

Exploiting synergies in molecular structures, isotopic signatures and faunal evidence to enhance archaeological interpretations

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The paucity of finds in the archaeological record at the earliest stages of development of human civilisations make it essential to combine multiple lines of evidence to achieve robust reconstructions. The past 3 decades have seen major developments in the use of organic residues from a wide variety of archaeological artifacts and deposits to enhance our knowledge of the use of particular finds, evidence of technological activities and the exploitation of a wide range of natural resources. Considerable interest has focussed on the chemical analysis of organic residues preserved in pottery vessels involved in the processing of animal and plant products, i.e. 'cooking' vessels. Such residues provide information relating to the specific functions of vessels and, more significantly, the wider aspects of settlement and regional economy and diet. In this respect food residues surviving in pottery vessels are highly complementary to other dietary indicators, particularly faunal remains.

This presentation will discuss the analytical approaches to the investigation of the major class of organic residue observed in prehistoric pottery, namely degraded animal fats. Although the major components detected, i.e. *n*-alkanoic acids and other acyl lipids, are rather non-specific biomarkers it will be shown how compound-specific stable isotope values greatly enhance their diagnostic potential. Examples will be given which demonstrate classifications of species origins based on the $\delta^{13}\text{C}$ values of $\text{C}_{16:0}$ and $\text{C}_{18:0}$ alkanolic acids as a result of them recording the physiological and metabolic differences between the major domesticates. An entirely new approach will be presented which shows how compound-specific carbon and deuterium isotope values of the same alkanolic acids can be used in tandem, exploiting metabolic and seasonality effects, to further refine assignments. In all cases the interpretations based on molecular and stable isotope signatures are supported by detailed assessments of faunal assemblages to provide hitherto unobtainable insights into the early exploitation of bovines and equids for their 'secondary products' in Europe, the Near East and Eurasia.

Peculiarities of Pd-Pb-Bi system minerals

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Samples and probes of Cu-Ni sulphide ores from Noril'sk deposits have been studied using SEM. New data on polarite and plumbopalladinite compositions are received. It leads to the reviewing of phase relationships in the system Pd-Pb-Bi. Minerals of this system, polarite $[\text{Pd}(\text{Pb},\text{Bi})]$, zvyagintsevite $[\text{Pd}_3\text{Pb}]$, plumbopalladinite $[\text{Pd}_3\text{Pb}_2]$, sobolevskite $[\text{PdBi}]$, and froodite $[\text{PdBi}_2]$ normally do not form the separate grains. They are included in complex intergrowths with other Platinum-Group Minerals as small grains (up to first tens microns). Although Pd-Pb-Bi minerals are described in many publications, some questions remain still open: 1) the limits of isomorphous replacement Pb-Bi in polarite; 2) the problem of ordered members of PdBi-PdBi isomorphous series; 3) the composition of plumbopalladinite; 4) polarite – sobolevskite relationships. Data on polarite composition show that near complete series PdBi-PdPb exists. However, according to the detail study of phases synthesized in PdPb-PdBi with x-ray diffraction, SEM+EDD along this series there are some ordered compounds with stoichiometric formula coefficients (Pd:Pb:Bi). The similar observations are determined for minerals too. Crystallochemical characteristics of PdBi and PdPb allow distinguishing new minerals in the polarite series. The composition of polarite depends on the mineral association. For example, more Bi-rich polarite is characteristic for associations, containing Sn- or As- bearing PGM (i.e. stannopalladinite, palarstanide, atokite, majakite, sperryllite etc.).

The composition of plumboipalladinite very often shows the deviation from stoichiometry 3:2. SEM+EDD study showed that plumbopalladinite 'non-stoichiometry' is caused by tiny inclusions ($n \cdot 10\text{nm} - n \mu\text{m}$) of zvyagintsevite, Pd_3Pb , polarite $\text{Pd}(\text{Pb},\text{Bi})$, urvantsevite, $\text{Pd}(\text{Pb},\text{Bi})_2$, froodite, PdBi_2 , and phase « Pd_2Pb ». Sometimes plumbopalladinite from Noril'sk deposits with composition Pd_3Pb_2 is presented by very tiny intergrowths of two mineral phases - ($\text{Pd}_2\text{Pb} + \text{PdPb}$) or ($\text{Pd}_3\text{Pb} + \text{PdPb}$). Therefore it is necessary to review the composition of every 'plumbopalladinite' find.