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Cooking traces on Copper Age pottery from central Italy: An integrated approach comprising use wear analysis, spectroscopic analysis and experimental archaeology

Vanessa Forte[a,*], Stella Nunziante Cesaro[b], Laura Medeghini[c]

[a] McDonald Institute for Archaeological Research, University of Cambridge, Downing Street, CB2 3ER Cambridge, UK
[b] Scientific Methodologies Applied to Cultural Heritage (SMATCH), ISMN-CNR, Sapienza University of Rome, P.le A. Moro 5, 00185 Rome, Italy
[c] Department of Earth Sciences, Sapienza University of Rome, P.le A. Moro 5, 00185 Rome, Italy

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ABSTRACT

This contribution discusses the results of an integrated approach of use wear analysis, spectroscopic analysis and experimental archaeology, applied for the investigation of the actual use of selected ceramic vessels, taken from domestic Copper Age contexts in the modern Rome area.

This study is based upon the consideration of a vessel as a tool, used during everyday life and thus reflecting human activities and social behaviours. To this end, the paper here presented proposes an interpretation of the actual use activities which led to the modification of prehistoric vessels. The methodology of this study integrates the traditional approach to ceramic use wear studies, based on experimental and ethnoarchaeological studies, with principles of tribology, along with the application of a dedicated experimental framework which enabled the development of a detailed collection of comparative use wear. Moreover, the application of spectroscopic analysis provided preliminary data related to the charred encrustations found inside the archaeological specimens. These data, when combined with use wear, palaeobotanical remains and archaeological preserved structures, aided interpretation of the archaeological ceramic vessels as cooking pots.

1. Introduction

Ceramic materials, especially in the form of pottery vessels, represent one of the most recurrent pieces of evidence related to everyday human life found in archaeological contexts.

The appearance of this technology is associated with important changes in the economy and social life of prehistoric communities (Barnett and Hoopes, 1995; Matson, 1965; Rice, 1999; Robb, 2007; Sassaman, 1993; Vitelli, 1989). Consequently, its growing presence in the everyday life of prehistoric groups enables a large variety of inferences regarding its use in terms of human behaviour, directly and indirectly reflecting choices of production and use. North American archaeological interpretive traditions encouraged the development of prehistoric pottery analysis from an anthropological perspective, connecting empirical analyses of ceramic materials with ethnoarchaeology. This approach led scholars to realise the importance of focusing their research on the actual use of an object in order to understand specific human behaviours, which was of paramount importance for the development of use wear analysis in ceramic studies.

Use wear analysis is a method based on the study of traces left on tools during their use. The lifecycle of a functional object is subject to intentional or unintentional human activities, often leading to modifications of the object's original features (Marreiros et al., 2015; Semenov, 1964; Vaughan, 1985).

The first observations of use traces on ceramic vessels focused on surface modifications and/or features attributed to use activities, defined as *abrasions*, *scratches*, *spalling* and *fire traces* (Bradfield, 1931; Braun et al., 1967; Chernela, 1969; Matson, 1965; Perino, 1966). These forms of evidence were described and localised on the objects, yet they lacked explanations of the processes involved in the formation of use wear and inferences of actual human behaviour. Interest in these latter aspects became more pronounced during the following decade, in relation to the growing processual debate on the theoretical and epistemological approach. In this period, American scholarship on ceramic use wear developed towards an anthropological approach to the interpretation of archaeological data, leading researchers to systematically investigate wear patterns as sources of information for the actual vessel function (De Garmo, 1975; Ericson et al., 1972; Fenner, 1977; Griffith, 1978; Rohn, 1971). These works represent the first attempt to apply the newly born traceological method to ceramic studies,

* Corresponding author.
E-mail addresses: vf261@cam.ac.uk (V. Forte), stella.nunziante@libero.it (S. Nunziante Cesaro), laura.medeghini@uniroma1.it (L. Medeghini).

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contemporaneous to the development of use wear analysis on lithic and bone tools (Hayden, 1979; Semenov, 1964).

Currently, our knowledge concerning use traces affecting ceramic vessels relies on an archaeological, experimental and ethnoarchaeological dataset developed mainly in the 1980s and 1990s (Bray, 1982; Bruce, 1989; Hally, 1983, 1986; Lugli and Vidale, 1996; Schiffer and Skibo, 1989; Skibo and Schiffer, 1987; Skibo, 1992). According to these studies, actions involved in cooking, storing and cleaning activities can damage the vessels and generate traces on their internal and external surfaces. While a solid foundation of knowledge regarding the principal processes of use modification is available, recently the systematic applications of use wear analyses on archaeological ceramics has remained limited to specific kinds of ceramic tools (e.g. pottery sherds for scraping activities) (Lopez Varela et al., 2002; Vieugué, 2015), with few studies focused on pottery (Banducci, 2014; Dugay, 1996; Vieugué, 2014; Vieugué et al., 2008; Vuković, 2009, 2011). To this end, interpretation of archaeological use wear on pottery usually relies on the ethnoarchaeological documentation established by Skibo (1992), which relates to the domestic ceramic assemblages of the Kalingas. Skibo (1992) developed a nomenclature on the basis of direct observation of use processes in a specific context. This study still represents a solid base in the field of ceramic use wear, even though the direct application of these observations on the archaeological materials may lead to generalised interpretations. Indeed, experimental studies on ceramics (Schiffer and Skibo, 1989; Skibo and Schiffer, 1987) demonstrated that features such as the compositional characters of raw materials and the physical properties of ceramics influence the development of wear. These findings show that dedicated studies of an object's context and associated materials, along with experiments and use wear analysis, are essential in order to adequately interpret archaeological materials and investigate the techno-functional choices that characterise a given community.

Although pioneering studies have defined the basic principles of ceramic alterations and the variables affecting wear processes, allowing for the distinction between use wear and post-depositional modifications, it is still difficult to define archaeologically the variety of overlapped processes or actions related to the item's use. For example, one of the most diffused and studied forms of wear on ceramic falls within the wide category of abrasive wear. These alterations, caused by a tribological system, are due to the contact, usually through sliding, of two surfaces in relative motion, which causes the detachment of materials. Currently, while we are able to identify abrasive wear on a vessel and define whether it has been more or less invasive, we are not able to precisely establish the nature of the material with which the vessel came in contact during its use.[1] Indeed, we are able to distinguish mechanical alterations (e.g. abrasive wear) from chemical ones (e.g. corrosive wear), defining them as separate processes. However, vessels are frequently involved in both mechanical and chemical processes that are usually associated with each other; for this reason, future research should focus on these interactions and the resulting wear. Moreover, systematic experimental frameworks dedicated to monitoring not just the development processes but also to documenting trace collections associated with specific variables on vessels, are still not well defined.

This kind of approach is not yet systematically applied in traceological studies on pottery. Moreover, ethnoarchaeological references primarily concern cooking vessels featuring a rounded base and which are put on the fire, often on supports, leading to specific context-dependant wear. Their use in wet cooking causes black carbonised areas on the internal base and in the band immediately above the water level (Skibo, 1992), these being the areas most exposed to the heat. This contribution aims to investigate whether the archaeological traces observed as extended internal carbonisation were only accidental, or if it is possible to directly connect them and other archaeological use wear with culinary habits or specific processed foods.

2. Wear processes on pottery

The term ‘wear’ is used herein to refer to all the modifications produced by a reduction of the surface, regardless of their mechanical or chemical nature; conversely, the word ‘residue’ is used for all modifications of the original ceramic surface that derived from amorphous substances, regardless of their physical nature or chemical composition. For this reason, the study of wear on pottery focuses on the way in which ceramic particles detach from the original surface. Indeed, ceramic is a mix of clay minerals and inclusions held together by chemical bonds after firing (at temperatures over 650 °C). As distinct from metals, where minerals are melted by firing (Radivojević et al., 2010), ceramic, both pre- and post-firing, is an aggregate of grains of different shape and size, and the way in which it wears is determined by the structure of this aggregate.

Use wear and post-depositional modifications may affect pottery mechanically and chemically and in a combination of both, altering the physical bonds between particles. After a bond breaks, the matrix particles and other mineral inclusions leave the ceramic body[2] and the wear morphology develops through the way in which the material detachment occurs. This concept derives from a field of engineering named tribology studying interacting surfaces in relative motion focusing on friction, lubrification and wear (Czichos, 1978; OECD, 1969).

The potentials of this approach have been applied in archaeology by Adams (1986, 2014) and Adams et al. (2009) in relation to the use of macro lithic tools and the main principle has also been investigated by Schiffer and Skibo (1989) during their first experiments on ceramic use wear. The application of such principles to understand surface modifications still has significant potential to analyse use traces on archaeological ceramic and to investigate their function through experiments and scientific analyses.

Use wear on pottery is usually the result of tribological mechanisms such as *fatigue*, *abrasive*, *corrosive and tribochemical wear* (Table 1) affecting the original topography of pottery surfaces that can be usually *flat*, *sinuous* or *uneven*. (Adams, 1986; Adams et al., 2009; Skibo and Schiffer, 1987).

Fatigue wear occurs during mechanical stress, e.g. pressure or impact (Adams, 2014), and produces *fractures*, *pits* (caused by the pedestalling of inclusions) (Adams et al., 2009 and references therein; Skibo and Schiffer, 1987) or *spall detachments*.

Abrasive wear results from a sliding movement between two surfaces of different hardness (Adams et al., 2009 and references therein; Schiffer and Skibo, 1989; Skibo, 2015). Alterations on a given ceramic surface appear in the form of *striations*, *scratches*, *levelling* (Adams et al., 2009), *rounding*, *grooves* or *depressions*. Structural and morphological alterations of ceramic material can also be produced by chemical mechanisms, via corrosive processes that occur during contact between certain liquid or semiliquid substances and a solid surface, causing *depressions* or *pits* (Adams et al., 2009; Adams, 2014; Arthur, 2002, 2003; Skibo, 1992; Skibo, 2015) (Table 1).

Corrosive wear on ceramic can develop when the surface absorbs substances due to paste porosity, causing a loss of material. This latter type of wear can be also caused by fermentation mechanisms producing “*lactic acid-forming bacteria that reduce the pH resulting in a highly acidic substance*” (Arthur, 2003; Oura et al., 1982). Such alteration generates extended superficial cracks of varying length and depth, caused by the pressure of the gas resulting from the fermenting substances trapped in

[1] A traceological investigation to identify the nature of materials interacting with ceramic has been performed by Van Gijn and Haufman (2008) and by Vieugué (2015) regarding specific ceramic tools (recycled potsherds).

[2] Some tribological systems cause a reinvolvement of ceramic particles (Olofsson, 2011, p. 12) but this phenomenon has not been yet explored in archaeological ceramic material studies.