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Untangling complex organic mixture in Prehistoric hearths

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In the last decades organic residue analysis of ceramic artefacts have advanced our understanding of culinary practices and economies in the past. Current approaches, deploying lipid residue analysis, have allowed a wide range of prehistoric commodities processed in pottery to be identified (1, 2). Recently, organic residues analysis has allowed us to gain a new perspective on the emergence and adoption of pottery by prehistoric hunter-gatherers. These data have shown a the strong reliance on the exploitation of aquatic resources (e.g. 3, 4). But this approach is limited by the fact that not all hunter-gatherer societies used pottery and that usage of pots seems specialised in comparison to the existing broader spectrum economies (4). Thus, looking at organic residues contained in fire structure remains would provide an extended testimony of diet and cooking practices complementary to the study of vegetal and faunal remains. Although organic residue analysis of prehistoric hearths began in the late eighties (5–7) they are still an an underestimated source of information and only a few studies have been exploring their potential. In this issue of PNAS, Choy et al (8) uses isotopic and molecular analysis of organic residues from hearths to obtain new insights into salmonid exploitation and processing by Alaskan hunter-gatherer of the end of the Pleistocene.

Choy et al.'s paper (8) main objective was to resolve the complex mixture of organic matter (OM) found within hearth and to obtain quantifiable data of the contribution of the various sources considered (regrouped as salmon, freshwater and terrestrial animal) to allow a comparison of the content of the fire structures from the USR occupations. This is a relevant issue as OM preserved in hearths may unlock archaeological information, although complex to deconvolute. Indeed, preserved OM is a mixture resulting from the potential input of: sedimentary OM initially present or coming from post-depositional process (e.g. deposition and migration of sediment), plant or animal tissues used as fuel (e.g. wood, bones, dung) or processed during cooking activities (e.g. roasting or grilling of animal resources) as well as other domestic activities. Moreover, the OM have been subject to a natural oxidation and to heat, conducting to a partial or total removal of compounds and to molecular transformations.

Choy et al. have followed analytical procedures previously employed . OM study in hearths have focused on the molecular characterisation of lipids from archaeological or experimental replicate using gas chromatography mass spectrometry (GC-MS) (e.g. 6, 9–12), associated more recently with stable isotopic analysis of bulk organic matter (EA-IRMS) (13) or of individual molecular compound obtained by gas chromatography combined with isotope ratio mass spectrometry (GC-c-IRMS) (14, 15). By combining theses biomolecular techniques, Choy et al. addressed the mixing issues .

The presence of anthropogenic OM is demonstrated by an higher $\delta^{15}N$ compared to the control samples. The $\delta^{15}N$ values also indicate a contribution of aquatic resources and the variability observed reflects the diversity of the composition of the OM. As the bulk $\delta^{13}C$ are possibly reflecting an input of wood fuel and as no specific biomarker have been recovered, further insight are obtained with the compound specific $\delta^{13}C$ value of individual fatty acids. Finally the composition of the mixture is resolved using SIAR, a Bayesian isotopic mixing model, allowing to calculate the relative contribution of the various sources (grouped as salmon, freshwater and terrestrial animal). Importantly the good bone preservation of the Component 3 of USR, allows Choy et al. to validate the result by obtaining a positive correlation between the calculated contribution of salmonids by SIAR and the frequency index of salmonids in the faunal assemblages. Thus Choy et al. can distinguish certain patterns of activity within Component 3 but also can infer the exploitation of anadromous salmon as early as in Component 2, showing that hunter-gatherers living in Alaska relied heavily for their diet on aquatic resources, and notably anadromous fishes, since the end of Pleistocene.

Control of fire is one of the exclusive and typical traits of humanity, as reflected in numerous myths where fire is the element that allows humanity to “get out” of the natural kingdom (16). But the fire in question is not any fire to heat or light, it is the fire that allows cooking (17), transforming a natural resource in cultural food. Once adopted, fire was never abandoned and as a consequence, there is no society that doesn’t process by heat at least a part of its food (18, 19). Organic residues analysis of archaeological hearths provides a direct testimony on the evolution of diet and subsistence practices in human societies.

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