Technological investigation of Early Neolithic pottery from Vörs, southwest Hungary

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ABSTRACT This study presents the results of the technological investigation of Neolithic pottery from Vörs, southwest Hungary. It forms part of a major project on pottery analysis of a multi-period archaeological site. The samples analysed were chosen through 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), X-ray fluorescence and X-ray powder diffraction analysis. It was found that in most cases organic material was used deliberately as temper. Other temper fragments detected involve mineral grains (monocrystalline quartz, feldspars, micas, opaque minerals and accessories), rock fragments (polycrystalline quartz grains, microcrystalline quartz grains, argillaceous rock fragments, sandstone grains, schist fragments, other metamorphic rock fragments and rarely volcanic rock fragments), clay pellets, and in one case grog. In order to gain information on firing technology, samples, found to be typical in respect of temper composition, were studied by X-ray powder diffraction analysis. These samples are "sandwich" ceramics, that is they have a reddish exterior and interior surface and margin, and a grey core. The surface and the margin was examined separately from the core. The differences in the composition of the paste suggest that the ceramics were fired at low maximum temperatures (750°C), with a high heating rate and short soaking time.

1. Introduction

This work is part of an interdisciplinary project to establish a diachronic study of a multi-period habitation site in Vörs, southwest Hungary. The approach combines archaeology and archaeometry. This article presents the results of the petrographic, mineralogical and geochemical study of Early Neolithic ceramics excavated at Vörs. The aim of the authors was to group the pottery samples according to their petrographic and geochemical properties and — where possible — make comments on ceramic-making technology.

2. 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. 1). 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. 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 (Kalicz et al., 2002).

According to the results of excavation performed so far, there were elements from the legacy of at least eight 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).

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 Early Neolithic Starčevo culture alone. The Starevo culture constitute the westernmost unit of the large Early Neolithic archaeological complex, comprising towards the East Körös culture and even more to the East, CriD 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 sixth millennium BC, with characteristic elements of the material culture: domesticated plants and animals, permanent settlement, polished stone tools and, pottery (Kalicz et al., 2002).

FIG. 1 – Map of the region

3. Analytical methods

Twenty-five samples from Vörs were studied, accompanied by five comparative samples from Szentgyörgyvölgy from the excavation of E. Bánffy (2000). 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).

Petrographic analysis was carried out under the polarizing microscope. Textural analysis was done according to the principals elaborated by (Pettijohn et al., 1987) and (Whitbread, 1986), accompanied by the quantitative analysis (volume percent) of the tempering material.

X-ray fluorescence analysis (XRF) was used to determine the following major and trace elements: Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K, P, Rb, Ba, Sr, Nb, Zr, Y, Co, Cr, Ni.

In order to gain information on firing technology of sandwich ceramics (see below) XRPD analysis was performed.

4. Results and discussion

4.1. Petrography

4.1.1. Macroscopic description

Most of the examined samples are so called sandwich ceramics (Fig. 2/a, e), that is the external and internal surfaces and margins of the sherds are of varied shades of brown[4], while the core is usually dark grey. Sample 50/04 (Fig. 2/c) is not a sandwich ceramic: its colour is light brown through the whole cross section. Samples 50/09, 50/10 and 50/17 are not like the sandwich ceramics samples either: their colour is grey in the whole cross section. The shape of the pores in all samples (except 53/02) suggests tempering with vegetal material (Fig. 2/a, b, c, e).

4.1.2. *Thin section petrography*

On basis of petrologic examinations the pottery samples could be divided into four groups. As a fifth group comparative samples from Szentgyörgyvölgy are also discussed.

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

Group 1a (16 specimens).

Fabric: The samples' fabric is dominantly serial. Sand size nonplastic inclusions make up about 10 volume percent of the ceramic. Tempering fragments are in most cases fairly sorted.

Nonplastic inclusions: Fine sand size tempering fragments are mainly monocrystalline quartz, feldspars, micas, opaque minerals and accessories, while medium sand size grains are dominantly K-feldspars, coarse or microcrystalline quartzite, mica-schists, other metamorphic rock fragments, or sandstone grains. Vegetal tempering is typical (Fig. 2/b).

Group 1b: (50/04)

Fabric: The sample has hiatal fabric. Grain-size distribution can be described by two maxima. Smaller grains are of sand size, coarse grains are clay pellets (Fig. 2/d). Sorting is very poor.

Nonplastic inclusions: Concerning size, composition and quantity of the grains — the tempering 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. Their composition is uniform, containing only few silt size monocrystalline quartz or muscovite grains. Their fabric is very similar to that of ceramics belonging to group 2 (see below). Vegetal tempering is characteristic in *group 1b* as well.

Group 2 (5 specimens)

Fabric: These samples have serial fabric. Grains are mainly of fine silt size with few exceptions of larger (400–500 µm) grains. Nonplastic inclusions are well sorted.

Pores are mostly formed in places of burnt out vegetal material (Fig. 2/f).

Nonplastic inclusions: These sherds contain exceptionally small quantity — 1–2 volume percent — of mineral or rock fragments. The composition of the nonplastic material is similar to that of Group 1a. Vegetal tempering is typical in *group* 2 as well.

Group 3 (53/02)

Fabric: The ceramic has got hiatal fabric with a grain-size distribution of two maxima. Sand size grains are accompanied by coarse fragments in the range of 400–1500 µm. Nonplastic inclusions are poorly sorted.

Nonplastic inclusions: The size, composition and quantity of the nonplastic material of this sherd is very similar to that of *group 1a*. Coarse (400–1500 µm) tempering grains are grog fragments, making up 15 volume percent of the ceramic. Argillaceous rock fragments and other grog fragments are also present in grog fragments. Vegetal tempering is not detected in this group.

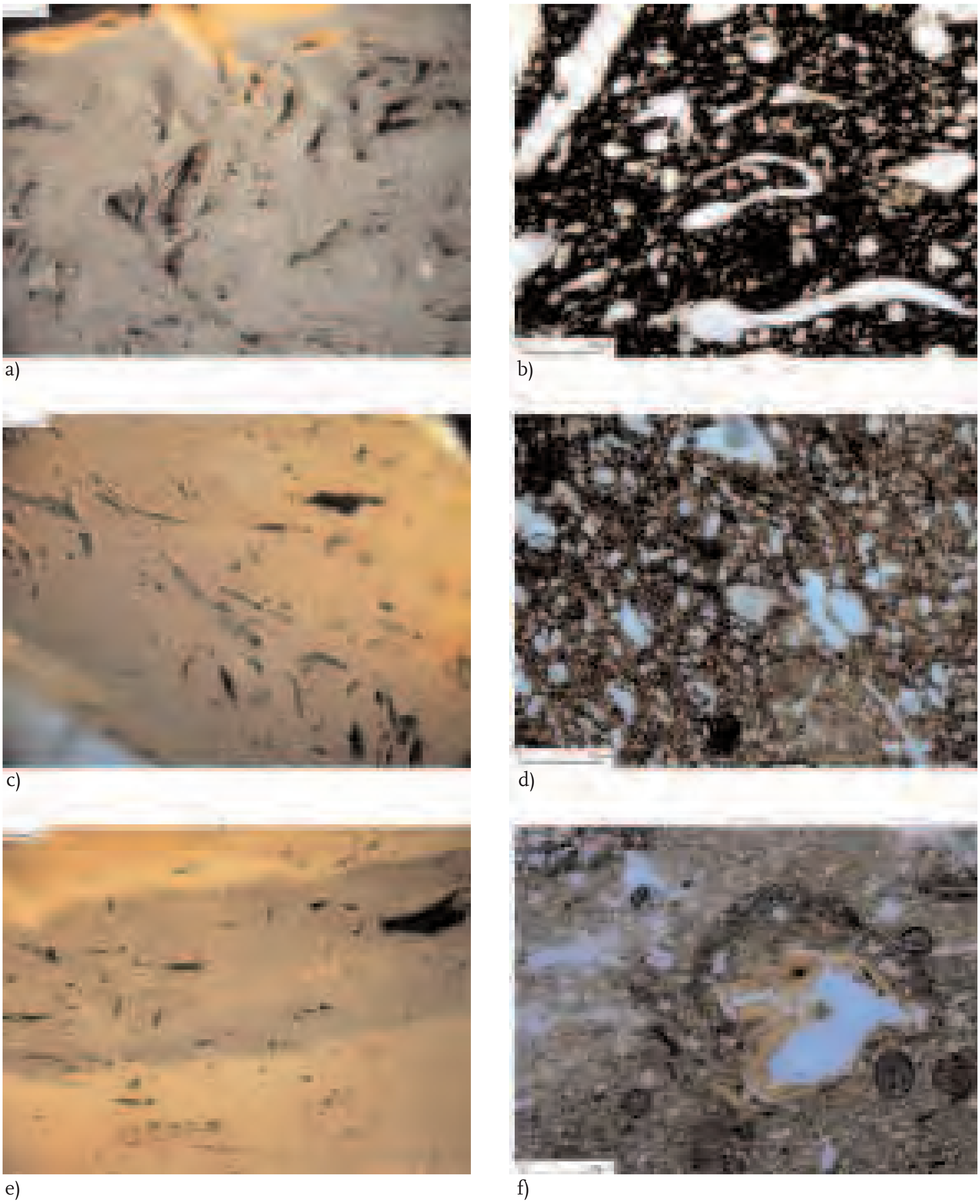

FIG. 2 – a) Binocular microscopic micrograph of pottery sample 50/08, cut surface (group 1); b) Polarization microscopic micrograph of pottery sample 50/08, with pores in places of burnt out vegetal material (group 1), 1N; c) Binocular microscopic micrograph of pottery sample 50/04, cut surface (group 1b); d) Polarization microscopic micrograph of pottery sample 50/04, with clay pellets (group 1b), 1N; e) Binocular microscopic micrograph of pottery sample 50/16, cut surface (group 2); f) Polarization microscopic micrograph of pottery sample 50/16, with pore in place of burnt out vegetal material, (group 2), 1N.

Group 4 (50/10, 43/16)
Fabric: The samples' fabric is hiatal with a grain-size distribution of two maxima. Sand size grains are accompanied by coarse fragments in the range of 400-3000 µm. Sorting is poor.

Nonplastic inclusions: Composition and quantity of the nonplastic inclusions is very similar to that of ceramics in group 1a. The difference is the presence of argillaceous rock fragments in about 5 volume percent. Vegetal tempering is characteristic.

Group 5 (comparative samples from Szentgyörgyvölgy)
Fabric: The fabric of these sherds is serial, nonplastic inclusions are of sand size. The inclusions are fairly sorted.
Nonplastic inclusions: Both the composition and quantity of nonplastic inclusions is very similar to that of group 1. Vegetal tempering is characteristic.

4.2 Geochemistry

Cluster analysis was performed on raw geochemical data. The dendrogram produced this way by Statistica program has a structure that can not be interpreted petrographically. If principal component analysis is applied, it turns out that geochemically mobile elements (such as Rb, Sr, Ba) play an important role in group forming. This fact brings up the idea of the effect of contamination during burial.

Normalising chemical data on the composition of a natural sediment can help to follow trends in the changes of the chemical composition of the sherds and allows comparison with the natural sediment itself. In this study chemical data was normalised on the composition of the Post Archaean Australian Shale (PAAS) (Taylor and McLennan, 1995). Multi element diagrams on major elements show high positive phosphorus anomaly in almost all of the samples. As in thin section there were no signs of tempering with materials having high phosphorus content (such as bone-ash) these high values are probably due to conta-

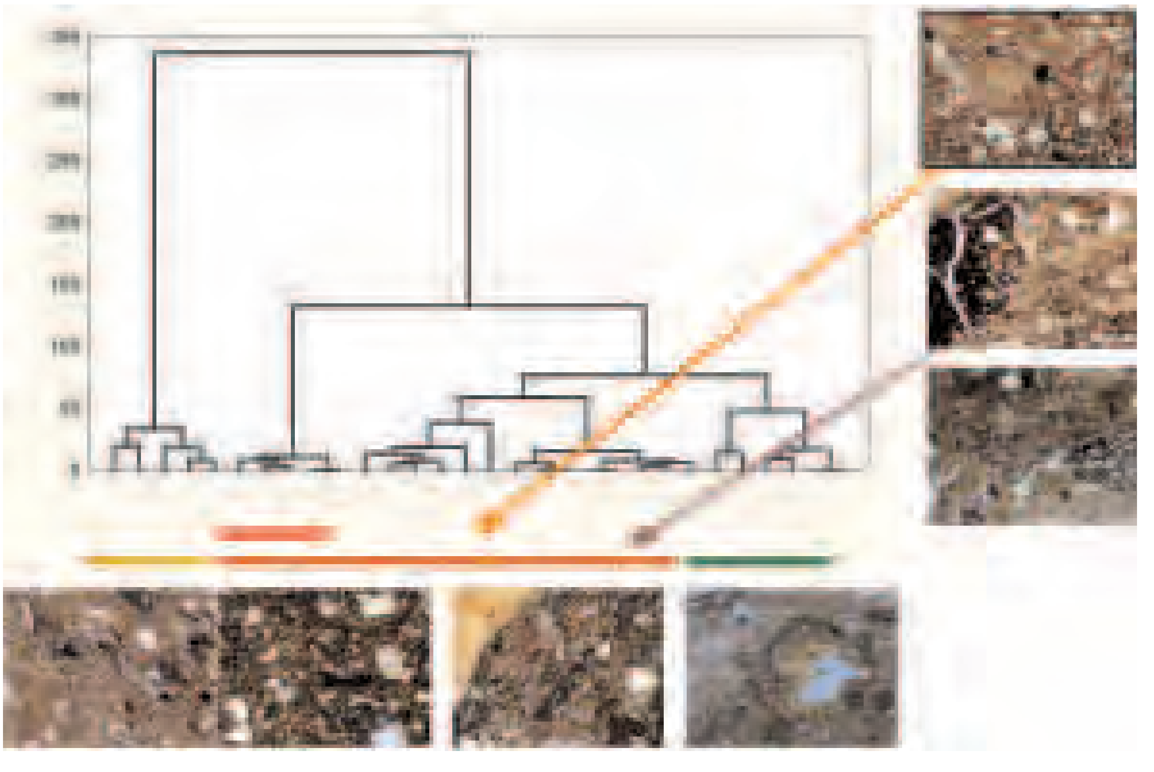

FIG. 3 – Comparison of petrographic and geochemical groups. See explanation in text.

mination (Wedepohl, 1970; Maggetti, 2001). Multi element diagrams on trace elements also show a strong negative Ni anomaly in some of the samples.

Following these considerations — in order to exclude the effect of contamination in group forming — cluster analysis was repeated after excluding the following, geochemically mobile elements: Rb, Sr, Ba, P, and the newly formed groups were interpreted together with petrographic results.

Petrographic analysis combined with geochemical measurements confirmed the existence of two major groups (Fig. 3). Comparative samples from Szentgyörgyvölgy form a separate, third group. The first group comprises petrographic groups 1 and 4, the second petrographic groups 2 and 3. The intermediate sample (50/04, petrographic group 1b) clusters to the first group.

There are five, geochemically outstanding samples. These belong to petrographic group 1, but have strong negative Ni anomaly. The possible cause for that might be the different composition of the clay matrix: these samples do not contain smectite, which may be responsible for greater Ni concentrations in the other samples.

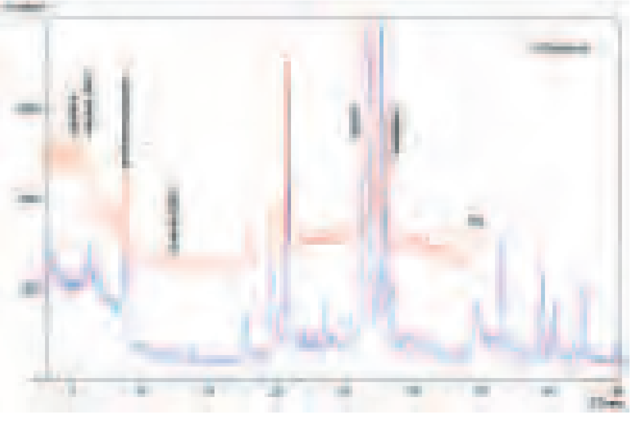

FIG. 4A – X-ray diffraction pattern of the core of sample 52/04.

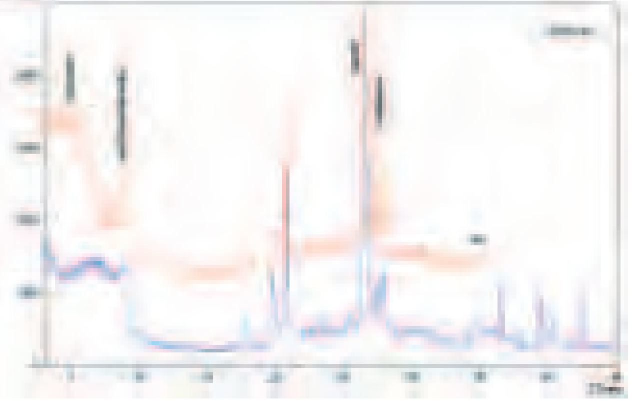

FIG. 4B – X-ray diffraction pattern of the margin of sample 52/04.

4.3 X-ray powder diffraction

The great majority of the examined samples are sandwich ceramics (see above). In order to gain information on firing technology these ceramic samples were subjected to x-ray powder diffraction analysis. Analysis was done on whole ceramic samples before and after glycolation. The brownish outer layer of the sandwich ceramics was separated from the grey core and analysed separately.

The composition of temper in the margin and the core was found to be very similar, comprising mainly quartz and feldspars. However major differences can be found in the composition of the paste. Sericite-muscovite (10 Å), coupled by smectite was identified in both parts, while chlorite was only detected in the cores (Fig. 4/a,b).

As a theoretical starting point the results of Livingstone Smith's ethnoarchaeological survey on bonfire firings were used (Livingstone, 2001).

5. Conclusions

Based on petrography and geochemistry the authors distinguished two pottery types among the Early Neolithic ceramic finds: 1) fairly or poorly sorted sandy potteries tempered with vegetal material, 2) very well sorted fine grained potteries tempered with either vegetal material, or in one case grog. The presence of the above groups and an intermediate sample (containing 10 volume percent clay pellets) may suggest: a) tempering a "pure" clay (of pottery type 2) with sand, b) levigation, or c) mixing two kinds of clays (a sandy and a "pure" one). Geochemical data tends to support either a) or b). X-ray diffraction analysis showed that sandwich ceramics were fired: at relatively low maximum temperatures (750°C), with short soaking time (presence of chlorite in the inner part, its absence in the outer part) and high heating rate (Livingstone's group 2).

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NOTES

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[4] Colour descriptions were made using Munsel's Rock colour chart (1984).

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