Journal of Archaeological Science 91 (2018) 43–51

Contents lists available at ScienceDirect

Journal of Archaeological Science

journal homepage: http://www.elsevier.com/locate/jas

Scientific preparations of archaeological ceramics status, value and long term future

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ARTICLE INFO

Article history:
Received 20 June 2017
Received in revised form
7 November 2017
Accepted 1 January 2018

Keywords:
Ceramic compositional analysis
Scientific preparations
Reference library
Curation
Archive

ABSTRACT

Thin sections, resin blocks, pressed pellets, fused beads, milled powders, solutions and digested residues are several key sample formats used in the invasive scientific analysis of ancient ceramics. They are crucial tools that enable researchers to characterise the mineralogical, geochemical, molecular and microstructural composition of pottery and other ceramic artefacts, in order to interpret their raw materials, manufacturing technology, production locations and functions. Despite the importance of such preparations, key issues about their status, such as whether they are still artefacts or not, who owns them and where they should reside after analysis, are rarely addressed in the archaeological or archaeometric literature. These questions have implications for the long-term future of thin sections, resin blocks and other sample formats, as well as their accessibility for future research. The present paper highlights the above problem and assess the roles, perspectives and needs of ceramic analysts, field archaeologists, commercial units, curators, policy makers, professional bodies, special interest groups and funding agencies. Finally, guidelines are put forward that can be taken into account when deciding on the value and research potential of scientific specimens of archaeological ceramics, as well as strategies for their curation.

1. Introduction

Archaeological ceramic analysis applies methods from the earth sciences, physics and chemistry to characterise the inorganic and organic composition of pottery and other types of ceramics. This is used to determine the production location of artefacts, reconstruct aspects of their manufacturing technology, date them and interpret the uses that they served in the past. Such data provides important evidence for the activities of ancient societies and can contribute to themes such as trade and exchange, migration, organisation of craft production, tradition and transmission of skills. Key approaches include thin section petrography, instrumental geochemistry, scanning electron microscopy, x-ray diffraction and organic residue analysis. In most cases it is necessary to sub-sample the studied ceramic artefact(s) and prepare them in a specific format for analysis. These include thin sections, polished resin blocks, mounted specimens, milled powders, pressed pellets, fused glass beads, digested solutions and extracted residues (Fig. 1). Samples are analysed via scientific apparatus and compositional and/or microstructural data of various types is collected in order to answer archaeological questions and test hypotheses posed by other evidence.

Scientific ceramic analysis has a long history and is regularly applied to academic research projects and commercial archaeological investigations in many parts of the world. In most cases an assemblage of several carefully selected ceramic artefacts is subjected to analysis, often via several complimentary methods, such as thin section petrography and instrumental geochemistry. This results in the production of thousands of scientific specimens by numerous laboratories each year, which are used to collect a vast amount of data. The fate of these samples, once analysis and data collection has taken place, varies considerably. Many are retained by the analyst in their personal collections or become part of laboratory reference libraries. Some specimens are returned to the museum, repository or commercial unit at which the parent artefact is housed. Others may be discarded or simply left behind when a project ends or the researcher moves institution, retires or dies.

This variation in practice is not always helpful in terms of access to material for repeat analyses, and can have a detrimental effect on the compatibility of data. It can also impact on the preservation and longevity of scientific sample collections, as well as the

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https://doi.org/10.1016/j.jas.2018.01.001
0305-4403/

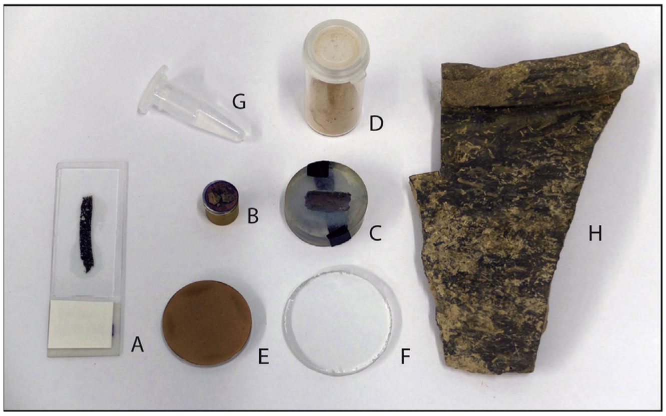

Fig. 1. Scientific sample formats used for the compositional analysis of archaeological ceramics. Thin section (A), SEM mount (B), polished block (C), milled powder for INAA, XRD, FT-IR (D), XRF pressed pellet (E) and fused bead (F), digested solution for ICP-MS/ extracted residue for GC-MS (G). Archaeological ceramic specimen with visible evidence of invasive sampling for compositional analysis (H).

conservation of their unique and finite parent artefacts. Opinions differ greatly on the true value of scientific preparations of archaeological ceramics post-analysis, as well the question of what exactly what it is that they represent. These are strongly influenced by the perspectives and needs of the main parties involved in ceramic analyses, including ceramic analysts, field archaeologists, commercial units, curators, government agencies, special interest groups and funding bodies. Occasional disputes over the custody of scientific samples underline a lack of agreement on this topic. Practices vary geographically due to different national and regional legislation, or lack thereof, and can also differ depending on the archaeological date, excavation location and the perceived importance of the specific ceramic parent object from which a sample was made. In addition, the format of a particular scientific preparation and its method of analysis are key factors in deciding what happens to it after analysis.

Formal guidelines on the treatment of studied specimens are sorely lacking within the extensive body of literature that exists on the fields of archaeological ceramic analysis, museum curation and heritage law. Despite the importance of this topic, it is rarely discussed on more than a case by case basis. Though a one-size-fits-all solution is not appropriate given the diversity of ceramic research projects undertaken worldwide, detailed consideration of the issue is very much overdue. By reviewing the range of perspectives on the status, value and custody of scientific preparations of archaeological ceramics, this paper intends to make a much needed start. This is achieved by reviewing the main sample formats in terms of what they represent, how they are analysed and the ways in which they are normally treated post-analysis. A detailed consideration is then made of the roles, perspectives and needs of ceramic analysts, archaeologists, commercial units, curators, policy makers, professional bodies and funding agencies in relation to scientific preparations of ancient ceramics. Finally, a set of considerations are proposed that might be taken into account when deciding on the fate of such samples.

This paper focuses on the scientific analysis of ceramics only, however many of the issues that are discussed are applicable to other types of artefacts including metals, glass, stone and organic materials. Ceramics are analysed scientifically in a wide variety of formats, many of which are also used for the study of these other material remains. The paper has drawn upon the author's experience analysing archaeological ceramics from several parts of the world, both as part of academic research and consultancy. It has also benefitted from discussions with colleagues from the field of ceramic analysis, as well as communication with field archaeologists, curators, commercial units and funding agencies. The paper has mainly consulted literature published in the English language and research undertaken in the UK, however, examples and opinions have been drawn from elsewhere where these were available. While the paper is unlikely to represent the full spectrum of opinions and practices surrounding scientific preparations of ceramics, it is hoped that by explicitly focussing on the topics of their status, value, custody and curation, that the various parties involved have a better appreciation of each others' needs and points of view. This may help inform future decisions on this important and sometimes sensitive matter, or at least stimulate further informed debate.

2. Scientific sample formats

Archaeological ceramics are analysed scientifically via a wide range of approaches and apparatus (see Hunt, 2016 and chapters therein). Most of these require the sample to be prepared in a specific format in order for data to be collected. Common types include thin sections, polished resin blocks, mounted specimens, milled powders, pressed pellets, fused glass beads, inorganic solutions and extracted residues (Fig. 1). It is worth considering the nature of these various preparations, the ways in which they are studied, the data that is collected and their requirements in terms of curation and re-analysis.

Thin sections are slices of an artefact that are made by cutting off a small chip, attaching it to a glass microscope slide and grinding this down to a thickness of 0.03 mm (Fig. 1A). These are studied under a polarising light microscope used for the analysis of geological thin sections. Thin sections typically require the removal of one or more grams of a sherd and the off-cut that remains after preparation is either encased within or covered by resin so is not always returned. If stored in purpose-made boxes and handled carefully, these delicate glass microscope slides represent a permanent record of the composition of an artefact that can be restudied repeatedly and in several different ways (Rice, 1987, p. 373; Quinn, 2013, p. 33).

Scanning electron microscopy (SEM) of ceramics can be performed on small fragments of sherds, mounted on a metal stub and coated with either gold or carbon to make it conductive (Fig. 1B). Samples for such analyses vary in size but can be small (<1 g) and are typically prized or cut off their parent artefact with pliers or a diamond saw. Setting specimens within a block of resin and polishing their exposed surface with fine diamond compounds (Fig. 1C), provides an opportunity to undertake microanalysis of inclusions, pottery surface finishes and other features, using the SEM in backscattered electron mode or with an energy dispersive detector (SEM-EDS) or with an electron microprobe (EMPA). Polished blocks and SEM mounts can be kept for many years for the purpose of reanalysis, if stored in a dry, dust free environment. Their surfaces can however tarnish over time and may need repolishing and re-coating with specialist laboratory equipment.

Bulk geochemical characterisation of ceramics produces quantitative data on the abundance of a range of elements or isotopes of a single element present in the sample. It can be undertaken using several types of apparatus, including instrumental neutron activation analysis (INAA), x-ray fluorescence spectroscopy (XRF) and inductively-coupled plasma mass spectrometry (ICP-MS). Each of these has their own methods of sample preparation, however a small amount (c. 1–5 g) of powdered, homogenised sample (Fig. 1D) is required for all three approaches, which can be either removed from a sherd by drilling, or produced by grinding a small piece in a pestle and mortar or ball mill. This powder is then