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Soil forensics as a tool to test reported artefact find sites

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ABSTRACT

The reported find sites for archaeological artefacts such as coin hoards, can in some cases be either accidently mistaken or potentially deliberately fabricated. However, testing the veracity of such reported find sites can be difficult. Advances in the analysis of soil samples for both criminal and environmental forensic investigations, is allowing the characterisation of very small soil samples to be achieved. In this study forty three soil samples were analysed from six groups of coins, each of which had been reported as an individual coin hoard collected at different locations in Devon and Somerset, UK. *In-situ* soils were removed from the surface of the coins and mineralogically analysed using automated scanning electron microscopy and energy dispersive analysis. The mineralogical data show that five of these six coin groups could not have been derived from individual find sites. The mineralogical data for one of the groups was indicative that the coins making up that group could potentially have been derived from a single location. Subsequent and independent to the mineralogical assessment of the coins, a numismatic inspection of the coins led to the same conclusions. Automated mineral analysis, which can be carried out on very small soil samples, may prove to be a useful technique for the assessment of the reported provenance of archaeological artefacts.

1. Introduction

The discovery of archaeological artefacts such as coin hoards through metal detection can, when carefully documented and recorded, provide important additional data on the distribution of sites of past human activity which might not otherwise have been identified or recorded. However, the veracity of claimed find sites may, on occasion, be challenged, as it is not unknown for the claimed find sites to be either accidentally incorrectly recorded or deliberately fabricated. For some regional and indeed, national museums, un-verified finds make up a significant component of new acquisitions. Field visits to reported find sites are costly and may not provide additional evidence to support, or contradict, the veracity of the claimed find location. Consequently, there is a need for an independent means to scientifically test the reported find sites.

Given that artefacts are commonly buried within, or found on, the soil surface, unless extensively cleaned, there will be soil present on the surface of the artefacts, and this offers an opportunity to assess the nature of the find location. Peacock and Williams (1997) discussed how traditional petrographic analysis of soil recovered from an Etruscan pottery vessel was used to demonstrate that it had been imported into the UK from Italy, possibly during the last century, rather than having been excavated from the claimed find site in Cheshire, UK. More recently, Hu et al. (2007) examined pollen recovered from terracotta fragments of a warrior and a horse from the Qin Shihuang Mausoleum. The profile of the pollen recovered from the soil from the horse was similar to that from a soil sample from the Qin Dynasty layer in Pit 2 at the Mausoleum. However, the pollen profile from the warrior suggested that this had come from a site which was further afield. In an equivalent study, Chester (2009) examined a pollen sample collected from a Classical Greek cult statue of a Goddess "Aphrodite" from the J. Paul Getty Museum. This statue was thought to have been made between 425 and 400 B.C. in either Sicily or southern Italy. Although the pollen profile enabled the general environment of the soil to be described, the taxa present did not allow a specific geographic location to be inferred (Chester, 2009). The use of pollen from adhering soil is however, potentially problematic, as pollen preservation within soil profiles is commonly very poor and relatively large samples are required to gain a

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sufficient pollen yield. In the case reported by Chester (2009), 10 g of soil were analysed; commonly such a large mass of soil may not be available for analysis.

In recent years there has been an increasing interest, and utilisation of, soil trace evidence in criminal and environmental forensic investigations (e.g. Ritz et al., 2009). In part this increase is due to improved analytical capabilities, meaning that reliable data sets can be measured from very small samples. In particular advances in the analysis of such small soil samples have been achieved through the use of automated mineral analysis, based on scanning electron microscopy with linked energy dispersive spectrometers (SEM-EDS). In this paper the application of automated mineral analysis of trace soil samples is tested in the evaluation of reported Roman coin find sites in SW England, UK. This technique, which can be used with very small soil samples, has considerable potential in the analysis of the reported find sites of archaeological artefacts.

2. Soil forensics

Whilst soil trace evidence has been used for more than 100 years in forensic investigations, there has recently been a significant upsurge in research into soil forensics and its direct application in both criminal and environmental investigations (e.g. Ruffell and McKinley, 2008; Ritz et al., 2009). From an investigative point of view, soil is an important class of trace evidence as it is both complex and highly variable spatially (Fitzpatrick et al., 2009; Pirrie and Ruffell, 2012). Typically, nearly all near-surface soils are composed of a mixture of organic and inorganic particulates. The organic components commonly comprise macroscopic plant fragments, spores, pollen, micro-organisms (e.g. testate amoebae) and potentially, reworked microfossils. The inorganic components present are naturally derived minerals largely reflecting the underlying bedrock geology along with any superficial geological units, and man-made particulate grains. Both research and forensic casework have demonstrated that because of the complexity of this mix of inorganic and organic components in soils, they can be shown to be highly variable spatially, such that discrete locations are characterised by distinctive soils.

Within forensic geoscience, the lack of databases of soil characteristics, at a scale of resolution appropriate to demonstrate the observed degree of spatial variation, has in part led to the important principle that soil forensic data cannot be used to test a “match” between a known location and an unknown sample, as it is never possible to state that another unknown location with the same soil characteristics does not occur. Instead, there is a recognition that soil forensic data can best be used in an exclusionary way – i.e. if the soil present on an artefact differs to the soil present at a reported find site then it is possible to exclude the possibility of an association between the two soils (cf. Morgan and Bull, 2007). However, available background data such as geological and soil survey maps, can be used to suggest the likely characteristics of a soil at an unknown location. In addition, the characteristics of a soil sample can be used to identify potential locations where that soil could have been derived from Pirrie and Ruffell (2012).

Because of the complexity of the components present in a soil, a very wide range of parameters can be used to characterise that soil. These include the overall bulk characteristics (grain size, colour etc), the organic components (pollen, micro-organisms etc) or the inorganic components (e.g. mineralogy). From an archaeological context, organic components of near surface soils, such as spores and pollen, can be preferentially lost within the buried soil profile. In addition, it is rarely possible to apply all available analytical methods to a soil sample and at the present time, there is no internationally accepted protocol for forensic soil analysis, although most workers would suggest a staged approach starting with the more general characteristics and then becoming more focussed. In most criminal forensic investigations, the sample size is typically very small and the analytical methods adopted need to be non-destructive and suited for small sample sizes. One such analytical approach is the characterisation of soil mineralogy, using automated scanning electron microscopy, linked with energy dispersive spectrometers (SEM-EDS). SEM-EDS analysis is a very widely adopted analytical technique and in recent years, a range of automated SEM-EDS systems have been developed and utilised in a wide range of applications, including forensic geoscience (e.g. Pirrie et al., 2004), Quaternary science (e.g. Speirs et al., 2008; Haberlah et al., 2011) and archaeology (Knappett et al., 2011; Momigliano, 2012). This method has been demonstrated to provide highly reproducible mineral analyses from small soil samples (Pirrie et al., 2009) and has been utilised in numerous serious crime investigations (Pirrie and Rollinson, 2011). In this study automated SEM-EDS analysis of soil mineralogy from small soil samples is used to test the veracity of reported find sites for six claimed Roman coin hoards, reportedly found in the UK.

3. The coin groups examined

Recently, six separate groups or assemblages of Roman coins, each comprising between 2 and >60 coins, were presented to a museum in South-West England, UK, by a metal detectorist (Table 1). The individual groups of coins were claimed by the finder as representing discrete coin hoards. The reported find sites were relatively poorly constrained, with most of the locations in the Torquay area of Devon, UK along with a separate location in Somerset, UK. All of the reported find sites are of potential archaeological significance, because they have not previously been documented as sites of Roman activity. In addition, the discovery of a large prehistoric and Romano-British settlement in Devon in 2011, following the detection of a significant number of Roman coins, significantly changed the perceived probability of evidence for Roman activity and Romano-British settlements throughout the region. However, other than this recent discovery, sites of Roman activity in the region are relatively poorly known, hence if the new find sites indicated by the coin groups could be verified, then together they would be of considerable regional archaeological interest. The absence of clearly defined find sites for the coin “hoards” meant that the veracity of these locations needed to be independently investigated. In addition, the discovery of six separate “hoards” was also considered as unusual for the area. The coin groups and the underlying bedrock geology at the reported find sites are summarised in Table 1. Note that where in this paper the individual groups of coins are referred to as “hoards”; the term hoard is retained as that was what was originally claimed by the metal detectorist. The veracity of this claim is however, shown to be unlikely.

4. Analytical methods

Each separate batch of coins submitted for examination was sealed within a plastic zip-lock sample bag. However, it was not clear as to whether these bags were the original ones which the coins were provided to the museum in, or whether the coins had subsequently been repackaged. On receipt the bags were digitally photographed with the coins still inside. The coins were then carefully removed and placed into individual sterile Petri dishes (Fig. 1). Each coin was then examined in turn using a binocular microscope. Many of the coins were either very clean, or superficially appeared clean, other than the presence of secondary corrosion materials on their surfaces (Fig. 2). However, small to very