300 m^2 continuous surface could be investigated. In 2000, 400 m^2 surface was added.

The archaeological age of the individual units was defined by the (macroscopic, typological) investigation of pottery. The closed units were sampled for soil sediments containing, in silted sample, remains of charred grains and other plant fossils, small bones, molluscs, pottery and stone tool chips. These items will be subjected to, different types of analyses including petrography of the pottery remains.

Though all periods represented at the site will be investigated in detail, the present survey is consecrated to the study of pottery fragments belonging to the Starčevo culture alone. This was done because the chief attraction of the site is the presence of Early Neolithic material. The Starèevo culture constitute the westernmost unit of the large Early Neolithic archaeological complex, comprising towards the East Körös culture and even more to the East, Cri° culture representing the first food-producing communities in the Carpathian Basin. In Hungary, the Körös and Starčevo cultures, related in many ways, used to exist in the first half and middle of the VIth millennium B.C., with characteristic elements of the material culture: domesticated plants and animals, permanent settlement, polished stone tools and, pottery. The characteristic pottery of the period is fine-grained, tempered typically with chaff from cereals, fired probably at relatively low temperature.

The pieces investigated were described and identified by traditional archaeological methods (the archaeological investigations of the pottery were made by Zs. M. Virág, macroscopical (physical) description by the authors). Most of the pottery samples were identified as side fragments; from large vessel (sample 52/01), from biconical vessel (sample 52/04), simple side fragment (sample 53/02), marginal fragment (sample 50/05), a fine chalice side fragment (sample 50/15) and handle from a cooking vessel (sample 50/08). Especially the small fragments used from the silted soil samples of closed units could not be specifically identified as certain vessel types so they can be best fit among the simple side fragments.

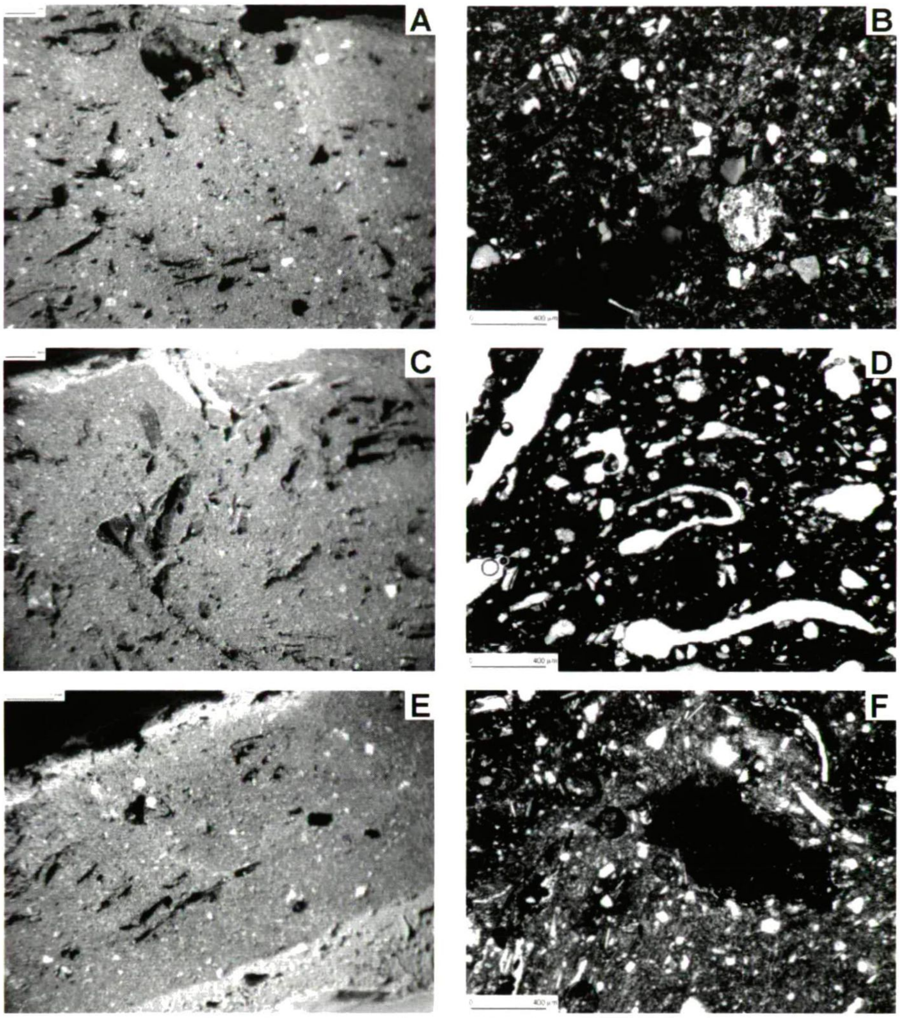

Fig. 4. ***(A)*** Binocular microscopic micrograph of pottery sample 50/01, cut surface (*group* 1); ***(B)*** Polarisation microscopic micrograph of high sphericity, well rounded polycrystalline quartzite and plagioclase in hiatal fabric (sample 50/01, *group* 1). +N; ***(C)*** Binocular microscopic micrograph of pottery sample 50/08, cut surface (*group* 1); ***(D)*** Polarisation microscopic micrograph of pores in places of burnt out chaff in hiatal fabric (sample 50/08, *group* 1). 1 N; ***(E)*** Binocular microscopic micrograph of pottery sample 50/13, cut surface (*group* 1); ***(F)*** Polarisation microscopic micrograph of oxidation layer broadened by a well preserved chaff temper (sample 50/13, *group*1). 1N.

RESULTS

Macroscopic description

Sherds were examined by naked eye and then under the binocular microscope and fabric properties were recorded in the system suggested by Orton et al. (1994).

Most of the examined samples – 50/01, 50/02, 50/03, 50/05, 50/07, 50/08, 50/12, 50/13, 50/14, 50/15, 50/16, 52/01,52/04 – are so called sandwich ceramics (Fig. 4A, C, E, and Fig 5A, D), that is the external and internal surfaces and margins of the sherds are of varied shades of brown (Colour descriptions were made using Munsel's Rock colour chart (1984): 5YR4/1, 5YR4/4, 5YR5/6, 5YR6/4, 10YR4/6, 10YR7/4), while the core is usually dark grey (N3, N4). These ceramics are mainly hard, have a smooth surface and irregular fracture. The inclusions are dominantly angular quartz grains, accompanied by sparse reddish brown (10YR4/6), well rounded fragments. The shape of the pores – elongated, with a length of 2–3 mm – is very characteristic, reflecting the use of vegetal temper.

Sherd 53/02 (Fig. 6E) is also a sandwich ceramic, but the composition of the inclusions is different from that of the majority. It contains abundant light brown (5YR6/4), angular fragments.

Sample 50/04 (Fig. 5C) is not a sandwich ceramic, its colour is light brown (5YR5/6) through the whole cross section. It is a hard ceramic, having smooth surface and irregular fracture. The composition of the inclusions is the same as in the case of the majority of the sherds, but some black, well preserved vegetal material is observable here as well. The shape of the pores also refer to vegetal temper: elongated pores with a length of 5–10 mm.

Samples 50/09 (Fig. 6A) and 50/10 (Fig. 6C) are not like the sandwich ceramics samples: they are soft, having smooth surface and laminated fracture. Their colour is grey (5YR4/1, N4) in the whole cross section. In sherd 50/09 the only visible inclusions are angular quartz grains – in a lesser amount than in the case of sandwich ceramics –, whereas in sample 50/10 – besides the abundant angular quartz grains – sparsely well rounded, light grey (N7) fragments are also visible. In sherd 50/09 the shape of the pores refer to vegetal temper: elongated or curved pores with a length of 2–3 mm. In sample 50/10 no signs of vegetal temper are visible.

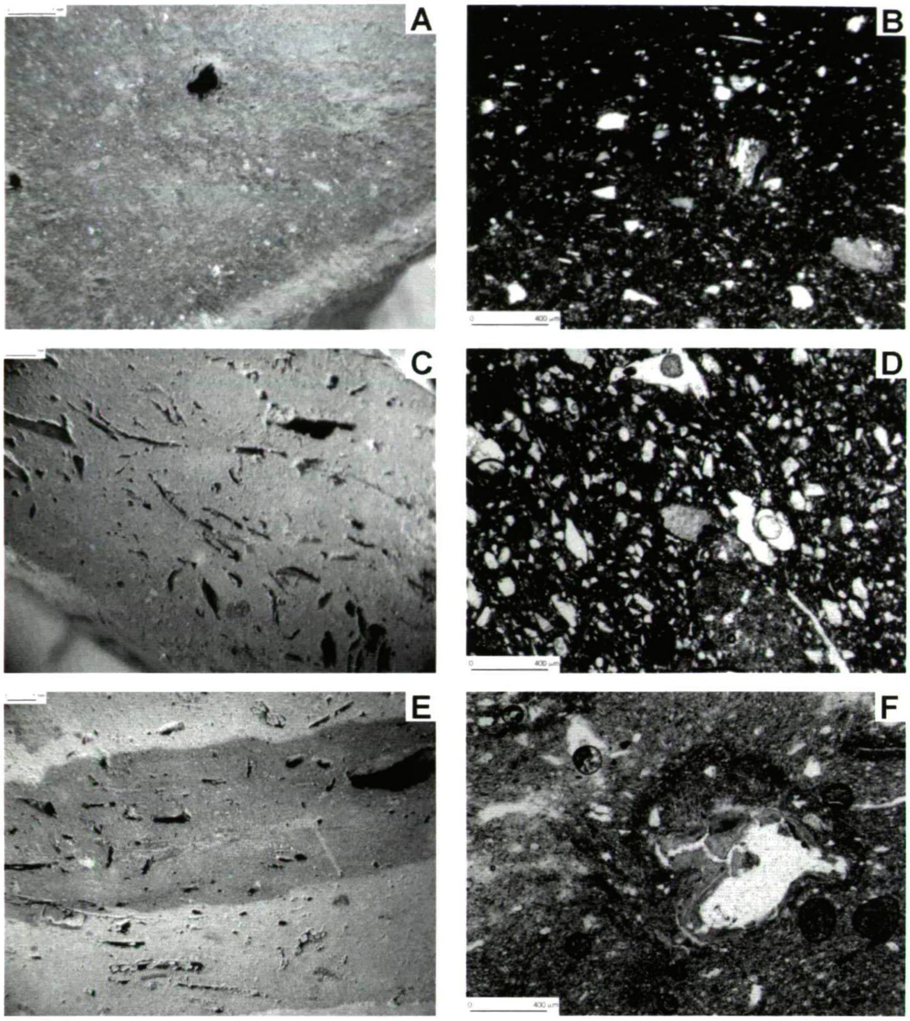

Fig. 5. ***(A)*** Binocular microscopic micrograph of pottery sample 52/01, cut surface (*group* 1); ***(B)*** Polarisation microscopic micrograph of high sphericity, well rounded polycrystalline quartzite in hiatal fabric (sample 52/01, *group* 1). +N; ***(C)*** Binocular microscopic micrograph of pottery sample 50/04, cut surface (*group* 1); ***(D)*** Polarisation microscopic micrograph of low sphericity, well rounded clay pellet and K-feldspar in hiatal fabric (sample 50/04, *group* 1b). 1N; ***(E)*** Binocular microscopic micrograph of pottery sample 50/16, cut surface (*group* 2); ***(F)*** Polarisation microscopic micrograph of pore in place of burnt out chaff temper (sample 50/16, *group* 2). 1N.

Thin section petrography

On basis of petrologic examinations the 17 pottery samples could be divided into four groups. Data are summarised on Table 1 and main types presented on Fig. 4-6, on binocular microscopic and polarisation microscopic micrographs, respectively.

Group 1 – this group is divided into two subgroups: 1a and 1b.

Group 1a

The majority of the ceramic samples, twelve sherds belong to this subgroup (50/01, 50/02, 50/03, 50/05, 50/07, 50/08, 50/12, 50/13, 50/14, 50/15, 52/01, 52/04).

Fabric

Colour of the groundmass is brown or dark brown in plain polarised light, and yellowish brown – optically active –, or dark brown – optically fairly active – in crossed polarised light. The samples' fabric is dominantly hiatal, grain-size distribution is bimodal. The size of fine sand nonplastics is below 100 µm, while that of medium sand size grains is between 200 and 300 µm. Maximum grain-size is around 400–500 µm. Nonplastic inclusions are fairly or well sorted.

The amount of pores – their formation is mainly due to vegetal tempering (see below) – is between 1.2 and 9.3 volume percent. Pores left after the burning out of the vegetal material have well defined shape: they are elongate with a length of 250–5500 µm (Fig. 4D).

Nonplastic material

Fine sand size nonplastics (below 100 µm) are mainly monocrystalline quartz and other mineral fragments, such as feldspars, micas, opaque minerals and accessories, while medium sand size grains (200–300 µm) are dominantly K-feldspars, polycrystalline or microcrystalline quartzite, mica-schists, other metamorphic rock fragments, or sandstone grains.

Monocrystalline quartz grains are of low sphericity, angular. Grains have either undulatory or sharp extinction. From this aspect sample 52/04 is slightly different, because here one can

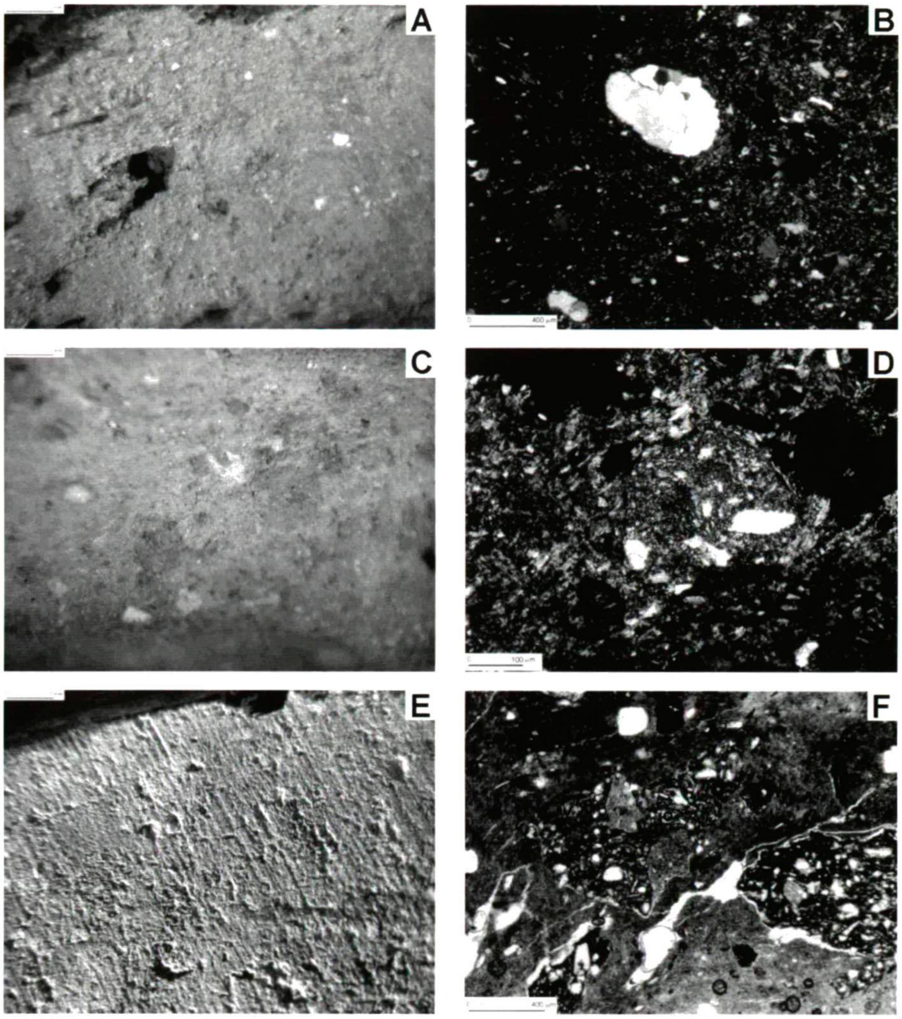

Fig. 6. ***(A)*** Binocular microscopic micrograph of pottery sample 50/09, cut surface (*group* 2); ***(B)*** Polarisation microscopic micrograph of low sphericity, subrounded polycrystalline quartzite in hiatal fabric (sample 50/09, *group* 2). +N; ***(C)*** Binocular microscopic micrograph of pottery sample 50/10, broken surface (*group*3); ***(D)*** Polarisation microscopic micrograph of high sphericity acid volcanic rock fragment in hiatal fabric (sample 50/10, *group* 3). +N; ***(E)*** Binocular microscopic micrograph of pottery sample 53/02, cut surface (*group* 4); ***(F)*** Polarisation microscopic micrograph of argillaceous rock fragment in hiatal fabric (sample 53/02, *group* 4). 1N.

find a relatively greater amount of well rounded grains on which sometimes embayments can be observed: these grains do not have undulatory extinction. Furthermore, accompanying these corroded fragments, splinter shaped quartz is also present.
Polycrystalline quartzites are not so uniform in respect of sphericity and roundness. Smaller grains – around 200 μm – are mainly low sphericity angular, while larger ones – 300 μm and up – are low sphericity, subrounded or high sphericity, well rounded (Fig. 4B and Fig. 5B). Composing grains have undulatory extinction and either equant-polygonal mosaic structure or sutured contact.

Microcrystalline quartzites, sandstones, mica-schists and other metamorphic rock fragments are high sphericity, well rounded. In mica-schists and other metamorphic rock fragments quartz crystals are often flattened and elongated, having undulatory extinction, while in sandstones they have equant-polygonal mosaic structure.

Vegetal tempering is typical (see fabric description) – sometimes well preserved vegetal fragments are observable (Fig. 4D) – although the amount of this material changes from one sample to the other (see the amount of pores in Table 1).

Group 1b:

Only one sample belongs to this subgroup (50/04).

Fabric

Colour of the groundmass is reddish-yellowish brown in plain polarised light and it is the same in crossed polarised light with a darker shade. The groundmass is optically active. The sample has hiatal fabric. Grain-size distribution can be described by three maxima. Fine sand size grains are below 100 μm, while medium sand size ones are between 200–300 μm. Coarse fragments are between 500–2000 μm. Maximum grain size is 2300 μm. Coarse grains are clay pellets (Fig. 5D). Tempering fragments of size 0–300 μm are well sorted, however considering the whole sample – including clay pellets – sorting is very poor.

The amount of pores is 14.3 volume percent and their formation is basically due to tempering with vegetal material. The shape of the pores is elongated, with a length of 250–5500 μm.

Nonplastic material

Concerning size, composition, roundness and sphericity of the grains – the nonplastic material of this sherd is very similar to that of *group 1a*. However the presence of clay pellets in such a great amount (10 volume percent) is exceptional. These well rounded, sometimes distorted grains have diffuse or merging boundaries. Their composition is uniform, containing only few quartz or muscovite grains (Fig. 5D). Vegetal tempering is characteristic in *group 1b* as well.

Group 2

Two samples belong to this group (50/09, 50/16).

Fabric

Colour of the groundmass is light brown in plain polarised light and yellowish brown in crossed polarised light. The groundmass is optically active. The samples have hiatal fabric. Grain-size distribution is bimodal. The size of fine silt size grains is below 50 μm, while the size of medium sand size grains is between 100–300 μm.

Maximum grain size is 550 µm. Nonplastic inclusions are well sorted.

Pores constitute 7.2–9.4 volume percent of the ceramic and are formed in places of burnt out vegetal material (Fig. 5F). The shape of the pores is usually elongated, their length is between 200–4000 µm.

Nonplastic material

These two sherds contain exceptionally small quantity – 2.4 (50/16), 3.6 (50/09) volume percent – of mineral or rock fragments. Most of the nonplastic material is monocrystalline quartz: low sphericity, angular grains. One part of the grains has undulatory extinction, while others have sharp extinction. Their size is below 50 µm.

Among fine fragments there are mainly mineral grains, namely feldspars, micas and opaque minerals. Polycrystalline quartz grains – 100–300 µm in size – are dominantly low sphericity, subrounded (Fig. 6B), and their composing grains have undulatory extinction, and make up an equant-polygonal mosaic structure. Sample 50/16 contains sandstone fragments, which are high sphericity, well rounded, with a diameter in the range of 100–300 µm. Vegetal tempering is typical in *group* 2 as well.

Group 3

Only one sample belongs to this group (50/10).

Fabric

Colour of the groundmass is brown in plain polarised light and dark brown in crossed polarised light. The groundmass is optically fairly active. The ceramic has got a hiatal fabric. Grain-size distribution is characterised by three maxima. Fine sand size grains are below 100 µm, medium sand size grains between 200–250 µm, while coarse fragments between 400–1500 µm. Maximum grain size is 1500 µm. Nonplastics are poorly sorted.

Pores constitute 4.1 volume percent of the ceramic, pore shapes – as they are irregular – do not refer to vegetal tempering.

Nonplastic material

Most of the nonplastic fragments are of low sphericity, angular monocrystalline quartz grains (0–100 µm), which do not have undulatory

Table 1. Quantity of the temper (volume percent). Legend (after clast names): 1 low sphericity, angular; 2 low sphericity, subrounded; 3 high sphericity, well rounded.

	50/01	50/02	50/03	50/04	50/05	50/07	50/08	50/09	50/10
Group	1a	1a	1a	1b	1a	1a	1a	2	3
Pores	3.1	6.8	3.4	4	6.5	3.5	8.8	9.4	4.1
Groundmass	87.2	80.4	91.2	81.7	88.4	87.6	83.5	87	77.2
Pea structure	Trace	-	Trace	-	-	-	Trace	-	-
Clay pellet	-	-	-	10	-	Trace	Trace	-	11.6
Grog	-	-	-	-	-	-	-	-	-
Chaff	-	-	-	Trace	-	Trace	-	-	-
Mineral and rock fragments	9.7	12.8	5.4	14.3	5.1	8.9	7.7	3.6	7.1
Distribution of clasts									
Quartz 1	49.5	47.5	68	69	74.6	57.9	72.6	44.8	34
Quartz 2	-	6.8	-	-	-	1.9	-	-	-
Quartz 3	-	-	-	-	3.2	-	-	-	-
K-feldspar	14.7	4.6	7.8	6,4	4.4	12,2	8.4	13.4	1,9
Plagioclase	6	-	3	1,2	-	2,2	1.2	3.4	-
Muscovite	1.3	1.1	Trace	1	1.6	1	1.9	Trace	Trace
Biotite	Trace	-	-	-	-	Trace	Trace	-	-
Epidote – Zoisite	2	0.4	1	Trace	Trace	Trace	1.3	-	Trace
Tourmaline	Trace	Trace	Trace	-	-	Trace	Trace	-	-
Zircon	Trace	0.3	-	-	Trace	Trace	Trace	-	-
Rutile	Trace	-	-	-	-	-	-	-	-
Garnet	-	-	Trace	Trace	-	-	-	-	-
Opaque minerals	1	1	3	7,6	4.3	2,6	3.6	1.7	6,6
Polycrystalline quartzite 1	13.9	15	15	12,5	9.8	14,2	9.7	-	
Polycrystalline quartzite 2	3.9	-	1	-	2.1	-	-	36.7	9,4
Polycrystalline quartzite 3	4.5	1.6	-	-	-	-	-	-	-
Microcrystalline quartzite	-	0.2	-	-	-	-	1.3	-	-
Argillaceous rock fragment	-	-	-	-	-	-	-	-	26,4
Sandstone	3.2	-	-	-	-	-	-	-	-
Mica-schist	-	-	-	-	-	3,2	-	-	-
Metamorphic rock fragments	-	-	-	2,3	-	4,8	-	-	-
Volcanic rock fragments	-	-	-	-	-	-	-	-	21,7

	50/12	50/13	50/14	50/15	50/16	52/01	52/04	53/02
Group	1a	1a	1a	1a	2	1a	1a	4
Pores	9.3	4.8	7.6	5.8	7.2	1.2	4	1.4
Groundmass	85.5	90.9	86.1	89.7	90.4	93.1	86.4	80.2
Pea structure	Trace	Trace	-	-	Trace	-	Trace	-
Clay pellet	-	-	-	-	-	-	-	2.6
Chaff	-	Trace	-	-	Trace	-	-	-
Grog	-	-	-	-	-	-	-	13.7
Mineral and rock fragments	5.2	4.3	6.3	4.5	2.4	5.7	9.6	4.7
Distribution of clasts								
Quartz 1	70.3	55.4	58.6	67.9	49.3	48.4	58.5	35.2
Quartz 2	-	-	2.5	-	-	-	17.5	-
Quartz 3	-	-	-	-	-	-	-	-
K-feldspar	11.7	15.6	16.5	16.8	6.6	24.2	11.2	Trace
Plagioclase	-	Trace	1.7	-	4	3	4.4	-
Muscovite	2.1	1.2	Trace	1	6.7	3.4	1.8	-
Biotite	-	-	-	-	-	-	-	-
Epidote – Zoisite	1	2.3	1.3	1.7	-	1.2	Trace	Trace
Tourmaline	-	-	Trace	-	-	Trace	-	9.3
Zircon	Trace	-	-	-	-	-	-	-
Rutile	-	-	-	-	-	-	-	-
Garnet	-	-	-	Trace	-	-	-	-
Opaque	-	11.6	1.6	Trace	6.7	5.2	Trace	4.6
Polycristalline quartzite 1	-	10.4	13.2	12.6	6.7	6.6	7	2.3
Polycristalline quartzite 2	12.8	-	-	-	13.3	8	-	9.3
Polycristalline quartzite 3	2.1	-	-	-	-	-	Trace	-
Microcrystalline quartzite	-	3.5	1.3	-	-	-	-	2.3
Argillaceous rock fragment	-	-	-	-	-	-	-	37
Sandstone	-	-	-	-	6.7	-	-	-
Mica-schist	-	-	3.3	-	-	-	-	-
Metamorphic rock fragments	-	-	-	-	-	-	-	-
Volcanic rock fragments	-	-	-	-	-	-	-	-

extinction. Other mineral fragments present are K-feldspars, opaque minerals, muscovite and accessories (the groundmass contains a relatively large amount of very fine grained (<15 μm) muscovite, (compared to other samples). Polycrystalline quartzite grains are low sphericity, subrounded. They are 200–250, 400–500 μm in size, composing grains have undulatory extinction and sutured contact.

Grains 400–1500 μm in size are argillaceous rock fragments, clay pellets and volcanic rock fragments. Argillaceous rock fragments are usually prolate, have conchoidal fractures and contain only few quartz and muscovite fragments. Clay pellets have sharp or merging boundaries, they are well rounded, sometimes distorted. Acid volcanic rock fragments are also present in this sample. They are high or low sphericity, well rounded grains having porphyritic holocrystalline texture with recrystallized groundmass and quartz phenocrysts (Fig. 6D). Vegetal tempering is not detected.

Group 4

Only one sample belongs to this group (53/02).

Fabric

Colour of the groundmass is yellowish brown both in plain and crossed polarised light. The groundmass is optically active. The ceramic has got hiatal fabric with a grain-size distribution of three maxima. The size of fine sand grains is below 150 μm, while the size of medium sand size grains is between 200–250 μm, and the size of coarse fragments is in the range of 400–1500 μm. Maximum grain size is 1500 μm. Nonplastics are poorly sorted.

Pores make up only 1.4 volume percent of the sherd, no signs of vegetal tempering are observable.

Nonplastic material

Mineral fragments are mainly monocrystalline, low sphericity and angular quartz grains – with size below 150 μm – having either undulatory or sharp extinction. Other minerals detected are K-feldspars, opaque minerals and accessories.

Polycrystalline quartzite – 200–250 μm in size – are mostly low sphericity, subrounded, containing grains of undulatory extinction, with sutured contact; and argillaceous rock fragments. This latter material is present as grains usually having prolate shape, sharp boundaries, containing only few inclusions (quartz, muscovite). Argillaceous rock fragments are also present in grog fragments. Coarse (400–1500 μm) tempering grains are grog fragments (Fig. 6F). This material makes up 13.7 percent of the ceramic's temper. There are grog fragments containing other grog fragments as inclusions. Vegetal tempering is not detected in this group.

Discussion

Petrologic examination of the pottery assemblage shows that most of the samples (15 sherds from *group 1* and *2*) were tempered deliberately with organic material, although potters did not always use the same amount.

The majority of the samples (13 sherds from *group* 1) were very closely related to each other (see below). There are, however, two samples (*group 2*) which were related to the majority (*groups 1a*, *1b*) on the basis of the composition of nonplastic inclusions, but differed from *Group 1* on the basis of granulometry. There were two other specimens (termed *group 3* and *4*) which seemed to be extraordinary in this context. The differences between *group 1* and *2* and the presence of the two outstanding samples can be explained in the following way.

Ceramics belonging to the majority (*group 1*) were tempered with vegetal material. They had bimodal grain size distribution with fine sand size mineral grains and medium sand size lithic fragments and mineral grains (feldspars). This could be caused by the use of a fairly sorted sandy clay, or could suggest the presence of two components which can be interpreted in two ways. One is that fine mineral grains were natural inclusions in the clay, and medium and coarse fragments were added deliberately as tempering material. In respect of sub*group 1b* and *group 2*, this seemed to be less likely than the use of a fairly sorted sandy clay. The more so, as the pottery is tempered deliberately with vegetal material. According to ethnoarchaeological studies (Druc, 1998), another explanation is also possible, and that is the mixing of two types of clays. This interpretation can be supported by the petrographic characteristics of sub*group 1b* and *group 2*. In sub*group 1b* the presence of petrologicly uniform clay pellets in an exceptionally great amount, may reflect the use of clay temper (Whitbread, 1986), through mixing of two types of clays. In the case of *group 2* the exeptionally low amount of silt size mineral fragments (see Table 1.), compared to that of other groups, with the presence of few medium sized lithic fragments, may be characteristic of a pure clay (with only few, very fine grains), while the other raw material may be a well sorted fine – medium sandy clay.

The sample belonging to *group 3* reflected a different ceramic-making technology. In this sherd both the fabric and the composition of the temper fragments was different. A relatively large quantity of very fine grained muscovite was present in the groundmass. Vegetal temper was not used here. There was also a large quantity of clay pellets present, but their characteristics were different from that of clay pellets found in sample 50/04, *group 1b*. Both the composition of the inclusions and the granulometry deviate from the majority of the sherds (see above). The presence of argillaceous rock fragments and acid volcanic rock fragments is extraordinary. This may reflect not only a different ceramic making technology but a different provenance for the raw material as well. Further investigations are needed to explore this problem.

Sherd 53/02 is a debatable sample from an archaeological point of view. It was found in a mixed unit, which is dominated by archaeological finds of the Late Copper Age Kostolac culture, but contained also pottery of the Starčevo culture. The piece in question was macroscopically assigned to the Starčevo culture by the archaeologists. The authors decided to examine the sample because they were interested if petrologic analysis can add some useful information to the decision of the problem.

The sample was found to be different from the majority of the sherds, especially because of the lack of vegetal temper and the presence of grog as temper material. The use of grog is not common in Early Neolithic samples from Hungary. In Neolithic samples of younger age, however there are some examples for the use of grog (Szakmány, 1996, 2001). The presence of grog as a temper material reflects a completely different ceramic making technology. According to ethnographical analogies described by Skibo et al. (1989), even the farming communities living at one settlement all year round, making typically organic-tempered pottery will use other temper in special periods of the vegetation period (when no chaff at hand). On the other hand, many mobile groups prefer to produce inorganic tempered pottery. Further investigations are needed to prove whether the specific ceramic sample referred to above came from the Neolithic or from later cultures.

CONCLUSIONS

In this paper, primary information on Early Neolithic pottery production was given on the basis of petrologic studies.

On the basis of temper composition potteries could be divided into four groups, each of which represents different pottery-making technology.

In most of the examined pottery fragments organic material was deliberately used as temper. This was probably due to the many advantages of this material: organic tempered pottery has good cooking effectiveness and is relatively light, thus the vessel can be moved more easily. Moreover it can be made in one sitting, so the production of this kind of ware took only a relatively short time, making it easy to replace e.g. broken potteries (Skibo et al., 1989).

Ceramics belonging to *group 1* and *2* – considering petrographic results only – are thought to be local products, while in the case of two sherds (*group 3* and *4*) it is not clear if the differences in fabric and composition of temper fragments can be attributed solely to different technology used or to different provenance. Further investigation of pottery samples from the site and coeval settlements may bring us closer to the decision of the problem.

REFERENCES

DRUC, I. C. (1998): From Clay to Pots: A Petrographical Analysis of Ceramic Production in the Callejón de Huaylas, North-Central Andes, Peru. Journal of Archaeological Science, **25**, 707–718.

KALICZ, N. (1990): Frühneolithische Siedlungsfunde aus Südwestungarn. Inventaria Praehistorica Hungariae, **4**, 1990., 1-164

KALICZ, N., VIRÁG, ZS., BIRÓ, K. (1998): The Northern periphery of the early Neolithic Starčevo culture in South-Western Hungary: a case study of an excavation at lake Balaton. Documenta Praehistorica (Poročilo), Ljubljana, **25**, 151-187.

KALICZ, N., BIRÓ, K., VIRÁG, ZS. (2002): Vörs, Máriaasszony-sziget. Régészeti Kutatások Magyarországon/Archaeological investigations in Hungary, 1999 Budapest. Kulturális Örökségvédelmi Hivatal és a Magyar Nemzeti Múzeum, 15-26.

MAGGETTI, M. (1982): Phase Analysis and Its Significance for Technology and Origin. In Olin, J.S.-Franklin, A.D. (eds): Archaeological Ceramics. Washington, D.C., Smithsoniai Institution Press, 11-133.

M. ARADI, CS. (1992): 1990-91, Vörs, Máriasszonysziget. Régészeti Füzetek, **44**, 26-27.

ORTON, C., TYERS, P., VINCE, A. (1994): Pottery in Archaeology. Cambridge University Press, 1-263.

PETTIJOHN, F. J., POTTER, P .E., SIEVER, R. (1987): Sand and Sandstone. New York, Springer-Verlag, 1-618.

SKIBO, J. M., SCHIFFER, M. B., REID, K. C. (1989): Organic-tempered Pottery: an Experimental Study. American Antiquity, **54**, 122–146.

SZAKMÁNY, GY. (1996), Petrographical Investigation in Thin Section of Some Potsherds. In Makkay, J., Starnini, E. and Tulok, M.: Excavations at Bicske-Galagonyás (part III). The Notenkopf and Sopot-Bicske Cultural Phases. - Societa per la Preistoria della Regione Friuli-Venezia Giulia, Quaderno 6, Trieste, 143-150.

SZAKMÁNY, GY. (1998): Insight into the Manufacturing Technology and the Workshops: Evidence from Petrographic Study of Ancient Ceramics. In: Költő, L.–Bartosiewitz, L. (eds.): Archaeometrical Research in Hungary. Budapest–Kaposvár–Veszprém, 77–83.

SZAKMÁNY, GY. (2001): Petrographic Analysis of the Ceramic Types of the Site at Felsővadász-Várdomb, from the Neolithic and the Bronze Age. Annales Musei Miskolciensis De Herman Ottó Nominati, Miskolc, **40**, 107–125. (in Hungarian)

VELDE, B., DRUC, I. C. (1998): Archaeological Ceramic Materials. Origin and Utilisation. Springer-Verlag Berlin/Heidelberg, 1-299.

WHITBREAD, I. K. (1986): The Characterisation of Argillaceous Inclusions in Ceramic Thin Sections. Archaeometry, **28(1)**, 79–88.

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