Experimental geochemistry: a multi-elemental characterisation of known activity areas

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Figure 1. *Experimental buildings and activity areas at Butser Ancient Farm, Hants, UK and Lejre Historical and Archaeological Research Centre, Denmark: a) Butser Ancient Farm; b) Bronzeworking workshop, Butser; c) 'Peasants' building, Iron Age village, Lejre; d) Forge, Lejre; e) Sunken-shack Viking village, Lejre. (Note: (a) Maiden Castle roundhouse on the location of the former Longbridge Deverill roundhouse.*

Introduction

Previous studies using multi-elemental analysis have identified elemental enrichments in activity areas such as cooking and food-preparation (Grattan *et al.* 2003), crafts such as metalworking (Cook *et al.* 2003, 2005), and agricultural practices such as manuring (Entwistle *et al.* 2007), on both ethnographic and archaeological sites. In the study reported here X-Ray Fluorescence analysis was used to explore elemental enrichment, particularly of heavy metals, of hearths and floors from known activity areas at two experimental archaeological sites (Butser Ancient Farm, Hampshire, UK and Lejre Forsøgscenter, Denmark). The primary aim of this research was to define levels of enrichment from experimental areas of metalworking and stabling for use in the detection of these activities in ancient sites.

Methodology

A range of target areas was selected at the two well-known experimental Iron Age villages of Butser in UK and Lejre in Denmark. Information was collected about the type and frequency of use in each target area. Geochemical samples were taken from deposits, including hearths and floors, as well as the parent geology. The samples were prepared in the X-Ray unit, SHES, University of Reading, and analysed using the Phillips PW1480 x-ray spectrometer.

The experimental Iron Age Longbridge Deverill roundhouse at Butser (Figure 1a) was built in 1991 and sampled at the time of its demolition and replacement in 2006. Among other activities, it had been used for some metal-working: lead-working took place on the hearth and bronze-finishing in the entrance. The non-constructed floors of these buildings comprised trampled plough rendzina. The experimental bronze-working area at the same site (Figure 1b) had been used twice a month for the previous three years.

At Lejre (Denmark), geochemical samples were collected from Building 2, the 'Peasants' building', (Figure 1c) and the disused ironworking forge (Figure 1d). The areas sampled within Building 2 included the hearth which is used for heating and cooking, and a disused cattle stable (in use 1965 - early 1980s). The floor in the Building 2 was constructed from the natural sediment from an adjacent clay pit; whereas the non-constructed floor in the forge was a trampled B-horizon. A sunken-shack in the Viking village (Figure 1e) was recorded and sampled to identify levels of heavy metal enrichment of stabling deposits overlying the

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cobbled floor.

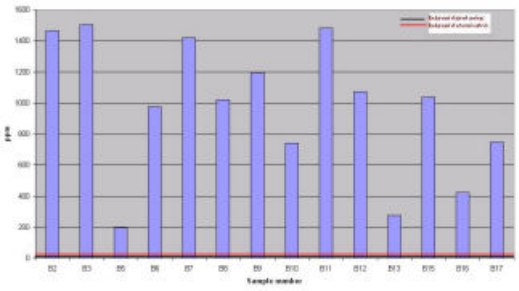


Figure 2. *Copper values from the floor of metalworking shed at Butser.*

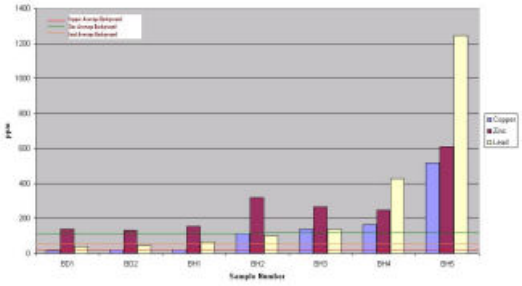


Figure 3. *Comparison of metals from the hearth and entrance of Longbridge Deverill roundhouse, Butser.*

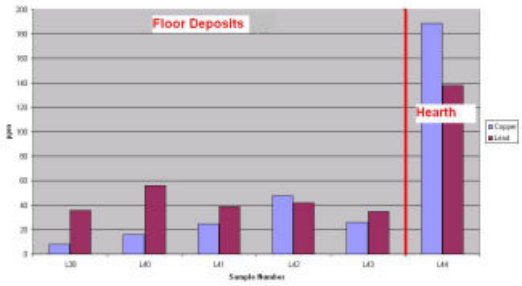


Figure 4. *Comparing hearth and floor: Iron Age village forge, Lejre.*

Furnace samples, (B2, B3), and samples, (B5-B17), from the 'hammering' area in the doorway, are significantly enriched in copper (Cu). Samples enriched in Cu (>1000ppm) (Figure 2), are distributed around the most recently used furnace. Samples least enriched in Cu, (B5, B13 and B16), were taken from the workshop floor, and were located furthest away from metalworking activities. In the roundhouse (Figure 3), the 'one-off' incident of bronze-finishing in the doorway was not detected. This result may have been affected by modern shoes removing sediment from the house floors and depositing it on the gravel track outside (process noted by Richard Macphail and Steve Dyer *pers. comm.*). Low level lead-working (Pb) on the hearth in the Longbridge Deverill roundhouse has been detected by significant Pb enrichment in samples BH4 and BH5. Enrichment of Cu, Zn and Pb in BH5 is interesting, suggesting that unrecorded bronze-working activity has been detected or, the enrichment is due to ashes.

Preliminary data have demonstrated that Cu and Zn are comparatively enriched in hearth deposits to those of the floors at both Lejre and Butser, even where no metal-working activities are recorded (Figures 4 and 5). Enrichments may be due to the input of organic debris such as ashes, or to the use of metal cooking-pots. Both Cu and Zn are known to preferentially form associations with organic matter (Kabatas-Pendias 2001).

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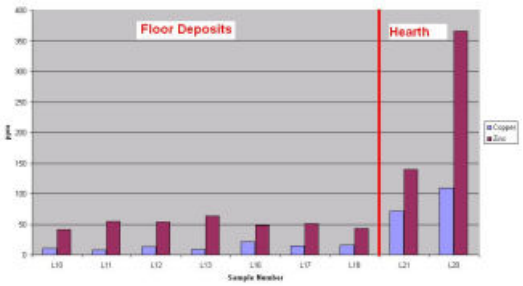


Figure 5. *Comparing hearth and floor: Iron Age village 'peasants' building, Lejre.*

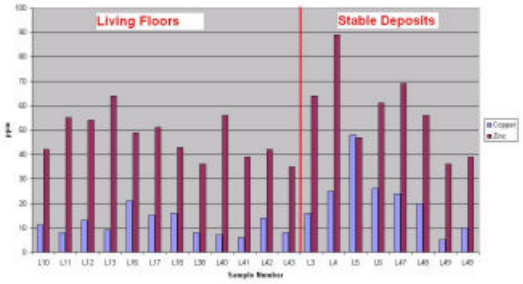


Figure 6. *Comparing living floors and stable deposits, Lejre.*

Enrichment of Stable deposits, Lejre

Levels of Cu and Zn in stabling deposits are not consistently more enriched than the house floors (Figure 6). There are no consistent discernable differences in the levels of Cu and Zn between a disused cattle stable that was regularly cleaned out during its use, (samples L3-L6), and a goat/sheep pen where layers of compressed dung still remain, (samples L47-L49).

Discussion

The metalworking areas were consistently enriched in the metals that were worked there. The distribution of the enrichment is localised and specific to the activity area. However, non-metalworking hearths were also significantly enriched in Cu and Zn, which may be due to the inclusion of organic copper and zinc compounds in generating the ashes. The use of metal cooking-pots is another possible source. However, stable deposits are not significantly enriched, despite having an organic input from dung.

Zn and Cu preferentially bind to organic matter and clay minerals are capable of holding zinc quite strongly (Kabata-Pendias 2001). Earthworms are known to increase the lead content of soils by coming to the surface to feed (Kabatas-Pendias 2001). Cultural enrichment of elements such as Cu and Zn does not seem to occur in high levels where activities such as manuring have taken place. Consequently enrichment should only take place where deposition has occurred over long periods (Entwistle *et al.* 2007). These metals may behave differently in organic deposits deriving from ash and dung.

Two hypotheses require further testing: that the dissolution of ashes releases metals causing enrichment and that large amounts of dung decay to enrich the sediment. Further analysis of these data will also address the potential reduction of metal enrichment through time, by factors such as clay translocation and disturbance due to bioturbation. Geochemical analysis in conjunction with soil micromorphology and ratio expressions of enrichment will further assist interpretation of these issues.

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