Analysis of Sediment from Copper Alloy Terret, Ferrybridge

Alan Vince

A copper alloy terret from the chariot burial at Ferrybridge, West Yorkshire (A1CHA 03, SF750) contained a core composed of loosely-cemented sediment. Examination of this core by S. O'Connor suggests to her that the core is integral to the construction of the object and that therefore it was probably obtained from a sediment close to the workshop where the terret was made.

In order to investigate the source of the object, therefore, a sample of the core was consolidated and a thin section produced, by Steve Caldwell, Department of Earth Sciences, University of Manchester. A second sample was ground to a fine powder and submitted to Dr J N Walsh, Royal Holloway College, London, where it was analysed using a combination of Inductively-Coupled Plasma Atomic Adsorption Spectroscopy and Inductively-Coupled Mass Spectroscopy. Using these combined techniques, a wide range of elements were measured (Appendices 1, 2 and 3). The sample was assigned the reference code V2838 and the thin section was added to the AVAC reference collection.

Visual Examination

The core sample was examined at x20 magnification using a stereo-microscope. It consists of a loosely-cemented quartzose silt with some larger quartzose grains. One of these larger grains was a water-polished, well-rounded quartz grain, probably originating in a Lower Cretaceous deposit, although such grains are common in later deposits (Tertiary and Quaternary) as detrital grains.

A fine off-white powdery deposit was clearly secondary and coated the outside of the core in places. Several examples of a spiral light green mineral, presumably a copper alloy corrosion product were noted growing into the sample. The off-white powder was excluded from the ICPS sample but it was not possible to isolate and remove the copper-rich corrosion products.

Thin Section Analysis

In thin section, the sample consists of moderate subangular grains up to 0.6mm across in a groundmass of finer-grained porous material. The off-white surface deposit is seen to be a fine-grained calcareous deposit, probably derived from the nearby Permian limestone. Some larger sparry grains appear to have grown *in situ.* The copper-alloy corrosion products appear as irregular opaque fragments up to 1.0mm long and c.0.2mm wide and as light green translucent grains up to 0.2mm across, some of which appear to have grown

alongside the calcareous material. The following inclusions were noted in the body of the sample:

- Quartz sandstone and derived quartz grains. Moderate fragments of fine-grained sandstone, consisting of angular grains of quartz and plagioclase feldspar up to 0.4mm across and muscovite laths up to 0.5mm long in an brown cement (reddish brown in reflected light) and loose grains with the same cement coating.

- Angular quartz. Moderate angular fragments, some with one or more flat faces, evidence for overgrowth, up to 0.5mm across. No compound grains are present but these grains are derived from an orthoquartzite.

- Light green material. Sparse translucent light green grains up to 0.3mm across.

- Charcoal. Sparse angular fragments, up to 0.5mm across, probably of wood charcoal.

- Fayalite slag? Sparse angular fragments of fayalite slag, including euhedral opaque grains, glass and fayalite.

- Hammerscale? Sparse tabular opaque grains up to 0.5mm long and c.0.15mm or less wide.

The groundmass consists of moderate angular quartz grains c.0.05mm to 0.2mm across and a scatter of fine-grained calcareous matter, less than 0.05mm across.

Chemical Analysis

The chemical analysis revealed a high amount of copper, due to the corrosion products. No other measured elements were similarly enhanced, indicating that no measured elements were present as contaminants in the copper (e.g. the Zinc value is unexceptional for clay and sand samples). Only the tin is slightly enhanced (87ppm).

Silica was measured at 73% which leaves c.5% of the sample's weight unaccounted for, presumably being organic matter and possibly some chemically-combined water.

In comparison with samples of clay and sand from various sites in England, the terret core contains a similar amount of silica to sand samples and more than most clay samples, 75% of which have 79% or less silica.

To take account of the variations in silica content between samples the data were normalised to Aluminium, present in clay minerals and feldspars. When compared with other English sand and clay samples, the sample has a very high relative Zirconium value (45 ppm) compared to between 2ppm and 15ppm for other English clays. This Zirconium value

is also remarkably high where compared with ceramics, and out of over 4000 samples analysed for AVAC none had such as high value. The nearest were some greyware vessels, assumed to be of north-eastern Lincolnshire origin, from Barton-upon-Humber, Northern and Western French medieval whitewares produced from Tertiary pipeclays and samples of clay and pottery from the Vale of Pickering.

The normalised data for 157 samples of clays and sands, together with the terret core, were then analysed using factor analysis. Four factors were found and the Ferrybridge sample is distinguished by having a high F1 score and a strong negative F4 score. Samples with similar compositions are:

- Beach sand from Easington, Holderness (one sample)
- Beach sand from Mapperton, on the East Yorkshire coast (two samples)

Two samples shared one of the scores but not both:

- A sample of alluvial clay from Follifoot, in the Vale of York
- A sample of sand from the Humber estuary at North Ferriby

A plot of F1 against F4 (Fig 1) suggests that the main reason why these samples group together is the lack of clay rather than any similarity in composition.

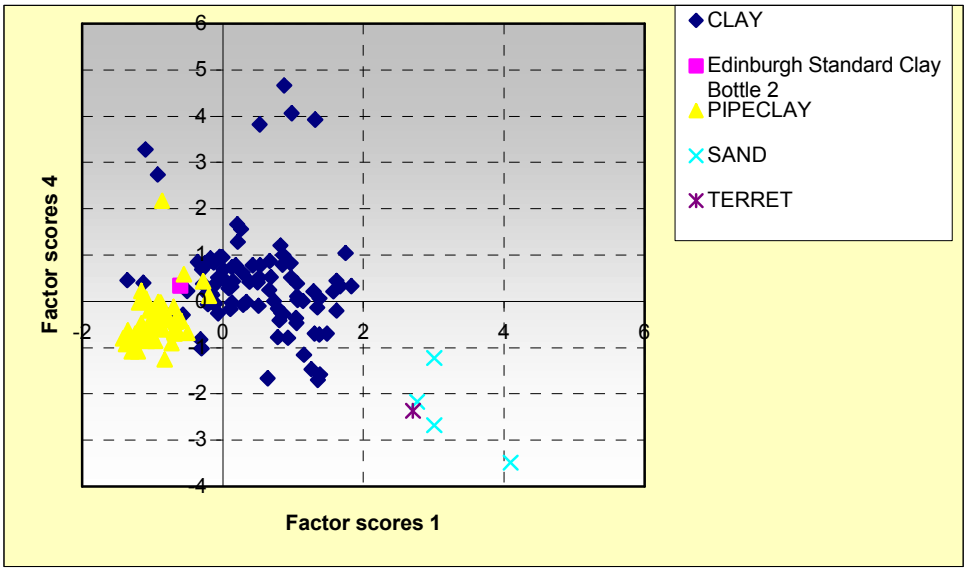

Figure 1

Discussion

The thin section analysis suggests that the sediment forming the terret core contains waste from metalworking (charcoal, slag, hammerscale) as well as material of natural origin. The latter includes a red micaceous sandstone and an orthoquartzite. Both of these are common in detrital deposits in the Vale of York. However, the polished quartz grain noted at x20 magnification would not be present in Vale of York sands, although it could be present in East Yorkshire boulder clays and other drift deposits, originating in the Lower Cretaceous deposits of the Vale of Pickering or their original continuation eastwards. The high quantity of fine quartz of silt and fine sand grades may indicate a lacustrine deposit, many of which overlie the boulder clays in North and East Yorkshire.

The high Zirconium content may simply indicate the presence of a single large Zircon grain in the sample and one would have to have taken several sub-samples from different parts of the core to establish that the sand/silt actually has such a high Zircon content. Even if this was the case, similar high Zirconium values are known in samples from the Vale of Pickering which would support a source in the Vale of Pickering or East Yorkshire.

Appendix 1

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V2838	8.48	6.42	0.72	2.06	0.96	2.14	0.52	0.24	0.082

Appendix 2

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V2838	438	42	12776	18	28	6	92	44	17	382	28	54	26	4	1	3	1	45	44	12

Appendix 3

TSNO	As	Rb	Nb	Mo	Ag	Sn	Sb	Cs	Pr	Gd	Tb	Er	Tm	Lu	Tl	Th	U	Bi
V2838	19	70	10	1	2	87	1	3	6	4		2		0	0	7	3	2