Thermal alteration of mineral phases in Bronze Age ceramics from Transylvania (Romania)

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Potshards of Late Bronze Age (1400–1200 B.C.) handmade pottery, exhumed in the archaeological site of Ilişua in North Transylvania (Romania) were studied by plane-polarized light optical microscopy (OM), X-Ray powder diffraction (XRD), thermal analyses (DTA), scanning electron microscopy (SEM), electron microprobe (EM) and electron paramagnetic resonance (EPR) in order to identify the phase components, their thermal alteration during the firing, and the raw materials. The ceramic fragments show in general a dark grey body colour, spotted by large white mineral clast and even pebbles as well as brick-red potshards. Across the wall thickness, the colour is rather homogeneous, only seldom a slight zoning with dark grey grading into reddish hues, can be noticed. The ceramic body is in general porous, due both to the elongated or irregular-shaped pores and to the microfissures.

The ceramics consists basically of a clayish matrix with combined, crystalline and amorphous fabric and exhibits different degrees of sintering and vitrification. In the matrix, variable amounts of magmatic, metamorphic and sedimentary lithoclasts, as well as various crystalloclasts, ceramoclasts and bioclasts are present. Granulometrically, based on the amount of Sm (small particles, between 0.02 and 0.5 mm), Md (medium size-particles, between 0.5 and 1 mm), Lg (large particles, over 1 mm), 55% of our samples classify as coarse ceramics while 45% can be assigned to the semifine one. The OM, SEM and EMP analyses reveal intimate thermal alteration processes, i.e. melting–diffusion–recrystallization, affecting mainly the matrix and its relationship with the clasts. The most important is the change of the clayish matrix, which forms a rigid body, where the particles are sticked together by sintering–melting processes. Fe migrated from the matrix into the softened rims of quartz grains. Parts of feldspar clasts became isotropic and the glassy, amorphous melt intruded into the cracks. New phases such as glass, gehlenite, wollastonite, hematite, anorthite, leucite, K-feldspar, and melilite formed as well. The burial alterations are marked by chalcedony deposition, analcime replacing the volcanic glass clasts and by P-enrichment.

Based on macroscopic and microscopic observations, as well as XRD, SEM, EPR and EMP data compared with reference data (MAGGETTI, 1982; DUMINUCO et al., 1998; RICCARDI et al., 1999; CULTRONE et al., 2001; BERTOLINO & FABRA, 2003, etc.) and with our previous experimental results, the firing conditions for the Late Bronze Age ceramics could be approximated in three large domains: 800–850, 850–950 and 950–1000°C. The mineralogical features of the matrix indicate that ceramics was obtained by mixing of kaolinitic–illitic and illitic–kaolinitic (±smectite) raw clays, with some iron- oxihydroxides content. The lack of calcite in the fired matrix as well as the scarcity of gehlenite and/or wollastonite indicates as well that they were non-calcareous clays or clays with only accidentally carbonate content. The clays came from at least two different sources, most likely located at hand. They were for example, the Badenian kaolinitic–illitic and illitic–kaolinitic clays occurring in the surroundings of Ilişua settlement. The high frequency of clay pellets reveal that some soil was added in the ceramic paste. The petrographic and mineralogical composition of the clasts points to the alluvial sandy sediments as tempering materials, derived from the Somes River flowing nearby the site.

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