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# THERMAL CHANGES OF CERTAIN HEAVILY BURNT ARTIFACTS FROM CHMIELÓW PIASKOWY NECROPOLY (THE HOLY CROSS MOUNTAINS)

Mineralogical research have been quite often involved in archaeology. One application refers to thermally changed artifacts found in cremation necropolies. The aim of the research was undefined remnants, described in previous archaeological articles as "burnt glass". In Poland, this substance is known from a cemetery of Przeworsk culture (2nd century AD) from Chmielów Piaskowy (N forehead of the Holy Cross Mts). According to burial customs, corpses were cremated together with animals and an everyday equipment. Burnt remnants were deposited into pits or clayey urns. Urns may have been spilled with remains of a stake (Godłowski, Wichman 1998). The Chmielów Piaskowy necropoly, was investigated archaeologically in 1938-39 years by R. Jamka and precisely described by Godłowski and Wichman (1998).

Archaeological artifacts were submitted to various intensity of heat that produced weak deformation of objects as well as sinters of still recognizable components (e.g. bones, beaks) together with a white-greyish, porous substance of unknown composition and provenance. Present study was aimed at identification of phase and chemical composition of the porous substance, and, in comparison with other components of inventory (also mentioned above sinters), collecting information on the provenance of the components. As far as it has been known to the author, research of this type have not been conducted so far.

The studied porous substance is macroscopically almost homogenous, white-greyish in colour (Fig. 1), with earthy or glassy luster, brittle and hard (*ca*. 5 M). Under polarized light background appears to be glassy and very porous. Irregularly dispersed, opaque particles are also present.

Further investigations were performed with FTIR, SEM/EDS, XRD and DTA/TG. FTIR examinations confirmed the glassy composition of the porous substance. Weak bands representing phosphate groups (569, 603, 660, 880, 965, 1090 $cm^{-1}$), carbonate (1430, 1465 $cm^{-1}$) and OH (1634 $cm^{-1}$) were ascertained (Fig. 3). Porous substance is composed of Si, P, Ca, Al, Mg, Na, C and sometimes contains Pb, Cu, Sn, Ag, Sb traces. Concentration of metals may be significant. They are irregularly dispersed in a volume of porous substance and do not occur in any apparent morphological forms.

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XRD examination revealed amorphic-like substance, consists of quartz, chalcedony, albite and, in sinters: apatite, analcite and kalsilite. DTA/TG examinations of porous substance from graves 14 and 20 revealed that thermal effect starts in various temperature: *ca*. 900$^{o}$C and 610$^{0}$C, respectively. No loss of mass is observed.

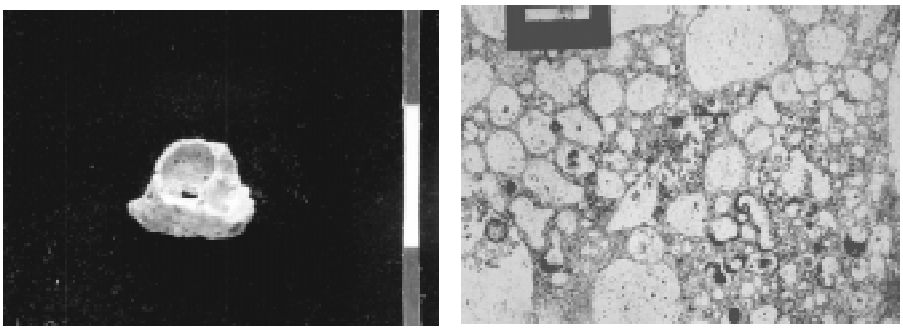

Fig. 1. Porous substance, grave 9 (left). One label stands for 5 mm. Microphotography of porous substance under polarized light (right). Magn. 20 times, without nicols.

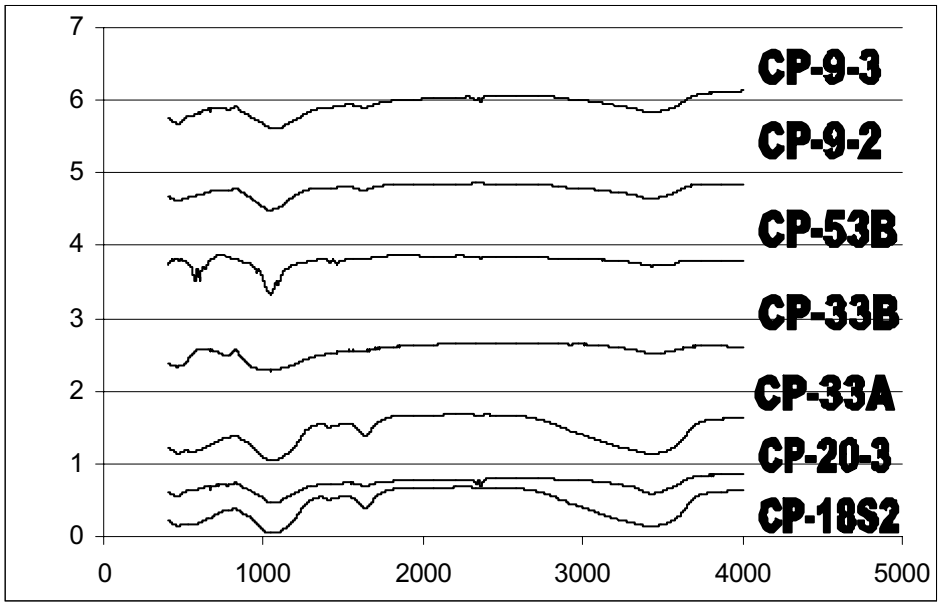


Fig. 3. FTIR spectra of porous substance.

## CONCLUSIONS

Thus, it is assumed that porous substance appears to be a silicate – phosphate glass formed from a) glass artifacts composed of Si-Na-Ca, Si-Ca-Sb, possibly Si-Pb, b) metal artifacts of Pb, Cu, Sn, Ag, c) bones, d) quartz sand, and/or, older ash (these latter were documented by the presence of tiny round hedenbergite slag in porous substance of the grave 28), e) fly ash, either with organic or inorganic dominant component.

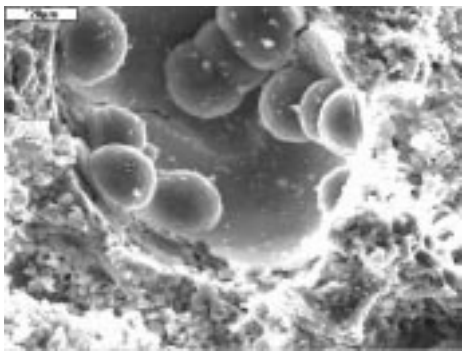

Fig. 4. Interior of a pore filled with secondary components of Ca, P, Al, Fe, Ti. Surrounding is composed of Si, Ca, P, K, Na. Grave 33. The bar stands for 20 μm.

Silicate – phosphate glasses appear in high temperatures (those produced from components that are similar to the ones occurring in a stake, i.e. crushed bones, glass and/or felspars): even 1400$^{o}$C (Barba *et al*. 1998). This temperature seems to be unattainable in cremation stakes, but vapour pressure may have lowered it. Analcite, leucite and kalsilite were ascertained only in sinters, not in porous substance. Their presence suggests glassy phases corrosion. It seems that phosphate glasses are stable compared to burnt archaelogical silicate glasses .

The results of investigation of porous substance compared with archaeological inventory proved that the chemical composition of porous substance preserved the information about not existing artifacts of Pb, Ag and Pb, Cu and Pb. A precise reason for the presence of analcite and kalsilite remains unknown: either it is a result of quenching a stake or vapour from bodies and wood.

Further investigations should be concentrated on experiments with controlled parameters of stakes.

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