# CHAPTER SIX
# Elucidating Pottery Function using a Multi-step Analytical Methodology combining Infrared Spectroscopy, Chromatographic Procedures and Mass Spectrometry

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To determine the function of a wide range of prehistoric ceramic vessels from several recently excavated archaeological sites, an interdisciplinary methodology was developed to link analytical chemistry, geochemistry and archaeology. This method comprised the description of charred surface residues and their distribution in ceramic containers, combined with a multi-step analytical strategy based upon a panel of complementary analytical techniques, namely infrared spectroscopy, direct inlet mass spectrometry and chromatographic procedures. The attribution of the molecular constituents that are detected and identified by these techniques into four categories of markers (biomarkers, anthropogenic transformation markers, natural degradation markers and contaminants) appeared a powerful tool for interpreting the molecular composition in terms of procurement, production and use of natural substances exploited by prehistoric people. Subcutaneous animal fats, dairy products, beeswax, plant oils, pine resins and birch bark tar were demonstrated to be processed in the containers studied. The identification of these substances led to the distinction of ceramic vessels linked with culinary activities from those related to technical activities, such as pottery repairing, coating or waterproofing as well as adhesive production, storage or use.

This chapter is intended to highlight both the analytical strategies developed and the results obtained on pottery function dealing with the characterization of organic remains preserved in archaeological ceramic vessels. I will first provide a general overview of the amorphous organic residues which may be preserved in ceramic containers. After this, the methodology as well as the processes that allow interpretation of chemical data in archaeology are described and explained. Finally, some results obtained on various ceramic vessels from Neolithic, Bronze and Iron Age sites in Belgium and France are presented and discussed.

Understanding pottery function is probably one of the most difficult tasks in archaeology. Until recently, most of the publications dealing with archaeological vessels discuss this matter only briefly, or not at all. Assumptions on pottery function are often quite general and usually limited to broad categories like food processing or the storage or transportation of various items (Rice 1987). The emphasis on culinary uses does not take into account the great diversity and variability of archaeological ceramic containers. This is probably due to the fact that most of the hypotheses on vessel use are primarily based on morphological and physical characteristics of the vessels. Theoretical relationships may obviously be supposed between morphology (shape, size, wall thickness) or physical properties (porosity, durability, resistance to thermal stress) and a particular use. For example, vessels with narrow openings may well have been containers for liquids; vessels with a round base and thin porous walls are more resistant to thermal stress and may have been used for cooking (Rice 1987; Orton et al. 1993). However, pottery function depends on a large number of properties, and their combination, and ethnographic research shows that no one-to-one correlation exists between use and the intrinsic properties of a vessel (Rice 1987, 224; Sigaut 1991). Furthermore, one must note that in most cases confusion exists between 'function' and 'functioning', as discussed by Sigaut (1991). Indeed, 'functioning refers to the way an object works or is worked, function refers to the whole set of ends for which it is put to use' (Sigaut 1991, 21). Defining vessel use by actions like storing, processing or transferring clearly implies functioning. Assessing pottery function must then not only deal with 'how was the vessel used?', but also with 'what did the vessel contain and with what purpose?'.

The only way to answer the second question is to identify the former contents of the vessels wherever these are preserved. Visible residues adhering to ceramic vessels and their location on the vessels were noticed and described as early as the end of the 19th century

(Heintzel 1880; 1881); the possibility to chemically identify them had to wait for almost a century and the availability of analytical tools such as chromatographic techniques and mass spectrometry (Condamin et al. 1976; Condamin and Formenti 1978; Evershed et al. 1990; 1991; 1992a; b; Heron and Evershed 1993; Charters et al. 1995; Regert et al. 1999). Coupling chemical identification of the contents of the vessels with archaeological criteria, including both intrinsic (shape, materials, physical properties, use traces) and extrinsic (context of discovery, experimental data, ethnographic data) attributes of the vessels, provides many prospects for better understanding pottery function and functioning (Barnard et al. 2007). With this in mind several series of ceramic vessels from different European regions, archaeological contexts and periods (all from recent and well documented excavations) were investigated.

| Description of the visible organic residue | Putative function of the organic remains |
|---|---|
| Regular thin residues covering all the surfaces of the vessel | Coating agents |
| Black rough residues with a low adherence to the pottery, mostly located on the inner part of the vessel or residues that have spilled on the outside of the vessel (located on the rim and the upper outer parts of the vessel) | Culinary commodities |
| Brown to black residues, hardly adhering to the pottery, located either on the inside or the outside surfaces of the vessel | Adhesive materials |
| Brown to black residues, often quite thick, strongly adhering to the pottery, related to damaged parts of the vessel | Repairing materials |

Table 1: Description of the kinds of visible amorphous organic residues encountered on archaeological ceramic vessels and their putative former function.

Organic matter is known to be particularly well preserved in specific environmental contexts such as anaerobic (lacustrin, fluvial or marine), very dry or frozen sites. At archaeological sites, amorphous organic remains either linked with culinary commodities (dairy products, vegetable oils, fermented beverages) or technical activities (adhesive production, dyeing) have been preserved from the Neolithic and probably earlier. Pottery favors the preservation of either carbonized surface residues or organic matter trapped in the porous ceramic matrix (Rice 1987, 211). Although such remains are usually related to pottery function, some of them may also be witnesses of the final stages of pottery production. Depending on their nature and the time when they were introduced in the pottery life, organic residues represent different aspects of the 'vessel life' (Table 1). Three cases will be briefly discussed: organic remains related to the last stage of pottery making; organic remains that provide information on pottery function and organic remains that may be related to pottery repair.

## Organic Remains and Pottery Production

Several organic materials from animal or plant origin may be added as temper to the clay used for pottery production (Rice 1987, 407). Such materials, including plant fibers, shell, animal hair and dung, are usually not considered 'organic residues' as they are part of the matrix of the vessel. Moreover, because they have been added to clay before the firing process, their molecular composition is usually not preserved and is not identified by organic residue analyses.

Organic substances may also have been used for coating the surfaces of a ceramic vessel to decrease its porosity, increase the heating effectiveness and strength or to achieve a particular aesthetic effect (Arnold 1985, 140; Schiffer 1990; Diallo et al. 1995). Ethnographic research has shown that various substances, such as tree resins, saps, bark decoctions and other organic mixtures, have been used for this purpose (Arnold 1985, 140; Diallo et al. 1995). Although this practice is frequently attested ethnographically, few archaeological clues ascertain the use of organic substances as coating agents. A clear example of an archaeological ceramic vessel undoubtedly coated with an organic agent was excavated at Grand Aunay (Regert et al. 2003a). Coating residues have been identified on this sherd, dating to the Iron Age, covering both its inside and outside surfaces. The residue was quite homogeneous with a slightly brilliant brown color; its thickness varied between 20-200 µm. Coating agents may be detected by observing both the surface aspect of the coating and a section of the sherd under a microscope.