Staffordshire Hoard Research Report 9

Phase 2 of the Analysis of Selected Items from the Staffordshire Hoard and of Contemporary Anglo-Saxon Objects from the British Museum and Stoke-on-Trent Potteries Museum and Art Gallery: a Study of Gold Compositions and Surface Enrichment

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2014

This report forms part of
The Staffordshire Hoard: an Anglo-Saxon Treasure
edited by C. Fern, T. Dickinson and L. Webster
and published by the Society of Antiquaries of London

Information about this report

This report was produced in 2014 as part of Stage 1 of the project, i.e. before fragments were joined and catalogued. The concordance of the K numbers given in the report to the catalogue numbers as they appear in the final publication is as given below. The list also includes the names of the objects as used in the final publication.

The work was funded by the core project with a contribution from the British Museum.

The following article was based on this work.

Blakelock, E., La Niece, S. and Fern, C. 2016. 'Secrets of the Anglo-Saxon goldsmiths: Analysis of gold objects from the Staffordshire Hoard', *Journal of Archaeological Science* 72, 44-56.

K number	Catalogue number	Name in publication
3	336	Hilt-plate in gold (part).
10	325	Hilt-plate in gold.
12	261	Hilt-plate in gold with gemmed bosses (part).
16	511	Mount in gold of bird form with garnet cloisonné decoration.
21	103	Hilt-collar in gold, of high form, with filigree decoration.
79	329	Hilt-plate in gold (part).
88	31	Pommel in gold, of cocked-hat form, with filigree decoration.
95	488	Mount in gold with forked end
107	574	Pyramid-fitting in gold with filigree and garnet cloisonné.
128	527	Serpent mount cast in gold.
130	541	Roundel with disc in gold, with garnet cloisonné, animal-ornamented panels and a glass gem-setting (part).
133	335	Hilt-plate in gold.
135	127	Hilt-collar in gold, of narrow form, with filigree decoration.
136	77	Pommel in cast silver, of cocked hat form with double sword-rings, gilded low relief decoration, and mounts with filigree and a gem-setting (part).
140	198	Hilt-ring of thick gold beaded wire.
271	113	Hilt-collar in gold, of high form, with filigree decoration.
273	550	Strip-mount in gold with garnet cloisonné decoration.
276	26	Pommel in gold, of cocked-hat form, with filigree decoration.
278	98	Hilt-collar in gold, of high form, with filigree decoration.
281	126	Hilt-collar in gold, of narrow form, with filigree decoration.
284	52	Pommel in gold, of cocked-hat form, with garnet cloisonné decoration (part).
288	591	Helmet cheek-piece, cast in silver and gilded, with animal ornament and a gold collar (part).

Continued

K number	Catalogue number	Name in publication
292	50	Pommel in gold, of cocked-hat form, with garnet cloisonné decoration
294	73	Pommel in cast silver, of round-back form, with low relief decoration, and one side a mount with filigree and cloisonné ornament.
297	464	Mount in gold of swastika form with bird heads and filigree decoration.
300	88	Hilt-collar, in gold, of high form, with filigree decoration.
301	76	Pommel in cast silver, of cocked hat form with double sword-rings, with cast interlace and niello inlay, and mounts, with cloisonné and filigree decoration (part).
302	580	Pyramid-fitting in cast silver with gold mounts, with filigree and garnet cloisonné decoration.
303	588	Pectoral cross in gold with a central garnet and filigree decoration.
306	63	Pommel in silver, of cocked-hat form, with filigree decoration.
309	5	Pommel in gold, of cocked-hat form, with filigree decoration.
347	56	Pommel in gold of round-back form, with incised decoration inlaid with niello and filigree ornament.
349	39	Pommel in gold, of cocked-hat form, with filigree decoration and on one side a cloisonné panel.
352	36	Pommel in gold, of cocked-hat form, with filigree and garnet cloisonné decoration.
354	169	Hilt-collar in gold, of narrow form, with a cap and garnet cloisonné decoration.
356	562	Edge-mount in gold of L-shaped form with garnet cloisonné.
358	57	Pommel in gold, of cocked-hat form, cast with animal-heads, with incised Style II decoration, and panels with niello lines, all framed by imitation wire.
360	43	Pommel in gold, of cocked-hat form, with cloisonné decoration.
365	470	Mount in gold with bird heads and filigree decoration.
370	167	Hilt-collar in gold, of high form, with garnet cloisonné decoration.
375	9	Pommel in gold, of cocked-hat form, with filigree decoration.
376	55	Miniature pommel, of cocked-hat form, in gold with garnet cloisonné decoration.
377	572	Pyramid-fitting in gold with garnet and glass cloisonné decoration.
379	409	Hilt-guards in cast silver, with panels of gilded interlace, and gold mounts with filigree decoration and a gem-setting (part).
381	22	Pommel in gold, of cocked-hat form, with filigree decoration.
399	359	Hilt-plate in gold with a fixed hilt-collar and filigree decoration (part).
449	168	Hilt-collar in gold, of high form, with garnet cloisonné decoration.
451	578	Pyramid-fitting in gold with garnet and glass cloisonné decoration.
454	474	Mount in gold filigree decoration and garnet gem-settings.
456	66	Pommel in cast silver, of cocked-hat form, with gilding.
457	2	Pommel in gold, of cocked-hat form, with filigree decoration.
458	32	Pommel in gold, of cocked-hat form, with filigree decoration.
462	573	Pyramid-fitting in gold with garnet and cloisonné decoration.

Continued

K number	Catalogue number	Name in publication
465	41	Pommel in gold, of cocked-hat form, with garnet cloisonné one side and on the shoulders, and filigree decoration the other side.
468	465	Mount in gold with bird head, with filigree decoration and one garnet boss.
513	558	Strip-mount in gold with garnet cloisonné decoration and filigree serpent mounts (part).
545	541	Roundel with disc in gold, with garnet cloisonné, animal-ornamented panels and a glass gem-setting (part).
547	140	Hilt-collar in gold, of narrow form, with filigree decoration (part).
550	540	Strip mount in gold with Latin inscriptions and gem-settings.
552	90	Hilt-collar in gold, of high form, with filigree decoration.
554	42	Pommel in gold, of cocked-hat form, with filigree decoration and one side a gem-setting.
560	92	Hilt-collar in gold, of high form, with filigree decoration
567	370	Hilt-plate cast in gold of oval form with animal ornament in low relief.
652	538	Mount in gold of a fish between birds (part).
653	565	Wing-shaped mount in gold with garnet cloisonné decoration.
655	539	Mount in gold of cross form with animal art and gem-settings (part).
656	539	Mount in gold of cross form with animal art and gem-settings (part).
657	539	Mount in gold of cross form with animal art and gem-settings (part).
658	539	Mount in gold of cross form with animal art and gem-settings (part).
659	539	Mount in gold of cross form with animal art and gem-settings (part).
660	166	Hilt-collar in gold, of high form, with cloisonné decoration.
669	12	Pommel in gold, of cocked-hat form, with filigree decoration.
673	553	Strip-mount in gold with garnet cloisonné decoration and one pointed end.
674	49	Pommel, in gold, of cocked-hat form, with garnet cloisonné decoration.
677	560	Rectangular mount in gold with garnet cloisonné decoration.
679	157	Hilt-collar in gold, of narrow form, combining a band of filigree and a band or garnet cloisonné .
680	40	Pommel in gold, of cocked-hat form, with filigree and one side cloisonné decoration.
685	586	Small buckle in gold with a rectangular back-plate.
686	8	Pommel in gold, of cocked-hat form, with filigree decoration.
689	410	Mount in gold from the tip of a hilt-guard with stepped ends and filigree decoration.
690	225	Plain hilt-ring cast in gold.
697	33	Pommel, in gold, of cocked-hat form, with filigree decoration.
699	108	Hilt-collar in gold, of high form, with filigree decoration.
714	11	Pommel in gold, of cocked-hat form, with filigree decoration (part).
796	461	Mount in gold of fish form with filigree decoration.
811	128	Hilt-collar in gold, of narrow form, with filigree decoration
816	529	Serpent mount cast in gold.
833	438	Mount in gold of trapezoidal form with filigree decoration.
843	543	Eye-shaped mount in gold with garnet cloisonné decoration.

Continued

K number	Catalogue number	Name in publication
855	151	Hilt-collar in gold, of narrow form, with filigree decoration (part).
865	477	Mount in gold of pelta form with scrolled terminals and filigree decoration.
878	420	Mount in gold, of triangular form, with filigree scrollwork.
920	481	Mount in gold of equal-arm cross with filigree decoration.
992	440	Mount in gold of rectangular form with filigree decoration.
1004	30	Pommel in gold, of cocked-hat form, with filigree decoration.
1048	295	Hilt-plate in gold.
1055	541	Roundel with disc in gold, with garnet cloisonné, animal-ornamented panels and a glass gem-setting (part).
1072	257	Hilt-plate in gold with a garnet boss.
1073	35	Pommel in gold, of round-back form, with filigree decoration.
1118	110	Hilt-collar in gold, of high form, with filigree decoration.
1136	365	Hilt-plate in gold with garnet cloisonné trim and gemmed bosses.
1137	293	Hilt-plate in gold (part).
1143	330	Hilt-plate in gold (part).
1150	363	Hilt-plate in gold with garnet cloisonné trim (part).
1155	159	Hilt-collar in gold, of high form, with garnet cloisonné decoration
1163	343	Hilt-plate in gold.
1167	53	Pommel in gold, of cocked-hat form, with garnet cloisonné decoration (part).
1221	313	Hilt-plate in gold.
1234	261	Hilt-plate in gold with gemmed bosses (part).
1272	46	Pommel in gold, of cocked-hat form, with garnet cloisonné decoration (part).
1314	539	Mount in gold of cross form with animal art and gem-settings (part).
1403	77	Pommel in cast silver, of cocked hat form with double sword-rings, gilded low relief decoration, and mounts with filigree and a gem-setting (part).
1425	583	Button-fitting in gold with garnet cloisonné decoration.
1497	460	Mount in gold of zoomorphic form with filigree scrollwork.
5008	558	Strip-mount in gold with garnet cloisonné decoration and filigree serpent mounts (part).

The British Museum

DEPARTMENT OF CONSERVATION AND SCIENTIFIC RESEARCH

Phase 2 of the analysis of selected gold items from the Staffordshire Hoard and of contemporary Anglo-Saxon objects from the British Museum and Stoke-on-Trent Potteries Museum and Art Gallery: a study of gold compositions and surface enrichment

Science Report PR07444-15

E. S. Blakelock

Abstract:
Phase 2 of the analytical study of the Staffordshire Hoard reported here was undertaken following a pilot study of 16 gold objects which demonstrated that some form of deliberately induced depletion gilding had taken place to remove both silver and copper from the surface, perhaps to improve the colour at the manufacturing stage (Blakelock 2013, 9-11). The aim of the second phase of this study was to extend the analytical database to include a broad range of object types spanning the entire Hoard time frame, and to determine the extent to which deliberate surface enrichment was used, especially on more complex pieces made from a number of different components.

98 individual pieces from the Staffordshire Hoard were analysed by SEM-EDX during this study. A further 36 pieces from the British Museum's collection and a pendant from Stoke-on-Trent Potteries Museum and Art Gallery were analysed as comparanda, allowing extension of the study to functional categories not included in the Hoard. In total 288 different components were analysed. Over 160 components were judged to be deliberately depleted in silver, with over 50 showing natural depletion and 24 components yielded inconclusive results. There is no relationship between the surface enrichment and the probable date, function, or find locations of the objects. Instead, the enrichment appears to be related to the workshop practice, as sheets were the component most often treated. In a few objects an apparent enrichment in silver was detected at the metal surface. From the available evidence, it was concluded that this phenomenon was the result of natural re-deposition of silver on the surface due to contact with corroding silver objects during burial.

Previous research has suggested that there may be a general decline in gold content in the contemporary Anglo-Saxon coinage over time (Williams and Hook 2013). The analysis of the bulk or core alloy of the Staffordshire Hoard objects (excluding the influence of any surface enrichment) has shown that there is considerable overlap in bulk compositions through the whole time period represented by the objects of the Hoard, with no obvious decline in gold content over time. This therefore suggests that the gold composition of the alloy cannot be used to date the objects. No relationship between the core composition and the function of the pieces was found and there are no differences between the secular pieces or those associated with Christianity. Interestingly it was noted that the bulk alloy of the male items of personal adornment were generally of higher gold content than the female items analysed for this study, but the latter had been surface treated, presumably to improve the colour of the metal.

CSR Project no. PR07444
August 2014
Internal Registration Numbers: See Table 9 in Appendix 1
External Registration Numbers: See Table 10 and Table 11 in Appendix 1

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1. Introduction

1.1 The Staffordshire Hoard and the research project

The Staffordshire Hoard is a large collection of Anglo-Saxon gold and silver metalwork. Discovered in a field near the village of Hammerwich, near Lichfield, in Staffordshire, England on 5 July 2009, it consists of more than 3,500 fragments, most of which appear to be from military fittings which had been deliberately dismantled.[1] There were some specifically Christian items in the assemblage including the Great Cross (K655, K656, K657, K658, K659 and K1314), pectoral cross (K303) and a Christian inscription (K550). This second phase study follows from the pilot study of 16 gold objects undertaken to determine whether there was evidence of any surface enrichment and/or depletion of the gold alloy that might affect future analysis programmes (Blakelock 2013). This research forms part of the first stage of the English Heritage-funded research and analysis project "Contextualising Metal-Detected Discoveries: Staffordshire Anglo-Saxon Hoard".

1.2 Surface phenomena in gold alloys

Surface enrichment of gold alloys is discussed in detail in the pilot enrichment study report (Blakelock 2013, 9-11) but will be briefly summarised here.

Pure gold is very resistant to all forms of corrosion, including attack by acids and alkalis (Wise 1964, 180), but most gold objects are in fact created using an alloy of gold with silver and copper. In nature, alluvial gold, collected from river deposits, occurs with silver at levels of up to 40 wt%, with many sources having an average of 10 wt% silver and up to 1 wt% copper (Möller 1995, 358; Raub 1995, 245). Silver and/or copper are also deliberately added to change the properties of gold; including the colour and working properties, such as the melting temperature, ductility and hardness (Pingel 1995, 394-397).

Previous studies of ancient gold alloy objects have shown that there can be differences in copper and silver contents of up to 10 wt% between the surface and the core (Lehrberger and Raub 1995, 353). Copper, as the least noble metal in these gold alloys, is often found to be depleted at the surface, because copper corrodes and forms soluble corrosion products which are leached away from the surface by the action of the burial environment (Hook and Needham 1989; Lehrberger and Raub 1995; Tate 1986; Voute 1995). Silver by contrast is more resistant to corrosion. The removal of silver from a gold alloy usually requires deliberate chemical action through methods like cementation or, more recently, by parting using mineral acids (Craddock 2000; La Niece 1995; Mongiatti *et al.* 2010). The result is a surface layer relatively enriched in gold (Lehrberger and Raub 1995, 353; Scott 1983b, 194; Voute 1995, 333).[2]

Typically any corrosion that occurs during burial (or etching due to deliberate treatment) results in the surface of the object being matted and/or pitted (Forty 1979; Forty 1981). Previous research has shown that bright, burnished surfaces may be a sign that the surface is the result of the goldsmith's craft in remedying the dull surface caused by corrosive agents,

[1] For more information visit http://www.staffordshirehoard.org.uk/.

[2] Some of these corrosion products can occasionally be re-deposited on the surface of the objects, for example as seen with the Hoxne Treasure (Cowell and Hook 2010), although the mechanism for this is not well understood.

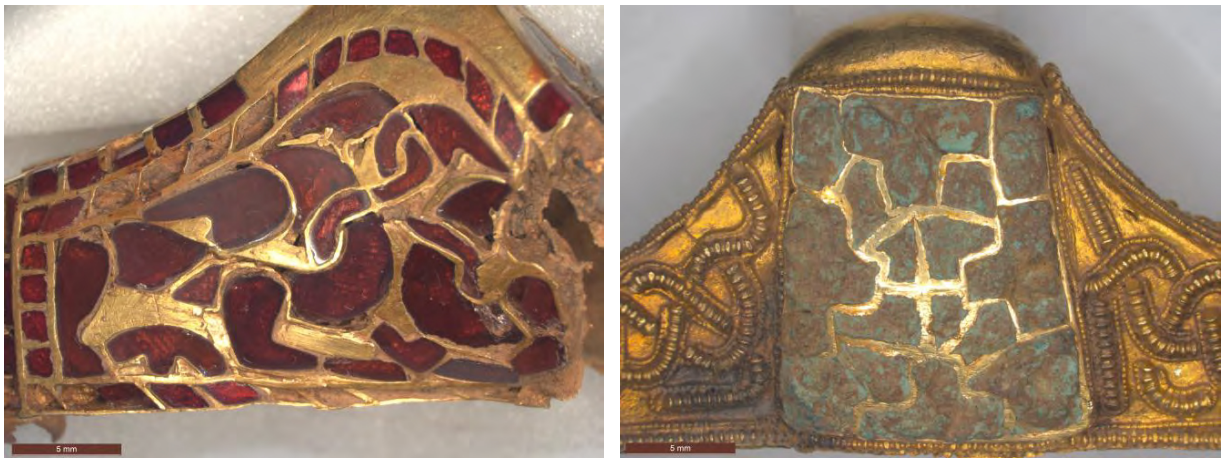
and thus indicates a deliberate treatment carried out by the goldsmith to enhance the surface (Craddock 2000; La Niece 1995, 41).

The pilot study was carried out to quantify any surface enrichment in 16 gold objects, mostly hilt-plates, from the Staffordshire Hoard and the results showed that in many cases there is significant but not consistent enrichment of the gold at the surface due to the depletion of both copper and silver (Blakelock 2013). The analysis of deep scratches, probably made when dismantling the swords before burial, confirmed the expected loss of copper from the surface typically observed during burial, and little loss of silver. However, the results from undamaged surfaces of the same objects suggest that some form of deliberately induced depletion gilding had been employed to remove both silver and copper from the surface, perhaps to improve the colour at the manufacturing stage.

1.3 Anglo-Saxon gold working

a) b)

Figure 1. a) Filigree decoration on K381 (scale bar 5 mm), b) a filigree panel on K352: behind the filigree panel on the left evidence for the copper-rich solder used can be seen (scale bar 8 mm).



a) b)

Figure 2. a) Cloisonné decoration on pommel K284 (scale bar 5 mm), b) cloisonné with an unknown inlay seen on pommel K349 (scale bar 5 mm).

The Staffordshire Hoard is typical of Anglo-Saxon goldwork in being heavily decorated and made up of several components, so a brief summary of the Anglo-Saxon gold working techniques represented is relevant to this study, although it should be noted that direct information on Anglo-Saxon goldsmiths' workshops and workshop practices is scarce (Coatsworth and Pinder 2002). Filigree wire decoration is the most prominent technique seen in the Staffordshire Hoard (Figure 1) but a large number of objects with cloisonné garnet and glass decoration is also present (Figure 2a). In addition to the normal garnet

cloisonné objects there are a small number of objects with an unknown inlay, which now is green in colour (Figure 2b). Some pieces also have niello inlays (Figure 3a). Niello is a black inlay which contrasts with the colour of the metal; the niello analysed from the Staffordshire Hoard is silver sulphide (La Niece 2013). In addition to the pieces with applied decoration, there are pieces with cast or engraved designs (Figure 3b).

a) b)

Figure 3. a) the niello pommel K347 (scale bar 5 mm), b) the cast seax hilt plate K567 (scale bar 2 mm).

Most of the joins observed on the Hoard are soldered. A metallic solder should closely match the colour of the gold piece, so that the joins are unobtrusive, and it must flow at temperatures appropriate to the gold to be soldered (Untracht 1975, 172). Copper and silver are usually added to gold to produce a suitable solder (Figure 1b). The addition of copper to the gold alloy has the greatest effect on lowering the melting temperature but can result in a reddish coloured alloy. The colour can be corrected by adding silver (Ogden 1982, 59). Very small quantities of solder are needed for attaching wires and too much will flood the area, destroying the contours of the beaded wire (Coatsworth and Pinder 2002, 96; Untracht 1975, 176). Another type of soldering process known from antiquity uses a copper salt mixed with an organic component rather than a metal alloy (Roberts 1974). This results in the addition of minute quantities of copper to the joint area which, when heated, combines with gold from the body of the object to form a solid state join. Mixing the copper salts with organic material may have made it easier to position the components as well as acting as a reducing agent (Ogden 1982, 64-65; Roberts 1974; Wolters 1982). SEM-EDX analysis of some join areas suggests the use of a metallic solder and no firm evidence for the use of copper salts was observed in the Staffordshire Hoard (Mongiatti forthcoming).

The source of the gold used by Anglo-Saxon goldsmiths is unknown. There is no evidence that gold was being mined/collected in this period, therefore it is suggested that gold was being imported and/or recycled from earlier objects and Merovingian coins (Hinton 2005, 66; Williams and Hook 2013, 63). During this period the ratio of gold to silver began to decline in Merovingian coinage (Hinton 2005, 66), which seems to have impacted the contemporary Anglo-Saxon coinage as shown in a recent a study by Williams and Hook (2013, 60) which revealed a general decline over time (Figure 4). However the variation in gold contents of the coins in their analytical study cautions against using composition to date Anglo-Saxon coins precisely. Any decline in gold content in coinage would depend on the rulers and moneyers in each kingdom and "what they thought they could get away with" (Hinton 2005, 67). There is a record that in the 630s King Dagobert received 20,000 high gold *solidi* from the Visigoths (Hinton 2005, 66). This and similar events may have impacted on the gold compositions of coins and artefacts. Repeated recycling and mixing of new and old objects and/or coins would confuse the overall trends in alloys used in jewellery For example if an old brooch or Visigoth *solidus* was melted down but no silver was added it would remain a relatively pure

gold alloy but if an old pommel was mixed and melted with more debased coinage the alloy would become more debased (Hinton 2005, 67).

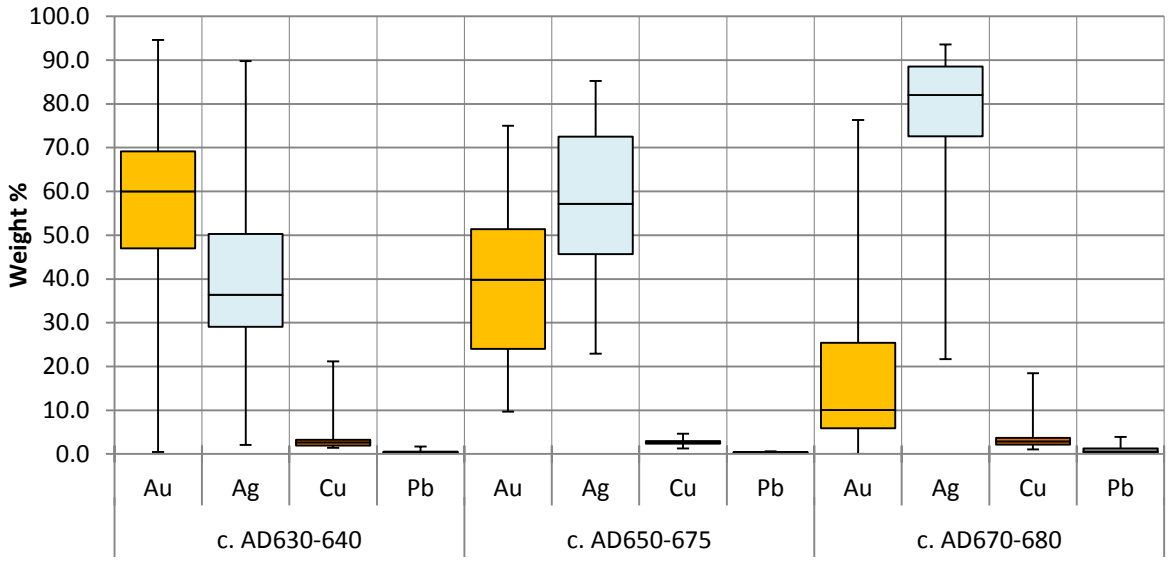


Figure 4. Box and whisker plot showing the apparent decline in gold content and rise in silver content over time using the sub-surface XRF analytical data from Williams and Hook (2013).

1.4 Research aims

The selection of similar artefacts for the pilot study to investigate surface enrichment may have introduced a degree of bias (Blakelock 2013), and therefore analysis of other types of artefacts from the Hoard and of pieces spanning the Hoard time frame was required to investigate the extent of surface enrichment, especially on more complex pieces made from a number of different components.

The main aim of this second stage of the project was to collect a body of analytical data from the different object types in the Staffordshire Hoard, including sword fittings and other categories of finds such as the Christian items. Items from the British Museum collections representing categories of objects not found in the Hoard (male and female decorative items) were also selected for analysis and comparison.

1.5 Object terminology

Before discussing the data it is important to define a number of the terms used in this report.

Pieces
These are individual items; these usually have their own individual K number (for the Staffordshire Hoard items) or registration number (for the British Museum items).

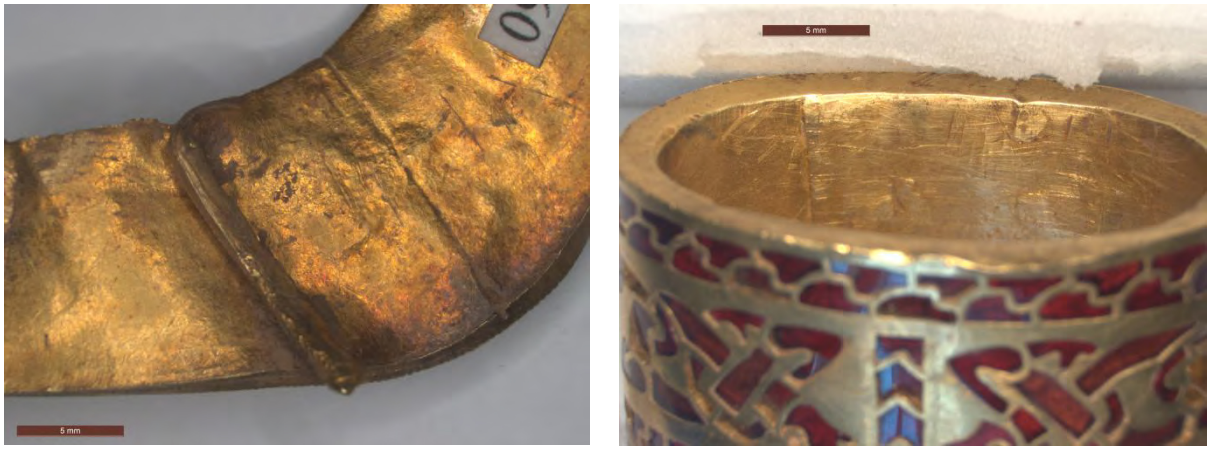
Objects
These may refer to single complete pieces (i.e. K88, K370) but is also used to describe a number of pieces that comprise a complete object (i.e. aK545, K1055 and K130 are all parts of the 'mystery' object).

Sets
This refers to a group of objects that belong together, for example the seax set (K376, K354, K690, K370 and K449) or the Market Rasen sword hilt set (2006,1001.1.a-e).

1.6 Component terminology

In addition to those above, the following terms are used in this report to describe the components of individual pieces.

Sheet
Within the Staffordshire Hoard and other Anglo-Saxon objects there is a tendency to use small, economical amounts of gold, with thin sheets used to create objects formed around cores (Coatsworth and Pinder 2002). Many of the objects in the Staffordshire Hoard were constructed from more than one sheet of gold alloy (Figure 5) to which decoration was applied. These decorated sheets are referred to as backing or base sheets, for example in the filigree panels (Figure 1b and Figure 6a). Some pieces consist of sheets that have engraved detail like the Great Cross (K655) (Figure 6b) and others have engraved detail with niello inlays (K347).



a) b)

Figure 5. Sheets were used to construct many of the pieces examined. These photographs show the join between two sheets on the inside of hilt-collars a) K560 (scale bar 5 mm) and b) K370 (scale bar 5 mm).

a) b)

Figure 6. a) Small sheets were also used as backings for filigree panels as in K677 (scale bar 5 mm). b) The Great Cross K655 was constructed from two joined sheets of which only the front sheet was decorated (scale bar 5 mm).

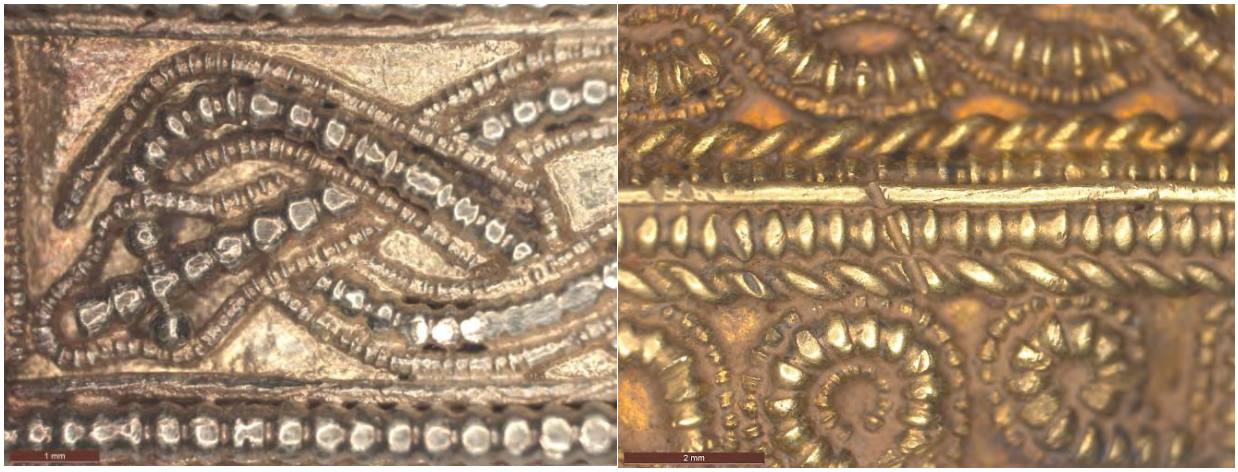
Body
This term is used for components that appear to have been cast and worked, for example pommel K358 and the Sutton Hoo great buckle (1939,1010.1) (Figure 7).

a) b)

Figure 7. a) Cast pommel K358 (scale bar 5 mm), b) Sutton Hoo Great Buckle 1939,1010.1 (scale bar 5 mm).

Wires

Filigree wire decoration is the most common decorative technique seen in the Staffordshire Hoard (Figure 8). The wires were formed by strip-twisting or, more commonly, block-twisting (Ogden 1982, 48-49; Whitfield 1990) and a shaped tool was rolled over the plain wire to form beaded wire (Nicolini 1995, 458; Whitfield 1998). Combinations of straight, twisted and beaded wires of different thicknesses were applied to the pieces (Figure 8). Many of the objects analysed had applied filigree (Figure 8a), but there were also a number of objects with filigree panels within a cloisonné design (Figure 8b).



a) b)

Figure 8. Examples of the wires used in the Staffordshire Hoard a) K855 showing a snakes head (scale bar 1 mm) and b) K276 (scale bar 2 mm).

Granule

Gold granules often form the eyes of snakes or beasts (Figure 8a). To make granules, small pieces or filings of gold alloy are heated until they melt and the surface tension of the molten metal causes them to form spherical balls (Ogden 1982, 67; Untracht 1975, 203-204).[3]

Cell wall

The cell walls for the garnet inlays are thin strips of gold soldered to the base sheets (Figure 9). For the purpose of this study, the borders surrounding the interior cell walls are also included in this group.

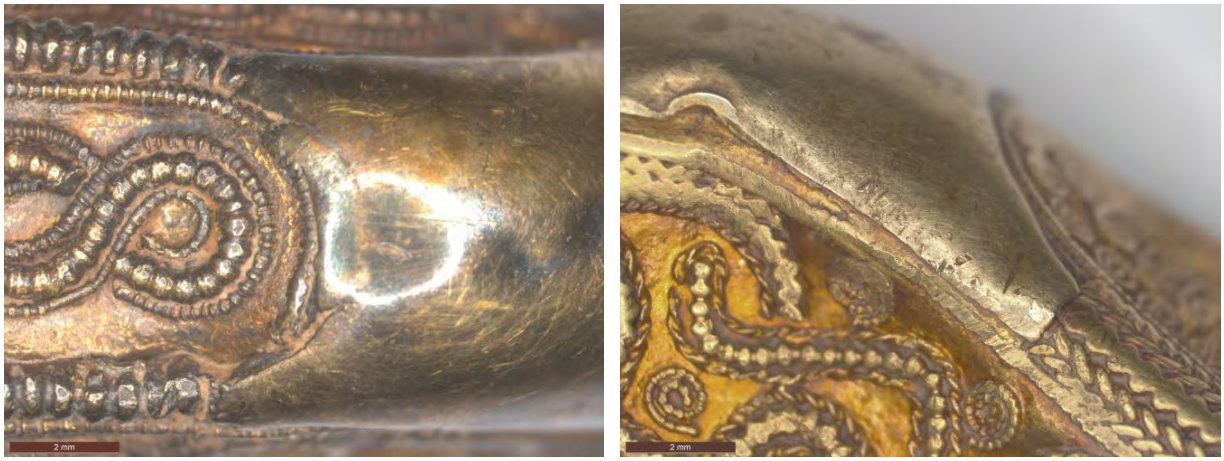
[3] Granules can also form when molten gold is dripped into water, or onto a bed of ash or powdered charcoal (Ogden 1982, 67; Wolters 1982).

a) b)

Figure 9. a) Cloisonné cell walls and gold foils underneath missing garnets on K843 (scale bar 2 mm).[4] b) Garnet cloisonné and gold panel of K130with the borders surrounding the interior cell walls indicated with arrows (scale bar 5 mm).

Cap

Many of the pommels analysed in this study had a cap at the top which was a separate component soldered onto the base sheet (Figure 10). These caps comprise a single sheet of gold alloy.



a) b)

Figure 10. Separate sheets that form the cap of pommel a) K306 (scale bar 2 mm) and b) K686 (scale bar 2 mm)

2. Methodology

2.1 Equipment

The objects were examined using optical microscopy and scanning electron microscopy with energy dispersive X-ray analysis (SEM-EDX). The optical microscope was used to select areas for analysis by SEM-EDX and investigate how each piece was constructed.

The SEM used was a Hitachi S-3700N Variable Pressure SEM, set at an accelerating voltage of 20 kV and at an acquisition time of 150 seconds. Images were recorded in the

[4] No foils were analysed in this study (Meeks and Holmes 1985).

secondary electron (SE) mode. The EDX compositional data were obtained using an Oxford Instruments INCA EDX microanalysis system with an INCAx-act Silicon Drift Detector (SDD). The SEM-EDX was calibrated using cobalt prior to any analytical work. Settings were at a process time of 5, the dead time was *c.*30% and the count rate was *c.*9000 counts per second on the cobalt standard. Unless noted otherwise, the optimum working distance of 10 mm was used. Specific energy lines were selected in the SEM-EDX INCA software to calculate the quantity of each element present.

For the majority of objects high vacuum conditions were used, but for objects where organic residues survive, the SEM was used under low vacuum conditions (30 Pa) to preserve these residues *in situ*. The Sutton Hoo clasps were also analysed under lowl vacuum conditions as the garnet cloisonné is very precise and there was concern that a change in pressure could loosen the garnets.

2.2 Equipment parameters

A basic introduction to SEM-EDX is provided in the pilot enrichment study report (Blakelock 2013). Experiments were carried out using the SEM-EDX on gold standards or objects to explore the factors which could potentially affect the analytical results. This study showed that the location of the detector in relation to the surface being analysed and the object geometry can significantly affect the results obtained, with objects with curved or tilted surfaces, at angles ±30º, are likely to produce significantly increased errors. The location of the detector in relation to the surface being analysed can also significantly affect the results. A comparison between the results from standards analysed under high and low vacuum conditions indicated that the use of low vacuum conditions in the SEM-EDX does not significantly alter the analytical results obtained.

2.3 Quantification method for the analytical data

A range of gold alloys of known composition was analysed in the SEM-EDX. The full results of the study of alloy standards are detailed in the pilot enrichment study report (Blakelock 2013). The quantification of gold, silver and copper with the SEM-EDX INCA software was achieved using MAC2[5] for the standardisation process, as it has comparable gold, silver and copper contents to the majority of the Staffordshire Hoard artefacts analysed during the pilot project (see the pilot study report for more details about the standardisation methods (Blakelock 2013)). To check the internal consistency of the SEM, standard MAC2 was analysed regularly, usually on a monthly basis, during the study (Table 16 in Appendix 4).

2.4 Enrichment study methodology

Surface X-ray fluorescence spectroscopy (XRF) showed that there was little variation in composition across a single object (Blakelock 2013). During the present study a small number of items were analysed in two or more locations using the SEM-EDX and this confirmed that there was only a small variation in sub-surface composition, so only one area on each component was analysed. In some cases, repeats were carried out on different areas, especially on components yielding unusual results.

The surface areas selected for analysis were relatively flat and easy to orientate within the SEM vacuum chamber at the optimum working distance of 10 mm from the EDX detector. Any areas with obvious surface debris were avoided. The surface areas analysed were

[5] The certified composition of MAC2 is 74.7 wt% Au, 19.2 wt% Ag, 5.1 wt% Cu and 1.03 wt% Sn.

locally wiped with industrial methylated spirits (IMS). This solvent cleaning does not alter the chemical composition of the metal alloy but removes any loose dirt and grease from the surface and may also remove some corrosion products (Araújo *et al.* 1993; Kallithrakas-Kontos and Katsanos 1998).

The extent of surface enrichment in gold (and depletion in copper and silver) was determined through the analysis of the composition of surface and sub-surface areas. These sub-surface areas were accessed by scraping the surface of the objects with a small tool under the optical microscope. The tool was sharpened to a chisel with an edge of less than 0.2 mm and the scraped areas were usually not larger than 1 mm^2. These small sub-surface areas were repeatedly analysed and scraped deeper until no further changes in composition were detected, indicating that the bulk or core alloy composition had been obtained. At each sub-surface depth, at least 4 analyses were carried out and the average composition calculated. On some objects a number of different components were analysed.

On some objects there were tool marks, abrasions and scrapes on the surface which had the same patina as the rest of the object surface, suggesting damage which had occurred before burial. These features will be termed 'scratches' in the rest of the report to distinguish them from the sub-surface cleaned areas that were deliberately prepared. Where possible, i.e. when a suitable flat area was available, the opportunity was taken to analyse these scratches for comparison with the surface and sub-surface results. Areas of heavy wear were avoided during this study, in particular the top of the pommels which exhibited most wear.

2.5 Data quality and precision

SEM-EDX analysis is a quantitative method if the sample is homogeneous and surface is flat, clean and free of corrosion layers. The surface and sub-surface areas prepared during this study were not perfectly smooth and therefore the data in this report is semi-quantitative at best. The precision and accuracy of the data produced by the SEM-EDX is typically ±0.1 for major elements. For each component investigated a number of areas are analysed and the averages have been calculated; the standard deviation[6] therefore gives an indication of large compositional ranges.

2.6 Objects selected for analysis

Ninety eight[7] individual pieces from the Staffordshire Hoard were analysed for the second stage of the materials analysis programme. These were selected by members of the Staffordshire Hoard project team to represent a range of object types and designs and to cover the entire period of the Hoard. A further 36 pieces from the British Museum's collection and a pendant from Stoke-on-Trent Potteries Museum and Art Gallery were analysed as comparanda, allowing extension of the study to functional categories not included in the Hoard.

The majority of the pieces examined may be grouped into categories based on function and style of decoration. Categories by function are: sword fittings, male items of personal adornment, female items of personal adornment, mounts, religious pieces and a final

[6] Standard deviation is used as a measure of the dispersion or variation from the mean in a distribution. In a normal distribution one standard deviation of the mean includes 65% of the results, two standard deviations include 95% and three standard deviations include 99%.

[7] This value excludes the 16 pieces from the pilot study, so the overall total number of pieces examined from the Staffordshire Hoard is 114.

miscellaneous category for objects such as helmet-fittings. The style of decoration has been classified based on the presence of filigree only, cloisonné only, filigree and cloisonné together, niello inlays, green cloisonné or if it has engraved decoration or it is undecorated.

Each object has been provisionally dated[8] or allocated to a chronological phase by Chris Fern (Table 1 left). These phases represent changes in artistic style and typology. For this study, a series of broader date ranges have been used to account for the overlap between the phases defined by Chris Fern (Table 1 right), although these are broadly based on his phases (Table 1 left). Some objects such as the Roman coin in pendant 1879,0714.1 and the belt plate .1096.'70 pre-date phase B. No objects analysed were dated between *c.*550-580. The later coins have been grouped together into a single category *c.*AD 650-680. Some objects, such as the plain hilt-plates, could not be closely dated to any one phase. These therefore have a much wider potential date ranges of *c.*AD580-650 or *c.*AD600-650.

C. Fern Phase	Date range
B	AD 580-610
C1	AD 600-620
C2	AD 610-625/630
D1	AD 620-650
D2	AD 630-660

Table 1. Showing the relationship between the dates and phases developed by Chris Fern.

Date ranges used in this study	Relation to C. Fern's Phases
***c.*AD 520-550**	
***c.*AD 580-610**	(B)
c.*AD580-650	*(B, C1, C2 & D1)*
***c.*AD 600-630**	(C1 & C2)
c.*AD600-650	*(C1, C2 & D1)*
***c.*AD 620-660**	(D1 & D2)
***c.*AD 650-680**	

Table 2. Detailing the date ranges used in this report. * Some objects could not be assigned to any single phase and therefore a range of phases was suggested.

2.7 Software and statistical methods used

The data was collected and the results were processed in Microsoft Excel. A full spread sheet of the data from the Staffordshire Hoard objects is available in the Project archive. Further statistical analysis of the data was carried out in IBM SPSS Statistics version 20. Various statistical tests were carried out on the data including, principal component analysis and multi-variate techniques but the results were inconclusive. The main statistical test that is applied in this report is the Kruskal-Wallis test for sample independence. The Kruskal–Wallis one-way analysis of variance by ranks is a non-parametric method for testing whether samples originate from the same distribution. It is used for comparing more than two samples that are independent, or not related.

[8] The provisional dates and phases as allocated by C. Fern in January 2014. These are likely to be developed during the course of future cataloguing work.

3. Results

In total 157 individual pieces from the Staffordshire Hoard and British Museum, as well as the pendant from the Potteries Museum and Art Gallery at Stoke-on-Trent were examined. These are summarised in Table 2. The largest functional group was the sword fittings; only one piece was associated with a helmet. No coins were found with the Staffordshire Hoard but some coins were analysed from the British Museum's collection during this study. The analyses were representative of the chronological period of the Hoard. The analysis of objects from the British Museum allowed pieces from different find locations to be compared. A range of styles of decoration were represented by the dataset.

In total 288 different components were analysed during the course of this project (Table 4 and Table 5). The most routinely analysed components were sheets, as these usually presented a large surface area suitable for analysis and were found on objects of most functional groups and decorative styles.

The average and standard deviation of the surface and sub-surface data are listed in Table 12, Table 13 and Table 14 in Appendix 2. A table of the results from ancient scratches on the surface of some of the pieces examined is in Table 15 in Appendix 2. The results for each piece examined are presented in Appendix 3, with a description of the analysis locations, a photograph of the piece and a brief discussion of the results.

The data from the surface analysis is summarised in Table 6, with averages, standard deviation and ranges for the different categories. Table 7 summarises the data for the sub-surface areas. In both cases the main outlier in the data set, K306 was excluded as analysis revealed this to be a silver pommel rather than gold.

There were three main groups in the overall dataset. The majority of the pieces and components analysed fell into a large group ranging in composition from *c.*66-88 wt% Au, 10-31 wt% Ag and 1.5-3 wt% Cu.

The second group had a higher gold content; particularly the two gold snake mounts K128 and K816, two pommels K1167 and K358, fork-ended mount K95 and hilt ring K140. The gold content of this group was similar to the Sutton Hoo shoulder clasps, and the Roman and Saxon coins set in the Anglo-Saxon pendants (1879,0714.1 and 1859,0512.1).

The third and smallest group consists of objects with a low gold content and is mostly composed of coins from the British Museum collection that post-date the Hoard. From the Staffordshire Hoard the group includes hilt-plate K133 (*c.*47.2 wt% Au, 50.4 wt% Ag and 2.3 wt% Cu) and pommel K669 (*c.*52-54 wt% Au, 43.5-45.5wt% Ag and 2.5 wt% Cu).

The enrichment factor for each of the components analysed was calculated based on the difference between the surface and the core, and its relation to the core composition (formula below and expressed as a percentage). This was then used to show the amount of enrichment or depletion of gold, silver and copper. Positive values for this factor indicate enrichment and negative values depletion.

	Function								Find Location										Style of Decoration								
Date Range	***Coin***	***Decorative item (female)***	***Decorative item (male)***	***Helmet***	***Mount***	***Religious function[1]***	***Sword fitting***	***Total***	***Unknown***	***Buckinghamshire***	***Cumberland***	***Kent***	***Lincolnshire***	***Norfolk***	***North Yorkshire***	***Northamptonshire***	***Staffordshire***	***Suffolk***	***Total***	***Cloisonné***	***Cloisonné (green)***	***Cloisonné (green) and filigree***	***Cloisonné and filigree***	***Coin***	***Filigree***	***Undecorated or engraved decoration***	***Niello***	***Total***
c.520-550			1					**1**				1							**1**				1					**1**
c.580-610			5				9	**14**		5			5				4		**14**				1		13			**14**
c.580-650					1		14	**15**			1						14		**15**						2	13		**15**
c.600-630		5	7		2		30	**44**				6		1			32	5	**44**	8	3	1	9		21	1	1	**44**
c.600-650			1		2		6	**9**									9		**9**						6	3		**9**
c.620-660	2	10	1	1	14	13	29	**70**	2			3			1	6	58		**70**	21	2		14	2	20	8	3	**70**
c.650-680	4							**4**	4										**4**					4				**4**
Total	**6**	**15**	**15**	**1**	**19**	**13**	**88**	**157**	**6**	**5**	**1**	**10**	**5**	**1**	**1**	**6**	**117**	**5**	**157**	**29**	**5**	**1**	**25**	**6**	**62**	**25**	**4**	**157**

Table 3. A cross table showing the number of pieces analysed grouped by date range, function, find location and style of decoration. 1) This includes the pieces from the mystery object (K130, K545, K1055), which is believed to have a religious function.

	Components										Date Range								
Function	*Body*	*Cap*	*Cell Wall*	*Cell Wall (border)*	*Coin*	*Sheet*	*Granule*	*Wire (Beaded)*	*Wire (Straight or twisted)*	*Total*	*Roman*	*c.520-550*	*c.580-610*	*c.600-630*	*c.580-650*	*c.600-650*	*c.620-660*	*c.650-680*	*Total*
Coin					6					**6**							2	4	**6**
Items of personal adornment (female) [1]			3		2	18				**23**	1			9			15		**23**
Items of personal adornment (male)	9					18		4		**31**		2	12	10		2	5		**31**
Helmet						1				**1**							1		**1**
Mount	3		4	1		22		7		**37**				4	1	2	30		**37**
Religious function [2]	1		2			15		3	1	**22**							22		**22**
Sword fitting	7	15	14	4		97	1	26	4	**168**			17	59	14	12	66		**168**
Total	**20**	**15**	**23**	**5**	**8**	**171**	**1**	**40**	**5**	**288**	**1**	**2**	**29**	**80**	**15**	**16**	**141**	**4**	**288**

Table 4. Cross table showing the number of components analysed grouped by object function, component types and date range. 1) This includes the two coins in the coin pendants. 2) This includes the components analysed from the mystery object (K130, K545, K1055), which is believed to have a religious function.

	Types of Decoration									Find Location										
Function	*Cloisonné*	*Cloisonné (green)*	*Cloisonné (green) and filigree*	*Cloisonné and filigree*	*Coin*	*Filigree*	*Undecorated or engraved decoration*	*Niello*	*Total*	*Unknown*	*Buckinghamshire*	*Cumberland*	*Kent*	*Lincolnshire*	*Norfolk*	*North Yorkshire*	*Northamptonshire*	*Staffordshire*	*Suffolk*	*Total*
Coin					6				**6**	6										
Items of personal adornment (female) [1]		2		14		1	6		**23**				7		1	1	9	3		**21**
Items of personal adornment (male)				12		15	3	1	**31**		12		9					2	8	**31**
Helmet						1			**1**									1		**1**
Mount	19			1		10	7		**37**									37		**37**
Religious function [2]	7					6	8	1	**22**									22		**22**
Sword fitting	38	7	2	17		82	17	5	**168**			1	2	6				159		**168**
Total	**64**	**9**	**2**	**44**	**6**	**115**	**47**	**7**	**288**	**6**	**12**	**1**	**18**	**6**	**1**	**1**	**9**	**224**	**8**	**288**

Table 5. Cross table showing the number of components analysed grouped by object function, style of decoration and find location. 1) This includes the two coins in the coin pendants. 2) This includes the components analysed from the mystery object (K130, K545, K1055), which is believed to have a religious function.

			Au			Ag			Cu		
		No	Average	Standard Deviation	Range	Average	Standard Deviation	Range	Average	Standard Deviation	Range
Find Location[1]	Buckinghamshire	12	86.9	4.29	82.4-95.5	11.6	3.68	4.3-15.6	1.5	0.91	0.2-3.3
	Cumberland	1	94.9			3.4			1.8		
	Kent	18	81.5	11.35	61.2-97.0	16.8	11.06	2.5-37.0	1.7	0.69	0.5-3.2
	Lincolnshire	6	85.9	3.96	78.3-88.8	12.5	3.34	10.2-18.7	1.6	0.68	1.0-2.9
	Norfolk	1	91.2			7.0			1.8		
	North Yorkshire	1	84.6			14.4			1.0		
	Northamptonshire	9	85.3	2.99	81.7-90.5	12.2	3.12	6.5-15.5	2.5	1.43	0.7-4.7
	Staffordshire	224	80.1	8.47	48.2-97.4	18.0	8.21	2.1-49.6	1.8	1.06	0.2-7.3
	Suffolk	8	95.8	2.71	91.0-98.6	3.5	2.64	1.1-8.2	0.7	0.71	0.2-2.4
Function	Coin	6	56.18	20.58	25.9-81	42.7	21.10	17.6-73.6	1.1	0.64	0.3-2
	Items of personal adornment (female)	23	86.63	5.99	75.5-98.3	11.6	5.72	0.6-23	1.8	1.12	0.5-4.7
	Items of personal adornment (male)	31	85.79	10.62	61.2-98.6	12.8	10.27	1.1-37	1.4	0.81	0.2-3.3
	Helmet	1	83.76			15.7			0.5		
	Mount	37	81.08	7.89	61.3-96.5	17.0	7.75	3.2-36.4	1.9	1.44	0.2-6.4
	Religious items	22	81.00	8.34	57.3-91.5	17.3	8.50	7.5-41	1.7	0.98	0.3-3.3
	Sword fitting hilt-plates	26	80.50	9.11	48.2-92.6	17.9	8.94	6.5-49.6	1.6	1.30	0.7-7.3
	Sword fitting hilt-collar/hilt-ring/mounts	47	83.94	6.65	67.3-95.4	14.3	6.23	3.4-30.4	1.8	0.89	0.3-3.8
	Sword fitting pommel	81	78.13	9.02	56.6-97.4	19.9	8.70	2.1-42.1	2.0	0.80	0.2-4.1
	Sword fitting sword pyramid/button	13	77.80	8.60	64-89.1	20.1	7.72	9.7-32.3	2.1	1.31	0.8-5.3
Date	Roman	1	96.7			2.1			1.2		
	c.520-580	2	89.3	0.84	88.7-89.9	9.0	1.80	7.7-10.3	1.7	0.95	1-2.4
	c.580-610	29	86.2	3.81	77.3-95.5	12.3	3.33	4.3-20.6	1.5	0.76	0.2-3.3
	c.580-650	15	83.3	12.02	48.2-96.5	15.5	11.74	3.2-49.6	1.2	0.48	0.3-2.2
	c.600-650	16	83.3	7.74	67.3-96.1	14.8	7.33	3.7-30.6	1.9	1.03	0.2-3.5
	c.600-630	79	81.0	10.38	56.6-98.6	17.2	9.90	0.6-42.1	1.8	0.91	0.2-4
	c.620-660	141	80.1	7.96	57.3-97.4	18.0	7.84	2.1-41	1.9	1.17	0.2-7.3
	c.650-680	4	45.2	14.71	25.9-61.7	54.0	15.11	36.8-73.6	0.9	0.55	0.3-1.5
Component	Body	20	89.3	9.86	67.3-98.6	9.7	9.10	1.1-30.6	1.0	0.86	0.2-3.3
	Cap	15	76.4	10.31	57.3-96.4	21.4	10.12	2.1-39.5	2.2	0.74	1.2-3.6
	Cell Wall	28	76.8	9.07	57.3-94.7	20.9	8.57	4.4-41	2.2	1.05	0.9-5.3
	Coin	8	66.5	25.86	25.9-98.3	32.4	26.16	0.6-73.6	1.1	0.54	0.3-2
	Sheet	170	83.2	6.91	48.2-97	15.1	6.84	1.6-49.6	1.7	1.08	0.2-7.3
	Wire	46	75.6	8.87	56.6-94.5	22.2	8.84	4.4-42.1	2.2	0.73	1-3.7
Types of Decoration	Cloisonné	66	79.8	7.52	61.3-96.4	18.3	7.28	2.1-36.4	1.9	1.04	0.5-7.3
	Cloisonné (green)	9	81.8	10.71	69.3-97	15.9	9.52	2.5-27.8	2.2	1.44	0.5-5.3
	Cloisonné (green) and filigree	2	83.1	8.24	77.3-88.9	14.2	7.73	8.7-19.6	2.7	0.52	2.4-3.1
	Cloisonné and filigree	47	82.4	10.46	57.3-98.6	16.1	10.10	1.1-41	1.6	0.88	0.2-3.7
	Coin	8	66.5	25.86	25.9-98.3	32.4	26.16	0.6-73.6	1.1	0.54	0.3-2
	Filigree	115	81.1	8.20	56.6-95.4	17.0	7.92	3.4-42.1	1.8	0.84	0.2-4
	Undecorated or engraved decoration	33	83.7	10.07	48.2-97.4	14.6	9.94	2.3-49.6	1.7	1.66	0.2-6.4
	Niello	7	81.4	8.69	71.3-94.7	17.2	8.32	4.4-26.5	1.4	0.53	0.8-2.2

Table 6. Average surface alloy compositions (including standard deviation and ranges) reported by find location, function, date, component and style of decoration.
[1]The find location totals does not include the coins because their find location is unknown.

			Au			Ag			Cu		
		No	Average	Standard Deviation	Range	Average	Standard Deviation	Range	Average	Standard Deviation	Range
Find Location[1]	Buckinghamshire	12	81.7	3.68	78.1-91.3	16.4	3.38	7.9-20.0	1.9	0.50	0.8-2.5
	Cumberland	1	88.2			9.6			2.2		
	Kent	18	75.2	11.26	59.8-91.2	22.5	11.35	7.9-37.9	2.3	0.75	0.5-3.6
	Lincolnshire	6	81.8	4.47	75.2-85.3	15.9	3.97	12.8-21.6	2.2	0.66	1.3-3.2
	Norfolk	1	80.7			15.8			3.5		
	North Yorkshire	1	68.7			27.4			4.0		
	Northamptonshire	9	76.7	3.29	72.2-83.0	19.8	3.35	12.0-23.7	3.5	1.05	2.3-5.0
	Staffordshire	224	77.1	8.06	47.2-98.0	20.5	7.90	1.7-50.4	2.4	0.78	0.1-5.0
	Suffolk	8	92.8	5.13	82.8-98.1	5.7	4.86	1.6-15.2	1.5	1.20	0.4-3.9
Function	Coin	6	39.0	26.06	8.6-76.3	58.3	25.89	21.3-89	2.7	0.56	2.3-3.6
	Items of personal adornment (female)	23	78.3	8.47	61.1-97.8	19.0	8.20	1-36.8	2.8	1.04	0.9-5
	Items of personal adornment (male)	31	81.2	11.37	59.8-98.1	16.9	11.13	1.6-37.9	1.9	0.87	0.4-3.9
	Helmet	1	73.2			24.7			2.1		
	Mount	37	79.8	7.43	65.4-98	17.9	7.15	1.7-32.1	2.3	0.92	0.1-4.6
	Religious items	22	79.6	8.71	58.7-88.9	17.9	9.17	7.6-39.5	2.5	0.86	1-4.8
	Sword fitting hilt-plates	26	75.9	7.62	47.2-89	21.9	7.57	11.5-50.4	2.2	0.75	0.7-5
	Sword fitting hilt-collar/hilt-ring/mounts	47	78.8	7.28	66.5-95.7	18.8	7.01	3.2-31.3	2.4	0.76	1.1-4.6
	Sword fitting pommel	81	75.1	8.11	52.2-95.7	22.3	7.91	2.6-45.4	2.6	0.68	1-4.9
	Sword fitting sword pyramid/button	13	79.0	8.51	65.9-87.9	18.7	7.84	10.9-31.7	2.2	0.95	0.9-3.9
Date	Roman	1	97.8			1.3			0.9		
	*c.*520-580	2	87.3	5.60	83.3-91.2	11.4	4.42	8.3-14.5	1.3	1.18	0.5-2.2
	*c.*580-610	29	81.9	5.28	71.1-91.3	16.2	4.90	7.8-26.3	2.0	0.57	0.8-3.2
	*c.*580-650	15	78.8	11.85	47.2-97.9	19.2	11.54	1.7-50.4	1.9	0.55	0.4-2.4
	*c.*600-650	16	78.0	8.13	67.1-98	19.6	7.39	1.9-30.7	2.4	1.01	0.1-4
	*c.*600-630	79	77.3	10.11	52.2-98.1	20.2	9.82	1-45.4	2.5	0.87	0.4-4.6
	*c.*620-660	141	76.8	7.60	51.6-95.7	20.7	7.64	2.6-45.1	2.5	0.81	0.7-5
	*c.*650-680	4	26.5	20.19	8.6-49.8	70.8	19.87	47.8-89	2.7	0.62	2.3-3.6
Component	Body	20	88.3	9.07	67-98.1	10.3	8.50	1.6-30.6	1.5	1.11	0.1-3.9
	Cap	15	75.1	10.54	53.9-95.7	22.3	10.26	2.6-43.6	2.6	0.71	1.3-3.7
	Cell Wall	28	77.1	8.17	58.7-94.4	20.4	7.93	4.1-39.5	2.5	0.84	1-4.9
	Coin	8	53.6	34.85	8.6-97.8	44.0	34.33	1-89	2.4	0.80	0.9-3.6
	Sheet	170	77.3	7.18	47.2-95.6	20.2	7.22	2.3-50.4	2.5	0.79	0.9-5
	Wire	46	76.2	8.82	58.2-95.7	21.5	8.55	3.2-38.7	2.3	0.68	0.5-3.6
Types of Decoration	Cloisonné	66	78.7	6.99	65.4-95.7	18.9	6.97	2.6-32.1	2.4	0.78	0.9-5
	Cloisonné (green)	9	80.7	7.84	70.2-90.7	16.8	7.36	7.5-27.2	2.5	0.65	1.5-3.7
	Cloisonné (green) and filigree	2	80.5	3.35	78.1-82.9	16.6	3.56	14-19.1	2.9	0.21	2.8-3.1
	Cloisonné and filigree	47	78.2	9.73	58.7-98.1	19.5	9.40	1.6-39.5	2.3	0.93	0.4-5
	Coin	8	53.6	34.85	8.6-97.8	44.0	34.33	1-89	2.4	0.80	0.9-3.6
	Filigree	115	76.0	7.92	52.2-95.7	21.4	7.80	3.2-45.4	2.5	0.74	1.1-4.8
	Undecorated or engraved decoration	33	79.8	10.18	47.2-98	18.0	9.85	1.7-50.4	2.3	1.12	0.1-4.8
	Niello	7	79.4	8.92	70.3-94.4	18.6	8.48	4.1-26.8	1.9	0.65	1-2.9

Table 7. Average sub-surface or bulk alloy compositions (including standard deviation and ranges) reported by find location, function, date (based on Chris Fern's provisional dates), component and style of decoration. [1]The find location totals does not include the coins because their find location is unknown.

4. Discussion

The discussion has been divided into subsections. The first section discusses the enrichment of gold alloys, outlining the factors distinguishing deliberate from natural enrichment and defining those terms as used here. It also addresses the less common silver surface phenomena encountered on some of the objects. The rest of the discussion (Section 5) considers how the analytical results may relate to factors such as date, regional distribution, object type and function and the workshop practices.

4.1 Gold enrichment

For a given gold alloy, there is no definitive distinction between natural depletion of base metals (and consequent gold enrichment) due to corrosion processes, accidental depletion during manufacture (e.g. as a result of pickling after solder work) and deliberate depletion during manufacture (to alter the colour of the surface). A combination of all three of these factors may be taking place on any particular component, complicating the evidence further.

Corrosion of gold alloys through natural mechanisms usually only results in the depletion of copper and small quantities of silver (Hook and Needham 1989; Möller 1995). Significant depletion of silver as well as copper from the surface of a gold alloy will not take place under normal burial conditions and indicates that a chemical process has occurred, similar to that used in gold refining (Craddock 2000; La Niece 1995; Scott 1983a).

The ancient scratches analysed during this study are key to understanding the enrichment processes of the Hoard because the surfaces of these ancient scratches will have undergone the natural depletion of corrosion during burial but they are often deep enough to have cut through the original surface which may have been depleted during manufacture. Using the data gathered from a number of scratches, deliberate depletion is suggested when there is a loss of more than 10% of the silver (from the surface when compared to the core), usually there is also a significant loss of copper from the surface as well (Table 15 in appendix 2). However it was not possible to determine in every case whether the depletion seen was natural or deliberate.

The level of silver loss possible from natural depletion due to burial corrosion of gold alloys as well as the influence of copper and silver from gold solders on analytical results might be calculated from replication experiments, but without this evidence the following categories, based on the results from the objects with ancient scratches, are used in this report:

- Under 2% silver loss is natural
- Between 2%-10% silver loss is either natural or deliberate
- Above 10% silver loss is deliberate

According to the above categories, over 160 components were judged to be deliberately depleted in silver, with over 50 showing natural depletion and 24 components impossible to determine (Figure 11). The amount of enrichment varied (Figure 11) and the most enriched component was the backing sheet of K560, which had a 79% loss of silver from the surface.

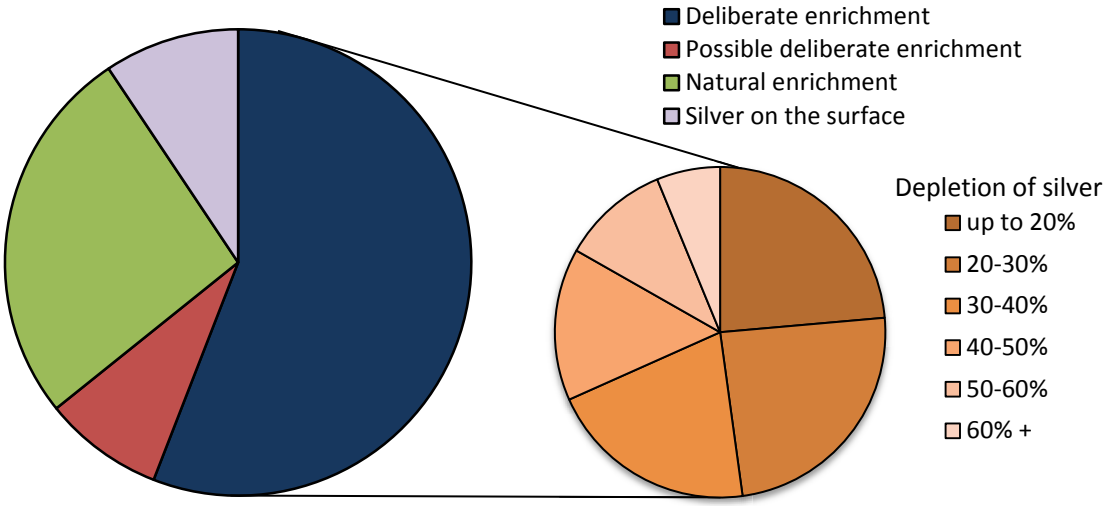


Figure 11. Pie charts showing the proportions of components that exhibit different levels of gold enrichment and the components that have enhanced silver on the surface. The chart on the right shows the level of gold enrichment seen in the components that appear to be deliberately enriched.

There appears to be a correlation between the degree of silver depletion/gold enrichment at the surface and the bulk alloy used: the scatter plot of gold enrichment against silver depletion of these Hoard items suggests that the lower the silver content the less enriched in gold the surface will be (Figure 44 in Appendix 4). The analysis has also demonstrated that it is not the completed objects that are being treated but chosen individual components that are being treated before assembly.

4.2 Silver on the surface

A number of pieces (Figure 11 and Table 17) had a higher proportion of silver present on the surface compared to the core alloy. This makes it appear that there is a loss of gold from the surface of the object which should not be possible.

One possible explanation for the apparent high silver on the surface of the beaded wires is their curved surface, as geometry factors (see Blakelock 2013 for more details) can affect the SEM-EDX analytical data. To determine whether this was the case, repeat measurements were carried out while changing the orientation of object but the increase in silver on the surface remained apparent. In some cases the presence of silver was detected across the entire object confirming that this was not an effect of geometry alone.

Analysis of a scratch from K1055 (see page 195) revealed that the enhancement in silver content was most likely to have occurred post-damage, presumably during burial, rather than during manufacturing processes such as soldering. The majority of the pieces showing elevated surface silver were found close to silver objects. This group of gold objects tend to have tarnished surfaces (Figure 12), perhaps due to a thin film of silver left by the nearby corroding objects. This therefore suggests that this apparent silver enrichment is natural re-deposition of silver on the surface due to contact with corroding silver objects. This phenomenon has also been noted on the gold of the Hoxne Late Roman Treasure (Cowell and Hook 2010).

In the small number of high-gold objects, the apparent increase in silver at the surface is within the analytical error of the SEM-EDX. It could also be due to minor inhomogeneity in composition within the object itself.

a) b)

Figure 12. Dark tarnish on the surfaces of a) K292 (scale bar 5 mm) and b) K545 (scale bar 5 mm), both of which had increased silver on the surface.

5. Gold alloy choices: discussion of composition and surface enrichment

5.1 Changes through time

5.1a Coinage

Williams and Hook (2013) carried out specific gravity measurements and sub-surface XRF analysis of coins which are roughly contemporary with the Staffordshire Hoard. It is clear from this study that there was an overall decline in the gold and corresponding rise in silver content of the coinage examined over time (Figure 4). This conclusion is supported by the Kruskal-Wallis test for sample independence which revealed that there were statistical differences between the time phases. Unfortunately, significant overlap in the composition of coins throughout the period makes it impossible to date individual items by their gold/silver ratio (Figure 4 and Figure 13).

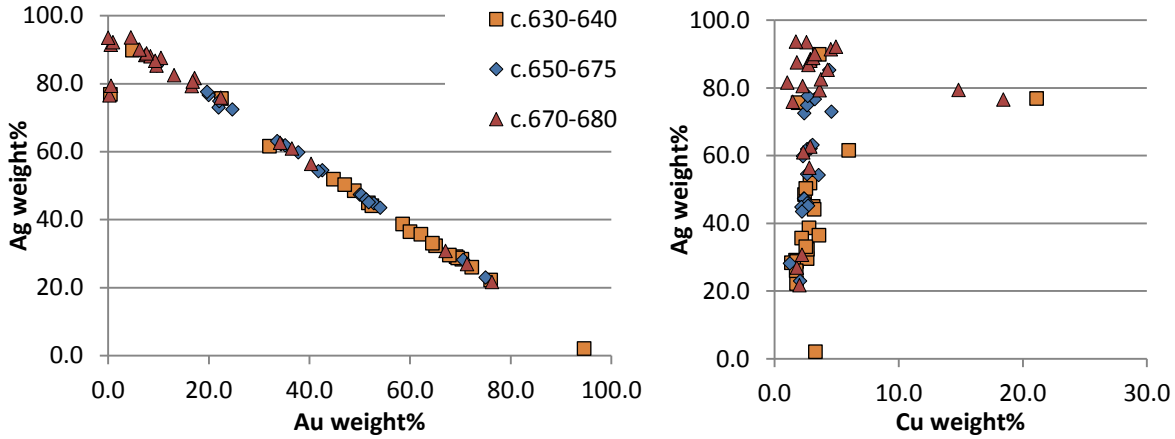


Figure 13. Plots of gold *vs* silver and copper *vs* silver contents of coins from the sub-surface XRF analysis carried out by Williams and Hook (2013).

Furthermore, there is evidence for surface enrichment of gold coins during this period. The sub-surface and surface analysis of six Anglo-Saxon coins showed (Figure 14) that there was enrichment present (Blakelock and Hook 2014). As shown in the initial pilot study, surface enrichment is likely to influence surface XRF results. Similarly, it should be noted

that the surface colour of a coin cannot be used to estimate the gold content (see section 5.2 below). This can only be determined by sub-surface element analysis.

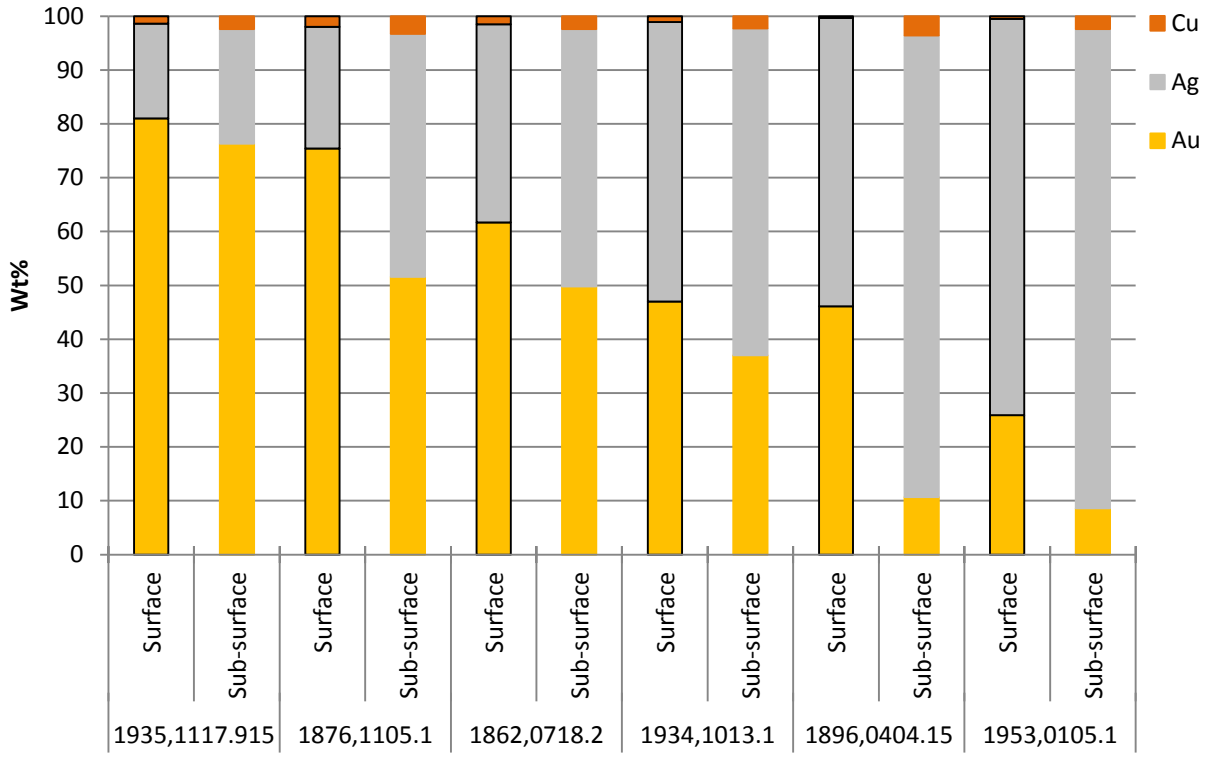


Figure 14. The surface and sub-surface results from the analysis of six coins from the British Museum (Blakelock and Hook 2014).

5.1b Anglo-Saxon objects

Only pieces which have been allocated to a specific phase by Fern are included in this section of the discussion (Figure 15). This therefore excludes many of the hilt-plates from the Hoard that have no decoration and therefore cannot be dated on stylistic grounds. The box and whisker plot of the analytical data (Figure 16) indicates a slight trend of decreasing gold and rise in silver content over time but there is considerable overlap in composition of the objects from the Hoard period. This was confirmed by the Kruskal-Wallis test for sample independence: when all dated objects are included, statistical differences are evident. When only objects dated between *c.*600-660 (Fern phases C1, C2, D1 and D2) are considered there is a 53% probability that the distribution of gold is the same across the four phases, 46% probability for silver and 94% probability for copper.

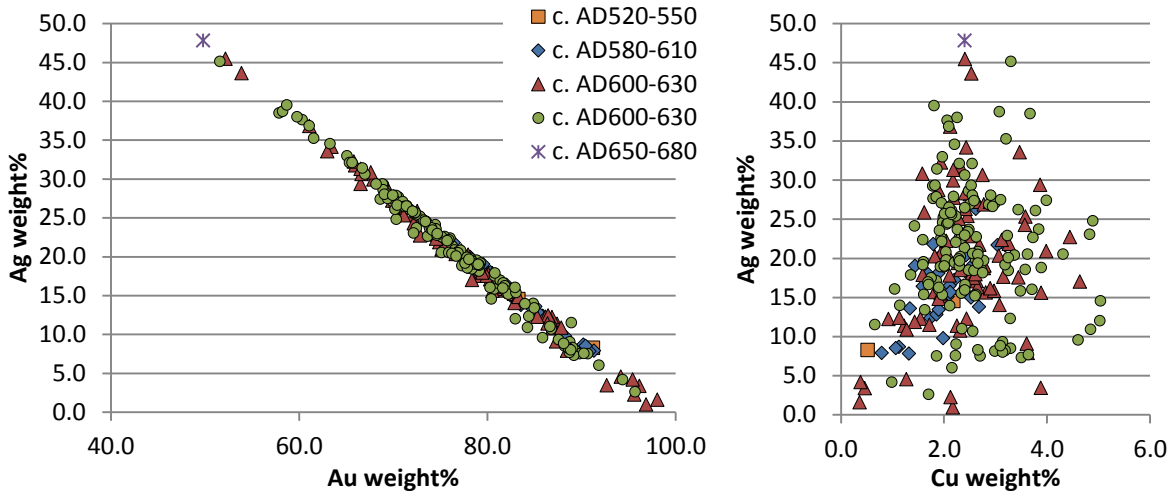


Figure 15. Plots of gold *vs* silver and copper *vs* silver contents of Staffordshire Hoard and British Museum Anglo-Saxon objects that could be firmly placed in a date range; this also excludes three of the four higher silver coins (which can be seen in Figure 45 in Appendix 4).

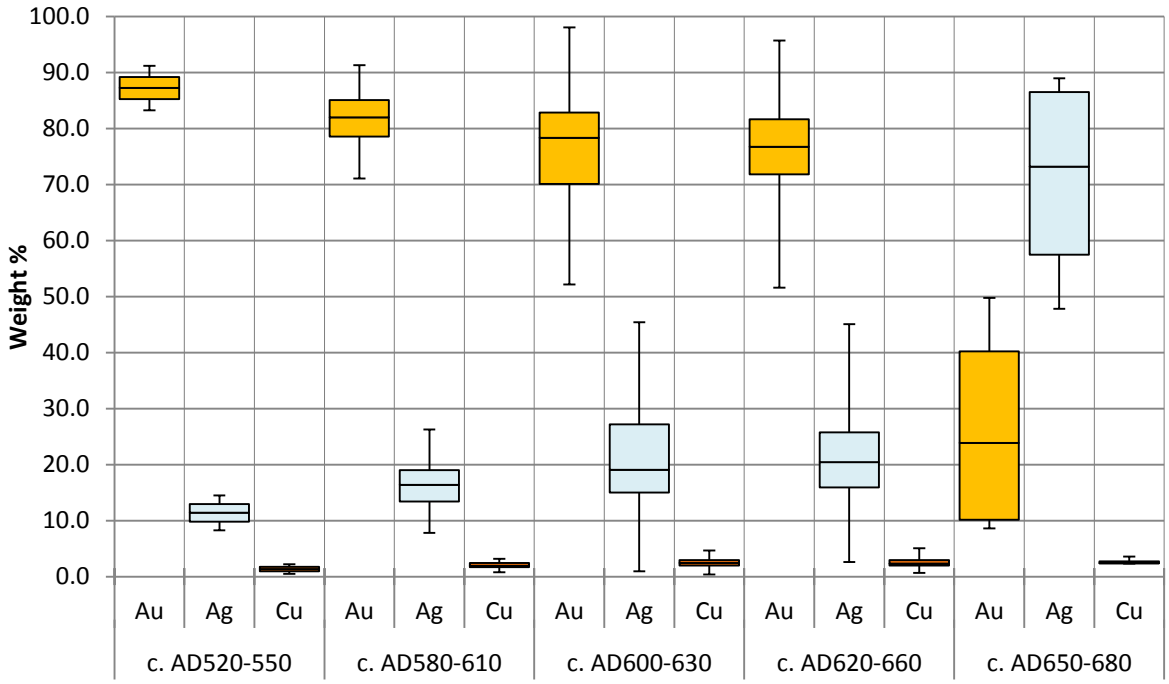


Figure 16. Box and whisker plot showing a slight decline in gold content and rise in silver content between c. AD520-660 for all the Staffordshire Hoard and British Museum Anglo-Saxon objects that could be firmly placed in a phase, although the whiskers of the plots show that there is considerable overlap between phases. In the final phase there is a more distinctive change to higher silver alloys.

To exclude the influence of varying function of different components, e.g. where alloys may have been chosen for specific tasks, data obtained from only the sheets were plotted (Figure 17). No significant decline in gold content over time can be seen. The data from sheets also confirmed a similar trend to that seen for all of the objects suggesting that there is compositional overlap between all the periods. When the data from the object sheets dated between *c.*AD600-660 where tested using the Kruskal-Wallis test for sample independence it demonstrated that all of the compositions were statistically similar (Figure 17). The test also indicated a real, but very slight, difference in gold and silver contents in the objects dated before *c.*AD600 (Figure 17) but again there is significant overlap in compositions.

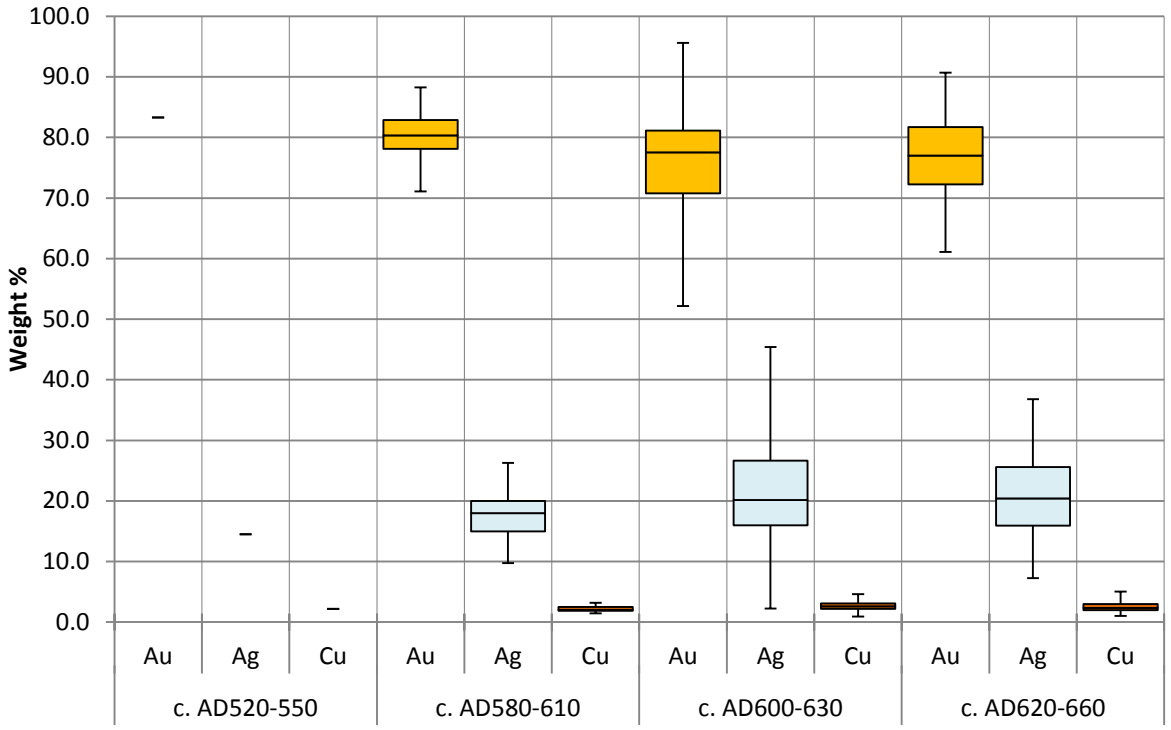


Figure 17. Box and whisker plot showing no significant decline in gold content of the sub-surface of the sheets through time. The whiskers of the plots show that there is considerable overlap between phases.

When the surface (rather than the sub-surface or bulk alloy) composition is considered (Figure 18 and Figure 19), there is also no observable decline in gold content over time; instead all the object components again overlap and form a single group. This is also the case when only the gold sheets are considered (Figure 47 in Appendix 4). The Kruskal-Wallis test for sample independence suggested that between *c.*AD600-650 there is an 81% probability that the distribution of gold is similar (from the same population) across the three phases, and 51% probability for silver.

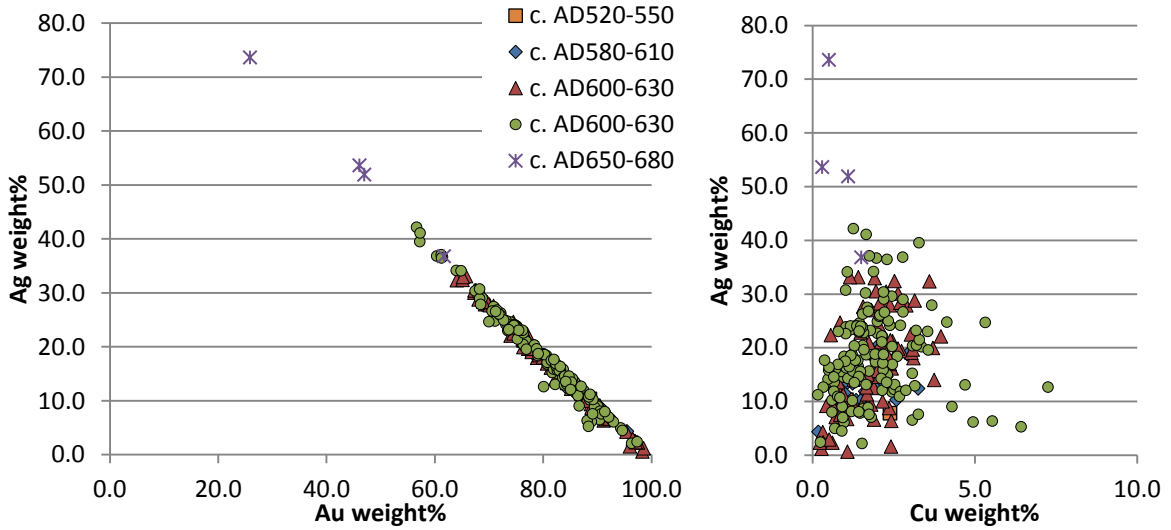


Figure 18. Plots of gold *vs* silver and copper *vs* silver contents of the surface of Staffordshire Hoard and British Museum Anglo-Saxon objects that could be placed in a time phase.

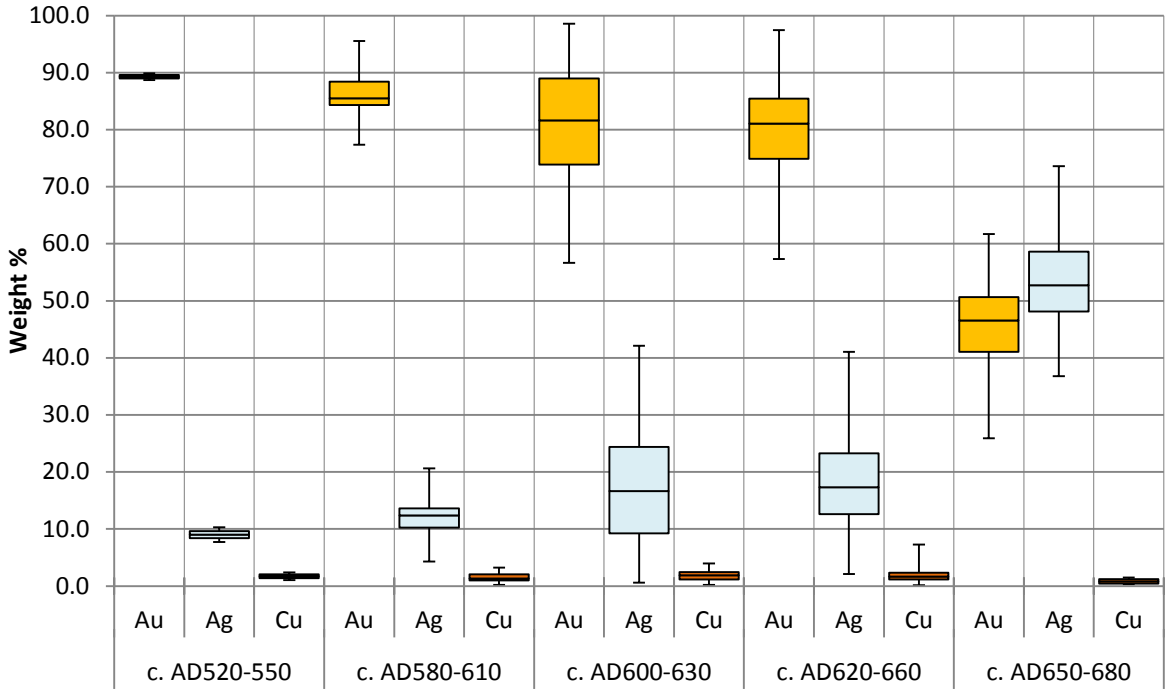


Figure 19. Box and whisker plot showing a slight decline in gold content and rise in silver content on the surface of the objects over time, for all the Staffordshire Hoard and British Museum Anglo-Saxon objects that could be placed in a time phase, although the whiskers of the plots show that there is considerable overlap between phases.

Finally the levels of enrichment on the surface of the objects were plotted over time (Figure 20 and Figure 46 in Appendix 4). The data suggests there were no obvious changes in surface enrichment preferences through time which may suggest a continuing desire for an enhanced golden appearance, also suggested by the consistent surface composition.

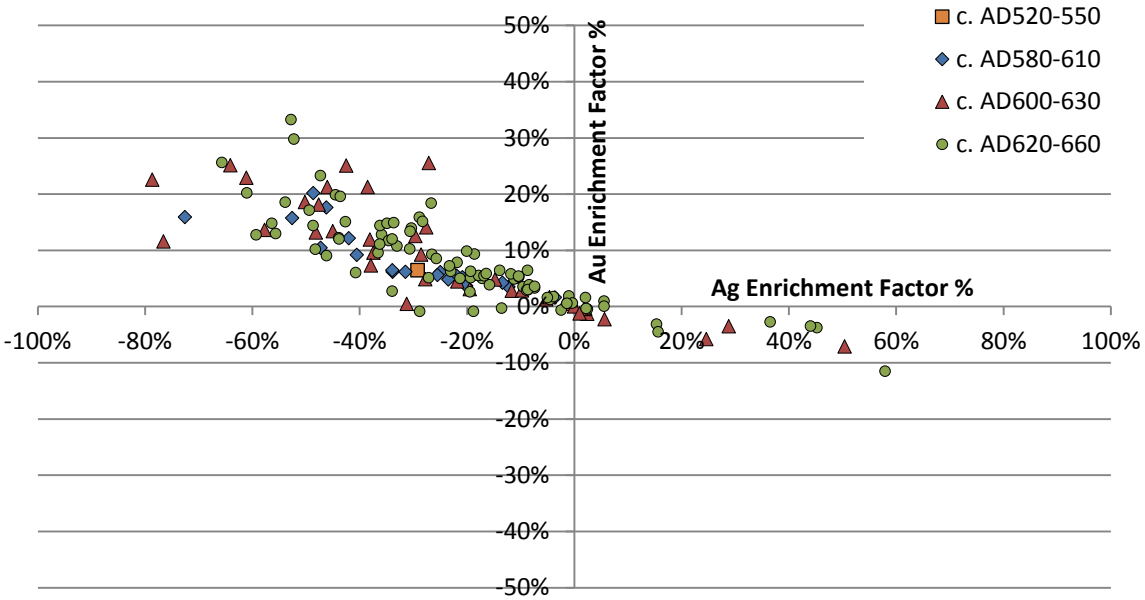


Figure 20. Plot showing the levels of gold enrichment and silver depletion in the sheets over time. The plot for all components over time is Figure 46 and is included in Appendix 4.

5.1c Summary

In summary, there appears to be a decrease in gold, and corresponding increase in silver, content of Anglo-Saxon coinage over time, but there is substantial compositional overlap between periods. For other object types, there is no such change in gold composition, particularly during the period of the Staffordshire Hoard. The few analysed objects that date before *c*.AD600 are slightly higher in gold content, but the compositions overlap with those of later objects so it is impossible to differentiate between early and later objects. There is also no clear relationship between surface composition, or level of enrichment, and time. This study has shown that it is not feasible to use the gold content to date the Staffordshire Hoard objects and therefore traditional techniques based on stylistic designs are likely to be more fruitful.

As there is no distinctive change in composition over time, all the objects, including the hilt-plates, will be included in the discussions in the following sections, with the exception of the Roman coin and the four Anglo-Saxon coins that post-date the Hoard.

5.2 Gold composition and colour

Surface colour has sometimes been used as an indicator of the composition of gold objects and to assist in classifying pieces, but there are no published results supporting this theory. The data collected during this study was used to test whether this is a valid methodology. Colour categories were assigned to the sub-group of pommels by Fern, and the sub-surface and surface compositions of these objects were compared. The 'yellow gold' objects generally had a higher gold content but the other colour categories proved to be similar in composition (Figure 21, Figure 48, and Figure 49 and Figure 50 in Appendix 4). Therefore it is concluded that it is not possible to use the surface colour, as observed with the naked eye, to determine composition. If the enrichment factors are compared to the colour categories, this reveals that the pieces that were 'yellow gold' objects were generally more enriched. This might suggest that the objects that now appear more golden may in fact just be those pieces that had been more burnished (see section 1.2). Conservation methods may also impact on surface appearance.

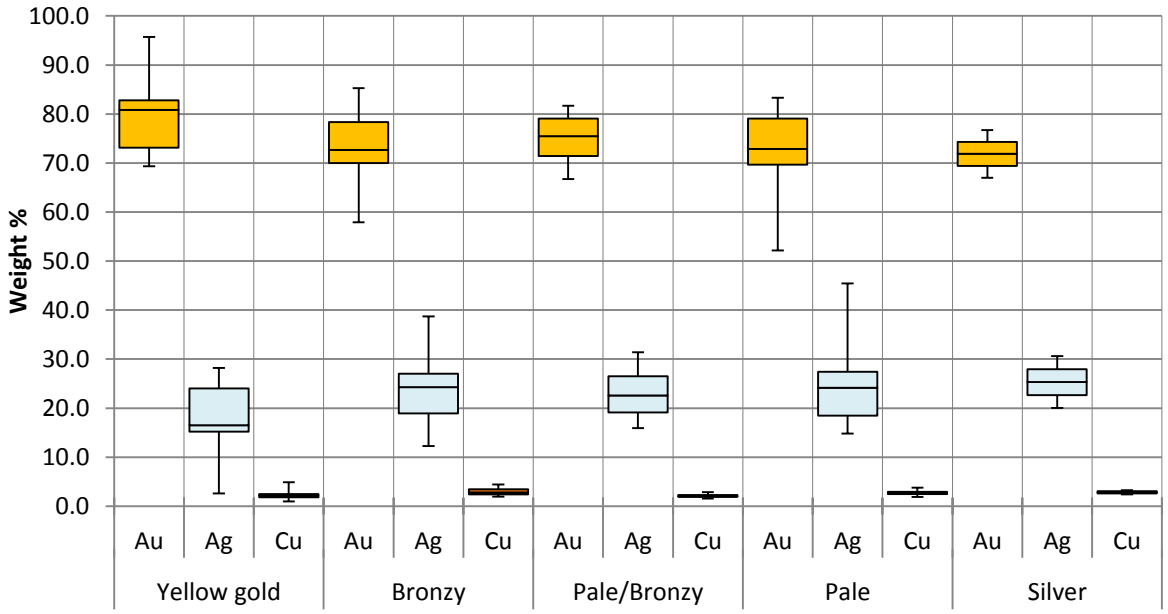


Figure 21. Box and whisker plots showing the sub-surface compositions of pommels categorised by colour, showing the considerable overlap between the groups.

The colour of the pieces as seen today will not be the same as the colour seen by the goldsmith and original owner in the past. The very high gold pieces, like the snakes (K128 and K816) and pommel (K358), are likely to have changed less in colour as they reveal only slight enrichment due to corrosion. However many of the pieces have lost a significant proportion of copper during burial which will have affected the surface colour now observed. Some objects have a thin film of silver which is thought to be due to contact with corroding silver in the burial environment (see above). In some cases this was identified during the analysis, i.e. high enrichment of silver on some objects but in other cases it is less obvious.

Figure 22. Colour differences between pieces of the same hilt-collar (photo taken by Chris Fern).

An example of the danger of using colour to classify objects was noted during the Staffordshire Hoard grouping exercise. Several pieces from the same object were identified based on style and physical joins but some appeared tarnished while others retained their golden colour (Figure 22). This is most likely due to differing burial environment and the proximity of some of the pieces to silver objects.

While the exact colour seen by the original owners can no longer be observed today, the contrasting gold colours between the backing sheets and their applied decoration are today visible on many of the pieces (Figure 23). Changes due to post-depositional processes are unlikely to cause this, as the burial environment will affect all components on a single piece equally. Instead these colour contrasts can be attributed to workshop practice discussed below (section 5.5). The use of contrasting colours was exploited in Anglo-Saxon design, for example red, white and blue inlays in many designs. The use of different gold alloys and treatments may have also been chosen by the goldsmith.

Figure 23. Colour contrast between the cap, wires and backing sheet of K88 (scale bar 10 mm).

5.3 Find location and regional grouping

To determine whether there were any compositional groups based on find locations, the sub-surface compositional data for the Staffordshire Hoard and the British Museum objects analysed were plotted against find location The find location does not represent the manufacture location, which is unknown. Some find locations are represented by only one piece or set.

Using the gold composition and find location it is not possible to distinguish workshops. The box and whisker plot (Figure 24) and binary diagram (Figure 51 in Appendix 4) revealed only one distinctive group, the objects from Suffolk. This was confirmed by using the Kruskal-Wallis test for sample independence which suggested that there are statistical differences when the Suffolk objects were included but that the remaining find locations were likely to be from similar populations. The objects in the Suffolk group include the Sutton Hoo shoulder clasps (1939,1010.4 and 1939,1010.5) and gold buckle (1939,1010.1) from Mound 1. The alloy used in the shoulder clasps and the buckle have a high gold content (Blakelock 2014c). That this is not representative of other Anglo-Saxon objects from Suffolk, is suggested by surface XRF analysis of objects for the Treasure process[9] which confirms that the majority of objects found in Suffolk have a range of compositions closer to those seen in the Staffordshire Hoard than to the Sutton Hoo finds.

There was no relationship between find location and the enrichment factor (Figure 52 in Appendix 4), which suggests that deliberate surface treatment was being carried out in workshops across the country and it is unlikely to be linked to any one workshop.

[9] Surface XRF analysis of Treasure items is occasionally carried out at the British Museum to assist during the assessment and valuation process. For more details visit http://finds.org.uk/treasure.

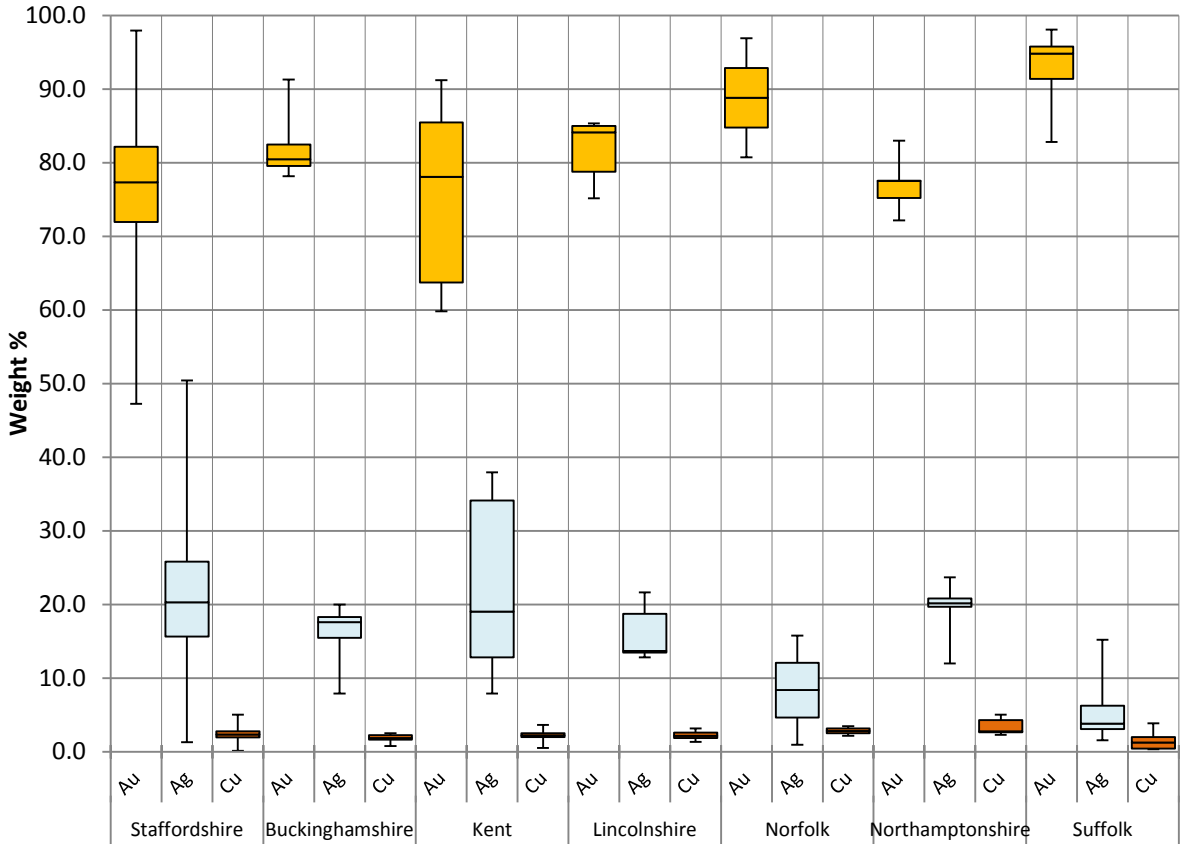


Figure 24. Box and whisker plots of sub-surface compositions by find location, excluding the single objects from North Yorkshire and Cumberland.

5.4 Object type and function

5.4a Functional groups

The Staffordshire Hoard consists predominately of military fitments, but there are a number of decorative mounts and a few Christian objects in the assemblage. Pieces from the British Museum were chosen to provide comparanda of functional groups not present in the Hoard itself. The core alloy composition and degree of surface enrichment was compared for each type of object.

There are few distinctive compositional groups based on object function (Figure 25 and Figure 53 in Appendix 4). Different types of sword fittings also demonstrated an overlap in composition (Figure 55 in Appendix 4). The different types of mounts, i.e. animal mounts, hilt mounts or strip mounts, were also compared to determine whether there was any relationship to composition no clear pattern was revealed (Figure 56 in Appendix 4). There was also no difference seen in the degree of enrichment of any of the functional groups (Figure 54 in Appendix 4).

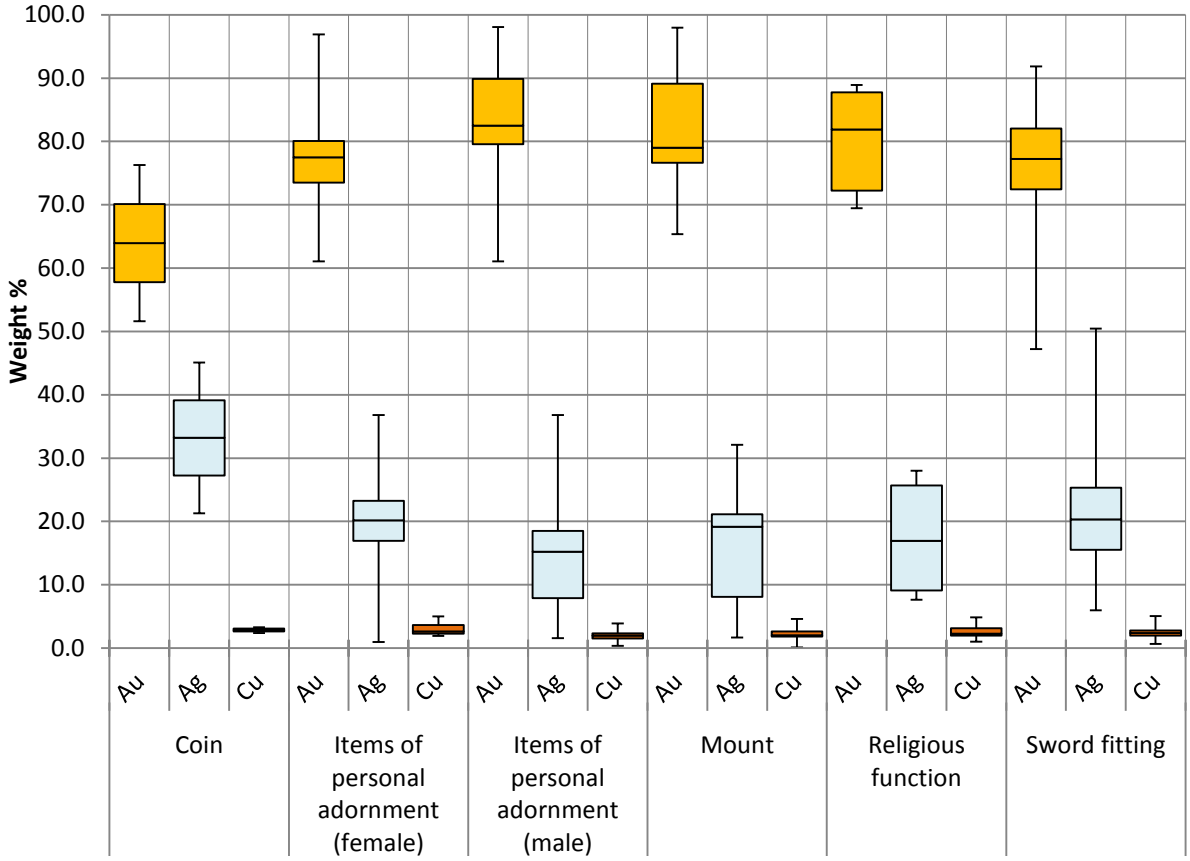


Figure 25. Box and whisker plots for the sub-surface data for sheets and bodies sorted by the major functional groups. The sword fittings include hilt-plates, hilt-collars/rings, pommels, sword mounts and sword pyramids.

A number of Christian objects were identified in the Staffordshire Hoard (Figure 26), and a number of pieces from the British Museum's collection also have connections with Christianity. Comparison between these objects and the secular items analysed revealed no differences in the core alloy chosen (Figure 27 and Figure 57 in Appendix 4). There was also no difference seen in the amount of enrichment (Figure 58 in Appendix 4). The 'mystery object' has been attributed to a priestly head-ornament (Hilts *et al.* 2014) but due to the overlap between the two groups it is not possible to assign this object as Christian or secular based on the gold composition.

a) b)

Figure 26. Christian crosses have been identified on a number of objects including a) K465 (scale bar 5 mm), b) the pectoral cross K303 (scale bar 5 mm).

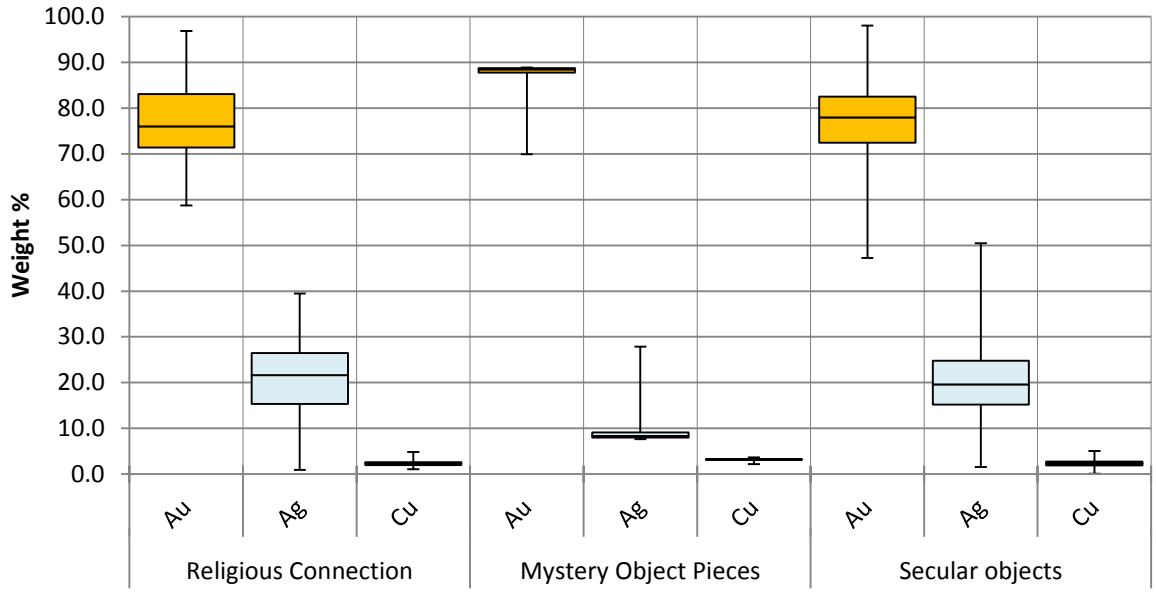


Figure 27. Box and whisker plots of sub-surface compositions showing the similarities between religious and secular objects.

5.4b Male vs female personal adornment

Another consideration is the difference between items of personal adornment associated with males and females. Classification of objects by gender is fraught with difficulty, but skeletons, whose sex can be determined, found with particular types of grave goods provide a clue to the gender of the owner of some of the pieces in this study. The Staffordshire Hoard has relatively few personal dress items, with the exception of buckle K685, so a number of contemporary male and female dress items were selected from the British Museum's collection. In addition, a garnet pendant (2006.LH.67) found in Staffordshire was also included in the study.

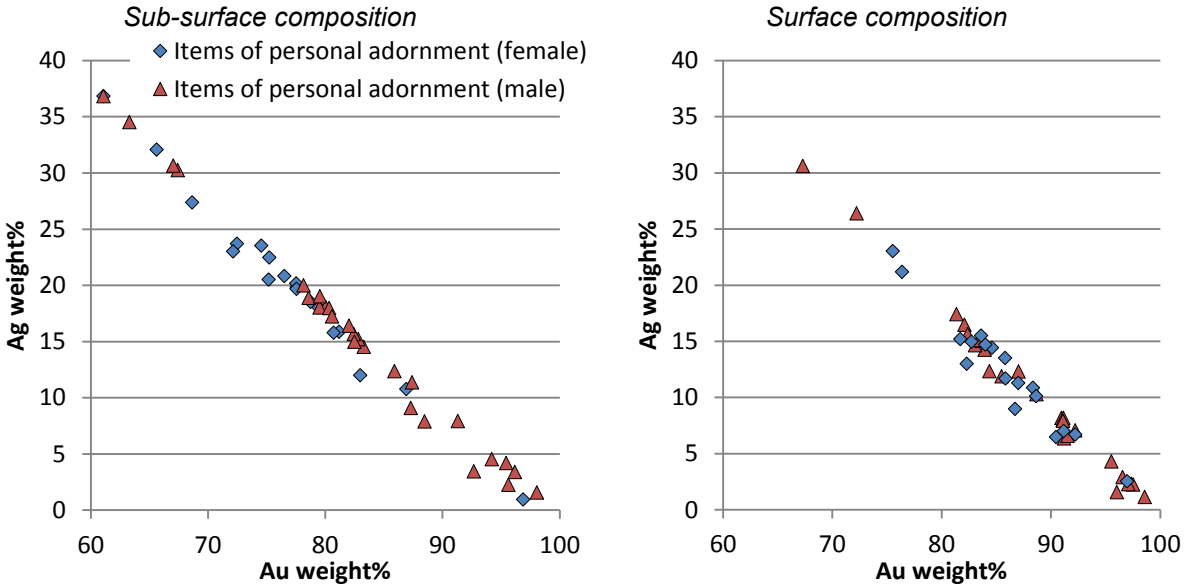


Figure 28. Plots of gold *vs* silver contents, showing the difference between the sub-surface and surface compositions of the male and female decorative items (Figure 59 and Figure 60 in Appendix 4).

The analysis revealed a general distinction between the male and female items of personal adornment (Figure 28). The male buckles and clasps tended to have higher core gold

content than the female pendants, but also than the majority of sword fittings from the Hoard. This is a factor that would benefit from further investigation. The Sutton Hoo items (very high status male pieces) were removed from the dataset to determine whether they were biasing the results but still the pattern remained, even if these were excluded.

There was also a difference in the types of objects being surface treated. With some exceptions the female accessories were more often surface treated than the male items (Figure 29). When the surface compositions were compared it became apparent that the majority plotted together (Figure 28), suggesting it would have been difficult to visually distinguish male from female pieces.

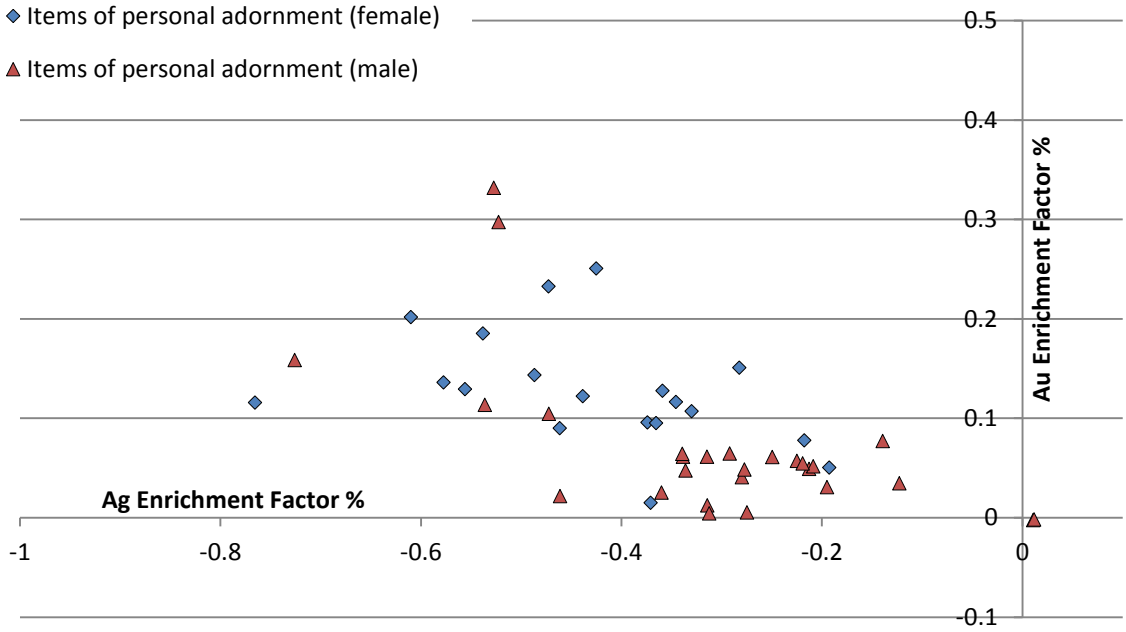


Figure 29. Plot showing the levels of gold enrichment and silver depletion in the sheets used in the male and female items.

5.5 Workshop practice

5.5a Components

During this study, the surface and sub-surface of 288 object components were analysed. The analysis of the components revealed that there was no distinctive core composition for the majority of individual component types. There is overlap between the core composition for sheets, wires and cell walls (Figure 30 and Figure 61). Thus, there appears to be no particular selection of gold alloys for their different working properties (Figure 30). The majority of the components fall within the alloy range that modern goldsmiths prefer for replicating filigree wires (Whitfield 1998, 60). The only exceptions were the components that were cast or had a solid body, which often had a higher gold content than other components analysed.

When the enrichment factor was examined for each component it was clear that the majority of sheets were being enriched (Table 8, Figure 31 and Figure 32). It is also clear that the other components were not being surface treated in the same way. This could be related to the method used to enrich the surface; a flat sheet once hammered from a cast ingot would provide an excellent surface to be treated using the cementation process and subsequent burnishing. By contrast, wires with their irregular surface would have been more difficult to treat, especially once beaded, and burnish to achieve a consistent enrichment. This does not, however, explain the differences in enrichment seen between sheets, cell walls and the

sheets that form the caps of pommels. Therefore it is likely this was an aesthetic choice made by the goldsmith, perhaps on the basis of colour.

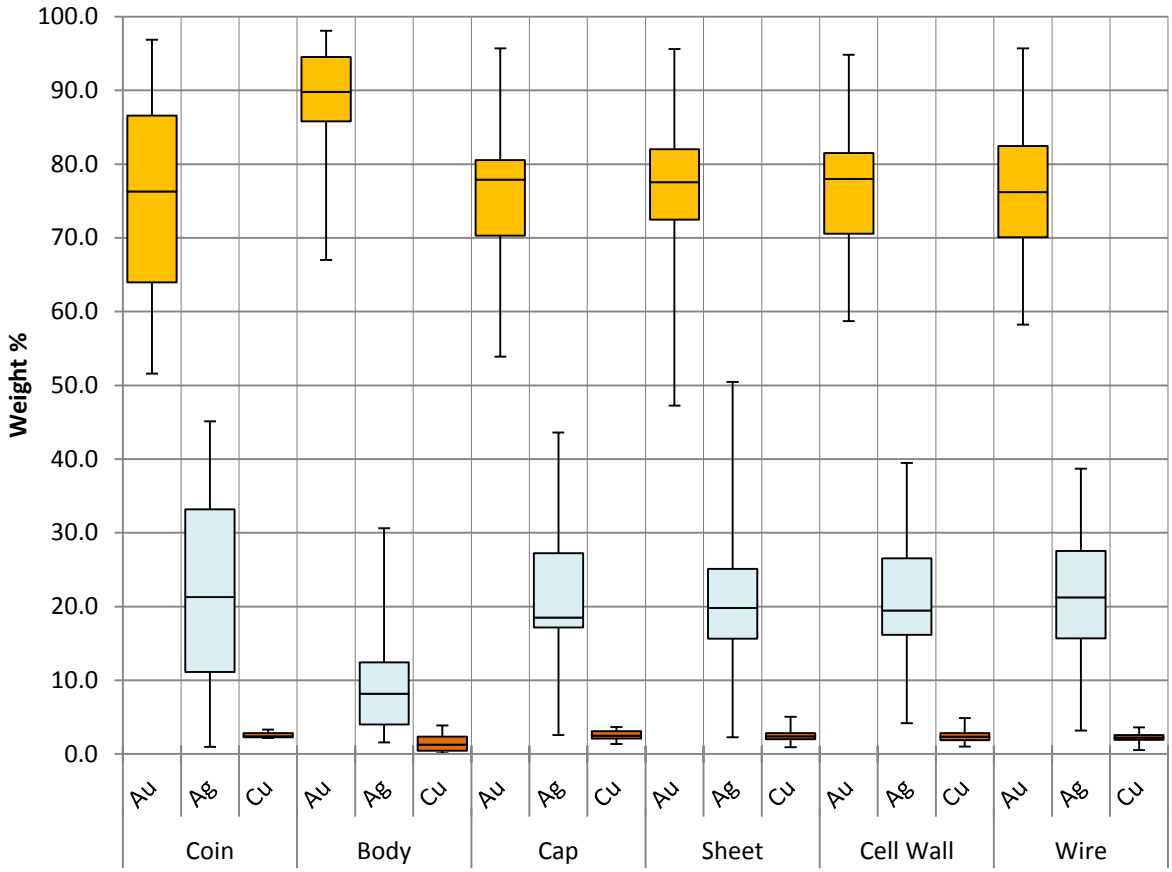


Figure 30. Box and whisker plots of sub-surface compositions demonstrating the overlap between different types of components. The exception are the body components that have a higher gold content.

	Total number	Number of components			
		Natural enrichment	Silver at the surface	Possible deliberate enrichment	Deliberate enrichment
Body	20	6	5		9
Cap	15	5	4	1	5
Cell Wall	28	12	9	2	5
Sheet	171	18	9	17	127
Wire	46	19	15	4	8

Table 8. The types of enrichment detected in the components

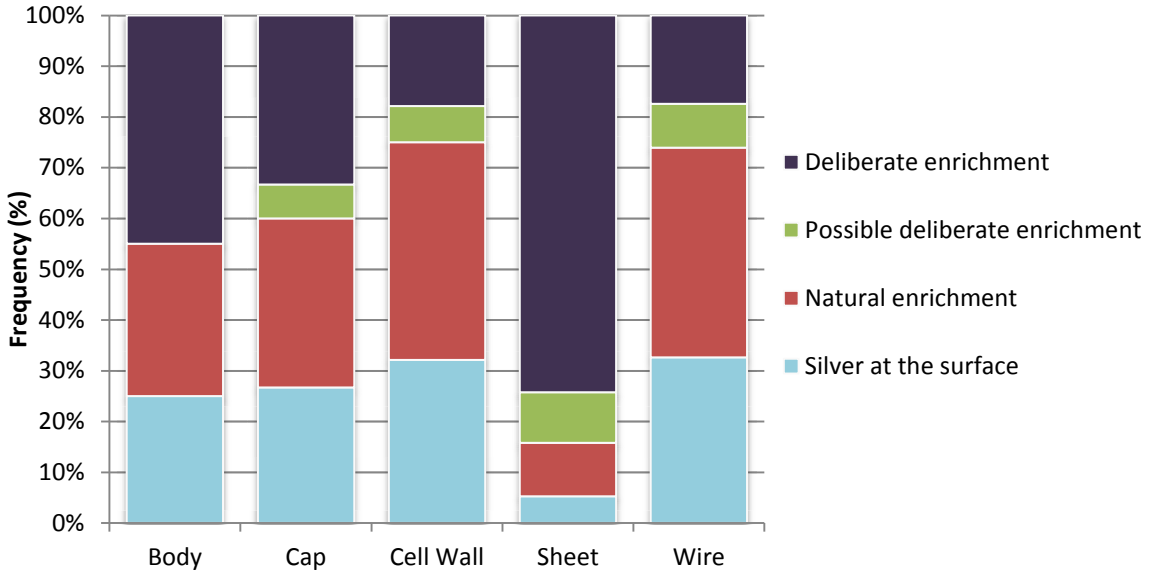


Figure 31. Percentage of components that have been deliberately enriched compared to those with natural enrichment and contamination from silver in the burial environment.

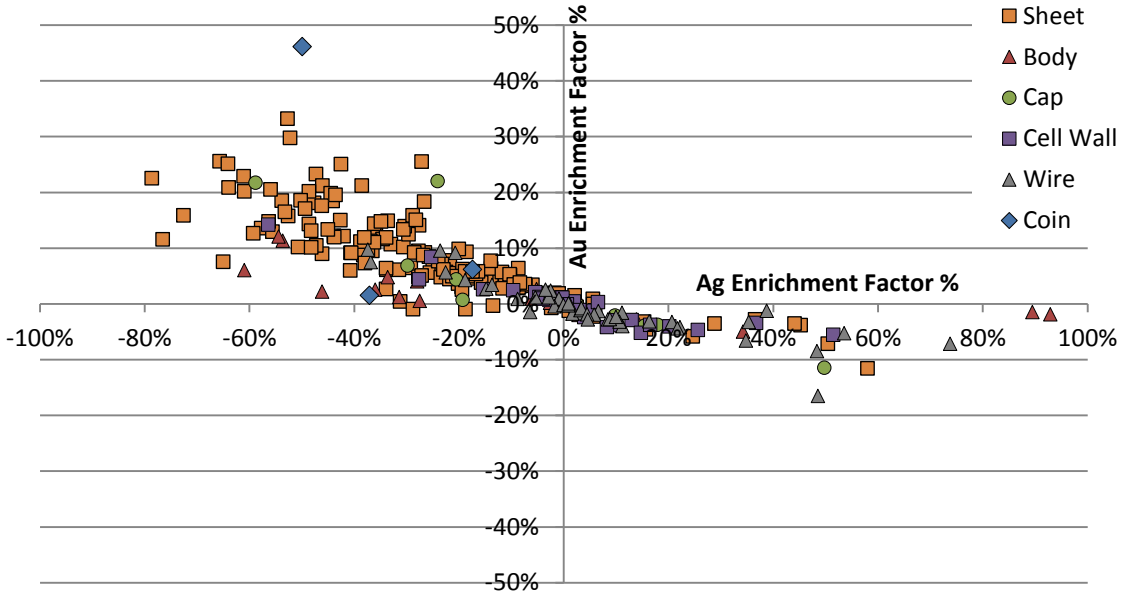


Figure 32. Levels of gold enrichment and silver depletion by component types.

An example of the types of decisions made by the goldsmith can be seen in pommel cap K88 (Figure 23). The analysis of the core alloys of all the components suggest they may be from the same gold alloy source (Figure 33). The sheet has been deliberately treated separately before being incorporated into the pommel whereas the wires and the cap were not treated. This created a colour contrast between the wires and the backing sheet. As all the components started with the same core alloy composition it is most likely that the enrichment of the sheet occurred in the same workshop during construction of the piece.

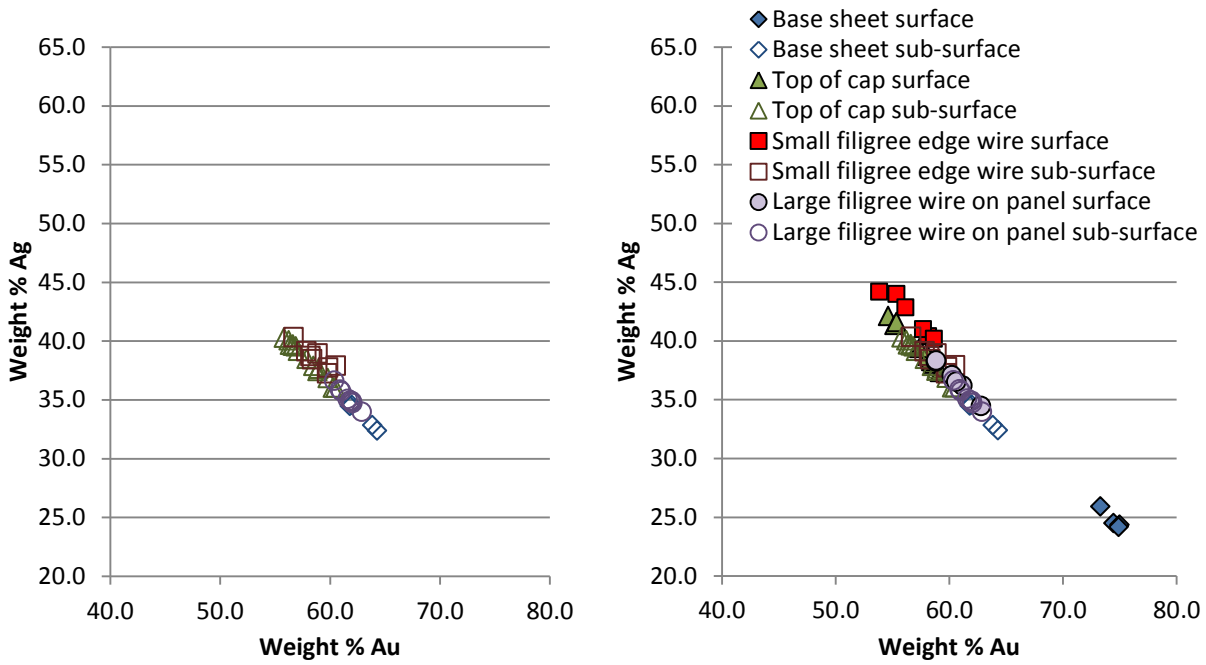


Figure 33. Plots of gold *vs* silver contents of different component types, determined by SEM-EDX analysis, for K88, left) sub-surface core analyses and right) surface and sub-surface analyses of all the components showing the enrichment of the backing sheet.

Pommel cap K697 is very similar in construction to K88 but its components are of different alloys (Figure 34). The same decisions and type of treatment has been carried out on the components of both, with the backing sheet treated but not the wires. In this case however, only a small contrast in colour would have been visible between the sheet, wires and cap. The different compositions of the components does not seem to relate to the physical properties required for manufacture, instead they may simply be the alloys available in the workshop, and perhaps point to the recycling of gold.

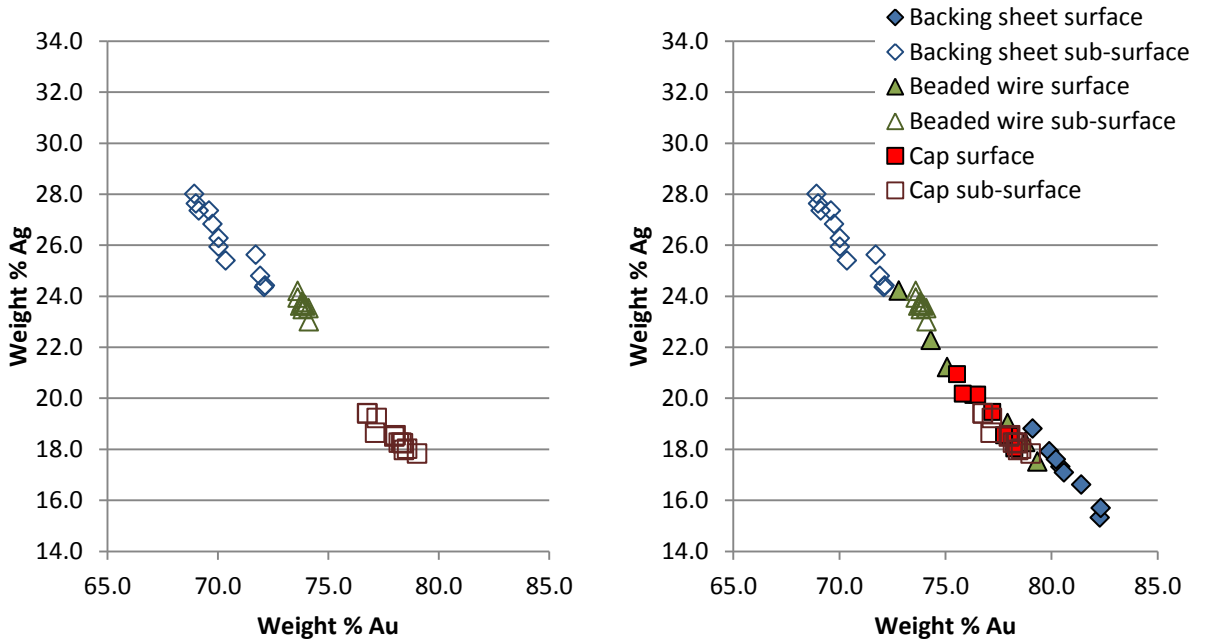


Figure 34. Plots of gold *vs* silver contents of different component types, determined by SEM-EDX analysis, for K697, left) sub-surface core analyses and right) surface and sub-surface analyses of all the components showing the enrichment of the backing sheet.

The pommel K358 was cast and has an inset gold and niello panel. Between this panel and the main body there is a gold alloy frame (Figure 35). Analysis of the cast gold body revealed that it was a similar alloy to the gold used for the niello panel, although it had

a slightly higher copper content (Figure 36). The main difference between the two components was that the body of the piece had been treated to remove the silver from the surface, but the panel does not appear to have been treated. The frame surrounding the gold and niello panel is a different gold alloy, which is higher in silver, and has not been treated. This again creates a colour contrast between the three components and the niello inlay.

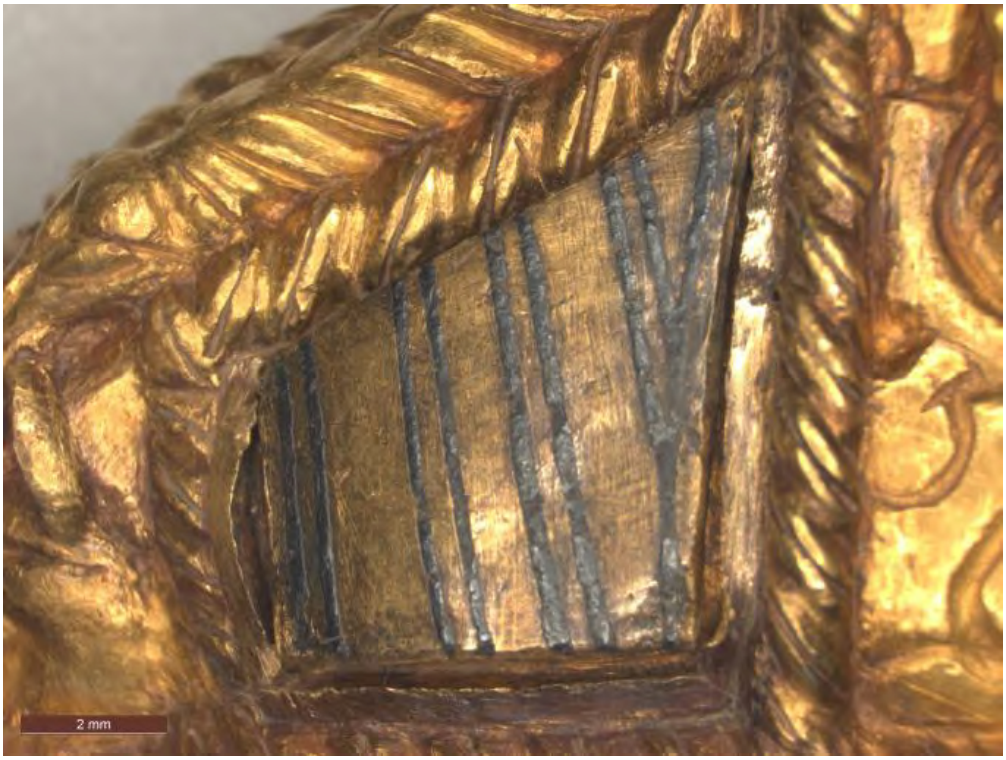


Figure 35. K358: cast body with inset gold and niello panel with surrounding gold frame (scale bar 2 mm).

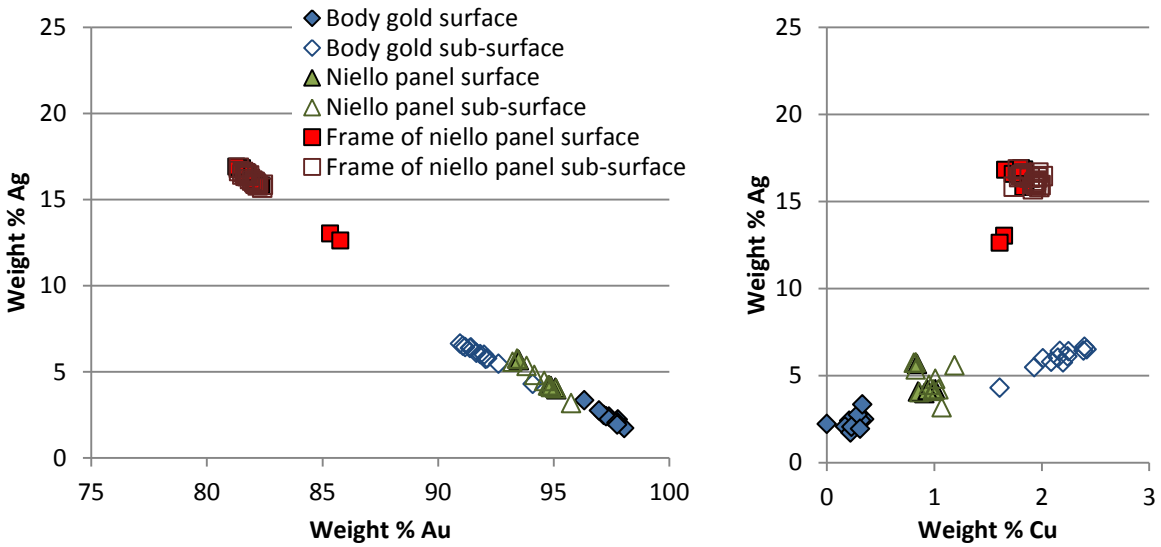


Figure 36. Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, for different components of K358 showing the differences between the sub-surface and surface analyses.

5.5b Types of decoration

Objects with different types of decoration were analysed to determine whether this was related to the composition of the alloy or the extent of enrichment. For this comparison only the sheets used in object construction were considered. This comparison based on decoration type revealed that there was no difference between the core composition of the sheets (Figure 37 and Figure 62). When the enrichment factors are plotted (Figure 38) it is revealed that, in general the sheets on the filigree decorated objects, as well as undecorated or engraved sheets, where more often enriched. This may be explained by the fact that these sheets would have been visible in the finished object whereas the sheets behind cloisonné work would have been concealed by the applied decoration.

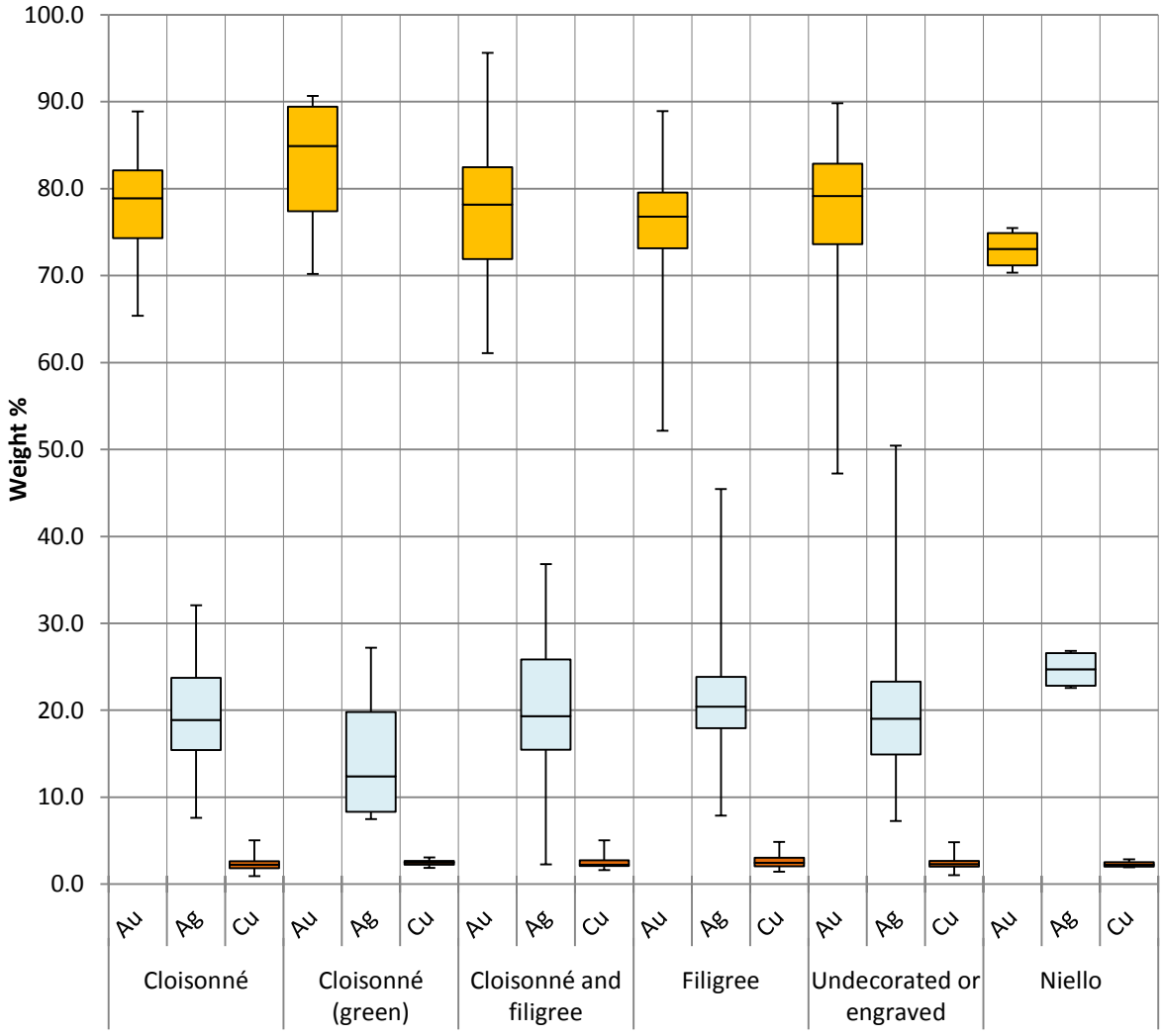


Figure 37. Box and whisker plots of sub-surface compositions of the sheets used in pieces with different types of decoration.

The sheets inlaid with niello were not enriched in gold, and instead tended to have higher levels of silver on the surface. This is most likely contamination from the silver sulphide niello inlay (La Niece 2013). The goldsmith would have cleaned the surface of the gold, but some traces of silver can remain on the surface.

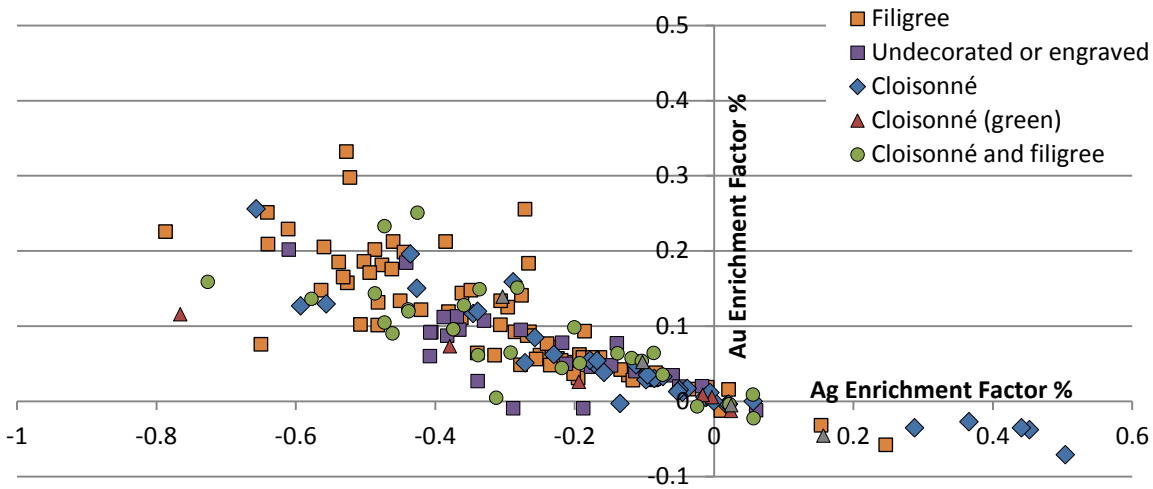


Figure 38. Levels of gold enrichment and silver depletion of the sheets used in pieces with different types of decoration.

5.5c Complex objects and sets

A number of objects were found together as pairs or sets. Each of these sets was examined to determine whether they were constructed from the same gold alloy. There is no agreed method for determining whether a gold alloy is from the same source, particularly when relying on bulk elements alone, so any potential similarities discussed in this section or in the in individual object results (Appendix 3) would need to be tested using other analytical methods. It has already been noted (section 5.5a) that in many cases there are distinct differences between the alloys chosen for different components within the same object. This was most often due to choices made by the goldsmith, perhaps to achieve a specific appearance, or indicating changes and modifications to a piece, but this may also reflect other practical reasons.

Faversham buckles (.1094.'70 and .1094.a.'70)
These buckles are constructed of gold sheets with filigree decoration applied. Both of the base sheets have a similar alloy composition although the level of enrichment is slightly different (Blakelock 2014e).

Taplow clasps (1883,1214.2 and 1883,1214.3)
The pair of Taplow clasps consists of two sub-triangular plates, one of which has an eye while the other had a loop. These are constructed of gold sheets wrapped around a copper alloy core: the front sheet is repoussé with applied filigree decoration. All four pieces share similar sub-surface compositions although there is a larger range of compositions (*c.*78.1–82.0 wt% gold, 16.4–20.0 wt% silver, 1.6–2.5 wt% copper) compared to the buckles mentioned above. There is a slight increase in the copper content of the front and back sheets, which may be due to differences in gold alloys used by the goldsmith (Blakelock 2014d).

Sutton Hoo shoulder clasps (1939,1010.4, 1939,1010.4a, 1939,1010.5 and 1939,1010.5a)
The Sutton Hoo shoulder clasps consist of four near identical parts, inlaid with garnet and glass cloisonné and filigree panels. The gold alloy of the four pieces is not the same; one piece contains *c.*4–5 wt% copper while the other three only had up to 1 wt% copper present. This suggests that they may have all been made from different melts, perhaps not surprising in view of the quantity of gold needed for each of the four components (each weight between 87.8–106.1 grams including inlays). All had been surface treated to yield approximately the same surface composition (Blakelock 2014c).

Gold eagles and fish mount (K652)
The analysis of the sheets making up the gold eagles and fish mount (K652) revealed that the front engraved and plain back sheets are distinctive from the sheets used to fill the gaps. The sheet used to fill the gaps may be a later modification (see page 156), although all have been treated so that the surface composition is similar.

Great Cross (K655-659)
The construction of the cross is unusual, with an engraved front face reinforced by a separate, undecorated sheet of gold on the back. Attached to the front of the cross are cabochon garnet settings. The gem settings are of a different composition to the sheets used to form the cross and the front sheet has been surface treated (Blakelock 2014b).

The 'mystery' object (K130, K545 and K1055)
The use of lower gold alloys where the component is hidden was noted in the 'mystery' object (K130, K545 and K1055), where all the sheets in all three pieces analysed had a similar core composition but the wire used to support the circumference of the stud (K545) was a higher silver alloy. This would originally not have been visible from the outside (Blakelock 2014a).

Desborough necklace (1876,0504.1)
The analysis of several pendants from the Desborough necklace revealed that few are similar to each other. The largest garnet pendant is distinctive in composition and form, and the bullae are also different in composition to all the garnet pendants analysed (Blakelock 2014f). The necklace is made up using pendants and bullae from at least two different sources and was probably assembled in the second half of the seventh century (Webster and Backhouse 1991, 28-29).

Market Rasen sword hilt (2006,1001.1.a-e)
The Market Rasen sword hilt has a pommel and two hilt collars that have a similar alloy composition but the two hilt-plates are distinctively different and may have been later replacements or modifications (Blakelock 2014h).

Seax set (K376, K354, K690, K370 and K449)
The analysis of the Staffordshire Hoard seax set revealed that the pommel had a different composition to the rest of the pieces and therefore may be a later replacement (Blakelock 2014i).

The analysis of pieces from a single context (e.g. Market Rasen), or which appear to be part of the same set (Staffordshire Hoard seax set), found differences in composition between component pieces. Replacements or modifications have been identified on some sword hilt sets, suggesting that these sets developed over time. This therefore suggests that composition alone cannot be used to confirm whether an object belongs to a particular set, and the context and/or physical evidence need to be taken into account.

5.5d Construction or repairs

A small number of objects were identified with possible repairs or modifications, though it is possible that some were an integral part of the original design or manufacture of the piece. In each case, the surface and sub-surface were analysed and compared to the other components in the piece. It is likely that one aim of the goldsmith would be to minimise any obvious observable colour differences between later repairs or modifications and the original.

In the case of hilt plates K1150 and K1136, which had cloisonné garnet decoration around the sides, there is a plain gold sheet instead of garnets around one section (Figure 39). It is not clear whether this was a deliberate choice by the maker, or a repair to conceal loss of

garnets. In both these hilt plates, analysis reveals that the 'repair' sheet has a similar surface and sub-surface composition to the sheet used on the back of the object (Figure 39). This suggests it could have been a deliberate choice by the maker, although the composition is different from that of the cell walls.

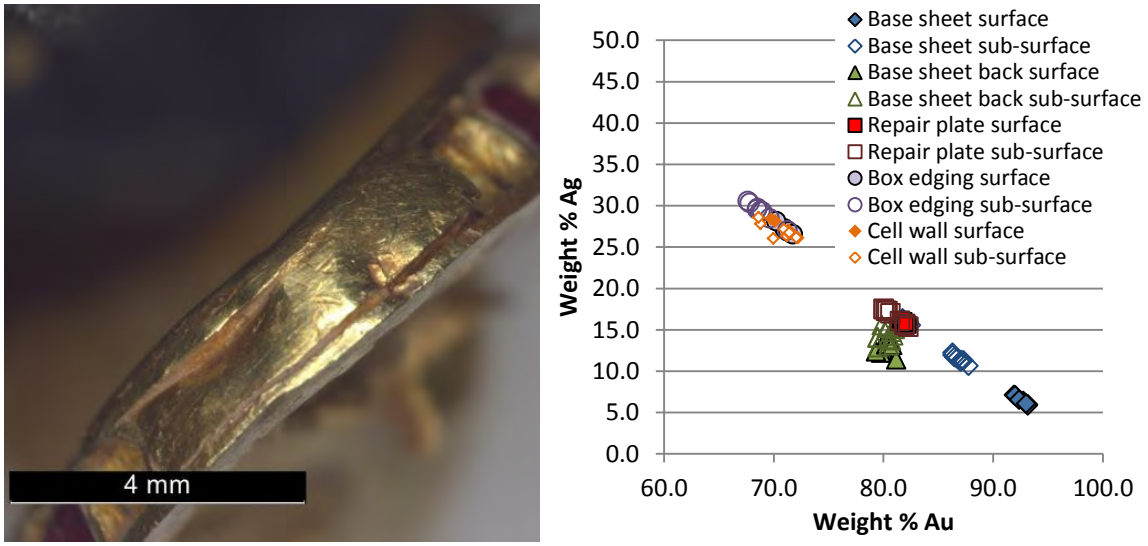


Figure 39. Sheet on the edge of K1150 (scale bar 4 mm). The scatter plot of gold *vs* silver contents of different components shows that it may have been an original part of the piece.

Both of the long thin filigree panels on the Crundale buckle (1893,0601.204) have a number of repairs present (Figure 40). Most of these covered small holes that can be seen from the back of the piece which might suggest repairs, but analysis reveals that the sub-surface composition is the same as the original sheet, and they had been enriched to the same level. Furthermore the filigree wires had been laid on top of many of these patches and therefore it is likely they were applied during the original manufacture of the piece, rather than as later repairs or modifications (Blakelock 2014g).

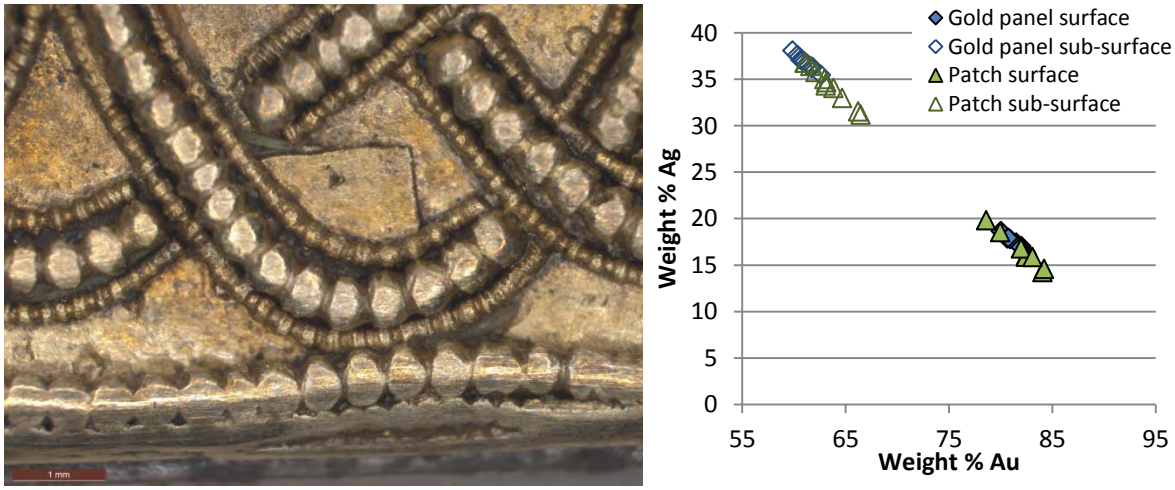


Figure 40. A repair/modification on the Crundale buckle (1893,0601.204) (scale bar 1 mm). Note how the filigree lies over the patch. The scatter plot of gold *vs* silver content shows that both the base sheet and the patch have a similar surface and sub-surface compositions.

The gold repair to the garnet in the gem setting (K569) for the Great Cross, on the other hand, had a distinctly different composition to the base of the piece (Figure 41), and even to the other pieces that comprise the cross (Blakelock 2014b), confirming that it was a later repair. In this case the composition of the repair was such that there would have been an obvious colour difference from the rest of the setting, and the Great Cross itself.

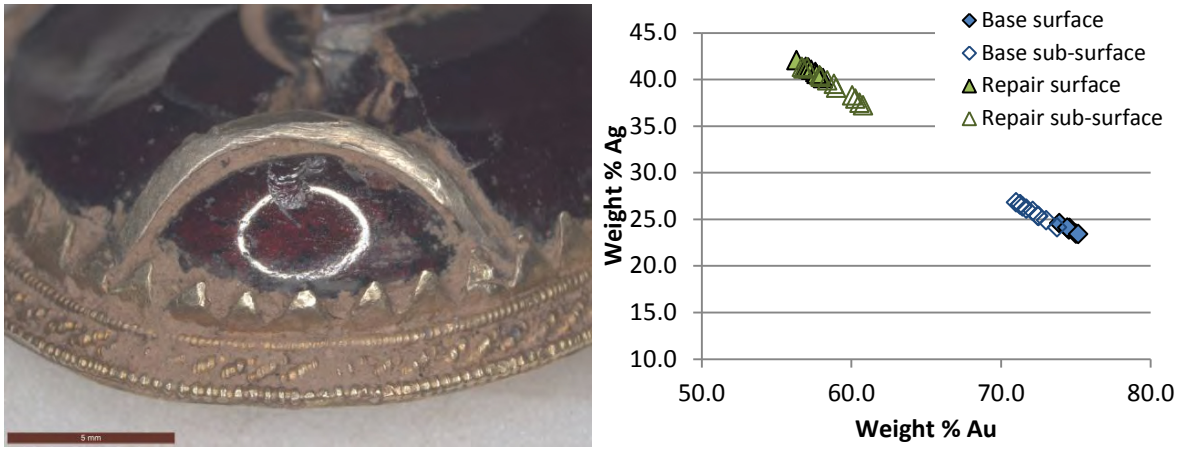


Figure 41. The gold repair to the garnet in the gem setting (K569) for the Great Cross (scale bar 5 mm). The scatter plot of gold *vs* silver content shows that the alloy of the repair is a different composition from that of the base.

Bruce-Mitford noted that there were several differences between the four Sutton Hoo clasps (Bruce-Mitford 1978). This study has been unable to confirm conclusively whether the differences noted were deliberate at the time of manufacture or whether they are later replacements or modifications. The gold panels behind the boars' legs were constructed from a distinct alloy to the main body of the clasps. The filigree panels which must be an original feature of the clasp were also not of the same alloy, so variations in sub-surface composition cannot be used as conclusive evidence of later intervention. The only evidence for a repair or replacement of the gold on the clasps (Figure 42 left) was the additional cell wall inserted above the tusk of clasp 1939,1010.5a (Blakelock 2014c).

Figure 42. Left) the extra cell wall above the tusk in clasp 1939,1010.5a compared to right) the arrangement seen in the three other Sutton Hoo clasps. Scale bar is 2mm.

5.5e Workshops

This analysis was unable to identify any workshop groups or to determine whether a specific source of gold was being exploited. This suggests that mixing and recycling of gold alloys was commonplace. The Anglo-Saxon goldsmiths may have been aiming for a particular golden colour or the working properties of a particular composition. Analysis indicated a clear relationship between the gold and silver contents of the alloys, but there was no correlation between silver and copper contents (Figure 43). This suggests that copper was entering the alloy independently of the silver, probably through the recycling process.

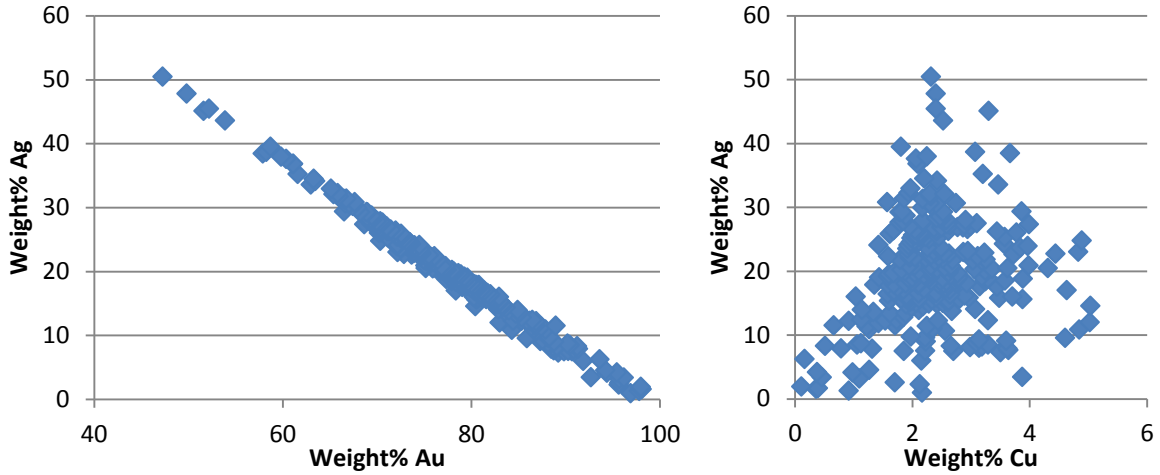


Figure 43. Plots of gold *vs* silver and copper *vs* silver contents of all objects, based on sub-surface SEM-EDX analysis demonstrating, left) the relationship between gold and silver content and right) no correlation between silver and copper content.

Analysis has clearly shown that the gold enrichment treatment was being carried out on specific components, predominately engraved sheets and the sheets backing the filigree decoration. In many cases, the core alloy used for all the components on a single piece was the same, if not similar, but the components had been treated differently. This suggests that the workshop goldsmith selected the components to be treated before they were soldered into place.

6. Conclusion

Previous research has suggested that there may be a general decline in gold content in the contemporary Anglo-Saxon coinage over time. (Williams and Hook 2013). The analysis of the Staffordshire Hoard objects has, however, shown that there is considerable overlap in bulk or core alloy compositions over the whole time period represented by the objects of the Hoard, with no obvious decline in gold content over time. This therefore suggests that the gold composition of the core alloy cannot be used to date the objects. No relationship between the core composition and the function of the pieces was found and there are no differences between the secular pieces or those associated with Christianity. It was noted that the core alloy of the male items of personal adornment were generally of higher gold content than the female items analysed for this study, but the latter had been surface treated, presumably to improve the colour of the metal.

There are several potential reasons for the range of alloy compositions seen. The primary reason is the recycling of gold objects and coins when creating new objects. It is unlikely that goldsmiths would have had access to large quantities of stock alloy. Instead it is thought they used gold provided by the patron commissioning the piece and this would take the form of coins or old items of gold rather than freshly mined or panned gold (Ogden 1982, 174). Recycling of old items will obviously result in an unpredictable mix of alloys and, if heirlooms and Roman gold coins were used, the finished object could have a high gold content, regardless of the date when it was made. The group of Staffordshire Hoard objects with a particularly high gold content, the two gold snake mounts (K128 and K816), two pommels (K1167 and K358), the fork-ended mount (K95) and the hilt ring (K140), had a similar gold content to the Sutton Hoo shoulder clasps (1939,1010.4 and 1939,1010.5) and the Roman and Saxon coins used in the pendants (1879 0714 1 and 1859 0512 1). These objects may have been manufactured from fresh gold direct from the source The presence of PGEs (platinum group elements) in the gold might support this suggestion but it is also possible they were made from high gold objects or coins, with limited recycling/mixing.

The analysis has shown that deliberate surface enrichment was carried out on the full range of Anglo-Saxon objects from both the Staffordshire Hoard and the British Museum collections. There is no relationship between enrichment and the dates, function, or find location. Instead, the enrichment appears to be related to the workshop practice, as sheets were the component most often treated. Not all sheets were treated; in cases where they are not visible the goldsmith often did not treat them. This suggests that the enrichment treatment was being carried out in the goldsmiths workshop, as and when necessary, probably to improve the colour of the metal.

7. Future work

The dataset of gold alloy compositional analyses collected and reported here is substantial and it is unlikely that if more data was collected the results and conclusions would differ. A wide distribution of dates, functions and components was analysed. The only exception is that few granules, plain or twisted wires were examined. However, these are unlikely to differ significantly in composition from the beaded wires which are well represented.

Further analysis of male and female gold items of personal adornment is needed to refute or confirm the suggestion that there is a difference in the gold content of the core alloy these objects. More surface and sub-surface research on contemporary coins is also required, to confirm that surface enrichment was routinely carried out on coins, and to what degree.

Previous studies by other researchers have shown that it is possible to understand more about surface depletion processes through microstructural examination, especially when combined with chemical analysis (La Niece 1995; Lehrberger and Raub 1995, 347-350; Voute 1995, 325). Enrichment of gold alloys changes the physical and chemical characteristics of the surface, and although burnishing removes some of this evidence, below this burnished surface a porous zone created by the loss in silver and copper can often be seen (Lehrberger and Raub 1995, 347). The silver depletion of the Staffordshire Hoard objects would therefore most likely be better understood through the microscopic examination and analysis of cross-sections of enriched components, such as sheets.

Previous visual examination of a number of Anglo-Saxon gold objects by Coatsworth and Pinder (2002, 99) suggested that copper salts were primarily used to bond filigree; however the analysis of solder areas on some Staffordshire Hoard objects revealed both elevated copper and silver levels, which suggests that a metallic solder was used rather than copper salts. There is little visual difference between joints made by the various soldering methods thought to have been used in the Anglo-Saxon period (Coatsworth and Pinder 2002) but the nature of the solder can sometimes be identified if a section of a soldered join can be examined at high magnification.

Acknowledgements

I would like to thank Aude Mongiatti and Susan La Niece for sharing their experience, thoughts and comments throughout the data collection process and while writing this report. Thanks also need to go to Hilary Cool and Mike Baxter for examining the dataset and providing advice on possible statistical tests and for confirming some of the observations. Finally, I would like to thank Susan La Niece, Duncan Hook and Catherine Higgitt for reading and commenting on the various drafts of the report.

Author: Eleanor Blakelock Counter signed: Susan La Niece

20th August 2014

Appendix 1 - Lists of objects

Object	PRN number	Location	Object Type	Function	Date	Fern Phase	Date Range	Decoration Type	Report number
.1028.a.'70	MCS13839	Kent	Disc-brooch	Item of personal adornment (female)	600-620	C1	*c*.600-630	Cloisonné (green)	PR7533 25
.1096.'70	MCS14755	Kent	Belt plate	Item of personal adornment (male)	520-550		*c*.520-550	Cloisonné and filigree	PR7533 20
.1094.'70	MCS14762	Kent	Buckle	Item of personal adornment (male)	600-620	C1	*c*.600-630	Filigree	PR7533 03
.1094.a.'70	MCS14745	Kent	Buckle	Item of personal adornment (male)	600-620	C1	*c*.600-630	Filigree	
.1145.'70	MCS14682	Kent	Pendant	Item of personal adornment (female)	610-630	C2	*c*.600-630	Cloisonné and filigree	PR7533 02
1859,0512.1	MCS16753	Norfolk	Pendant	Item of personal adornment (female)	613-632	C2	*c*.600-630	Cloisonné	PR7533 13
1860,1024.1	MCS16770	Kent	Disc-brooch	Item of personal adornment (female)	610-630	C2	*c*.600-630	Cloisonné and filigree	PR7533 15
1862,0718. 2	CMB186674	Unknown	Coin	Coin	660-670		*c*.650-680	Coin	PR7533 05
1871,1207.1	MCS15498	North Yorkshire	Pendant	Item of personal adornment (female)	630-660	D1	*c*.620-660	Cloisonné and filigree	PR7533 19
1876,0504.1	MCS3387	Northamptonshire	Necklace	Item of personal adornment (female)	630-660	D1	*c*.620-660	Plain cross with garnet, cloisonné, plain gold bullae	PR7533 18
1876,1105.1	CMB186683	Unknown	Coin	Coin	640-650	D1	*c*.620-660	Coin	PR7533 07
1876,0717.1	MCS3869	Cumberland	Mount	Sword fitting	580/600-630/50	B-D1	*c*.580-650	Filigree	PR7533 22
1879,0714.1	MCS13419	Staffordshire	Pendant	Item of personal adornment (female)	610-630	C2	*c*.600-630	Cloisonné	PR7533 21
1879,1013.1	MCS13405	Kent	Disc-brooch	Item of personal adornment (female)	610-630	C2	*c*.600-630	Cloisonné and filigree	PR7533 23
1883,1214.1	MCS12192	Buckinghamshire	Buckle	Item of personal adornment (male)	580-610	B	*c*.580-610	Cloisonné and filigree	PR7533 16
1883,1214.2	MCS12166	Buckinghamshire	Clasp	Item of personal adornment (male)	580-610	B	*c*.580-610	Filigree	PR7533 14
1883,1214.3	MCS12184	Buckinghamshire	Clasp	Item of personal adornment (male)	580-610	B	*c*.580-610	Filigree	PR7533 14
1893,0601.204	MCS3909	Kent	Buckle	Item of personal adornment (male)	620-650	D1	*c*.620-660	Filigree	PR7533 17
1894,1103.1.a	MCS10114	Kent	Pommel	Sword fitting	630-660	D2	*c*.620-660	Mostly plain, engraved etc	PR7533 04
1896,0404.15	CMB186732	Unknown	Coin	Coin	670-680		*c*.650-680	Coin	PR7533 08
1921,1020.1	MCS6745	Kent	Pendant	Item of personal adornment (female)	630-660	D2	*c*.620-660	Filigree	PR7533 12
1934,1013.1	CMB186716	Unknown	Coin	Coin	660-670		*c*.650-680	Coin	PR7533 10
1935,1117.915	CMB186684	Unknown	Coin	Coin	620-650	D1	*c*.620-660	Coin	PR7533 06
1939,1010.1	MCS15228	Suffolk	Buckle	Item of personal adornment (male)	600-620	C1	*c*.600-630	Niello	PR7533 25
1939,1010.4	MCS15706	Suffolk	Shoulder clasp	Item of personal adornment (male)	610-625/30	C2	*c*.600-630	Cloisonné and filigree	PR7533 26
1939,1010.4a	MCS15670	Suffolk	Shoulder clasp	Item of personal adornment (male)	610-625/30	C2	*c*.600-630	Cloisonné and filigree	
1939,1010.5	MCS15693	Suffolk	Shoulder clasp	Item of personal adornment (male)	610-625/30	C2	*c*.600-630	Cloisonné and filigree	
1939,1010.5a	MCS15688	Suffolk	Shoulder clasp	Item of personal adornment (male)	610-625/30	C2	*c*.600-630	Cloisonné and filigree	
1953,0105.1	CMB186730	Unknown	Coin	Coin	670-680		*c*.650-680	Coin	PR7533 09
2006,1001.1.a	MCS26199	Lincolnshire	Pommel	Sword fitting	580-610	B	*c*.580-610	Filigree	PR7533 11
2006,1001.1.b	MCS26200	Lincolnshire	Hilt plate	Sword fitting	580-610	B	*c*.580-610	Filigree	
2006,1001.1.c	MCS26201	Lincolnshire	Hilt collar	Sword fitting	580-610	B	*c*.580-610	Filigree	
2006,1001.1.d	MCS26202	Lincolnshire	Hilt collar	Sword fitting	580-610	B	*c*.580-610	Filigree	
2006,1001.1.e	MCS26203	Lincolnshire	Hilt plate	Sword fitting	580-610	B	*c*.580-610	Filigree	

Table 9. List of Anglo-Saxon objects from the British Museum that were analysed during this study.

Object	Object Type		Function	Proposed Date	Fern Phase	Date Range	Decoration Type
K3	Hilt plate		Sword fitting	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K10	Hilt plate		Sword fitting	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K12	Hilt plate		Sword fitting	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K16	Mount	Animal Mount	Mount	620-650	D1	*c*.620-660	Cloisonné
K21	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	610-630	C2	*c*.600-630	Filigree
K79	Hilt plate		Sword fitting	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K88	Pommel	Pommel (cocked-hat)	Sword fitting	610-630	C2	*c*.600-630	Filigree
K95	Mount	Fork-ended	Mount	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K107	Sword pyramid	Pyramid (tall)	Sword fitting	610-630	C2	*c*.600-630	Cloisonné
K128	Mount	Animal Mount	Mount	600-650	C1-D1	*c*.600-650	Mostly plain, engraved etc
K130	Roundel		Religious function?	630-660	D2	*c*.620-660	Cloisonné
K133	Hilt plate		Sword fitting	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K135	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	610-630	C2	*c*.600-630	Filigree
K136	Pommel	Pommel inset	Sword fitting	630-660	D2	*c*.620-660	Filigree
K140	Hilt-collar/Hilt-ring	Hilt-ring	Sword fitting	580/600-630/50	B-D1	*c*.580-650	Filigree
K271	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	620-650	D1	*c*.620-660	Filigree
K273	Mount	Strip-mount	Mount	620-650	D1	*c*.620-660	Cloisonné
K276	Pommel	Pommel (cocked-hat)	Sword fitting	610-630	C2	*c*.600-630	Filigree
K278	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	620-650	D1	*c*.620-660	Filigree
K281	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	610-630	C2	*c*.600-630	Filigree
K284	Pommel	Pommel (cocked-hat)	Sword fitting	620-650	D1	*c*.620-660	Cloisonné
K288	Helmet-fitting	Helmet 'eye-brow'	Helmet	620-650	D1	*c*.620-660	Filigree
K292	Pommel	Pommel (cocked-hat)	Sword fitting	610-630	C2	*c*.600-630	Cloisonné
K294	Pommel	Pommel (round-back)	Sword fitting	630-660	D2	*c*.620-660	Cloisonné and filigree
K297	Mount	Animal Mount	Mount	610-630	C2	*c*.600-630	Filigree
K300	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	580-610	B	*c*.580-610	Filigree
K301	Pommel	Pommel (insert)	Sword fitting	630-660	D2	*c*.620-660	Cloisonné and filigree
K302	Sword pyramid	Pyramid (tall)	Sword fitting	630-660	D2	*c*.620-660	Cloisonné
K303	Pectoral cross		Religious function	620-650	D1	*c*.620-660	Filigree
K306	Pommel	Pommel (cocked-hat)	Sword fitting	620-650	D1	*c*.620-660	Filigree
K309	Pommel	Pommel (cocked-hat)	Sword fitting	600-620	C1	*c*.600-630	Filigree
K347	Pommel	Pommel (round-back)	Sword fitting	620-650	D1	*c*.620-660	Niello
K349	Pommel	Pommel (cocked-hat)	Sword fitting	610-630	C2	*c*.600-630	Cloisonné (green) and filigree
K352	Pommel	Pommel (cocked-hat)	Sword fitting	600-620	C1	*c*.600-630	Cloisonné and filigree
K354	Hilt-collar/Hilt-ring	Hilt collar	Sword fitting	620-650	D1	*c*.620-660	Cloisonné

Table 10. List of Anglo-Saxon objects from the Staffordshire Hoard that were analysed during this study.

Object	Object Type		Function	Proposed Date	Fern Phase	Date Range	Decoration Type
K356	Mount	Edge mount	Mount	620-650	D1	*c*.620-660	Cloisonné
K358	Pommel	Pommel (cocked-hat)	Sword fitting	620-650	D1	*c*.620-660	Niello
K360	Pommel	Pommel (cocked-hat)	Sword fitting	600-630	C	*c*.600-630	Cloisonné (green)
K365	Mount	Hilt-mount	Sword fitting	610-630	C2	*c*.600-630	Filigree
K370	Hilt-collar/Hilt-ring	Hilt collar	Sword fitting	620-650	D1	*c*.620-660	Cloisonné
K375	Pommel	Pommel (cocked-hat)	Sword fitting	580-610	B	*c*.580-610	Filigree
K376	Pommel	Pommel (cocked-hat)	Sword fitting	620-650	D1	*c*.620-660	Cloisonné
K377	Sword pyramid		Sword fitting	600-620	C1	*c*.600-630	Cloisonné
K379	Mount	Hilt-mount	Mount	630-660	D2	*c*.620-660	Cloisonné
K381	Pommel	Pommel (cocked-hat)	Sword fitting	610-630	C2	*c*.600-630	Filigree
K399	Hilt-collar/Hilt-ring	Hilt-collar/hilt plate	Sword fitting	600-650	C1-D1	*c*.600-650	Filigree
K449	Hilt-collar/Hilt-ring	Hilt collar	Sword fitting	620-650	D1	*c*.620-660	Cloisonné
K451	Sword Pyramid	Pyramid (tall)	Sword fitting	620-650	D1	*c*.620-660	Cloisonné (green)
K454	Mount	Hilt-mount	Mount	620-650	D1	*c*.620-660	Filigree
K455	Pommel	Pommel (cocked-hat)	Sword fitting	600-620	C1	*c*.600-630	Filigree
K457	Pommel	Pommel (cocked-hat)	Sword fitting	580-610	B	*c*.580-610	Filigree
K458	Pommel	Pommel (cocked-hat)	Sword fitting	620-650	D1	*c*.620-660	Filigree
K462	Sword pyramid		Sword fitting	600-620	C1	*c*.600-630	Cloisonné
K465	Pommel	Pommel (cocked-hat)	Sword fitting	610-630	C2	*c*.600-630	Cloisonné and filigree
K468	Mount	Hilt-mount	Mount	610-630	C2	*c*.600-630	Filigree
K513	Mount	Strip-mount	Mount	620-650	D1	*c*.620-660	Cloisonné
K545	Stud		Religious function?	630-660	D2	*c*.620-660	Cloisonné
K547	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	600-650	C1-D1	*c*.600-650	Filigree
K550	Inscription		Religious function	630-660	D2	*c*.620-660	Niello
K552	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	580-610	B	*c*.580-610	Filigree
K554	Pommel	Pommel (cocked-hat)	Sword fitting	610-630	C2	*c*.600-630	Filigree
K560	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	600-620	C1	*c*.600-630	Filigree
K567	Hilt Plate		Sword fitting	620-650	D1	*c*.620-660	Mostly plain, engraved etc
K652	Mount	Animal mount	Mount	620-650	D1	*c*.620-660	Mostly plain, engraved etc
K653	Mount	Ear shaped	Mount	620-650	D1	*c*.620-660	Cloisonné
K655	Great Cross		Religious function	630-660	D2	*c*.620-660	Mostly plain, engraved etc
K656	Gem setting from cross		Religious function	630-660	D2	*c*.620-660	Cloisonné and filigree
K657	Gem setting from cross		Religious function	630-660	D2	*c*.620-660	Cloisonné and filigree
K658	Gem setting from cross		Religious function	630-660	D2	*c*.620-660	Cloisonné and filigree
K659	Gem setting from cross		Religious function	630-660	D2	*c*.620-660	Cloisonné and filigree

Table 9 cont. List of Anglo-Saxon objects from the Staffordshire Hoard that were analysed during this study.

Object	Object Type		Function	Proposed Date	Fern Phase	Date Range	Decoration Type
K660	Hilt-collar/Hilt-ring	Hilt collar	Sword fitting	620-650	D1	*c*.620-660	Cloisonné (green)
K669	Pommel	Pommel (cocked-hat)	Sword fitting	600-620	C1	*c*.600-630	Filigree
K673	Mount	Strip mount	Mount	620-650	D1	*c*.620-660	Cloisonné
K674	Pommel	Pommel (cocked-hat)	Sword fitting	610-630	C2	*c*.600-630	Cloisonné
K677	Mount	Strip-mount	Mount	620-650	D1	*c*.620-660	Cloisonné and filigree
K679	Hilt-collar/Hilt-ring	Hilt-ring	Sword fitting	620-650	D1	*c*.620-660	Cloisonné and filigree
K680	Pommel	Pommel (cocked-hat)	Sword fitting	610-630	C2	*c*.600-630	Cloisonné (green)
K685	Buckle		Item of personal adornment (male)	600-650	C1-D1	*c*.600-650	Mostly plain, engraved etc
K686	Pommel	Pommel (cocked-hat)	Sword fitting	600-620	C1	*c*.600-630	Filigree
K689	Hilt-collar/Hilt-ring	Hilt-guard mount	Sword fitting	600-650	C1-D1	*c*.600-650	Filigree
K690	Hilt-collar/Hilt-ring	Hilt collar	Sword fitting	620-650	D1	*c*.620-660	Cloisonné
K697	Pommel	Pommel (cocked-hat)	Sword fitting	620-650	D1	*c*.620-660	Filigree
K699	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	610-630	C1	*c*.600-630	Filigree
K714	Pommel	Pommel (cocked-hat)	Sword fitting	610-630	C2	*c*.600-630	Filigree
K796	Mount	Animal Mount	Mount	620-650	D1	*c*.620-660	Filigree
K811	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	620-650	D1	*c*.620-660	Filigree
K816	Mount	Animal Mount	Mount	600-650	C1-D1	*c*.600-650	Mostly plain, engraved etc
K833	Mount	Hilt-mount	Sword fitting	600-650	C1-D1	*c*.600-650	Filigree
K843	Mount	Eye shaped	Mount	620-650	D1	*c*.620-660	Cloisonné
K855	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	610-630	C2	*c*.600-630	Filigree
K865	Mount	Hilt-mount	Mount	630-660	D2	*c*.620-660	Filigree
K878	Mount	Hilt-mount	Sword fitting	600-650	C1-D1	*c*.600-650	Filigree
K920	Cross mount		Religious function	620-650	D1	*c*.620-660	Filigree
K992	Mount	Hilt-mount	Sword fitting	600-650	C1-D1	*c*.600-650	Filigree
K1004	Pommel	Pommel (cocked-hat)	Sword fitting	610-630	C2	*c*.600-630	Filigree
K1048	Hilt plate		Sword fitting	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K1055	Cylinder		Religious function?	630-660	D2	*c*.620-660	Cloisonné
K1072	Hilt plate		Sword fitting	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K1073	Pommel	Pommel (round-back)	Sword fitting	620-650	D1	*c*.620-660	Filigree
K1118	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	620-650	D1	*c*.620-660	Filigree
K1136	Hilt Plate		Sword fitting	620-650	D1	*c*.620-660	Cloisonné
K1137	Hilt plate		Sword fitting	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K1143	Hilt plate		Sword fitting	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K1150	Hilt Plate		Sword fitting	620-650	D1	*c*.620-660	Cloisonné
K1155	Hilt-collar/Hilt-ring	Hilt-collar	Sword fitting	610-630	C2	*c*.600-630	Cloisonné

Table 9 cont. List of Anglo-Saxon objects from the Staffordshire Hoard that were analysed during this study.

Object	Object Type		Function	Proposed Date	Fern Phase	Date Range	Decoration Type
K1163	Hilt plate		Sword fitting	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K1167	Pommel	Pommel (cocked-hat)	Sword fitting	620-650	D1	*c*.620-660	Cloisonné
K1221	Hilt plate		Sword fitting	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K1234	Hilt plate		Sword fitting	580-630/50	B-D1	*c*.580-650	Mostly plain, engraved etc
K1272	Pommel	Pommel (fragment)	Sword fitting	610-630	C2	*c*.600-630	Mostly plain, engraved etc
K1314	Gem setting from cross		Religious function	630-660	D2	*c*.620-660	Cloisonné and filigree
K1403	Pommel	Pommel inset	Sword fitting	630-660	D2	*c*.620-660	Filigree
K1425	Sword Button	Sword Button	Sword fitting	600-620	C1	*c*.600-630	Cloisonné
K1497	Mount	Animal Mount	Mount	620-650	D1	*c*.620-660	Filigree
K5008	Cross mount		Religious function	620-650	D1	*c*.620-660	Filigree

Table 9 cont. List of Anglo-Saxon objects from the Staffordshire Hoard that were analysed during this study.

Object	Object Type	Function	Proposed Date	Fern Phase	Date Range	Decoration Type
Pendant 2006.LH.67	Pendant	Item of personal adornment (female)	630-660	D2	*c*.620-660	Cloisonné and filigree

Table 11. Details of the pendant from Potteries Museum and Art Gallery analysed during this study.

Appendix 2 - Data

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
.1028.a.'70	Cell wall	Cell wall	surface	**89.9**	**8.9**	**1.2**	*0.36*	*0.28*	*0.12*			
1028.a.'70	Cell wall	Cell wall	sub-surface	**86.2**	**12.3**	**1.5**	*0.38*	*0.29*	*0.13*	0.04	-0.28	-0.24
.1028.a.'70	Sheet	Sheet	surface	**97.0**	**2.5**	**0.5**	*0.29*	*0.29*	*0.06*			
.1028.a.'70	Sheet	Sheet	sub-surface	**86.9**	**10.8**	**2.3**	*0.71*	*0.56*	*0.18*	0.12	-0.77	-0.78
.1096.'70	Sheet	Backing sheet	surface	**88.7**	**10.3**	**1.0**	*0.45*	*0.38*	*0.10*			
.1096.'70	Sheet	Backing sheet	sub-surface	**83.3**	**14.5**	**2.2**	*0.55*	*0.43*	*0.30*	0.06	-0.29	-0.52
.1096.'70	Wire (beaded)	Filigree wire	surface	**89.9**	**7.7**	**2.4**	*0.99*	*0.84*	*0.17*			
.1096.'70	Wire (beaded)	Filigree wire	sub-surface	**91.2**	**8.3**	**0.5**	*0.70*	*0.59*	*0.15*	-0.01	-0.06	3.65
.1094.'70	Sheet	Back sheet	surface	**91.2**	**6.4**	**2.4**	*0.58*	*0.72*	*0.19*			
.1094.'70	Sheet	Back sheet	sub-surface	**88.5**	**7.9**	**3.6**	*1.16*	*0.60*	*1.30*	0.03	-0.19	-0.33
.1094.a.'70	Sheet	Back sheet	surface	**91.5**	**6.6**	**1.9**	*0.28*	*0.42*	*0.34*			
.1094.a.'70	Sheet	Back sheet	sub-surface	**87.3**	**9.1**	**3.6**	*1.09*	*0.82*	*1.32*	0.05	-0.28	-0.47
.1145.'70	Sheet	Back sheet	surface	**92.2**	**6.7**	**1.1**	*0.09*	*0.10*	*0.13*			
.1145.'70	Sheet	Back sheet	sub-surface	**81.2**	**15.8**	**3.0**	*0.89*	*0.76*	*0.19*	0.14	-0.58	-0.64
1859,0512.1	Sheet	Backing sheet for cross	surface	**91.2**	**7.0**	**1.8**	*1.01*	*1.05*	*0.38*			
1859,0512.1	Sheet	Backing sheet for cross	sub-surface	**80.7**	**15.8**	**3.5**	*1.79*	*2.04*	*0.75*	0.13	-0.56	-0.48
1859,0512.1	Coin	Coin	surface	**98.3**	**0.6**	**1.1**	*0.32*	*0.18*	*0.18*			
1859,0512.1	Coin	Coin	sub-surface	**96.8**	**1.0**	**2.2**	*0.74*	*0.14*	*0.76*	0.01	-0.37	-0.50
1860,1024.1	Sheet	Backing sheet	surface	**76.3**	**21.2**	**2.5**	*0.78*	*0.68*	*0.14*			
1860,1024.1	Sheet	Backing sheet	sub-surface	**61.1**	**36.8**	**2.1**	*0.71*	*0.67*	*0.13*	0.25	-0.43	0.16
1862,0718.2	Coin	Front	surface	**61.7**	**36.8**	**1.5**	*1.91*	*1.44*	*0.07*			
1862,0718.2	Coin	Front	sub-surface	**49.8**	**47.8**	**2.4**	*0.93*	*0.75*	*0.27*	0.24	-0.23	-0.38
1871,1207.1	Sheet	Backing sheet for filigree (front)	surface	**84.6**	**14.4**	**1.0**	*1.96*	*1.97*	*0.10*			
1871,1207.1	Sheet	Backing sheet for filigree (front)	sub-surface	**68.6**	**27.4**	**4.0**	*0.44*	*0.44*	*0.13*	0.23	-0.47	-0.76
1876,0504.1	Sheet	Cross piece 1 back	surface	**83.6**	**15.5**	**0.9**	*0.99*	*0.97*	*0.08*			
1876,0504.1	Sheet	Cross piece 1 back	sub-surface	**77.6**	**19.8**	**2.6**	*0.25*	*0.26*	*0.13*	0.08	-0.22	-0.66
1876,0504.1	Sheet	Cross piece 2 back	surface	**85.8**	**13.5**	**0.7**	*1.01*	*0.94*	*0.09*			
1876,0504.1	Sheet	Cross piece 2 back	sub-surface	**77.5**	**20.2**	**2.3**	*1.07*	*1.09*	*0.18*	0.11	-0.33	-0.71
1876,0504.1	Sheet	Garnet pendant 1 back	surface	**90.4**	**6.5**	**3.1**	*0.70*	*0.61*	*0.30*			
1876,0504.1	Sheet	Garnet pendant 1 back	sub-surface	**83.0**	**12.0**	**5.0**	*1.50*	*1.15*	*0.54*	0.09	-0.46	-0.39

Table 12. SEM-EDX analysis data for the British Museum objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
1876,0504.1	Sheet	Garnet pendant 1 suspension loop	surface	**82.8**	**14.9**	**2.3**	*1.09*	*0.96*	*0.15*			
1876,0504.1	Sheet	Garnet pendant 1 suspension loop	sub-surface	**78.8**	**18.5**	**2.7**	*0.59*	*0.60*	*0.09*	0.05	-0.19	-0.15
1876,0504.1	Sheet	Garnet pendant 2 back	surface	**85.8**	**11.7**	**2.5**	*0.82*	*0.76*	*0.34*			
1876,0504.1	Sheet	Garnet pendant 2 back	sub-surface	**76.5**	**20.8**	**2.7**	*0.26*	*0.24*	*0.19*	0.12	-0.44	-0.08
1876,0504.1	Sheet	Garnet pendant 3 back	surface	**88.7**	**10.1**	**1.2**	*0.21*	*0.24*	*0.12*			
1876,0504.1	Sheet	Garnet pendant 3 back	sub-surface	**77.5**	**19.7**	**2.8**	*0.59*	*0.59*	*0.11*	0.14	-0.49	-0.56
1876,0504.1	Sheet	Garnet pendant 3 suspension loop	surface	**81.7**	**15.2**	**3.1**	*0.99*	*1.02*	*0.22*			
1876,0504.1	Sheet	Garnet pendant 3 suspension loop	sub-surface	**72.5**	**23.7**	**3.8**	*2.24*	*1.99*	*0.40*	0.13	-0.36	-0.20
1876,0504.1	Sheet	Gold bullae 1 back	surface	**86.7**	**9.0**	**4.3**	*0.69*	*0.49*	*0.32*			
1876,0504.1	Sheet	Gold bullae 1 back	sub-surface	**72.2**	**23.0**	**4.8**	*1.38*	*2.24*	*0.95*	0.20	-0.61	-0.11
1876,0504.1	Sheet	Gold bullae 2 back	surface	**82.3**	**13.0**	**4.7**	*0.89*	*0.93*	*0.33*			
1876,0504.1	Sheet	Gold bullae 2 back	sub-surface	**75.2**	**20.5**	**4.3**	*0.36*	*0.58*	*0.47*	0.10	-0.37	0.09
1876,1105.1	Coin	Front	surface	**75.4**	**22.6**	**2**	*4.78*	*4.13*	*0.67*			
1876,1105.1	Coin	Front	sub-surface	**51.6**	**45.1**	**3.3**	*1.28*	*1.46*	*0.25*	0.46	-0.50	-0.39
1876,0717.1	Sheet	Sheet	surface	**94.8**	**3.4**	**1.8**	*0.32*	*0.25*	*0.15*			
1876,0717.1	Sheet	Sheet	sub-surface	**88.2**	**9.6**	**2.2**	*1.95*	*1.88*	*0.34*	0.08	-0.65	-0.19
1879,0714.1	Sheet	Backing sheet	surface	**84.0**	**14.7**	**1.3**	*0.45*	*0.42*	*0.10*			
1879,0714.1	Sheet	Backing sheet	sub-surface	**75.2**	**22.5**	**2.3**	*0.49*	*0.48*	*0.06*	0.12	-0.35	-0.43
1879,0714.1	Cell wall	Cell wall	surface	**80.8**	**17.3**	**1.9**	*1.23*	*1.12*	*0.15*			
1879,0714.1	Cell wall	Cell wall	sub-surface	**74.5**	**23.1**	**2.4**	*0.26*	*0.27*	*0.09*	0.08	-0.25	-0.18
1879,0714.1	Coin	Coin	surface	**96.7**	**2.1**	**1.2**	*1.29*	*0.69*	*0.62*			
1879,0714.1	Coin	Coin	sub-surface	**97.8**	**1.3**	**0.9**	*0.48*	*0.26*	*0.23*	-0.01	0.67	0.27
1879,1013.1	Cell wall	Cell wall	surface	**82.5**	**16.1**	**1.4**	*0.36*	*0.38*	*0.07*			
1879,1013.1	Cell wall	Cell wall	sub-surface	**80.5**	**17.9**	**1.6**	*0.60*	*0.55*	*0.09*	0.02	-0.10	-0.13
1879,1013.1	Sheet	Panel sheet	surface	**87.0**	**11.3**	**1.7**	*1.14*	*1.04*	*0.27*			
1879,1013.1	Sheet	Panel sheet	sub-surface	**79.5**	**18.0**	**2.5**	*0.95*	*0.97*	*0.10*	0.10	-0.37	-0.34
1883,1214.1	Sheet	Back plate	surface	**91.1**	**8.2**	**0.7**	*0.71*	*0.68*	*0.03*			
1883,1214.1	Sheet	Back plate	sub-surface	**85.9**	**12.4**	**1.7**	*0.98*	*0.95*	*0.10*	0.06	-0.34	-0.62
1883,1214.1	Sheet	Backing sheet	surface	**95.5**	**4.3**	**0.2**	*0.56*	*0.41*	*0.15*			
1883,1214.1	Sheet	Backing sheet	sub-surface	**82.5**	**15.6**	**1.9**	*0.41*	*0.36*	*0.12*	0.16	-0.73	-0.91
1883,1214.1	Sheet	Backing sheet of front panel	surface	**91.1**	**7.9**	**1.0**	*1.52*	*1.50*	*0.08*			
1883,1214.1	Sheet	Backing sheet of front panel	sub-surface	**82.5**	**15.0**	**2.5**	*0.87*	*0.93*	*0.08*	0.10	-0.47	-0.61
1883,1214.1	Body	Pin	surface	**91.1**	**8.0**	**0.9**	*0.55*	*0.56*	*0.04*			
1883,1214.1	Body	Pin	sub-surface	**91.3**	**7.9**	**0.8**	*1.38*	*1.26*	*0.14*	0.00	0.01	0.16

Table 11 cont. SEM-EDX data for the British Museum objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
1883,1214.2 eye	Sheet	Back sheet	surface	**84.0**	**14.2**	**1.8**	*0.37*	*0.36*	*0.03*			
1883,1214.2 eye	Sheet	Back sheet	sub-surface	**80.0**	**18.1**	**1.9**	*0.19*	*0.16*	*0.08*	0.05	-0.21	-0.04
1883,1214.2 eye	Sheet	Front sheet	surface	**83.1**	**14.6**	**2.3**	*0.15*	*0.11*	*0.18*			
1883,1214.2 eye	Sheet	Front sheet	sub-surface	**78.6**	**18.9**	**2.5**	*0.25*	*0.17*	*0.22*	0.06	-0.22	-0.10
1883,1214.2 hook	Sheet	Back sheet	surface	**87.0**	**12.3**	**0.7**	*0.21*	*0.22*	*0.04*			
1883,1214.2 hook	Sheet	Back sheet	sub-surface	**82.0**	**16.4**	**1.6**	*0.30*	*0.31*	*0.06*	0.06	-0.25	-0.58
1883,1214.2 hook	Sheet	Front sheet	surface	**84.3**	**12.4**	**3.3**	*1.26*	*1.13*	*0.16*			
1883,1214.2 hook	Sheet	Front sheet	sub-surface	**79.5**	**18.0**	**2.5**	*0.26*	*0.27*	*0.45*	0.06	-0.31	0.33
1883,1214.3 eye	Sheet	Back sheet	surface	**83.7**	**15.0**	**1.3**	*0.82*	*0.75*	*0.10*			
1883,1214.3 eye	Sheet	Back sheet	sub-surface	**79.6**	**19.0**	**1.4**	*0.38*	*0.40*	*0.10*	0.05	-0.21	-0.11
1883,1214.3 eye	Sheet	Front sheet	surface	**82.4**	**15.6**	**2.0**	*0.04*	*0.08*	*0.07*			
1883,1214.3 eye	Sheet	Front sheet	sub-surface	**78.1**	**20.0**	**1.9**	*0.35*	*0.44*	*0.29*	0.05	-0.22	0.06
1883,1214.3 hook	Sheet	Back sheet	surface	**85.5**	**11.9**	**2.6**	*0.45*	*0.47*	*0.66*			
1883,1214.3 hook	Sheet	Back sheet	sub-surface	**80.3**	**18.0**	**1.7**	*0.40*	*0.37*	*0.06*	0.06	-0.34	0.56
1883,1214.3 hook	Sheet	Front sheet	surface	**83.4**	**15.1**	**1.5**	*1.27*	*1.14*	*0.14*			
1883,1214.3 hook	Sheet	Front sheet	sub-surface	**80.6**	**17.2**	**2.2**	*0.76*	*0.61*	*0.78*	0.03	-0.12	-0.31
1893,0601.204	Wire (beaded)	Filigree on panel	surface	**61.4**	**36.6**	**2.0**	*2.64*	*2.55*	*0.15*			
1893,0601.204	Wire (beaded)	Filigree on panel	sub-surface	**60.3**	**37.6**	**2.1**	*1.17*	*1.22*	*0.29*	0.02	-0.03	-0.04
1893,0601.204	Sheet	Gold panel	surface	**81.4**	**17.4**	**1.2**	*0.91*	*0.84*	*0.17*			
1893,0601.204	Sheet	Gold panel	sub-surface	**61.1**	**36.8**	**2.1**	*0.74*	*0.69*	*0.11*	0.33	-0.53	-0.41
1893,0601.204	Wire (beaded)	Large filigree border	surface	**61.2**	**37.0**	**1.8**	*1.33*	*1.30*	*0.11*			
1893,0601.204	Wire (beaded)	Large filigree border	sub-surface	**59.8**	**37.9**	**2.3**	*1.58*	*1.12*	*0.51*	0.02	-0.02	-0.22
1893,0601.204	Sheet	Repair	surface	**82.1**	**16.5**	**1.4**	*1.94*	*1.89*	*0.24*			
1893,0601.204	Sheet	Repair	sub-surface	**63.3**	**34.5**	**2.2**	*1.87*	*1.95*	*0.17*	0.30	-0.52	-0.36
1893,0601.204	Wire (beaded)	Spiral filigree	surface	**64.0**	**34.1**	**1.9**	*1.35*	*1.18*	*0.23*			
1893,0601.204	Wire (beaded)	Spiral filigree	sub-surface	**65.1**	**32.9**	**2.0**	*1.75*	*1.42*	*0.47*	-0.02	0.04	-0.04
1894,1103.1.a	Cap	Cap	surface	**73.7**	**23.1**	**3.2**	*0.08*	*0.11*	*0.02*			
1894,1103.1.a	Cap	Cap	sub-surface	**76.8**	**20.0**	**3.2**	*0.46*	*0.41*	*0.06*	-0.04	0.15	-0.02
1894,1103.1.a	Body	Detail of design	surface	**68.8**	**29.0**	**2.2**	*1.42*	*1.34*	*0.13*			
1894,1103.1.a	Body	Detail of design	sub-surface	**67.0**	**30.6**	**2.4**	*1.02*	*1.06*	*0.09*	0.03	-0.05	-0.09
1896,0404.15	Coin	Front	surface	**46.1**	**53.6**	**0.3**	*5.33*	*5.34*	*0.06*			
1896,0404.15	Coin	Front	sub-surface	**10.7**	**85.7**	**3.6**	*0.4*	*0.93*	*0.14*	3.31	-0.37	-0.92

Table 11 cont. SEM-EDX analysis data for the British Museum objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
1921,1020.1	Sheet	Backing sheet	surface	**88.3**	**10.9**	**0.8**	*0.57*	*0.61*	*0.17*			
1921,1020.1	Sheet	Backing sheet	sub-surface	**74.6**	**23.5**	**1.9**	*0.83*	*0.83*	*0.04*	0.19	-0.54	-0.59
1934,1013.1	Coin	Front	surface	**47**	**51.9**	**1.1**	*0.33*	*0.3*	*0.08*			
1934,1013.1	Coin	Front	sub-surface	**37**	**60.7**	**2.3**	*1.33*	*1.18*	*0.26*	0.27	-0.14	-0.52
1935,1117.915	Coin	Front	surface	**81**	**17.6**	**1.4**	*0.78*	*1.15*	*0.63*			
1935,1117.915	Coin	Front	sub-surface	**76.3**	**21.3**	**2.4**	*0.93*	*0.95*	*0.08*	0.06	-0.17	-0.42
1939,1010.1	Body	Body	surface	**91.0**	**8.2**	**0.8**	*0.31*	*0.33*	*0.07*			
1939,1010.1	Body	Body	sub-surface	**87.4**	**11.4**	**1.2**	*0.31*	*0.32*	*0.05*	0.04	-0.28	-0.31
1939,1010.1	Body	Eye	surface	**92.2**	**7.1**	**0.7**	*0.77*	*0.68*	*0.10*			
1939,1010.1	Body	Eye	sub-surface	**82.8**	**15.2**	**2.0**	*0.18*	*0.18*	*0.07*	0.11	-0.54	-0.64
1939,1010.4a	Body	Border	surface	**97.4**	**2.3**	**0.3**	*0.14*	*0.13*	*0.08*			
1939,1010.4a	Body	Border	sub-surface	**96.1**	**3.4**	**0.5**	*0.56*	*0.41*	*0.16*	0.01	-0.31	-0.29
1939,1010.4a	Body	Inset gold	surface	**98.6**	**1.1**	**0.3**	*0.14*	*0.24*	*0.17*			
1939,1010.4a	Body	Inset gold	sub-surface	**98.0**	**1.6**	**0.4**	*0.12*	*0.16*	*0.07*	0.01	-0.27	-0.24
1939,1010.4b	Body	Border	surface	**97.5**	**2.3**	**0.2**	*0.12*	*0.08*	*0.10*			
1939,1010.4b	Body	Border	sub-surface	**95.4**	**4.2**	**0.4**	*0.14*	*0.17*	*0.05*	0.02	-0.46	-0.41
1939,1010.4b	Sheet	Filigree panel	surface	**96.0**	**1.6**	**2.4**	*0.36*	*0.29*	*0.11*			
1939,1010.4b	Sheet	Filigree panel	sub-surface	**95.6**	**2.3**	**2.1**	*0.43*	*0.13*	*0.48*	0.00	-0.31	0.14
1939,1010.5a	Body	Border	surface	**97.1**	**2.3**	**0.6**	*0.69*	*0.89*	*0.24*			
1939,1010.5a	Body	Border	sub-surface	**92.7**	**3.4**	**3.9**	*0.63*	*0.53*	*1.13*	0.05	-0.34	-0.84
1939,1010.5b	Body	Border	surface	**96.6**	**2.9**	**0.5**	*0.35*	*0.23*	*0.13*			
1939,1010.5b	Body	Border	sub-surface	**94.2**	**4.5**	**1.3**	*0.67*	*0.44*	*0.43*	0.03	-0.36	-0.59
1953,0105.1	Coin	Front	surface	**25.9**	**73.6**	**0.5**	*2.49*	*2.44*	*0.08*			
1953,0105.1	Coin	Front	sub-surface	**8.6**	**89**	**2.4**	*0.69*	*0.8*	*0.11*	2.01	-0.17	-0.79
2006,1001.1.a	Sheet	Backing sheet	surface	**88.5**	**10.2**	**1.3**	*0.51*	*0.49*	*0.11*			
2006,1001.1.a	Sheet	Backing sheet	sub-surface	**85.3**	**12.8**	**1.9**	*0.33*	*0.34*	*0.12*	0.04	-0.20	-0.27
2006,1001.1.a	Cap	Cap	surface	**85.1**	**13.6**	**1.3**	*0.12*	*0.13*	*0.03*			
2006,1001.1.a	Cap	Cap	sub-surface	**85.1**	**13.6**	**1.3**	*0.09*	*0.08*	*0.05*	0.00	0.00	-0.04
2006,1001.1.b	Sheet	Front	surface	**78.4**	**18.7**	**2.9**	*0.72*	*0.67*	*0.38*			
2006,1001.1.b	Sheet	Front	sub-surface	**75.2**	**21.6**	**3.2**	*0.68*	*0.59*	*0.18*	0.04	-0.13	-0.08
2006,1001.1.c	Sheet	Backing sheet	surface	**88.2**	**10.3**	**1.5**	*0.13*	*0.15*	*0.10*			
2006,1001.1.c	Sheet	Backing sheet	sub-surface	**83.5**	**13.8**	**2.7**	*0.77*	*0.82*	*0.12*	0.06	-0.26	-0.43

Table 11 cont. SEM-EDX analysis data for the British Museum objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
2006,1001.1.d	Sheet	Backing sheet	surface	**88.7**	**10.3**	**1.0**	*0.34*	*0.35*	*0.05*			
2006,1001.1.d	Sheet	Backing sheet	sub-surface	**84.7**	**13.4**	**1.9**	*1.55*	*1.56*	*0.13*	0.05	-0.23	-0.49
2006,1001.1.e	Sheet	Front	surface	**86.6**	**11.8**	**1.6**	*0.80*	*0.83*	*0.08*			
2006,1001.1.e	Sheet	Front	sub-surface	**77.2**	**20.4**	**2.4**	*0.70*	*0.57*	*0.15*	0.12	-0.42	-0.33

Table 11 cont. SEM-EDX analysis data for the British Museum objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
Pendant 2006.LH.67	Sheet	Backing sheet	surface	**75.6**	**23.0**	**1.4**	*1.21*	*1.14*	*0.10*			
Pendant 2006.LH.67	Sheet	Backing sheet	sub-surface	**65.6**	**32.1**	**2.3**	*0.76*	*0.76*	*0.07*	0.15	-0.28	-0.37

Table 13. SEM-EDX analysis data of the pendant from Potteries Museum and Art Gallery analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K3	Sheet	Front	surface	**90.3**	**8.8**	**0.9**	*0.93*	*0.92*	*0.19*			
K3	Sheet	Front	sub-surface	**82.7**	**14.9**	**2.4**	*2.17*	*1.70*	*0.51*	0.09	-0.41	-0.61
K10	Sheet	Front	surface	**90.0**	**9.2**	**0.8**	*2.20*	*1.79*	*0.44*			
K10	Sheet	Front	sub-surface	**82.8**	**14.9**	**2.3**	*1.05*	*1.07*	*0.06*	0.09	-0.38	-0.67
K12	Sheet	Front	surface	**86.1**	**12.8**	**1.1**	*0.44*	*0.52*	*0.13*			
K12	Sheet	Front	sub-surface	**77.4**	**20.3**	**2.3**	*1.04*	*0.87*	*0.40*	0.11	-0.37	-0.54
K16	Sheet	Backing sheet	surface	**82.8**	**16.2**	**1.0**	*0.48*	*0.51*	*0.07*			
K16	Sheet	Backing sheet	sub-surface	**78.9**	**19.5**	**1.6**	*0.48*	*0.52*	*0.09*	0.05	-0.17	-0.35
K21	Sheet	Backing sheet	surface	**77.1**	**22.3**	**0.6**	*1.14*	*1.10*	*0.07*			
K21	Sheet	Backing sheet	sub-surface	**67.6**	**30.8**	**1.6**	*0.71*	*0.78*	*0.15*	0.14	-0.28	-0.64
K79	Sheet	Front	surface	**71.0**	**28.0**	**1.0**	*2.11*	*2.33*	*0.36*			
K79	Sheet	Front	sub-surface	**71.9**	**26.4**	**1.7**	*0.82*	*0.77*	*0.19*	-0.01	0.06	-0.43
K88	Sheet	Base Sheet	surface	**74.6**	**24.6**	**0.8**	*0.71*	*0.72*	*0.14*			
K88	Sheet	Base Sheet	sub-surface	**62.9**	**33.6**	**3.5**	*1.27*	*1.12*	*0.19*	0.18	-0.27	-0.76
K88	Cap	Cap	surface	**57.2**	**39.5**	**3.3**	*1.72*	*1.75*	*0.13*			
K88	Cap	Cap	sub-surface	**57.9**	**38.4**	**3.7**	*1.58*	*1.47*	*0.17*	-0.01	0.03	-0.11
K88	Wire (beaded)	Large filigree wire on panel	surface	**60.4**	**36.8**	**2.8**	*1.50*	*1.45*	*0.10*			
K88	Wire (beaded)	Large filigree wire on panel	sub-surface	**61.6**	**35.2**	**3.2**	*0.79*	*0.82*	*0.10*	-0.02	0.04	-0.13
K88	Wire (beaded)	Small filigree edge wire	surface	**56.6**	**42.1**	**1.3**	*1.85*	*1.81*	*0.44*			
K88	Wire (beaded)	Small filigree edge wire	sub-surface	**58.2**	**38.7**	**3.1**	*1.25*	*1.27*	*0.09*	-0.03	0.09	-0.59
K95	Body	Front	surface	**96.5**	**3.2**	**0.3**	*0.10*	*0.10*	*0.07*			
K95	Body	Front	sub-surface	**97.9**	**1.7**	**0.4**	*0.15*	*0.11*	*0.04*	-0.01	0.90	-0.14
K107	Sheet	Backing sheet	surface	**67.5**	**30.5**	**2.0**	*0.75*	*0.69*	*0.13*			
K107	Sheet	Backing sheet	sub-surface	**67.9**	**29.9**	**2.2**	*0.46*	*0.49*	*0.12*	0.00	0.02	-0.10
K107	Cell Wall	Cell wall	surface	**67.4**	**30.0**	**2.6**	*0.45*	*1.10*	*0.72*			
K107	Cell Wall	Cell wall	sub-surface	**66.0**	**31.7**	**2.3**	*0.55*	*0.63*	*0.15*	0.02	-0.05	0.14
K128	Body	Body	surface	**93.7**	**6.1**	**0.2**	*0.48*	*0.55*	*0.16*			
K128	Body	Body	sub-surface	**93.6**	**6.2**	**0.2**	*0.52*	*0.57*	*0.16*	0.00	-0.03	0.00
K130	Sheet	Backing sheet	surface	**89.2**	**7.5**	**3.3**	*0.19*	*0.40*	*0.35*			
K130	Sheet	Backing sheet	sub-surface	**88.8**	**7.6**	**3.6**	*0.45*	*0.49*	*0.16*	0.01	-0.01	-0.10
K133	Sheet	Edge	surface	**48.2**	**49.6**	**2.2**	*1.70*	*1.69*	*0.19*			
K133	Sheet	Edge	sub-surface	**47.2**	**50.5**	**2.3**	*0.67*	*0.60*	*0.09*	0.02	-0.02	-0.03
K135	Sheet	Interior sheet	surface	**90.5**	**9.1**	**0.4**	*0.62*	*0.62*	*0.08*			
K135	Sheet	Interior sheet	sub-surface	**74.7**	**22.8**	**2.5**	*1.20*	*1.25*	*0.11*	0.21	-0.46	-0.67

Table 14. SEM-EDX analysed data for the Staffordshire Hoard objects analysed during this study. .

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K136	Sheet	Back of sheet	surface	**81.6**	**17.4**	**1.0**	*1.43*	*1.01*	*0.45*			
K136	Sheet	Back of sheet	sub-surface	**79.3**	**19.1**	**1.6**	*1.80*	*1.54*	*0.36*	0.03	-0.09	-0.36
K140	Wire (beaded)	Wire	surface	**94.6**	**4.4**	**1.0**	*0.86*	*0.90*	*0.09*			
K140	Wire (beaded)	Wire	sub-surface	**95.7**	**3.2**	**1.1**	*0.18*	*0.16*	*0.05*	-0.01	0.39	-0.06
K271	Sheet	Backing sheet	surface	**85.8**	**12.0**	**2.2**	*0.79*	*0.61*	*0.23*			
K271	Sheet	Backing sheet	sub-surface	**77.3**	**18.8**	**3.9**	*2.15*	*1.94*	*0.82*	0.11	-0.36	-0.45
K273	Sheet	Backing sheet (back)	surface	**85.4**	**14.1**	**0.5**	*1.61*	*1.64*	*0.08*			
K273	Sheet	Backing sheet (back)	sub-surface	**81.0**	**17.1**	**1.9**	*0.39*	*0.41*	*0.05*	0.05	-0.18	-0.74
K276	Sheet	Backing sheet	surface	**89.5**	**8.8**	**1.7**	*0.67*	*0.61*	*0.34*			
K276	Sheet	Backing sheet	sub-surface	**72.9**	**22.7**	**4.4**	*0.35*	*0.28*	*0.16*	0.23	-0.61	-0.63
K276	Wire (twisted)	Twisted wire	surface	**78.0**	**19.3**	**2.7**	*2.47*	*1.94*	*0.58*			
K276	Wire (twisted)	Twisted wire	sub-surface	**71.1**	**25.3**	**3.6**	*0.32*	*0.76*	*0.49*	0.10	-0.24	-0.23
K278	Sheet	Backing sheet	surface	**75.3**	**23.3**	**1.4**	*1.14*	*1.05*	*0.20*			
K278	Sheet	Backing sheet	sub-surface	**68.9**	**28.6**	**2.5**	*0.74*	*0.74*	*0.06*	0.09	-0.19	-0.45
K281	Sheet	Backing sheet	surface	**79.2**	**18.9**	**1.9**	*1.13*	*0.95*	*0.24*			
K281	Sheet	Backing sheet	sub-surface	**70.3**	**26.9**	**2.8**	*1.93*	*2.02*	*0.18*	0.12	-0.30	-0.30
K281	Wire (Beaded)	Wire	surface	**68.1**	**28.8**	**3.1**	*0.86*	*0.91*	*0.48*			
K281	Wire (Beaded)	Wire	sub-surface	**69.3**	**28.3**	**2.4**	*0.89*	*0.94*	*0.07*	-0.02	0.02	0.30
K284	Sheet	Base sheet	surface	**90.1**	**9.0**	**0.9**	*0.55*	*0.54*	*0.04*			
K284	Sheet	Base sheet	sub-surface	**71.8**	**26.1**	**2.1**	*1.00*	*0.96*	*0.10*	0.26	-0.66	-0.57
K288	Sheet	Backing sheet	surface	**83.8**	**15.7**	**0.5**	*1.43*	*1.32*	*0.20*			
K288	Sheet	Backing sheet	sub-surface	**73.2**	**24.7**	**2.1**	*0.77*	*0.73*	*0.13*	0.14	-0.36	-0.76
K292	Sheet	Base sheet	surface	**79.3**	**18.4**	**2.3**	*1.70*	*1.53*	*0.29*			
K292	Sheet	Base sheet	sub-surface	**85.3**	**12.3**	**2.4**	*0.52*	*0.53*	*0.06*	-0.07	0.50	-0.04
K292	Cap	Cap	surface	**77.9**	**19.0**	**3.1**	*0.91*	*0.58*	*0.46*			
K292	Cap	Cap	sub-surface	**81.0**	**16.1**	**2.9**	*0.92*	*0.83*	*0.60*	-0.04	0.18	0.06
K292	Cell Wall	Cell wall/border	surface	**77.6**	**19.8**	**2.6**	*0.53*	*0.48*	*0.11*			
K292	Cell Wall	Cell wall/border	sub-surface	**79.9**	**17.5**	**2.6**	*0.82*	*0.80*	*0.08*	-0.03	0.13	0.03
K292	Sheet	Rivet base	surface	**69.7**	**28.2**	**2.1**						
K292	Sheet	Rivet base	sub-surface	**77.2**	**20.8**	**2.0**						
K294	Sheet	Base sheet	surface	**74.7**	**23.8**	**1.5**	*0.79*	*0.84*	*0.19*			
K294	Sheet	Base sheet	sub-surface	**70.2**	**26.0**	**3.8**	*1.36*	*1.54*	*0.45*	0.06	-0.09	-0.59

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K294	Cell Wall	Cell Wall	surface	**67.5**	**30.3**	**2.2**	*1.50*	*1.55*	*0.11*			
K294	Cell Wall	Cell Wall	sub-surface	**71.2**	**26.4**	**2.4**	*0.83*	*0.81*	*0.11*	-0.05	0.15	-0.09
K294	Wire (beaded)	Large filigree wire on panel	surface	**68.3**	**28.9**	**2.8**	*2.27*	*2.10*	*0.36*			
K294	Wire (beaded)	Large filigree wire on panel	sub-surface	**69.1**	**28.0**	**2.9**	*1.75*	*1.74*	*0.41*	-0.01	0.03	-0.04
K294	Wire (twisted)	Twisted Wire	surface	**68.5**	**27.8**	**3.7**	*0.35*	*0.29*	*0.36*			
K294	Wire (twisted)	Twisted Wire	sub-surface	**70.5**	**26.6**	**2.9**	*1.11*	*1.18*	*0.44*	-0.03	0.05	0.25
K297	Wire (beaded)	Filigree wire	surface	**77.4**	**20.9**	**1.7**	*1.24*	*1.27*	*0.15*			
K297	Wire (beaded)	Filigree wire	sub-surface	**78.0**	**20.2**	**1.8**	*0.47*	*0.51*	*0.25*	-0.01	0.03	-0.04
K297	Sheet	Front of backing sheet	surface	**82.7**	**15.9**	**1.4**	*2.37*	*2.27*	*0.22*			
K297	Sheet	Front of backing sheet	sub-surface	**75.8**	**22.2**	**2.0**	*0.70*	*0.82*	*0.47*	0.09	-0.29	-0.32
K300	Sheet	Backing sheet	surface	**89.7**	**9.4**	**0.9**	*1.14*	*1.18*	*0.11*			
K300	Sheet	Backing sheet	sub-surface	**88.2**	**9.8**	**2.0**	*0.33*	*0.35*	*0.08*	0.02	-0.04	-0.53
K300	Wire (bead)	Bead	surface	**84.3**	**13.6**	**2.1**	*1.32*	*1.49*	*0.18*			
K300	Wire (bead)	Bead	sub-surface	**90.9**	**7.8**	**1.3**	*0.23*	*0.26*	*0.07*	-0.07	0.74	0.57
K300	Wire (beaded)	Large beaded wire	surface	**85.5**	**13.3**	**1.2**	*1.11*	*1.06*	*0.09*			
K300	Wire (beaded)	Large beaded wire	sub-surface	**90.2**	**8.7**	**1.1**	*1.23*	*1.15*	*0.12*	-0.05	0.54	0.09
K300	Wire (beaded)	Small beaded wire	surface	**87.5**	**11.5**	**1.0**	*1.17*	*1.09*	*0.24*			
K300	Wire (beaded)	Small beaded wire	sub-surface	**90.4**	**8.5**	**1.1**	*0.76*	*0.63*	*0.16*	-0.03	0.35	-0.07
K301	Sheet	Back of piece	surface	**88.4**	**10.7**	**0.9**	*1.43*	*1.21*	*0.29*			
K301	Sheet	Back of piece	sub-surface	**79.0**	**19.0**	**2.0**	*0.63*	*0.56*	*0.09*	0.12	-0.44	-0.58
K301	Sheet	Base Sheet	surface	**82.4**	**16.8**	**0.8**	*1.23*	*1.23*	*0.05*			
K301	Sheet	Base Sheet	sub-surface	**81.7**	**15.9**	**2.4**	*1.13*	*1.02*	*0.21*	0.01	0.06	-0.67
K301	Cell Wall	Cell Wall	surface	**71.9**	**26.0**	**2.1**	*0.88*	*1.22*	*0.47*			
K301	Cell Wall	Cell Wall	sub-surface	**74.0**	**23.7**	**2.3**	*1.46*	*1.27*	*0.20*	-0.03	0.10	-0.08
K301	Wire (beaded)	Large filigree edge wire	surface	**64.9**	**34.0**	**1.1**	*3.26*	*3.21*	*0.12*			
K301	Wire (beaded)	Large filigree edge wire	sub-surface	**66.7**	**31.4**	**1.9**	*1.43*	*1.38*	*0.06*	-0.03	0.08	-0.42
K301	Wire (beaded)	Large filigree wire on panel	surface	**74.8**	**24.0**	**1.2**	*1.52*	*1.32*	*0.27*			
K301	Wire (beaded)	Large filigree wire on panel	sub-surface	**78.1**	**19.6**	**2.3**	*1.35*	*1.28*	*0.11*	-0.04	0.22	-0.49
K302	Sheet	Backing sheet	surface	**74.6**	**24.0**	**1.4**	*1.70*	*1.75*	*0.25*			
K302	Sheet	Backing sheet	sub-surface	**74.7**	**22.7**	**2.6**	*0.48*	*0.51*	*0.21*	0.00	0.06	-0.48

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K303	Sheet	Back sheet	surface	**89.5**	**8.8**	**1.7**	*0.96*	*0.55*	*0.50*			
K303	Sheet	Back sheet	sub-surface	**84.3**	**10.9**	**4.8**	*0.81*	*0.91*	*0.38*	0.06	-0.19	-0.65
K303	Wire (beaded)	Filigree	surface	**84.0**	**12.8**	**3.2**	*1.04*	*1.09*	*0.18*			
K303	Wire (beaded)	Filigree	sub-surface	**86.8**	**10.6**	**2.6**	*0.81*	*0.95*	*0.25*	-0.03	0.21	0.23
K303	Wire (beaded)	Filigree backing panel	surface	**90.7**	**7.8**	**1.5**	*1.19*	*1.03*	*0.23*			
K303	Wire (beaded)	Filigree backing panel	sub-surface	**84.4**	**12.3**	**3.3**	*0.81*	*0.79*	*0.72*	0.08	-0.37	-0.55
K303	Wire (beaded)	Large filigree border	surface	**85.3**	**12.2**	**2.5**	*1.75*	*1.71*	*0.15*			
K303	Wire (beaded)	Large filigree border	sub-surface	**86.6**	**11.0**	**2.4**	*0.19*	*0.17*	*0.07*	-0.02	0.11	0.07
K306	Sheet	Backing sheet	surface	**90.3**	**9.1**	**0.6**	*0.18*	*0.18*	*0.03*			
K306	Sheet	Backing sheet	sub-surface	**72.1**	**25.4**	**2.5**	*0.35*	*0.34*	*0.12*	0.25	-0.64	-0.75
K306	Cap	Cap	surface	**71.2**	**27.0**	**1.8**	*2.08*	*1.96*	*0.26*			
K306	Cap	Cap	sub-surface	**71.3**	**26.3**	**2.4**	*1.16*	*1.11*	*0.12*	0.00	0.03	-0.25
K306	Wire (beaded)	Wire	surface	**69.8**	**27.8**	**2.4**	*3.57*	*3.04*	*0.61*			
K306	Wire (beaded)	Wire	sub-surface	**72.7**	**25.0**	**2.3**	*1.75*	*1.74*	*0.37*	-0.04	0.11	0.04
K309	Sheet	Front	surface	**1.0**	**95.4**	**3.6**	*0.35*	*0.22*	*0.15*			
K309	Sheet	Front	sub-surface	**0.3**	**96.9**	**2.8**	*0.53*	*0.47*	*0.45*	2.32	-0.02	0.26
K347	Sheet	Base Sheet	surface	**75.1**	**23.1**	**1.8**	*1.61*	*1.58*	*0.07*			
K347	Sheet	Base Sheet	sub-surface	**75.5**	**22.6**	**1.9**	*1.78*	*1.81*	*0.08*	-0.01	0.02	-0.08
K347	Sheet	Raised detail	surface	**75.2**	**23.8**	**1.0**	*0.96*	*0.80*	*0.16*			
K347	Sheet	Raised detail	sub-surface	**71.5**	**26.5**	**2.0**	*1.47*	*1.13*	*0.41*	0.05	-0.10	-0.49
K347	Sheet	Sheet below detail	surface	**80.1**	**18.7**	**1.2**	*1.28*	*1.19*	*0.15*			
K347	Sheet	Sheet below detail	sub-surface	**70.3**	**26.8**	**2.9**	*0.70*	*0.71*	*0.17*	0.14	-0.30	-0.57
K349	Sheet	Base sheet	surface	**88.9**	**8.7**	**2.4**	*1.07*	*1.06*	*0.32*			
K349	Sheet	Base sheet	sub-surface	**82.9**	**14.0**	**3.1**	*0.41*	*0.51*	*0.16*	0.07	-0.38	-0.23
K349	Cell Wall (border)	Gold panel	surface	**77.3**	**19.6**	**3.1**	*0.75*	*0.88*	*0.23*			
K349	Cell Wall (border)	Gold panel	sub-surface	**78.1**	**19.1**	**2.8**	*0.35*	*0.37*	*0.08*	-0.01	0.03	0.11
K352	Sheet	Backing sheet	surface	**85.2**	**12.2**	**2.6**	*2.60*	*2.39*	*0.25*			
K352	Sheet	Backing sheet	sub-surface	**81.6**	**15.6**	**2.8**	*0.30*	*0.33*	*0.10*	0.04	-0.22	-0.07
K352	Cap	Cap	surface	**85.6**	**12.5**	**1.9**	*0.14*	*0.18*	*0.09*			
K352	Cap	Cap	sub-surface	**80.1**	**17.8**	**2.1**	*1.36*	*1.39*	*0.07*	0.07	-0.30	-0.10
K352	Cell Wall (border)	Panel	surface	**91.7**	**7.4**	**0.9**	*0.40*	*0.33*	*0.11*			
K352	Cell Wall (border)	Panel	sub-surface	**80.3**	**17.1**	**2.6**	*0.81*	*0.68*	*0.32*	0.14	-0.56	-0.68
K354	Sheet	Base sheet	surface	**89.2**	**10.2**	**0.6**	*0.60*	*0.60*	*0.07*			
K354	Sheet	Base sheet	sub-surface	**85.0**	**13.9**	**1.1**	*0.84*	*0.78*	*0.16*	0.05	-0.27	-0.47

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K356	Wire (beaded)	Border filigree wire	surface	**79.7**	**18.6**	**1.7**	*0.13*	*0.04*	*0.09*			
K356	Wire (beaded)	Border filigree wire	sub-surface	**80.7**	**17.5**	**1.8**	*0.13*	*0.18*	*0.06*	-0.01	0.07	-0.06
K356	Cell Wall	Cell wall	surface	**76.5**	**20.1**	**3.4**	*0.94*	*1.68*	*1.23*			
K356	Cell Wall	Cell wall	sub-surface	**80.3**	**16.0**	**3.7**	*0.44*	*0.56*	*0.72*	-0.05	0.26	-0.09
K356	Cell Wall (border)	Edge wall	surface	**78.2**	**20.3**	**1.5**	*2.97*	*3.07*	*0.11*			
K356	Cell Wall (border)	Edge wall	sub-surface	**81.4**	**16.9**	**1.7**	*2.16*	*2.27*	*0.12*	-0.04	0.20	-0.08
K356	Wire (beaded)	Filigree wire	surface	**75.7**	**22.7**	**1.6**	*3.50*	*3.79*	*0.33*			
K356	Wire (beaded)	Filigree wire	sub-surface	**82.7**	**15.3**	**2.0**	*1.00*	*0.99*	*0.10*	-0.08	0.48	-0.20
K356	Sheet	Side sheet	surface	**72.3**	**26.2**	**1.5**	*2.89*	*2.94*	*0.11*			
K356	Sheet	Side sheet	sub-surface	**81.7**	**16.6**	**1.7**	*0.56*	*0.59*	*0.07*	-0.12	0.58	-0.09
K358	Body	Base gold	surface	**97.5**	**2.3**	**0.2**	*0.51*	*0.46*	*0.10*			
K358	Body	Base gold	sub-surface	**91.8**	**6.0**	**2.2**	*0.86*	*0.64*	*0.23*	0.06	-0.61	-0.89
K358	Cell Wall (border)	Border of niello panel	surface	**82.7**	**15.6**	**1.7**	*1.82*	*1.75*	*0.10*			
K358	Cell Wall (border)	Border of niello panel	sub-surface	**81.9**	**16.2**	**1.9**	*0.31*	*0.33*	*0.08*	0.01	-0.04	-0.08
K358	Cell Wall (border)	Niello panel	surface	**94.7**	**4.4**	**0.9**	*0.67*	*0.70*	*0.07*			
K358	Cell Wall (border)	Niello panel	sub-surface	**94.8**	**4.2**	**1.0**	*0.81*	*0.50*	*0.07*	0.00	0.07	-0.08
K360	Sheet	Base gold (interior)	surface	**69.3**	**27.8**	**2.9**	*0.88*	*0.86*	*0.14*			
K360	Sheet	Base gold (interior)	sub-surface	**70.2**	**27.2**	**2.6**	*1.17*	*1.13*	*0.40*	-0.01	0.02	0.09
K365	Sheet	Backing sheet	surface	**85.7**	**13.5**	**0.8**	*0.66*	*0.65*	*0.03*			
K365	Sheet	Backing sheet	sub-surface	**72.6**	**25.8**	**1.6**	*0.58*	*0.54*	*0.09*	0.18	-0.48	-0.51
K365	Wire (beaded)	Beaded wire	surface	**75.7**	**22.8**	**1.5**	*2.87*	*2.64*	*0.30*			
K365	Wire (beaded)	Beaded wire	sub-surface	**69.4**	**28.7**	**1.9**	*2.09*	*2.09*	*0.15*	0.09	-0.21	-0.22
K370	Sheet	Base Sheet	surface	**84.5**	**14.0**	**1.5**	*0.67*	*0.59*	*0.16*			
K370	Sheet	Base Sheet	sub-surface	**82.1**	**15.3**	**2.6**	*0.56*	*0.56*	*0.16*	0.03	-0.09	-0.43
K375	Sheet	Backing sheet	surface	**87.1**	**10.3**	**2.6**	*1.44*	*1.17*	*0.41*			
K375	Sheet	Backing sheet	sub-surface	**75.3**	**21.7**	**3.0**	*0.94*	*0.71*	*0.40*	0.16	-0.53	-0.15
K375	Wire (beaded)	Beaded wire	surface	**77.3**	**20.6**	**2.1**	*3.22*	*3.24*	*0.22*			
K375	Wire (beaded)	Beaded wire	sub-surface	**76.4**	**21.8**	**1.8**	*1.21*	*1.20*	*0.07*	0.01	-0.05	0.15
K376	Sheet	Base sheet	surface	**71.6**	**26.7**	**1.7**	*1.01*	*1.06*	*0.09*			
K376	Sheet	Base sheet	sub-surface	**70.4**	**27.8**	**1.8**	*1.04*	*1.01*	*0.06*	0.02	-0.04	-0.07
K376	Sheet	Base sheet (side)	surface	**73.5**	**24.1**	**2.4**	*1.10*	*0.74*	*0.37*			
K376	Sheet	Base sheet (side)	sub-surface	**72.5**	**25.3**	**2.2**	*1.61*	*1.50*	*0.12*	0.02	-0.05	0.07
K376	Cell wall	Cell wall	surface	**71.2**	**24.7**	**4.1**	*1.58*	*1.37*	*0.24*			
K376	Cell wall	Cell wall	sub-surface	**70.3**	**24.8**	**4.9**	*1.60*	*2.27*	*1.41*	0.01	0.00	-0.15

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K377	Body	Base bar	surface	**89.1**	**9.7**	**1.2**	*0.85*	*0.64*	*0.24*			
K377	Body	Base bar	sub-surface	**86.8**	**11.5**	**1.7**	*0.25*	*0.24*	*0.05*	0.01	-0.06	-0.08
K377	Sheet	Base sheet	surface	**87.7**	**11.5**	**0.8**	*0.21*	*0.20*	*0.07*			
K377	Sheet	Base sheet	sub-surface	**86.9**	**12.2**	**0.9**	*0.41*	*0.40*	*0.03*	0.01	-0.05	-0.34
K377	Cell wall	Cell wall	surface	**87.9**	**11.2**	**0.9**	*0.80*	*0.72*	*0.10*			
K377	Cell wall	Cell wall	sub-surface	**86.7**	**11.9**	**1.4**	*0.58*	*0.43*	*0.67*	0.03	-0.15	-0.29
K379	Sheet	Backing sheet	surface	**85.3**	**13.4**	**1.3**	*0.88*	*0.87*	*0.12*			
K379	Sheet	Backing sheet	sub-surface	**74.1**	**23.4**	**2.5**	*0.53*	*0.49*	*0.09*	0.15	-0.43	-0.48
K379	Wire (beaded)	Wire	surface	**61.3**	**36.4**	**2.3**	*3.33*	*2.99*	*0.45*			
K379	Wire (beaded)	Wire	sub-surface	**73.4**	**24.5**	**2.1**	*0.70*	*0.56*	*0.42*	-0.17	0.49	0.10
K381	Sheet	Backing sheet	surface	**76.9**	**21.0**	**2.1**	*3.02*	*1.70*	*1.50*			
K381	Sheet	Backing sheet	sub-surface	**63.5**	**34.1**	**2.4**	*0.93*	*0.89*	*0.10*	0.21	-0.39	-0.13
K381	Cap	Cap	surface	**87.8**	**10.0**	**2.2**	*0.89*	*0.71*	*0.22*			
K381	Cap	Cap	sub-surface	**72.1**	**24.3**	**3.6**	*0.96*	*0.95*	*0.50*	0.22	-0.59	-0.39
K399	Sheet	Collar backing sheet	surface	**86.2**	**10.8**	**3.0**	*0.81*	*1.04*	*0.30*			
K399	Sheet	Collar backing sheet	sub-surface	**73.9**	**23.1**	**3.0**	*1.39*	*1.36*	*0.16*	0.17	-0.53	0.03
K399	Sheet	Hilt plate backing sheet	surface	**81.1**	**16.9**	**2.0**	*0.87*	*0.94*	*0.12*			
K399	Sheet	Hilt plate backing sheet	sub-surface	**75.3**	**22.2**	**2.5**	*0.39*	*0.51*	*0.18*	0.08	-0.24	-0.19
K399	Wire (twisted)	Hilt plate wire	surface	**84.4**	**13.0**	**2.6**	*2.00*	*1.42*	*0.77*			
K399	Wire (twisted)	Hilt plate wire	sub-surface	**76.9**	**20.8**	**2.3**	*2.32*	*2.33*	*0.16*	0.10	-0.37	0.14
K449	Sheet	Base sheet	surface	**85.2**	**13.1**	**1.7**	*0.73*	*0.62*	*0.16*			
K449	Sheet	Base sheet	sub-surface	**82.2**	**15.5**	**2.3**	*1.04*	*0.94*	*0.14*	0.04	-0.16	-0.29
K451	Body	Base	surface	**75.8**	**22.0**	**2.2**	*0.39*	*0.37*	*0.14*			
K451	Body	Base	sub-surface	**78.0**	**19.3**	**2.7**	*0.20*	*0.20*	*0.05*	-0.03	0.14	-0.19
K451	Cell Wall	Cell wall	surface	**70.1**	**24.6**	**5.3**	*2.24*	*1.87*	*2.19*			
K451	Cell Wall	Cell wall	sub-surface	**73.7**	**22.6**	**3.7**	*1.86*	*1.84*	*1.55*	-0.04	0.08	0.37
K454	Sheet	Backing sheet	surface	**90.6**	**8.0**	**1.4**	*1.18*	*1.11*	*0.09*			
K454	Sheet	Backing sheet	sub-surface	**88.9**	**8.1**	**3.0**	*0.95*	*0.89*	*0.57*	0.02	-0.01	-0.52
K455	Sheet	Base sheet	surface	**83.4**	**14.6**	**2.0**	*0.43*	*0.38*	*0.13*			
K455	Sheet	Base sheet	sub-surface	**81.1**	**16.5**	**2.4**	*1.13*	*1.07*	*0.34*	0.03	-0.12	-0.14
K455	Wire (beaded)	Beaded wire	surface	**82.3**	**15.7**	**2.0**	*1.25*	*1.31*	*0.34*			
K455	Wire (beaded)	Beaded wire	sub-surface	**82.5**	**15.7**	**1.8**	*1.09*	*1.21*	*0.19*	0.00	0.00	0.10

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K457	Sheet	Backing sheet	surface	**90.4**	**9.0**	**0.6**	*0.78*	*0.81*	*0.10*			
K457	Sheet	Backing sheet	sub-surface	**82.8**	**15.1**	**2.1**	*0.69*	*0.65*	*0.09*	0.09	-0.41	-0.71
K457	Cap	Cap	surface	**85.0**	**13.1**	**1.9**	*0.76*	*0.79*	*0.08*			
K457	Cap	Cap	sub-surface	**81.4**	**16.5**	**2.1**	*1.32*	*1.35*	*0.09*	0.04	-0.20	-0.08
K457	Wire (beaded)	Filigree	surface	**84.4**	**13.4**	**2.2**	*1.74*	*1.71*	*0.09*			
K457	Wire (beaded)	Filigree	sub-surface	**82.2**	**15.7**	**2.1**	*2.08*	*2.03*	*0.11*	0.03	-0.15	0.04
K458	Sheet	Base sheet	surface	**79.3**	**18.8**	**1.9**	*1.46*	*1.39*	*0.19*			
K458	Sheet	Base sheet	sub-surface	**70.0**	**27.0**	**3.0**	*1.02*	*1.04*	*0.21*	0.13	-0.31	-0.36
K458	Wire (beaded)	Filigree wire	surface	**68.1**	**29.5**	**2.4**	*1.34*	*1.23*	*0.19*			
K458	Wire (beaded)	Filigree wire	sub-surface	**68.2**	**29.3**	**2.5**	*1.73*	*1.76*	*0.11*	0.00	0.01	-0.03
K462	Body	Base bar	surface	**84.7**	**14.0**	**1.3**	*0.61*	*0.59*	*0.09*			
K462	Body	Base bar	sub-surface	**87.8**	**10.9**	**1.3**	*0.70*	*0.71*	*0.13*	-0.05	0.34	0.03
K462	Sheet	Base sheet	surface	**82.2**	**16.6**	**1.2**	*0.50*	*0.51*	*0.03*			
K462	Sheet	Base sheet	sub-surface	**86.5**	**12.4**	**1.1**	*0.38*	*0.38*	*0.05*	-0.04	0.29	-0.01
K462	Cell wall	Cell wall	surface	**81.6**	**17.2**	**1.2**	*0.77*	*1.08*	*0.40*			
K462	Cell wall	Cell wall	sub-surface	**86.3**	**11.4**	**2.3**	*0.55*	*0.82*	*0.79*	-0.06	0.51	-0.48
K465	Sheet	Base sheet	surface	**65.1**	**32.4**	**2.5**	*0.29*	*0.32*	*0.08*			
K465	Sheet	Base sheet	sub-surface	**66.7**	**30.6**	**2.7**	*0.30*	*0.30*	*0.09*	-0.02	0.06	-0.08
K465	Cap	Cap	surface	**65.2**	**32.9**	**1.9**	*0.46*	*0.58*	*0.25*			
K465	Cap	Cap	sub-surface	**65.9**	**32.2**	**1.9**	*1.02*	*1.05*	*0.08*	-0.01	0.02	-0.01
K465	Cell wall	Cell wall	surface	**69.0**	**28.3**	**2.7**	*1.34*	*1.37*	*0.08*			
K465	Cell wall	Cell wall	sub-surface	**69.9**	**27.2**	**2.9**	*2.36*	*2.41*	*0.09*	-0.01	0.04	-0.06
K468	Sheet	Back of sheet	surface	**73.9**	**22.1**	**4.0**	*0.88*	*1.19*	*0.43*			
K468	Sheet	Back of sheet	sub-surface	**74.9**	**21.8**	**3.3**	*1.31*	*1.33*	*0.07*	-0.01	0.01	0.22
K468	Sheet	Front of sheet	surface	**76.4**	**19.9**	**3.7**	*0.27*	*0.20*	*0.12*			
K468	Sheet	Front of sheet	sub-surface	**75.1**	**20.9**	**4.0**	*0.26*	*0.34*	*0.26*	0.02	-0.05	-0.07
K513	Sheet	Backing sheet of mount	surface	**82.5**	**16.4**	**1.1**	*0.28*	*0.24*	*0.05*			
K513	Sheet	Backing sheet of mount	sub-surface	**78.3**	**19.7**	**2.0**	*2.53*	*2.24*	*0.37*	0.05	-0.17	-0.44
K513	Sheet	Backing sheet of panel	surface	**75.8**	**22.8**	**1.4**	*2.63*	*2.31*	*0.42*			
K513	Sheet	Backing sheet of panel	sub-surface	**65.4**	**32.1**	**2.5**	*3.09*	*2.87*	*0.32*	0.16	-0.29	-0.44
K513	Cell wall	Cell wall of panel	surface	**70.6**	**26.6**	**2.8**	*1.09*	*1.16*	*0.27*			
K513	Cell wall	Cell wall of panel	sub-surface	**70.1**	**27.3**	**2.6**	*2.28*	*2.16*	*0.27*	0.01	-0.03	0.08
K513	Wire (beaded)	Panel filigree	surface	**72.2**	**25.7**	**2.1**	*0.90*	*1.06*	*0.34*			
K513	Wire (beaded)	Panel filigree	sub-surface	**73.6**	**24.3**	**2.1**	*2.85*	*2.87*	*0.05*	-0.02	0.06	0.00

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K545	Sheet	Back sheet	surface	**84.2**	**13.5**	**2.3**	*0.52*	*0.47*	*0.08*			
K545	Sheet	Back sheet	sub-surface	**87.6**	**9.3**	**3.1**	*0.25*	*0.20*	*0.09*	-0.04	0.45	-0.27
K545	Sheet	Backing sheet (back)	surface	**85.5**	**11.8**	**2.7**	*0.70*	*0.64*	*0.07*			
K545	Sheet	Backing sheet (back)	sub-surface	**88.6**	**8.2**	**3.2**	*0.29*	*0.30*	*0.09*	-0.04	0.44	-0.15
K545	Sheet	Backing sheet (front)	surface	**86.4**	**10.9**	**2.7**	*0.35*	*0.44*	*0.09*			
K545	Sheet	Backing sheet (front)	sub-surface	**88.9**	**8.0**	**3.1**	*0.22*	*0.17*	*0.11*	-0.03	0.37	-0.14
K545	Wire (straight)	Centre wire	surface	**68.3**	**30.7**	**1.0**	*1.33*	*1.36*	*0.10*			
K545	Wire (straight)	Centre wire	sub-surface	**69.9**	**27.9**	**2.2**	*1.11*	*1.10*	*0.09*	-0.02	0.10	-0.53
K545	Cell wall	Front cell wall	surface	**85.1**	**12.0**	**2.9**	*0.21*	*0.19*	*0.05*			
K545	Cell wall	Front cell wall	sub-surface	**88.1**	**8.8**	**3.1**	*0.26*	*0.31*	*0.08*	-0.03	0.37	-0.07
K547	Sheet	Backing sheet	surface	**91.3**	**7.9**	**0.8**	*0.71*	*0.64*	*0.11*			
K547	Sheet	Backing sheet	sub-surface	**75.5**	**22.0**	**2.5**	*0.48*	*0.45*	*0.08*	0.21	-0.64	-0.68
K550	Sheet	Front side	surface	**71.3**	**26.5**	**2.2**	*2.16*	*2.08*	*0.25*			
K550	Sheet	Front side	sub-surface	**74.7**	**22.9**	**2.4**	*1.26*	*1.31*	*0.14*	-0.05	0.16	-0.08
K552	Sheet	Backing sheet	surface	**85.9**	**13.4**	**0.7**	*0.67*	*0.62*	*0.09*			
K552	Sheet	Backing sheet	sub-surface	**73.1**	**24.9**	**2.0**	*1.33*	*1.33*	*0.06*	0.18	-0.46	-0.67
K552	Sheet	Raised backing sheet	surface	**85.4**	**13.5**	**1.1**	*0.78*	*0.82*	*0.08*			
K552	Sheet	Raised backing sheet	sub-surface	**71.1**	**26.3**	**2.6**	*0.63*	*0.64*	*0.10*	0.20	-0.49	-0.59
K554	Sheet	Base sheet	surface	**85.7**	**12.6**	**1.7**	*0.37*	*0.39*	*0.04*			
K554	Sheet	Base sheet	sub-surface	**76.6**	**20.3**	**3.1**	*0.66*	*0.56*	*0.22*	0.12	-0.38	-0.46
K560	Sheet	Backing sheet (back)	surface	**95.4**	**4.3**	**0.3**	*0.71*	*0.64*	*0.08*			
K560	Sheet	Backing sheet (back)	sub-surface	**77.9**	**20.0**	**2.1**	*1.13*	*1.13*	*0.07*	0.23	-0.79	-0.85
K567	Body	Front	surface	**87.5**	**11.8**	**0.7**	*0.74*	*0.86*	*0.08*			
K567	Body	Front	sub-surface	**87.9**	**11.4**	**0.7**	*0.67*	*0.77*	*0.06*	-0.02	0.03	-0.01
K652	Sheet	Back of decorated sheet	surface	**89.0**	**6.1**	**4.9**	*0.54*	*0.36*	*0.75*			
K652	Sheet	Back of decorated sheet	sub-surface	**89.8**	**7.5**	**2.7**	*0.64*	*0.53*	*0.17*	-0.01	-0.19	0.83
K652	Sheet	Back of gap sheet	surface	**88.2**	**6.3**	**5.5**	*0.74*	*0.39*	*0.43*			
K652	Sheet	Back of gap sheet	sub-surface	**85.9**	**9.5**	**4.6**	*0.92*	*0.52*	*1.27*	0.03	-0.34	0.20
K652	Sheet	Backing sheet	surface	**88.4**	**5.2**	**6.4**	*0.44*	*0.31*	*0.34*			
K652	Sheet	Backing sheet	sub-surface	**89.2**	**7.3**	**3.5**	*0.65*	*0.43*	*0.73*	-0.01	-0.29	0.84
K652	Sheet	Front of decorated sheet	surface	**94.4**	**4.9**	**0.7**	*0.19*	*0.15*	*0.06*			
K652	Sheet	Front of decorated sheet	sub-surface	**89.0**	**8.3**	**2.7**	*0.24*	*0.23*	*0.07*	0.06	-0.41	-0.74
K653	Sheet	Front of backing sheet	surface	**83.0**	**15.5**	**1.5**	*2.16*	*2.26*	*0.34*			
K653	Sheet	Front of backing sheet	sub-surface	**69.4**	**27.5**	**3.1**	*0.51*	*0.72*	*0.75*	0.20	-0.44	-0.52

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K655	Sheet	Back	surface	**83.2**	**16.3**	**0.5**	*0.74*	*0.67*	*0.09*			
K655	Sheet	Back	sub-surface	**80.8**	**17.8**	**1.4**	*1.41*	*1.09*	*0.36*	0.03	-0.09	-0.62
K655	Sheet	Front	surface	**87.1**	**12.6**	**0.3**	*1.40*	*1.40*	*0.09*			
K655	Sheet	Front	sub-surface	**83.0**	**16.0**	**1.0**	*0.56*	*0.47*	*0.16*	0.05	-0.21	-0.67
K656	Sheet	Base	surface	**82.0**	**17.6**	**0.4**	*1.49*	*1.49*	*0.04*			
K656	Sheet	Base	sub-surface	**71.4**	**26.5**	**2.1**	*0.60*	*0.64*	*0.07*	0.15	-0.34	-0.82
K657	Sheet	Base	surface	**76.4**	**22.6**	**1.0**	*1.02*	*1.01*	*0.07*			
K657	Sheet	Base	sub-surface	**72.3**	**25.6**	**2.1**	*0.64*	*0.72*	*0.11*	0.06	-0.12	-0.52
K658	Sheet	Base	surface	**76.2**	**23.0**	**0.8**	*0.47*	*0.47*	*0.05*			
K658	Sheet	Base	sub-surface	**72.4**	**25.6**	**2.0**	*0.27*	*0.25*	*0.05*	0.05	-0.10	-0.60
K659	Sheet	Base	surface	**74.6**	**23.9**	**1.5**	*0.45*	*0.44*	*0.08*			
K659	Sheet	Base	sub-surface	**72.1**	**25.8**	**2.1**	*0.88*	*0.86*	*0.06*	0.04	-0.07	-0.30
K659	Cell wall	Repair	surface	**57.3**	**41.0**	**1.7**	*0.53*	*0.57*	*0.06*			
K659	Cell wall	Repair	sub-surface	**58.7**	**39.5**	**1.8**	*1.47*	*1.48*	*0.14*	-0.02	0.04	-0.08
K660	Sheet	Base gold	surface	**93.0**	**6.0**	**1.0**	*0.99*	*0.89*	*0.16*			
K660	Sheet	Base gold	sub-surface	**90.6**	**7.5**	**1.9**	*0.49*	*0.28*	*0.28*	0.03	-0.19	-0.47
K660	Sheet	Base gold (interior)	surface	**90.8**	**7.5**	**1.7**	*0.48*	*0.26*	*0.32*			
K660	Sheet	Base gold (interior)	sub-surface	**90.3**	**7.5**	**2.2**	*0.38*	*0.33*	*0.23*	0.01	0.00	-0.22
K669	Sheet	Backing sheet	surface	**65.5**	**33.1**	**1.4**	*0.84*	*0.79*	*0.12*			
K669	Sheet	Backing sheet	sub-surface	**52.2**	**45.4**	**2.4**	*1.99*	*2.05*	*0.08*	0.26	-0.27	-0.41
K669	Cap	Cap	surface	**65.7**	**33.1**	**1.2**	*3.48*	*3.29*	*0.22*			
K669	Cap	Cap	sub-surface	**53.9**	**43.6**	**2.5**	*4.44*	*4.56*	*0.15*	0.22	-0.24	-0.55
K673	Sheet	Backing sheet	surface	**81.1**	**17.6**	**1.3**	*2.26*	*2.09*	*0.28*			
K673	Sheet	Backing sheet	sub-surface	**78.4**	**19.4**	**2.2**	*1.58*	*1.52*	*0.14*	0.03	-0.10	-0.40
K673	Wire (beaded)	Filigree wire	surface	**72.8**	**24.9**	**2.3**	*2.35*	*2.57*	*0.21*			
K673	Wire (beaded)	Filigree wire	sub-surface	**75.2**	**22.5**	**2.3**	*0.90*	*0.90*	*0.09*	-0.03	0.11	0.00
K673	Cell wall	Thick cell wall	surface	**75.8**	**22.1**	**2.1**	*0.83*	*0.89*	*0.08*			
K673	Cell wall	Thick cell wall	sub-surface	**78.7**	**19.0**	**2.3**	*0.81*	*0.84*	*0.11*	-0.04	0.17	-0.07
K673	Cell wall	Thin cell wall	surface	**76.9**	**21.0**	**2.1**	*0.30*	*0.17*	*0.19*			
K673	Cell wall	Thin cell wall	sub-surface	**77.8**	**19.9**	**2.3**	*0.40*	*0.38*	*0.12*	-0.01	0.06	-0.06
K674	Sheet	Base sheet	surface	**70.8**	**27.6**	**1.6**	*1.94*	*1.98*	*0.20*			
K674	Sheet	Base sheet	sub-surface	**70.0**	**27.8**	**2.2**	*1.31*	*1.34*	*0.10*	0.01	-0.01	-0.29
K677	Sheet	Back of mount	surface	**78.4**	**20.3**	**1.3**	*2.42*	*2.95*	*0.45*			
K677	Sheet	Back of mount	sub-surface	**72.2**	**25.7**	**2.1**	*0.87*	*0.87*	*0.05*	0.10	-0.20	-0.37

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K679	Sheet	Base sheet	surface	**84.4**	**13.1**	**2.5**	*1.55*	*1.22*	*0.18*			
K679	Sheet	Base sheet	sub-surface	**85.0**	**13.4**	**1.6**	*0.77*	*0.54*	*0.25*	-0.01	-0.02	0.56
K679	Sheet	Internal sheet	surface	**83.7**	**14.2**	**2.1**	*0.60*	*0.99*	*0.70*			
K679	Sheet	Internal sheet	sub-surface	**84.0**	**13.9**	**2.1**	*0.58*	*0.52*	*0.64*	0.00	0.02	0.00
K680	Sheet	Base gold	surface	**76.2**	**21.4**	**2.4**	*0.79*	*0.70*	*0.17*			
K680	Sheet	Base gold	sub-surface	**75.6**	**21.7**	**2.7**	*0.87*	*0.85*	*0.08*	0.01	-0.02	-0.10
K680	Cell wall	Cell wall	surface	**74.5**	**22.5**	**3.0**	*0.46*	*0.48*	*0.14*			
K680	Cell wall	Cell wall	sub-surface	**74.6**	**22.3**	**3.1**	*0.36*	*0.31*	*0.21*	0.00	0.01	-0.03
K685	Sheet	Back sheet	surface	**72.2**	**26.4**	**1.4**	*0.54*	*0.50*	*0.10*			
K685	Sheet	Back sheet	sub-surface	**67.1**	**30.6**	**2.3**	*1.12*	*1.16*	*0.11*	0.08	-0.14	-0.39
K685	Body	Stud	surface	**67.3**	**30.6**	**2.1**	*0.81*	*0.85*	*0.10*			
K685	Body	Stud	sub-surface	**67.4**	**30.3**	**2.3**	*1.29*	*1.32*	*0.15*	0.00	0.01	-0.10
K686	Sheet	Backing sheet	surface	**89.4**	**9.1**	**1.5**	*0.58*	*0.54*	*0.08*			
K686	Sheet	Backing sheet	sub-surface	**79.1**	**17.5**	**3.4**	*0.88*	*0.52*	*0.63*	0.13	-0.48	-0.56
K686	Cap	Cap	surface	**70.1**	**27.8**	**2.1**	*2.07*	*1.92*	*0.19*			
K686	Cap	Cap	sub-surface	**69.3**	**28.2**	**2.5**	*0.50*	*0.51*	*0.06*	0.01	-0.01	-0.17
K689	Sheet	Backing sheet	surface	**86.9**	**10.5**	**2.6**	*1.04*	*0.88*	*0.26*			
K689	Sheet	Backing sheet	sub-surface	**72.1**	**23.9**	**4.0**	*0.99*	*1.98*	*1.41*	0.21	-0.56	-0.35
K689	Wire (beaded)	Beaded wire	surface	**82.4**	**14.5**	**3.1**	*2.84*	*2.47*	*1.30*			
K689	Wire (beaded)	Beaded wire	sub-surface	**78.0**	**18.7**	**3.3**	*0.60*	*0.59*	*0.08*	0.06	-0.23	-0.06
K689	Wire (twisted)	Platted wire	surface	**81.2**	**15.3**	**3.5**	*1.55*	*1.65*	*0.85*			
K689	Wire (twisted)	Platted wire	sub-surface	**77.8**	**18.9**	**3.3**	*1.06*	*1.12*	*0.12*	0.04	-0.19	0.06
K690	Body	Base sheet	surface	**92.2**	**6.9**	**0.9**	*1.88*	*1.65*	*0.25*			
K690	Body	Base sheet	sub-surface	**82.2**	**15.2**	**2.6**	*1.21*	*1.28*	*0.11*	0.12	-0.54	-0.64
K697	Sheet	Backing sheet	surface	**80.8**	**17.0**	**2.2**	*1.14*	*1.15*	*0.15*			
K697	Sheet	Backing sheet	sub-surface	**70.4**	**26.2**	**3.4**	*1.24*	*1.28*	*0.43*	0.15	-0.35	-0.37
K697	Wire (beaded)	Beaded wire	surface	**76.4**	**20.4**	**3.2**	*2.67*	*2.59*	*0.29*			
K697	Wire (beaded)	Beaded wire	sub-surface	**73.8**	**23.7**	**2.5**	*0.18*	*0.31*	*0.19*	0.03	-0.14	0.29
K697	Cap	Cap	surface	**76.9**	**19.5**	**3.6**	*1.03*	*1.03*	*0.22*			
K697	Cap	Cap	sub-surface	**77.9**	**18.5**	**3.6**	*0.75*	*0.55*	*0.28*	-0.01	0.05	0.00
K699	Sheet	Backing sheet	surface	**88.8**	**9.4**	**1.8**	*0.60*	*0.59*	*0.10*			
K699	Sheet	Backing sheet	sub-surface	**78.4**	**17.0**	**4.6**	*1.05*	*0.94*	*1.53*	0.13	-0.45	-0.61

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K714	Sheet	Backing sheet	surface	**84.0**	**14.6**	**1.4**	*1.03*	*0.93*	*0.13*			
K714	Sheet	Backing sheet	sub-surface	**79.5**	**17.9**	**2.6**	*1.30*	*0.99*	*0.39*	0.06	-0.19	-0.48
K714	Wire (beaded)	Large beaded wire	surface	**80.0**	**18.0**	**2.0**	*0.31*	*0.38*	*0.12*			
K714	Wire (beaded)	Large beaded wire	sub-surface	**82.6**	**15.5**	**1.9**	*1.41*	*1.29*	*0.19*	-0.03	0.16	0.04
K714	Wire (beaded)	Small beaded wire	surface	**83.3**	**15.0**	**1.7**	*2.49*	*2.19*	*0.37*			
K714	Wire (beaded)	Small beaded wire	sub-surface	**83.3**	**14.8**	**1.9**	*0.99*	*0.91*	*0.18*	0.00	0.01	-0.11
K796	Sheet	Back of sheet	surface	**80.3**	**18.5**	**1.2**	*1.45*	*1.40*	*0.10*			
K796	Sheet	Back of sheet	sub-surface	**75.9**	**22.1**	**2.0**	*1.61*	*1.44*	*0.23*	0.06	-0.16	-0.40
K811	Sheet	Backing sheet (back)	surface	**78.8**	**19.6**	**1.6**	*0.89*	*0.91*	*0.28*			
K811	Sheet	Backing sheet (back)	sub-surface	**77.6**	**19.2**	**3.2**	*0.37*	*0.42*	*0.15*	0.02	0.02	-0.50
K811	Sheet	Backing sheet (front)	surface	**79.1**	**18.7**	**2.2**	*0.31*	*0.33*	*0.07*			
K811	Sheet	Backing sheet (front)	sub-surface	**76.2**	**20.4**	**3.4**	*0.50*	*0.50*	*0.07*	0.04	-0.08	-0.35
K816	Body	Body	surface	**96.1**	**3.7**	**0.2**	*0.39*	*0.27*	*0.14*			
K816	Body	Body	sub-surface	**98.0**	**1.9**	**0.1**	*0.28*	*0.22*	*0.12*	-0.02	0.93	0.50
K833	Sheet	Backing sheet	surface	**83.5**	**15.0**	**1.5**	*1.20*	*1.11*	*0.15*			
K833	Sheet	Backing sheet	sub-surface	**79.0**	**18.1**	**2.9**	*0.47*	*0.52*	*0.12*	0.06	-0.17	-0.49
K833	Wire (beaded)	Beaded wire	surface	**76.7**	**20.9**	**2.4**	*0.27*	*0.24*	*0.09*			
K833	Wire (beaded)	Beaded wire	sub-surface	**80.3**	**17.1**	**2.6**	*0.34*	*0.36*	*0.11*	-0.04	0.22	-0.08
K843	Sheet	Back	surface	**84.1**	**14.5**	**1.4**	*1.97*	*1.73*	*0.25*			
K843	Sheet	Back	sub-surface	**79.1**	**18.9**	**2.0**	*1.22*	*1.18*	*0.06*	0.06	-0.23	-0.28
K855	Sheet	Backing sheet	surface	**82.2**	**14.0**	**3.8**	*1.16*	*1.21*	*0.68*			
K855	Sheet	Backing sheet	sub-surface	**69.4**	**28.0**	**2.6**	*2.06*	*2.23*	*0.49*	0.19	-0.50	0.45
K855	Wire (beaded)	Filigree	surface	**67.3**	**30.4**	**2.3**	*1.09*	*1.11*	*0.08*			
K855	Wire (beaded)	Filigree	sub-surface	**66.5**	**31.3**	**2.2**	*1.13*	*1.15*	*0.12*	0.01	-0.03	0.04
K865	Sheet	Backing sheet	surface	**88.7**	**11.1**	**0.2**	*1.36*	*1.39*	*0.11*			
K865	Sheet	Backing sheet	sub-surface	**75.8**	**22.0**	**2.2**	*1.11*	*1.07*	*0.32*	0.17	-0.49	-0.93
K878	Sheet	Backing sheet (back)	surface	**91.8**	**7.3**	**0.9**	*0.92*	*0.93*	*0.14*			
K878	Sheet	Backing sheet (back)	sub-surface	**83.3**	**14.8**	**1.9**	*1.37*	*1.35*	*0.10*	0.10	-0.51	-0.52
K920	Sheet	Back	surface	**91.5**	**7.9**	**0.6**	*0.58*	*0.55*	*0.06*			
K920	Sheet	Back	sub-surface	**83.1**	**15.3**	**1.6**	*0.96*	*0.95*	*0.05*	0.10	-0.48	-0.62
K992	Sheet	Backing sheet	surface	**80.6**	**16.8**	**2.6**	*0.21*	*0.47*	*0.41*			
K992	Sheet	Backing sheet	sub-surface	**74.1**	**23.0**	**2.9**	*0.96*	*0.98*	*0.32*	0.09	-0.27	-0.11
K992	Wire (beaded)	Beaded wire	surface	**77.9**	**20.9**	**1.2**	*2.40*	*1.80*	*0.71*			
K992	Wire (beaded)	Beaded wire	sub-surface	**76.0**	**21.6**	**2.4**	*1.56*	*1.49*	*0.18*	0.03	-0.03	-0.50

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K1004	Sheet	Backing sheet	surface	**73.9**	**24.1**	**2.0**	*1.32*	*1.29*	*0.14*			
K1004	Sheet	Backing sheet	sub-surface	**78.3**	**19.4**	**2.3**	*1.54*	*1.51*	*0.06*	-0.06	0.25	-0.10
K1004	Cap	Cap	surface	**70.1**	**27.7**	**2.2**	*0.65*	*0.67*	*0.09*			
K1004	Cap	Cap	sub-surface	**79.2**	**18.5**	**2.3**	*0.28*	*0.30*	*0.08*	-0.11	0.50	-0.06
K1048	Sheet	Front	surface	**83.3**	**15.1**	**1.6**	*0.39*	*0.37*	*0.08*			
K1048	Sheet	Front	sub-surface	**79.6**	**18.4**	**2.0**	*0.49*	*0.54*	*0.09*	0.05	-0.18	-0.20
K1055	Body	Front	surface	**75.3**	**21.4**	**3.3**	*2.36*	*1.98*	*0.53*			
K1055	Body	Front	sub-surface	**88.2**	**8.5**	**3.3**	*0.71*	*0.56*	*0.18*	-0.15	1.53	0.00
K1072	Sheet	Front	surface	**81.7**	**17.5**	**0.8**	*0.73*	*0.70*	*0.12*			
K1072	Sheet	Front	sub-surface	**78.6**	**19.7**	**1.7**	*0.45*	*0.42*	*0.08*	0.04	-0.11	-0.55
K1073	Sheet	Backing sheet	surface	**90.7**	**8.1**	**1.2**	*0.34*	*0.33*	*0.05*			
K1073	Sheet	Backing sheet	sub-surface	**79.0**	**18.5**	**2.5**	*0.30*	*0.28*	*0.19*	0.15	-0.56	-0.51
K1073	Cap	Cap	surface	**77.3**	**20.2**	**2.5**	*0.97*	*1.00*	*0.12*			
K1073	Cap	Cap	sub-surface	**79.0**	**18.4**	**2.6**	*1.90*	*1.90*	*0.09*	-0.02	0.10	-0.05
K1073	Wire (beaded)	Large beaded wire	surface	**79.1**	**18.3**	**2.6**	*0.45*	*0.54*	*0.13*			
K1073	Wire (beaded)	Large beaded wire	sub-surface	**79.1**	**18.1**	**2.8**	*0.54*	*0.50*	*0.13*	0.00	0.01	-0.05
K1073	Wire (beaded)	Small beaded wire	surface	**76.6**	**20.3**	**3.1**	*2.46*	*1.97*	*0.54*			
K1073	Wire (beaded)	Small beaded wire	sub-surface	**75.9**	**20.5**	**3.6**	*2.80*	*2.53*	*0.51*	0.01	-0.01	-0.15
K1118	Sheet	Backing sheet	surface	**80.7**	**16.8**	**2.5**	*0.88*	*0.77*	*0.22*			
K1118	Sheet	Backing sheet	sub-surface	**73.9**	**22.9**	**3.2**	*0.74*	*1.15*	*0.59*	0.09	-0.26	-0.24
K1118	Wire (beaded)	Large beaded wire	surface	**73.4**	**23.0**	**3.6**	*0.21*	*0.16*	*0.34*			
K1118	Wire (beaded)	Large beaded wire	sub-surface	**72.8**	**25.2**	**2.0**	*0.42*	*0.51*	*0.25*	0.01	-0.09	0.79
K1118	Wire (beaded)	Small beaded wire	surface	**73.2**	**24.1**	**2.7**	*0.13*	*0.16*	*0.08*			
K1118	Wire (beaded)	Small beaded wire	sub-surface	**73.4**	**24.6**	**2.0**	*0.48*	*0.58*	*0.11*	0.00	-0.02	0.37
K1136	Sheet	Back	surface	**82.5**	**16.6**	**0.9**	*0.95*	*0.87*	*0.16*			
K1136	Sheet	Back	sub-surface	**76.1**	**22.3**	**1.6**	*1.40*	*1.37*	*0.17*	0.08	-0.26	-0.44
K1136	Cell wall	Cell wall	surface	**68.3**	**30.1**	**1.6**	*0.50*	*0.51*	*0.06*			
K1136	Cell wall	Cell wall	sub-surface	**69.0**	**29.2**	**1.8**	*0.67*	*0.68*	*0.13*	-0.01	0.03	-0.08
K1136	Sheet	Front	surface	**80.7**	**18.3**	**1.0**	*0.47*	*0.55*	*0.13*			
K1136	Sheet	Front	sub-surface	**76.8**	**20.6**	**2.6**	*0.61*	*0.53*	*0.18*	0.05	-0.11	-0.62
K1136	Sheet	Repair sheet	surface	**83.4**	**15.9**	**0.7**	*0.20*	*0.22*	*0.07*			
K1136	Sheet	Repair sheet	sub-surface	**74.5**	**24.1**	**1.4**	*1.20*	*1.14*	*0.09*	0.12	-0.34	-0.50

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K1137	Sheet	Front	surface	**75.0**	**23.8**	**1.2**	*0.43*	*0.46*	*0.07*			
K1137	Sheet	Front	sub-surface	**72.6**	**25.3**	**2.1**	*0.96*	*0.83*	*0.26*	0.03	-0.06	-0.46
K1143	Sheet	Front	surface	**85.3**	**13.6**	**1.1**	*0.69*	*0.58*	*0.17*			
K1143	Sheet	Front	sub-surface	**83.6**	**14.4**	**2.0**	*0.82*	*0.69*	*0.26*	0.02	-0.05	-0.45
K1150	Sheet	Back	surface	**80.1**	**12.6**	**7.3**	*0.59*	*0.62*	*0.75*			
K1150	Sheet	Back	sub-surface	**80.5**	**14.5**	**5.0**	*0.65*	*0.96*	*1.40*	0.00	-0.13	0.44
K1150	Sheet	Box edging	surface	**71.2**	**27.1**	**1.7**	*0.56*	*0.60*	*0.07*			
K1150	Sheet	Box edging	sub-surface	**68.9**	**29.3**	**1.8**	*1.14*	*1.12*	*0.09*	0.03	-0.07	-0.04
K1150	Cell wall	Cell wall	surface	**70.9**	**27.4**	**1.7**	*1.02*	*0.96*	*0.09*			
K1150	Cell wall	Cell wall	sub-surface	**70.6**	**26.9**	**2.5**	*1.22*	*0.84*	*0.76*	0.00	0.02	-0.32
K1150	Sheet	Front sheet	surface	**92.6**	**6.5**	**0.9**	*0.53*	*0.50*	*0.08*			
K1150	Sheet	Front sheet	sub-surface	**82.2**	**15.9**	**1.9**	*0.32*	*0.33*	*0.06*	0.13	-0.59	-0.51
K1150	Sheet	Repair plate	surface	**82.0**	**15.8**	**2.2**	*0.23*	*0.26*	*0.06*			
K1150	Sheet	Repair plate	sub-surface	**81.0**	**16.6**	**2.4**	*0.91*	*0.89*	*0.06*	0.01	-0.05	-0.09
K1155	Sheet	Base sheet	surface	**81.5**	**16.1**	**2.4**	*0.68*	*0.54*	*0.27*			
K1155	Sheet	Base sheet	sub-surface	**81.1**	**16.3**	**2.6**	*0.55*	*0.57*	*0.05*	0.00	-0.01	-0.08
K1155	Sheet	Internal sheet	surface	**80.7**	**16.9**	**2.4**	*0.91*	*0.87*	*0.13*			
K1155	Sheet	Internal sheet	sub-surface	**78.5**	**18.7**	**2.8**	*0.36*	*0.40*	*0.14*	0.03	-0.10	-0.14
K1163	Sheet	Front	surface	**81.0**	**17.4**	**1.6**	*0.32*	*0.52*	*0.48*			
K1163	Sheet	Front	sub-surface	**74.0**	**24.1**	**1.9**	*1.97*	*1.91*	*0.25*	0.09	-0.28	-0.17
K1167	Sheet	Base sheet	surface	**74.0**	**24.5**	**1.5**	*0.72*	*0.72*	*0.11*			
K1167	Sheet	Base sheet	sub-surface	**70.6**	**27.6**	**1.8**	*0.42*	*0.44*	*0.09*	0.05	-0.11	-0.19
K1167	Cap	Cap	surface	**96.4**	**2.1**	**1.5**	*0.36*	*0.11*	*0.45*			
K1167	Cap	Cap	sub-surface	**95.7**	**2.6**	**1.7**	*0.45*	*0.17*	*0.34*	0.01	-0.19	-0.10
K1167	Cell wall	Cell wall	surface	**89.8**	**8.6**	**1.6**	*0.51*	*0.97*	*0.62*			
K1167	Cell wall	Cell wall	sub-surface	**88.8**	**9.0**	**2.2**	*0.81*	*1.09*	*0.60*	0.01	-0.05	-0.30
K1221	Sheet	Front	surface	**83.9**	**15.0**	**1.1**	*0.83*	*0.85*	*0.20*			
K1221	Sheet	Front	sub-surface	**70.8**	**26.8**	**2.4**	*3.24*	*3.18*	*0.36*	0.18	-0.44	-0.53
K1234	Sheet	Front	surface	**88.0**	**11.1**	**0.9**	*0.61*	*0.59*	*0.04*			
K1234	Sheet	Front	sub-surface	**79.7**	**18.2**	**2.1**	*1.37*	*1.42*	*0.09*	0.11	-0.39	-0.56
K1272	Sheet	Front	surface	**84.4**	**13.3**	**2.3**	*0.98*	*0.85*	*0.45*			
K1272	Sheet	Front	sub-surface	**80.5**	**15.6**	**3.9**	*0.72*	*0.72*	*0.57*	0.05	-0.15	-0.40

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average			*Standard Deviation*			Enrichment Factor		
				Au	Ag	Cu	*Au*	*Ag*	*Cu*	Au	Ag	Cu
K1314	Sheet	Base	surface	**75.5**	**23.3**	**1.2**	*1.68*	*1.66*	*0.13*			
K1314	Sheet	Base	sub-surface	**71.0**	**27.0**	**2.0**	*1.61*	*1.62*	*0.07*	0.06	-0.14	-0.40
K1403	Sheet	Back of sheet	surface	**84.8**	**14.5**	**0.7**	*2.54*	*2.62*	*0.12*			
K1403	Sheet	Back of sheet	sub-surface	**79.2**	**18.9**	**1.9**	*1.82*	*1.81*	*0.06*	0.07	-0.23	-0.66
K1425	Sheet	Base decoration	surface	**78.9**	**18.0**	**3.1**	*1.18*	*1.24*	*0.10*			
K1425	Sheet	Base decoration	sub-surface	**79.3**	**17.6**	**3.1**	*1.53*	*1.55*	*0.08*	0.00	0.02	-0.01
K1425	Cell wall	Cell wall	surface	**64.1**	**32.3**	**3.6**	*1.43*	*1.21*	*0.19*			
K1425	Cell wall	Cell wall	sub-surface	**66.7**	**29.4**	**3.9**	*1.54*	*1.67*	*0.37*	-0.04	0.10	-0.07
K1497	Sheet	Backing sheet (back)	surface	**74.7**	**24.0**	**1.3**	*1.91*	*1.96*	*0.10*			
K1497	Sheet	Backing sheet (back)	sub-surface	**77.2**	**20.8**	**2.0**	*0.36*	*0.33*	*0.07*	-0.03	0.15	-0.35
K1497	Sheet	Backing sheet (front)	surface	**84.7**	**14.2**	**1.1**	*1.62*	*1.59*	*0.07*			
K1497	Sheet	Backing sheet (front)	sub-surface	**76.9**	**20.4**	**2.7**	*0.68*	*0.67*	*0.12*	0.10	-0.31	-0.59
K1497	Wire (beaded)	Filigree wire	surface	**73.2**	**24.8**	**2.0**	*0.85*	*0.86*	*0.09*			
K1497	Wire (beaded)	Filigree wire	sub-surface	**78.4**	**18.4**	**3.2**	*1.18*	*1.27*	*0.30*	-0.07	0.35	-0.38
K5008	Sheet	Back sheet	surface	**83.2**	**15.6**	**1.2**	*0.91*	*0.86*	*0.12*			
K5008	Sheet	Back sheet	sub-surface	**69.4**	**28.0**	**2.6**	*1.01*	*1.04*	*0.09*	0.20	-0.44	-0.51

Table 13 cont. SEM-EDX analysis data for the Staffordshire Hoard objects analysed during this study.

Object	Area Analysed			Average		
				Wt% Au	Wt% Ag	Wt% Cu
K88	Pommel	Side of cap	surface	57.3	39.5	3.3
			sub-surface	57.9	38.4	3.7
			scratch	57.1	39.4	3.6
K3	Hilt plate	Front	surface	90.2	8.8	0.9
			sub-surface	82.7	14.9	2.4
			scratch	91.4	7.6	1.0
K1221	Hilt plate	Front	surface	83.9	15.0	1.1
			sub-surface	70.9	26.8	2.4
			scratch	71.2	27.3	1.5
K1234	Hilt plate	Front	surface	88.0	11.1	0.9
			sub-surface	79.2	18.1	2.1
			scratch	83.9	15.0	1.1
K370	Hilt collar	Base sheet	surface	84.5	14.0	1.5
			sub-surface	82.0	15.3	2.6
			Scratch	82.4	16.2	1.4
K376	Pommel	Base sheet	surface	71.5	26.8	1.7
			sub-surface	70.3	27.8	1.8
			scratch	68.4	29.9	1.7
K356	Hilt collar	Base sheet	surface	89.2	10.2	0.6
			sub-surface	84.9	13.9	1.1
			scratch	85.5	13.5	1.0
K690	Hilt collar	Base sheet	surface	92.2	6.9	0.9
			sub-surface	82.2	15.2	2.6
			scratch	85.4	12.7	1.9
K465	Pommel	Cell wall	surface	69.0	28.3	2.7
			sub-surface	69.9	27.2	2.9
			scratch	66.2	31.4	2.4
K567	Hilt Plate	Front	surface	87.2	11.8	0.7
			sub-surface	89.0	11.5	0.7
			scratch	87.2	12.1	0.7
K652	Mount	Front of decorated sheet	surface	94.4	4.9	0.7
			sub-surface	89.1	8.3	2.7
			scratch	90.7	6.6	2.6
K468	Mount	Back of sheet	surface	74.0	22.1	4.0
			sub-surface	74.9	21.8	3.3
			scratch	73.8	22.3	3.9
K1055	Cylinder	Front	surface	75.3	21.4	3.3
			sub-surface	88.2	8.5	3.3
			scratch	63.3	34.6	2.1
K550	Inscription	Front side	surface	71.3	26.5	2.2
			scratch	73.0	24.8	2.3
			sub-surface	74.7	22.9	2.4
K513	Mount	Backing sheet of mount	surface	82.4	16.4	1.1
			sub-surface	78.2	19.7	2.0
			scratch	79.4	19.4	1.2
K657	Gem setting from cross	Base	surface	76.4	22.6	1.0
			sub-surface	72.3	25.6	2.1
			scratch	78.2	20.9	1.0

Table 15. SEM-EDX analysis data for the ancient scratches compared to surface and sub-surface results obtained during this study.

Appendix 3 - Object reports

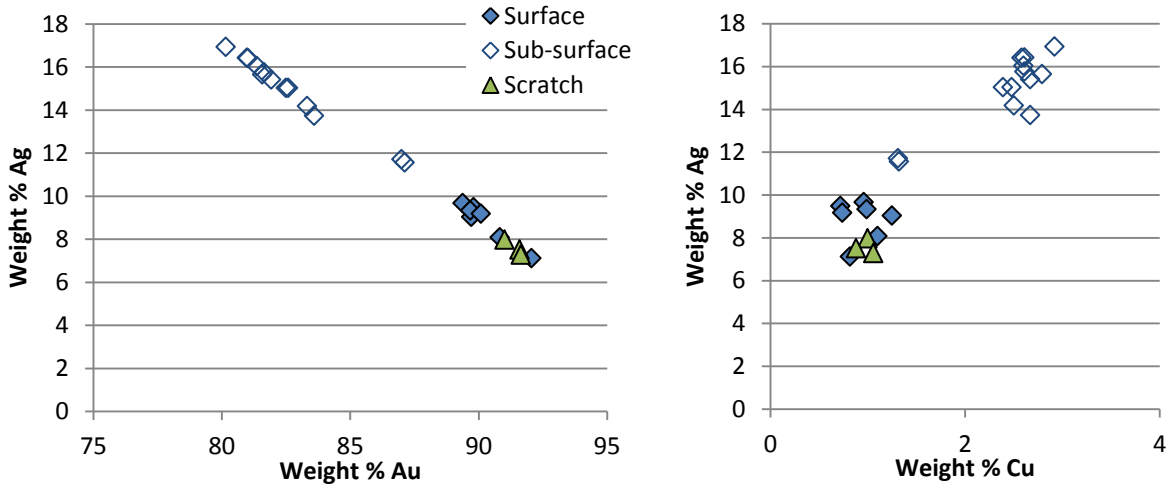
Gold enrichment in Staffordshire Hoard K3: results of SEM-EDX analysis

Object Type Hilt plate
Date 600-650
Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the base sheet on the back of the hilt plate.

Area analysed	No. of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	7	Average	90.3	8.8	0.9
		Standard Deviation	*0.93*	*0.92*	*0.19*
Scratch	3	Average	91.4	7.6	1.0
		Standard Deviation	*0.36*	*0.35*	*0.09*
Sub-surface	13	Average	82.7	14.9	2.4
		Standard Deviation	*2.17*	*1.70*	*0.51*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 80-85 wt% gold, 13-17 wt% silver, the rest being copper. The analysis revealed a *c.*6.1 wt% loss of silver from the surface (a difference of *c.*41% from surface to core), which is indicative of deliberate treatment to enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the scratch suggests it may have occurred post deposition as there was no loss of copper or silver from the surface within the scratch.

Eleanor Blakelock
Analysed December 2012

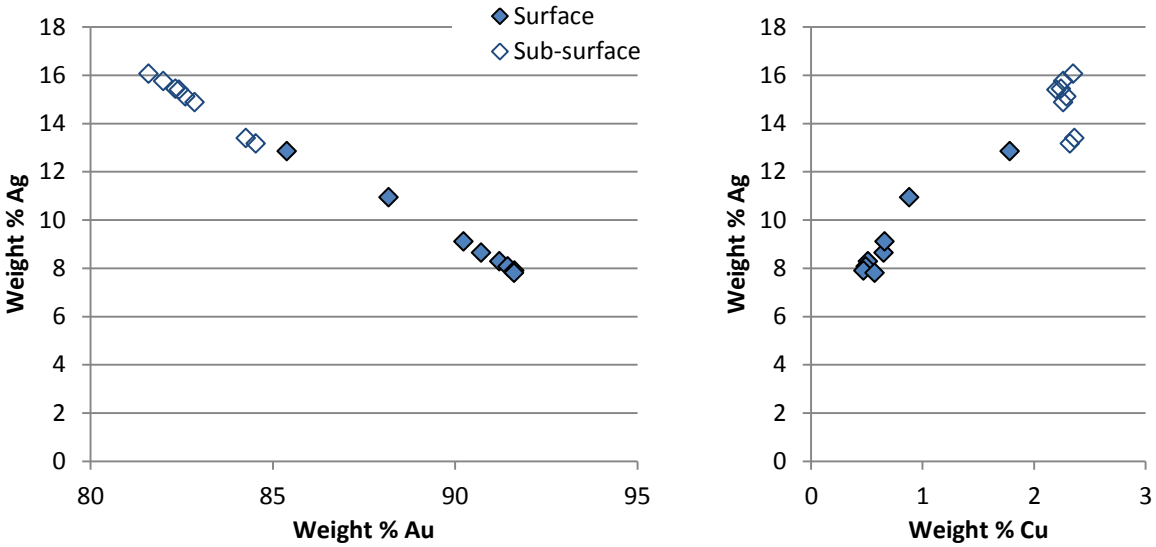
Gold enrichment in Staffordshire Hoard K10: results of SEM-EDX analysis

Object Type Hilt plate
Date 600-650
Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the back of the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	90.0	9.2	0.8
		Standard Deviation	*2.20*	*1.79*	*0.44*
Sub-surface	8	Average	82.8	14.9	2.3
		Standard Deviation	*1.05*	*1.07*	*0.06*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 81-84 wt% gold, 13-16 wt% silver, the rest being copper. The analysis revealed a *c.*5.7 wt% loss of silver from the surface (a difference of *c.*38% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed December 2012

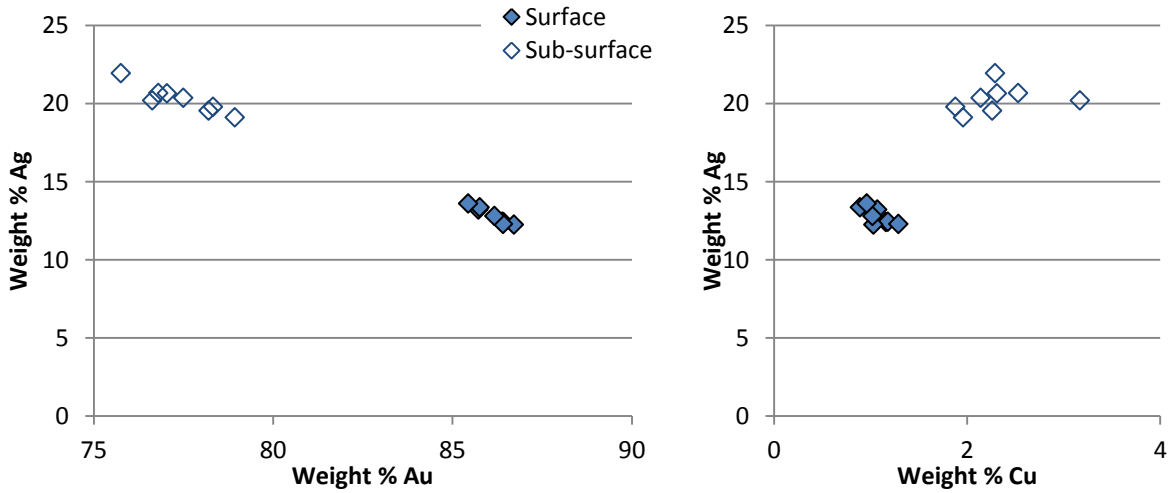
Gold enrichment in Staffordshire Hoard K12: results of SEM-EDX analysis

Object Type Hilt plate
Date 600-650
Decoration Filigree ✓ Glass
Garnet Other

SEM-EDX analysis was undertaken on the base sheet on the back of the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	86.1	12.8	1.1
		Standard Deviation	*0.44*	*0.52*	*0.13*
Sub-surface	8	Average	77.4	20.3	2.3
		Standard Deviation	*1.04*	*0.87*	*0.40*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 76-79 wt% gold, 19-22 wt% silver, the rest being copper. The analysis revealed a *c.*7.5 wt% loss of silver from the surface (a difference of *c.*37% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed December 2012

Gold enrichment in Staffordshire Hoard K16: results of SEM-EDX analysis

Object Type Mount
Date 600-635

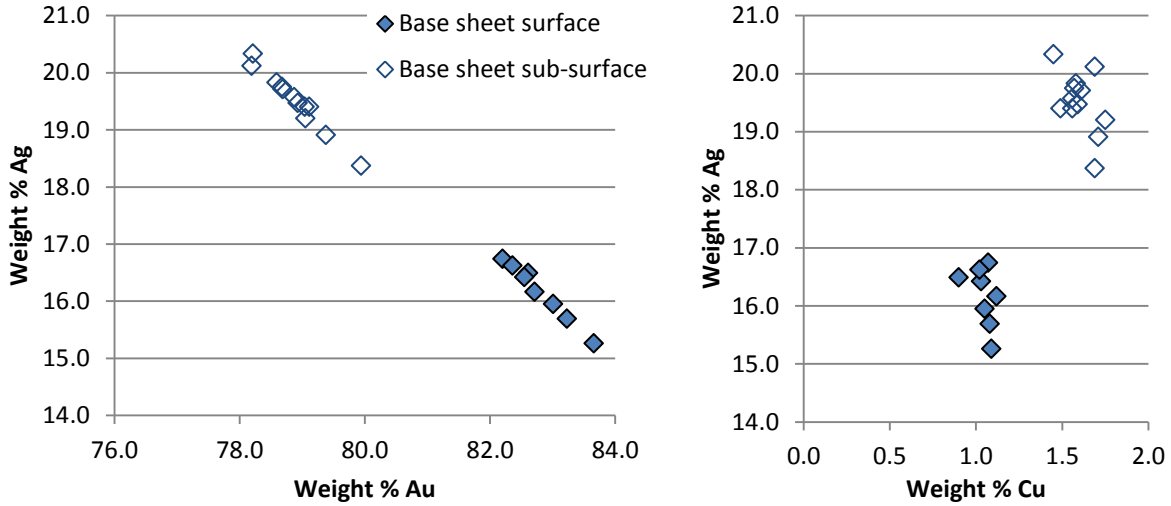
Decoration

Filigree		Glass	
Garnet	✓	Other	

SEM-EDX analysis was undertaken on the base sheet on the back of the mount.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	82.8	16.2	1.0
		Standard Deviation	*0.48*	*0.51*	*0.07*
Sub-surface	12	Average	78.9	19.5	1.6
		Standard Deviation	*0.48*	*0.52*	*0.09*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 78-80 wt% gold, 19-20 wt% silver, the rest being copper. The analysis revealed a *c.*3.3 wt% loss of silver from the surface (a difference of *c.*17% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K21: results of SEM-EDX analysis

Object Type Hilt Collar
Date 625-650

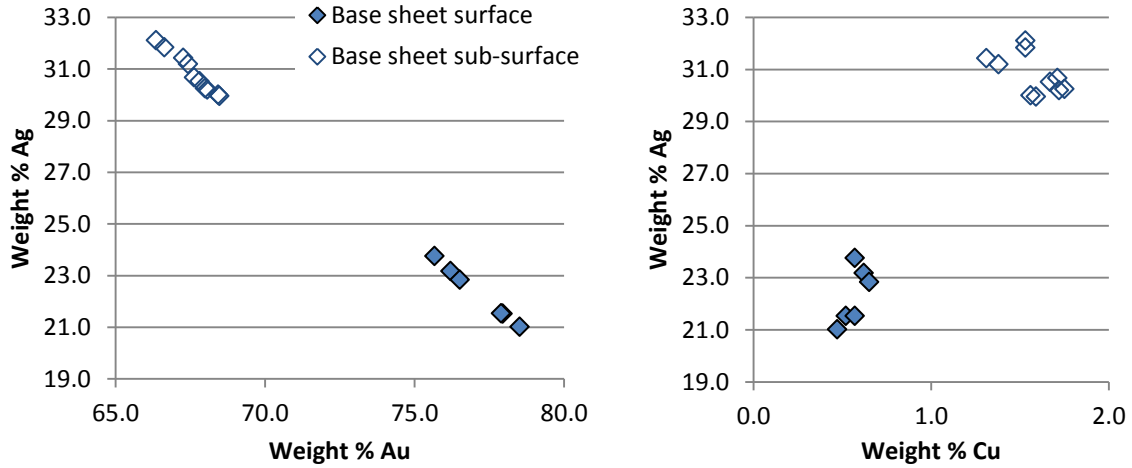
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the gold sheet to which the filigree was attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	6	Average	77.1	22.3	0.6
		Standard Deviation	*1.14*	*1.10*	*0.07*
Sub-surface	10	Average	67.6	30.8	1.6
		Standard Deviation	*0.71*	*0.78*	*0.15*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 66-69 wt% gold, 30-32 wt% silver, the rest being copper. The analysis revealed a *c.*8.5 wt% loss of silver from the surface (a difference of *c.*28% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K79: results of SEM-EDX analysis

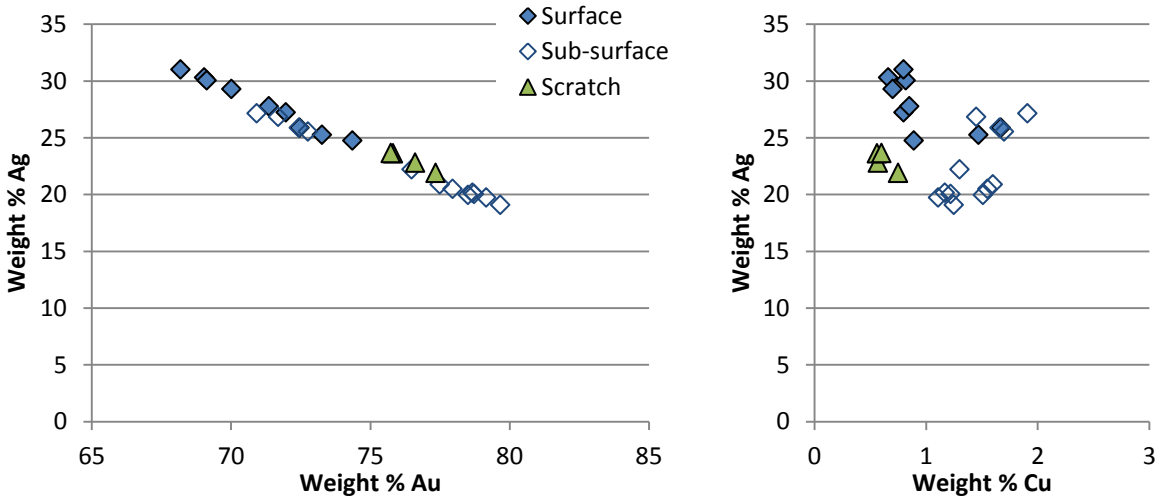
Object Type Hilt plate
Date 600-650

Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the base sheet on the back of the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	9	Average	71.0	28.0	1.0
		Standard Deviation	*2.11*	*2.33*	*0.36*
Scratch	4	Average	76.4	23.0	0.6
		Standard Deviation	*0.76*	*0.82*	*0.09*
Sub-surface	12	Average	71.9	26.4	1.7
		Standard Deviation	*0.82*	*0.77*	*0.19*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 71-73 wt% gold, 25-28 wt% silver, the rest being copper. The analysis revealed a small loss of copper at the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. There was a small increase in silver at the surface which may be re-deposited silver from nearby corroding silver alloy objects.

Eleanor Blakelock
Analysed December 2012

Gold enrichment in Staffordshire Hoard K88: results of SEM-EDX analysis

Object Type Pommel
Date 610-630

Decoration				
	Filigree	✓	Glass	
	Garnet		Other	

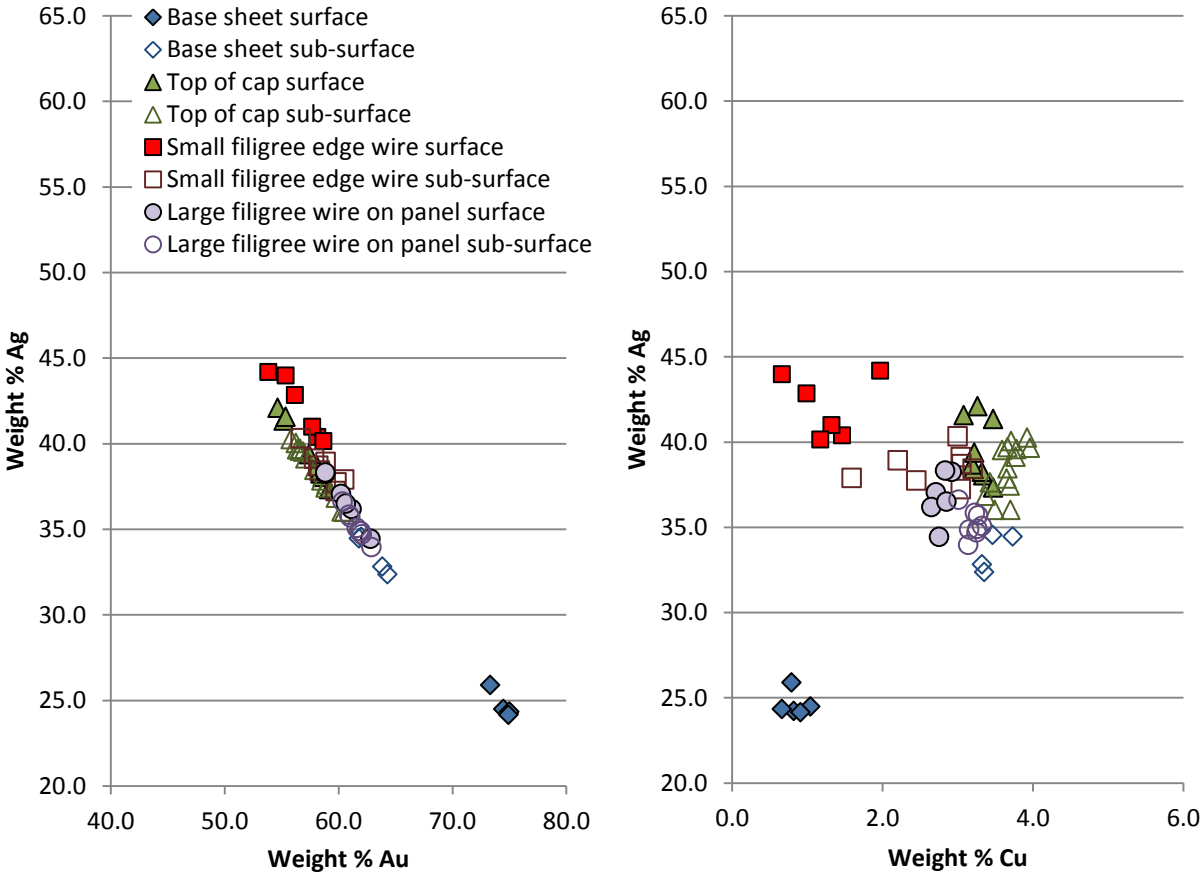
SEM-EDX analysis was undertaken on a range of components, including two types of filigree wire, the separate cap and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	5	Average	74.6	24.6	0.8
		Standard Deviation	*0.71*	*0.72*	*0.14*
Base sheet sub-surface	8	Average	62.9	33.6	3.5
		Standard Deviation	*1.27*	*1.12*	*0.19*
Top of cap surface	9	Average	57.2	39.5	3.3
		Standard Deviation	*1.72*	*1.75*	*0.13*
Top of cap sub-surface	14	Average	57.9	38.4	3.7
		Standard Deviation	*1.58*	*1.47*	*0.17*
Small filigree edge wire surface	6	Average	56.6	42.1	1.3
		Standard Deviation	*1.85*	*1.81*	*0.44*
Small filigree edge wire sub-surface	8	Average	58.7	38.6	2.7
		Standard Deviation	*1.24*	*0.96*	*0.57*
Large filigree wire on panel surface	6	Average	60.4	36.8	2.8
		Standard Deviation	*1.50*	*1.45*	*0.10*
Large filigree wire on panel sub-surface	8	Average	61.6	35.2	3.2
		Standard Deviation	*0.79*	*0.82*	*0.10*

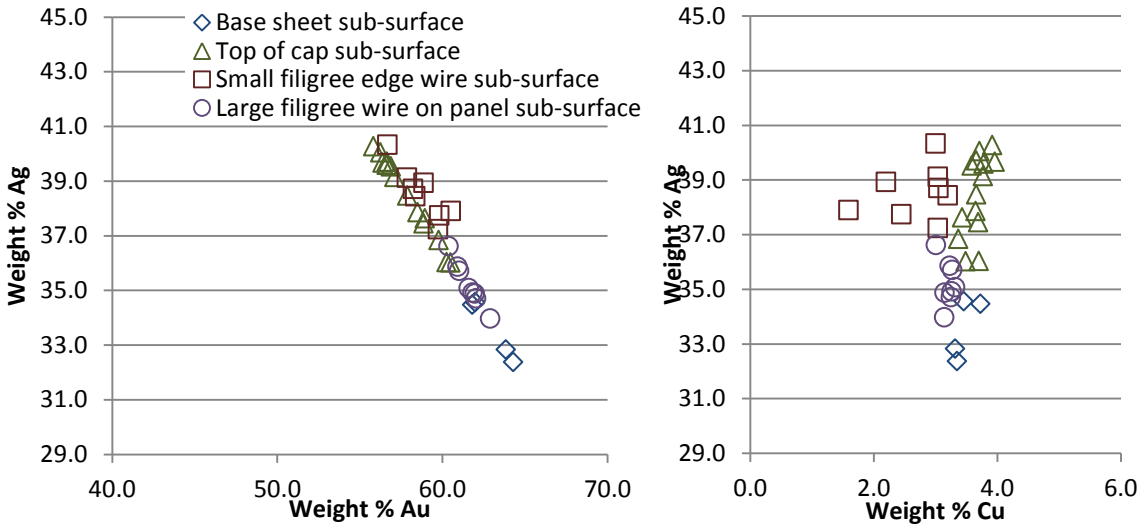
SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a *c.*8.9 wt% loss of silver from the surface of the base sheet (a difference of *c.*27% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the other components revealed only a loss of copper from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Comparison of the sub-surface compositions of each component suggests that all the components may have been made using the same, or a similar, gold alloy. The possible exception is the base sheet which had a slightly lower silver content, but there is still significant compositional overlap. The base sheet is the only component demonstrating deliberate gold enrichment which suggests that the sheet was treated separately before being incorporated into the pommel.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed May 2013

Gold enrichment in Staffordshire Hoard K95: results of SEM-EDX analysis

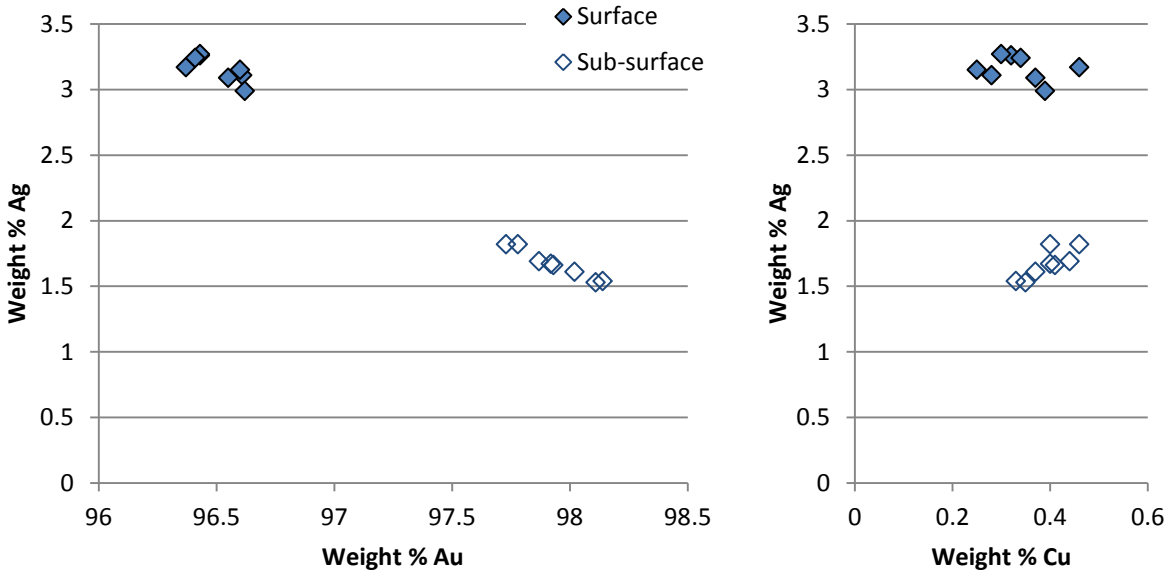
Object Type Fitting
Date 600-650

Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the base sheet on the front of this fitting.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	96.5	3.2	0.3
		Standard Deviation	*0.10*	*0.10*	*0.07*
Sub-surface	8	Average	97.9	1.7	0.4
		Standard Deviation	*0.15*	*0.11*	*0.04*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 97-98 wt% gold, 1-2 wt% silver, with traces of copper. The analysis revealed a small loss of copper at the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. There was a small increase in silver at the surface which may be re-deposited silver from nearby corroding silver alloy objects.

Eleanor Blakelock
Analysed January 2013

Gold enrichment in Staffordshire Hoard K107: results of SEM-EDX analysis

Object Type Sword pyramid
Date 610-630

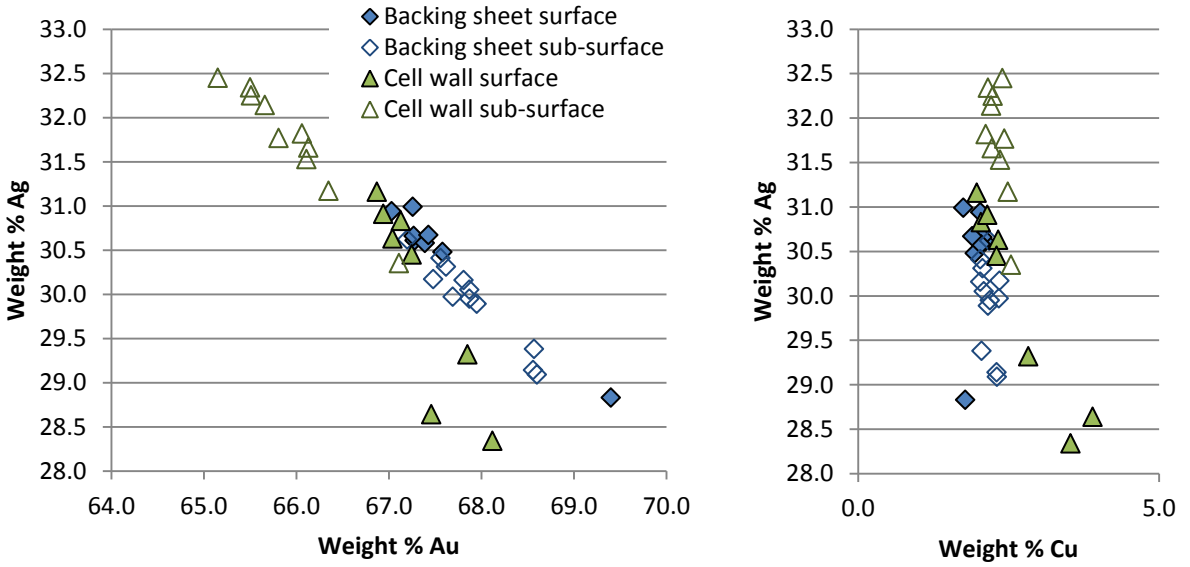
Decoration				
	Filigree	✓	Glass	
	Garnet	✓	Other	

SEM-EDX analysis was undertaken on the base sheet of the pyramid and a cell wall.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	67.5	30.5	2.0
		Standard Deviation	*0.75*	*0.69*	*0.13*
Base sheet sub-surface	12	Average	67.9	29.9	2.2
		Standard Deviation	*0.46*	*0.49*	*0.12*
Cell wall surface	8	Average	67.4	30.0	2.6
		Standard Deviation	*0.45*	*1.10*	*0.72*
Cell wall sub-surface	12	Average	66.0	31.7	2.3
		Standard Deviation	*0.55*	*0.63*	*0.15*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis of the base sheet revealed a small loss of copper at the surface of most components is indicative of natural surface enrichment that can occur during burial. There was also an increase in silver at the surface which is possibly re-deposited silver from close contact to corroding silver objects in the burial environment or contamination from the solder. Comparison of the sub-surface compositions of the components suggests that both were most likely made with a similar but different gold alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed December 2013

Gold enrichment in Staffordshire Hoard K128: results of SEM-EDX analysis

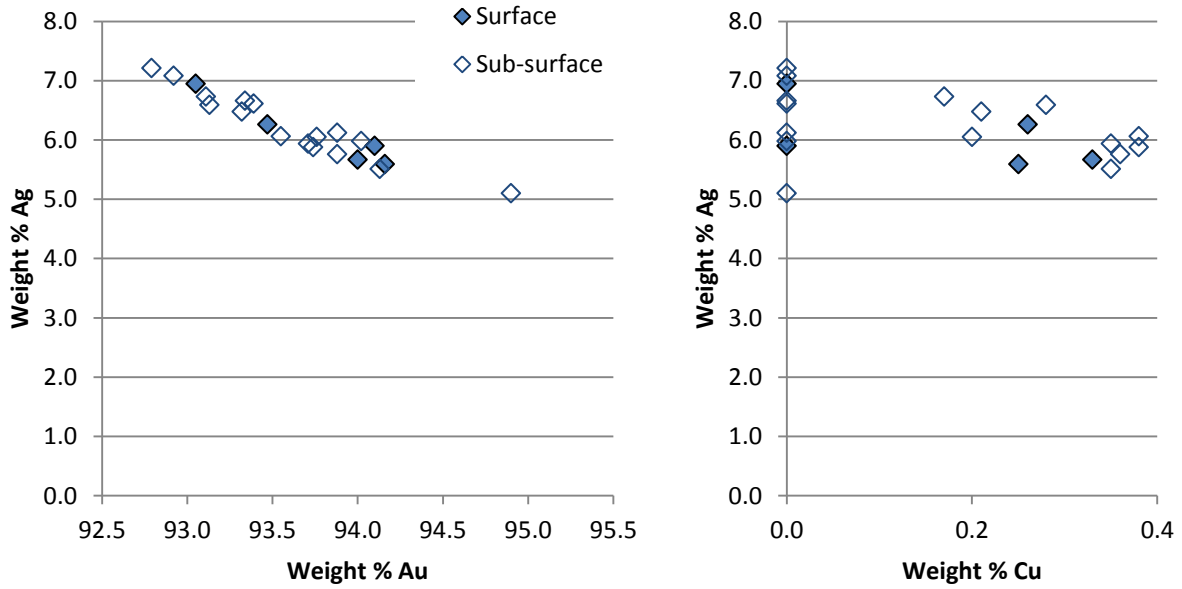
Object Type Moulded Serpent
Date 630-670

Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the body of the serpent.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	5	Average	93.7	6.1	0.2
		Standard Deviation	*0.48*	*0.55*	*0.16*
Sub-surface	16	Average	93.6	6.2	0.2
		Standard Deviation	*0.52*	*0.57*	*0.16*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 93-95 wt% gold, 5-7 wt% silver, with traces of copper. The analysis revealed a loss of *c.*0.2 wt% silver from the surface, and a difference of less than 5% from surface to core, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K130: results of SEM-EDX analysis

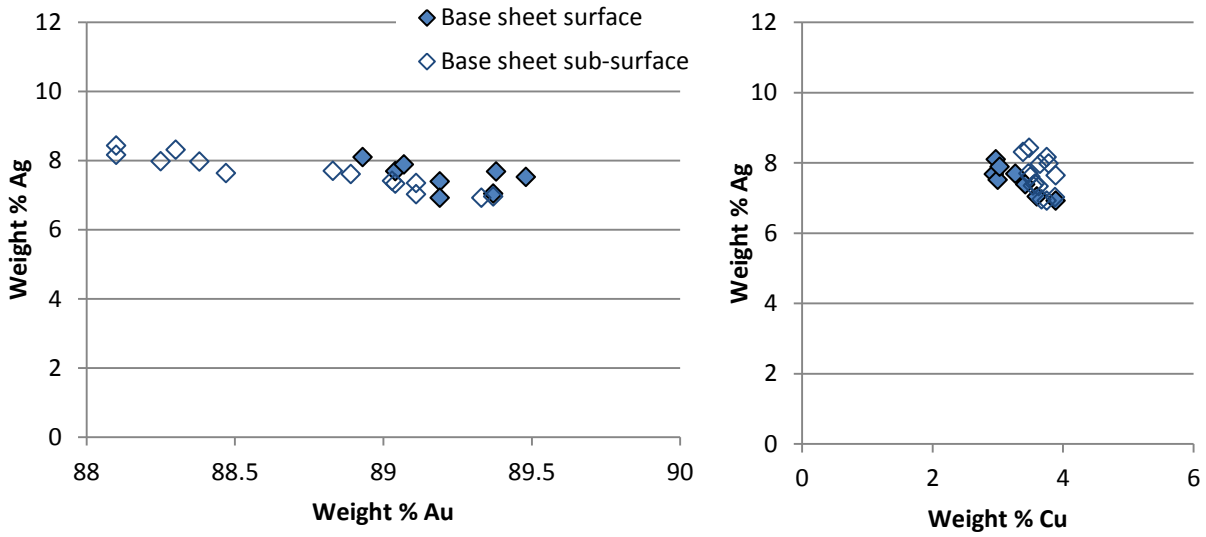
Object Type Roundel
Date 630-670

Decoration Filigree ☐ Glass ☐
Garnet ✓ Other ☐

SEM-EDX analysis was undertaken on the base sheet to which the cell walls and panels are attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	89.2	7.5	3.3
		Standard Deviation	*0.19*	*0.40*	*0.35*
Sub-surface	14	Average	88.8	7.6	3.6
		Standard Deviation	*0.45*	*0.49*	*0.16*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 88-90 wt% gold, 7-9 wt% silver, the rest being copper. The analysis revealed a small loss of copper and only a slight loss of silver from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. The front of the base sheet would only be visible at the edges of the piece and therefore the goldsmith may not have treated the sheet.

Eleanor Blakelock
Analysed September 2013

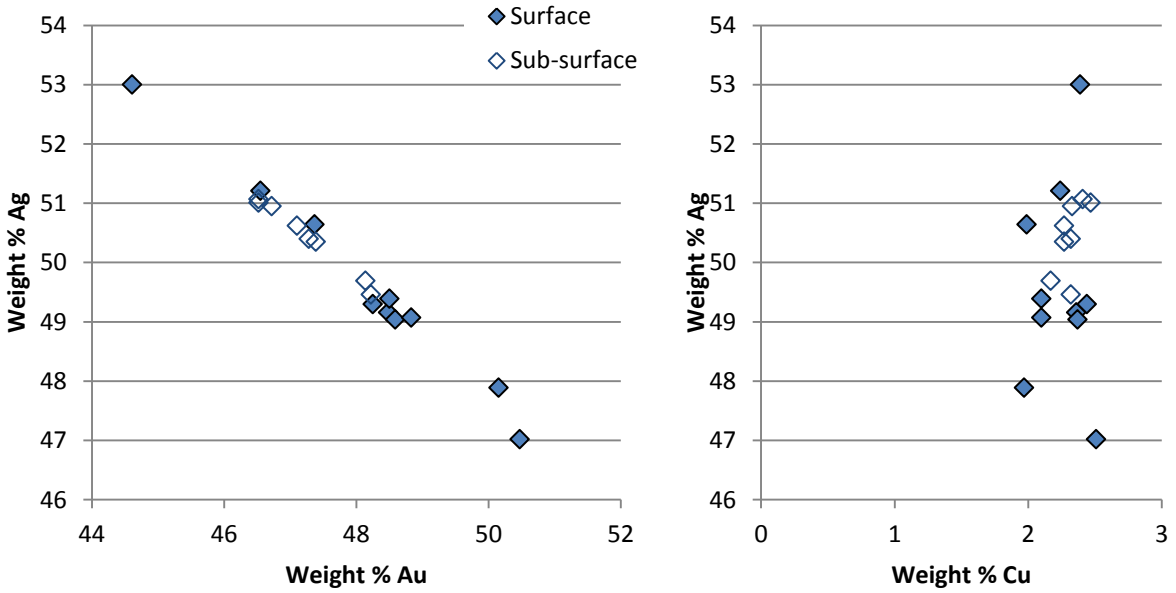
Gold enrichment in Staffordshire Hoard K133: results of SEM-EDX analysis

Object Type Hilt plate
Date 600-650
Decoration Filigree ✓ Glass
Garnet Other

SEM-EDX analysis was undertaken on the edge of the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	10	Average	48.2	49.6	2.2
		Standard Deviation	*1.70*	*1.69*	*0.19*
Sub-surface	8	Average	47.3	50.4	2.3
		Standard Deviation	*0.67*	*0.60*	*0.09*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 46-48 wt% gold, 49-51 wt% silver, the rest being copper. The analysis revealed a *c.*0.9 wt% loss of silver from the surface (a difference of *c.*2% from surface to core), which may indicate natural loss during burial.

Eleanor Blakelock
Analysed January 2011

Gold enrichment in Staffordshire Hoard K135: results of SEM-EDX analysis

Object Type Hilt collar
Date 600-635

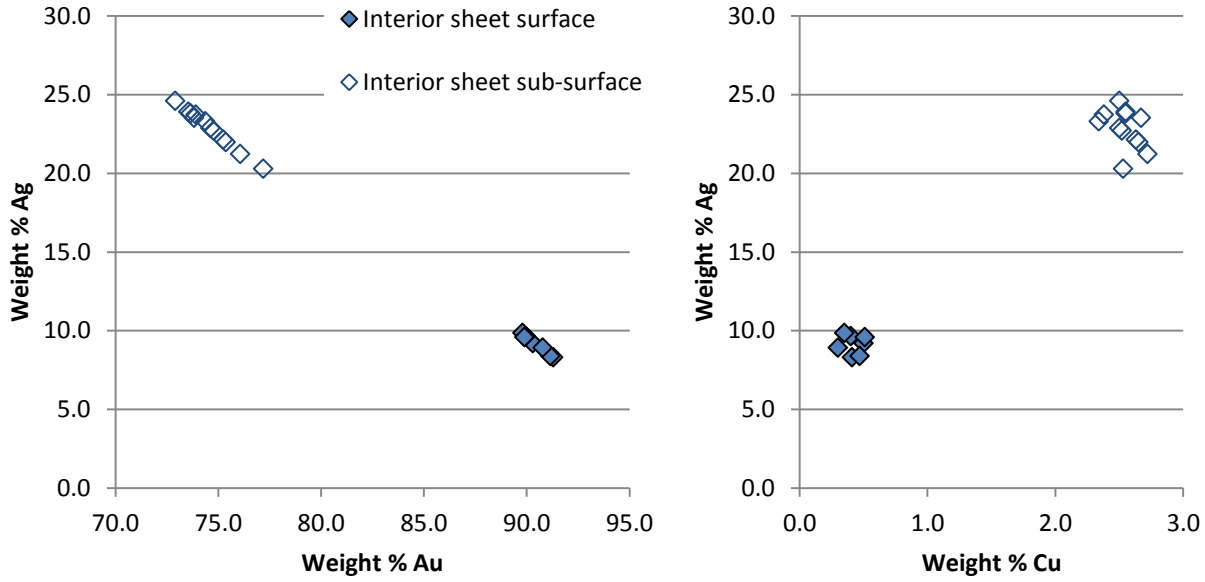
Decoration

Filigree	✓	Glass	
Garnet		Other	

SEM-EDX analysis was undertaken on the gold sheet to which the filigree was attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	7	Average	90.5	9.1	0.4
		Standard Deviation	*0.62*	*0.62*	*0.08*
Sub-surface	12	Average	74.7	22.8	2.5
		Standard Deviation	*1.20*	*1.25*	*0.11*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 73-76 wt% gold, 21-24 wt% silver, the rest being copper. The analysis revealed a *c.*13.7 wt% loss of silver from the surface (a difference of *c.*60% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K136: results of SEM-EDX analysis

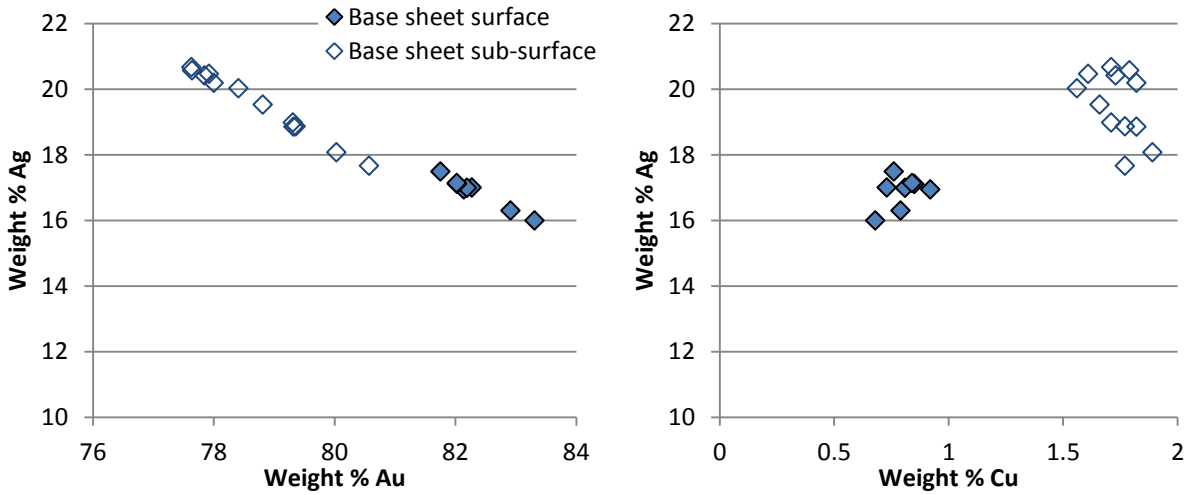
Object Type Pommel
Date 630-670

Decoration				
	Filigree	✓	Glass	
	Garnet		Other	✓

SEM-EDX analysis was undertaken on the back of the pommel insert base sheet. The central stone analysed by Janet Ambers at the British Museum using Raman spectroscopy was identified as the colourless form of quartz known as rock crystal.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	81.6	17.4	1.0
		Standard Deviation	*1.43*	*1.01*	*0.45*
Sub-surface	12	Average	79.3	19.1	1.6
		Standard Deviation	*1.80*	*1.54*	*0.36*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 77-81 wt% gold, 17-21 wt% silver, the rest being copper. The gold analysis revealed a *c.*1.7 wt% loss of silver from the surface (a difference of *c.*9% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal but may also suggest natural loss during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K140: results of SEM-EDX analysis

Object Type Hilt ring
Date 600-635

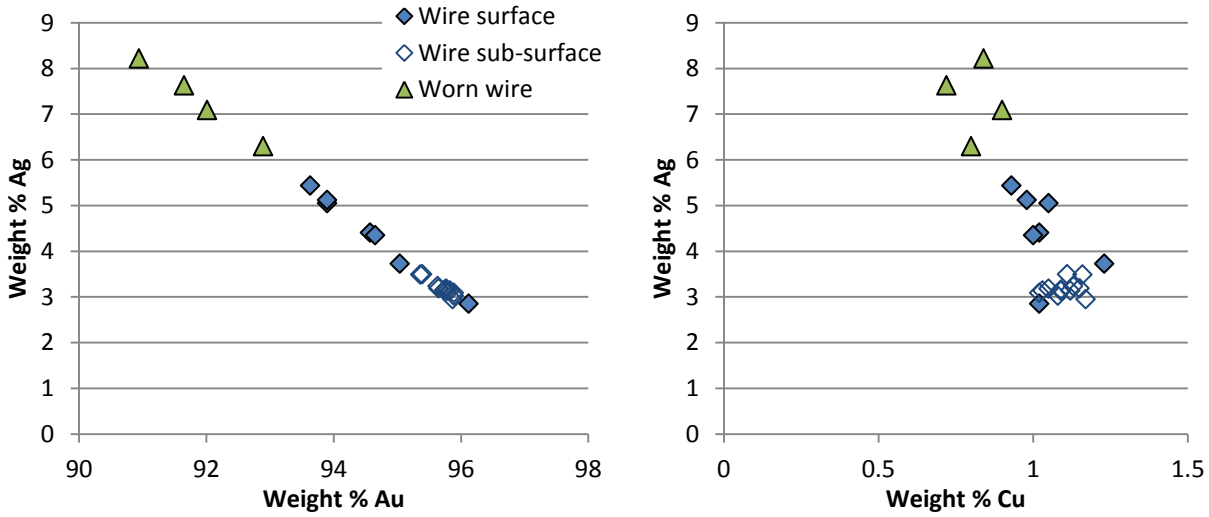
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the edge of the beaded wire hilt ring.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	7	Average	94.6	4.4	1.0
		Standard Deviation	*0.86*	*0.90*	*0.09*
Sub-surface	12	Average	95.7	3.2	1.1
		Standard Deviation	*0.18*	*0.16*	*0.05*
Worn surface	4	Average	91.9	7.3	0.8
		Standard Deviation	*0.81*	*0.82*	*0.08*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 91-93 wt% gold, 6-8 wt% silver, the rest being copper. The analysis revealed a small loss of copper at the surface, in quantities suggesting corrosion that can occur during burial which results in natural surface enrichment. There was a small increase in silver at the surface which may be re-deposited silver from nearby corroding silver alloy objects.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K271: results of SEM-EDX analysis

Object Type Hilt Collar
Date 625-650

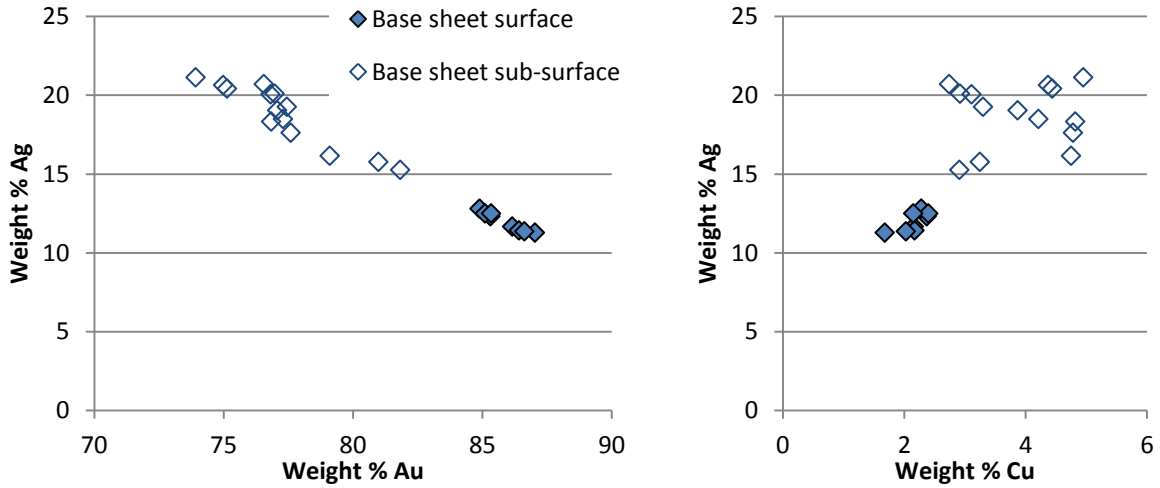
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the gold sheet to which the wire was attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	85.8	12.0	2.2
		Standard Deviation	*0.79*	*0.61*	*0.23*
Sub-surface	14	Average	77.3	18.8	3.9
		Standard Deviation	*2.15*	*1.94*	*0.82*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 75-80 wt% gold, 17-21 wt% silver, the rest being copper. The analysis revealed a *c.*6.8 wt% loss of silver from the surface (a difference of *c.*36% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K273: results of SEM-EDX analysis

Object Type Mount
Date 600-635

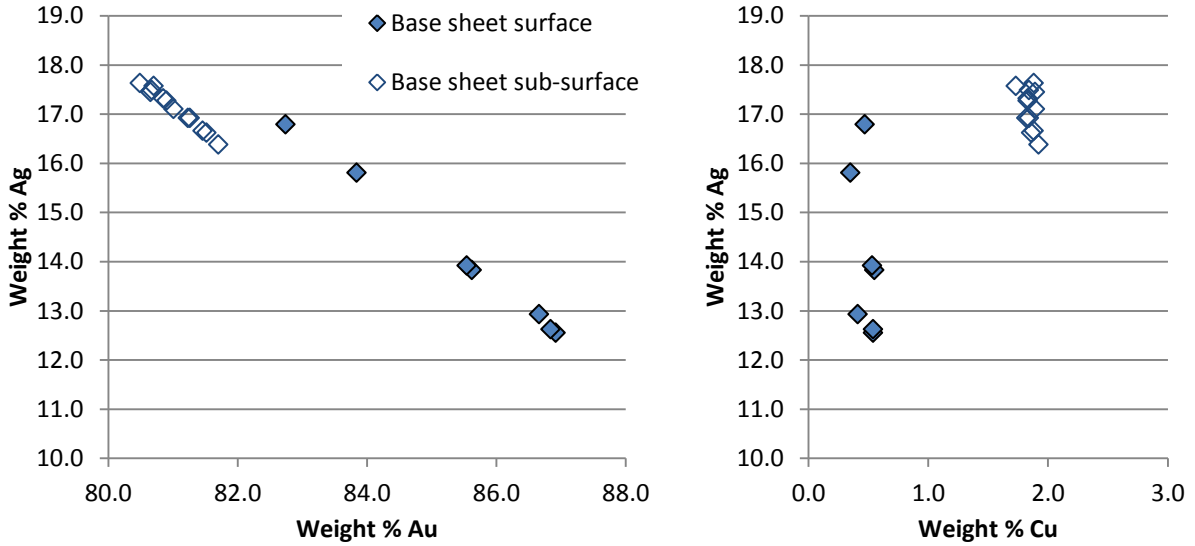
Decoration

Filigree	✓	Glass	
Garnet	✓	Other	

SEM-EDX analysis was undertaken on the base sheet on the back of the mount.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	7	Average	85.4	14.1	0.5
		Standard Deviation	*1.61*	*1.64*	*0.08*
Sub-surface	12	Average	81.0	17.1	1.9
		Standard Deviation	*0.39*	*0.41*	*0.05*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 80-82 wt% gold, 16-18 wt% silver, the rest being copper. The analysis revealed a *c.*3.0 wt% loss of silver from the surface (a difference of *c.*18% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K276: results of SEM-EDX analysis

Object Type Pommel
Date 580-610

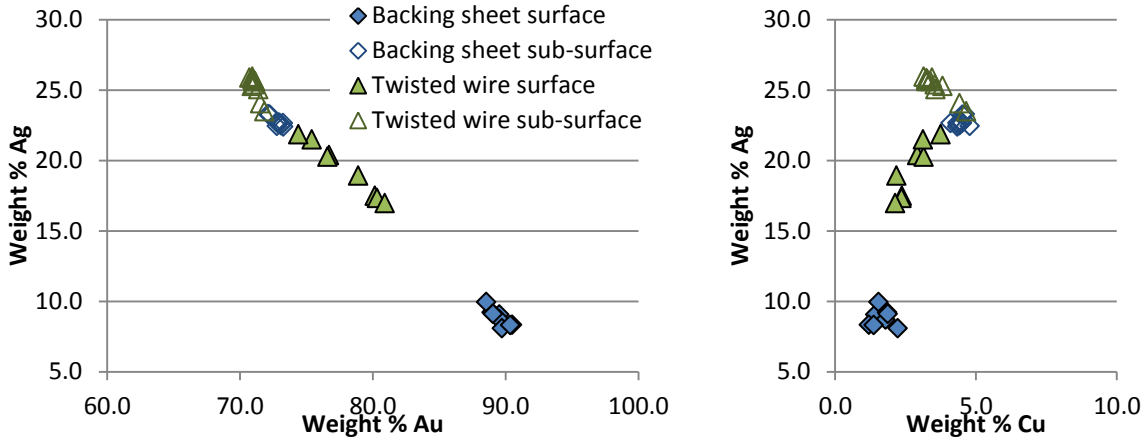
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the twisted wire and the base sheet to which the wire was attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Backing sheet surface	8	Average	89.5	8.8	1.7
		Standard Deviation	*0.67*	*0.61*	*0.34*
Backing sheet sub-surface	12	Average	72.9	22.7	4.4
		Standard Deviation	*0.35*	*0.28*	*0.16*
Twisted wire surface	6	Average	78.0	19.3	2.7
		Standard Deviation	*2.47*	*1.94*	*0.58*
Twisted wire sub-surface	10	Average	71.1	25.3	3.6
		Standard Deviation	*0.32*	*0.76*	*0.49*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The sub-surface composition of both components is comparable, although the sheet had a higher copper content, suggesting a similar, gold alloy was used. The analysis revealed a *c.*13.9 wt% loss of silver from the surface of the base sheet (a difference of *c.*61% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the twisted wire revealed a loss of silver from the surface, *c.*6.0 wt% loss of silver from the surface of the base sheet (a difference of *c.*24% from surface to core), which is again indicative of deliberate treatment.

Eleanor Blakelock
Analysed December 2013

Gold enrichment in Staffordshire Hoard K278: results of SEM-EDX analysis

Object Type Hilt Collar
Date 625-650

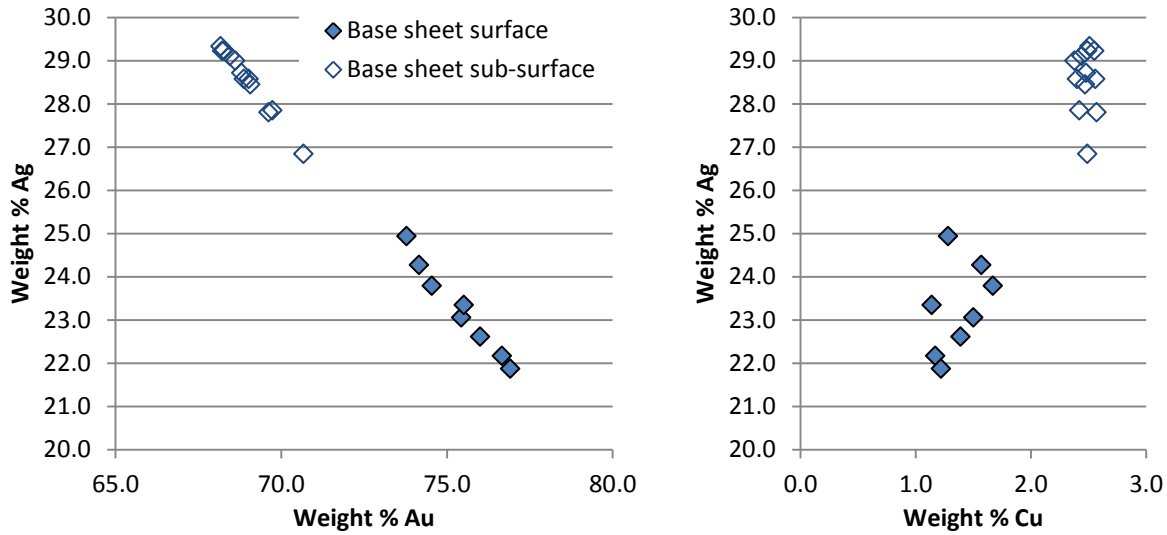
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the gold sheet to which the filigree was attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	75.3	23.3	1.4
		Standard Deviation	*1.14*	*1.05*	*0.20*
Sub-surface	12	Average	68.9	28.6	2.5
		Standard Deviation	*0.74*	*0.74*	*0.06*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 68-70 wt% gold, 27-30 wt% silver, the rest being copper. The analysis revealed a *c.*5.3 wt% loss of silver from the surface (a difference of *c.*19% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K281: results of SEM-EDX analysis

Object Type Hilt-collar
Date 610-630

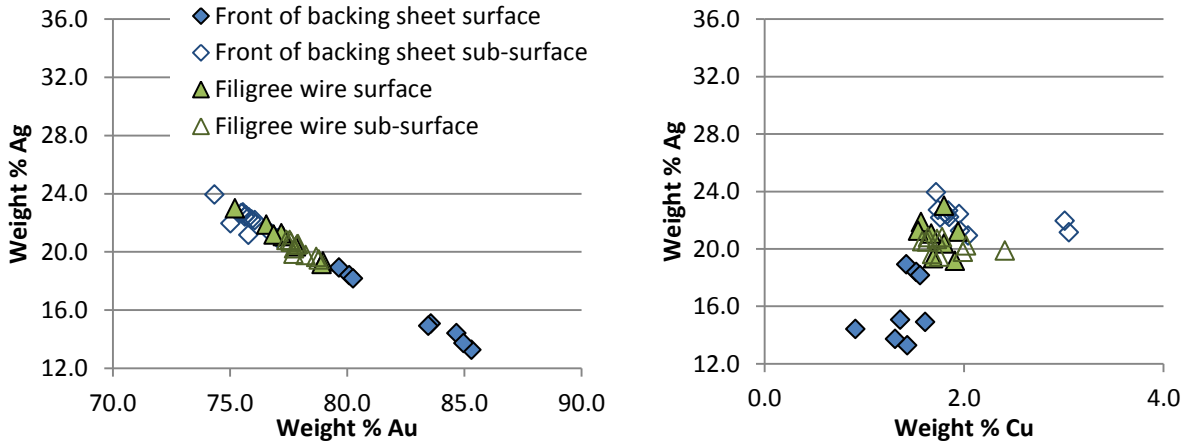
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the filigree wires and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Backing sheet surface	12	Average	79.2	18.9	1.9
		Standard Deviation	*1.13*	*0.95*	*0.24*
Backing sheet sub-surface	14	Average	70.3	26.9	2.8
		Standard Deviation	*1.93*	*2.02*	*0.18*
Filigree wire surface	14	Average	68.1	28.8	3.1
		Standard Deviation	*0.86*	*0.91*	*0.48*
Filigree wire sub-surface	21	Average	69.3	28.3	2.4
		Standard Deviation	*0.89*	*0.94*	*0.07*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The sub-surface composition of both components is similar suggesting the same, or a similar, gold alloy was used. The analysis revealed a *c.*8.0 wt% loss of silver from the surface of the base sheet (a difference of *c.*30% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the filigree wire revealed a small increase in silver and copper at the surface, possibly due to contamination from the solder.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K284: results of SEM-EDX analysis

Object Type Pommel
Date 620-650

Decoration Filigree [ ] Glass [ ]
Garnet [✓] Other [ ]

SEM-EDX analysis was undertaken on the gold sheet at the base of the pommel.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	7	Average	90.1	9.0	0.9
		Standard Deviation	*0.55*	*0.54*	*0.04*
Sub-surface	8	Average	71.8	26.1	2.1
		Standard Deviation	*1.00*	*0.96*	*0.10*

SEM-EDX surface and sub-surface compositions (the results are normalised).

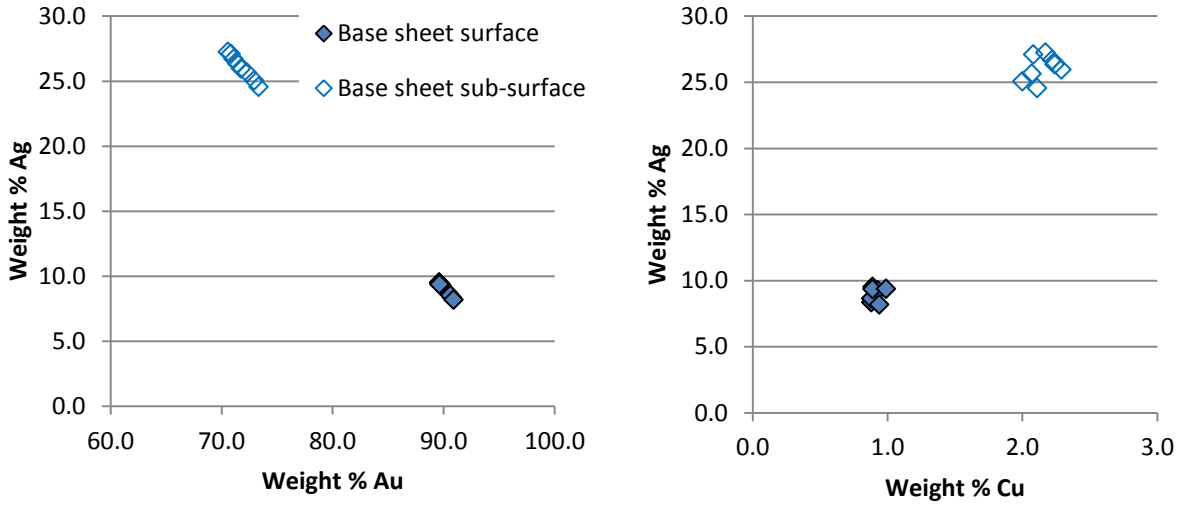


Figure 2. Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 71-73 wt% gold, 25-27 wt% silver, the rest being copper. The analysis revealed a *c.*17.1 wt% loss of silver from the surface (a difference of *c.*66% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed June 2013

Gold enrichment in Staffordshire Hoard K288: results of SEM-EDX analysis

Object Type Helmet 'eye-brow'
Date 625-650

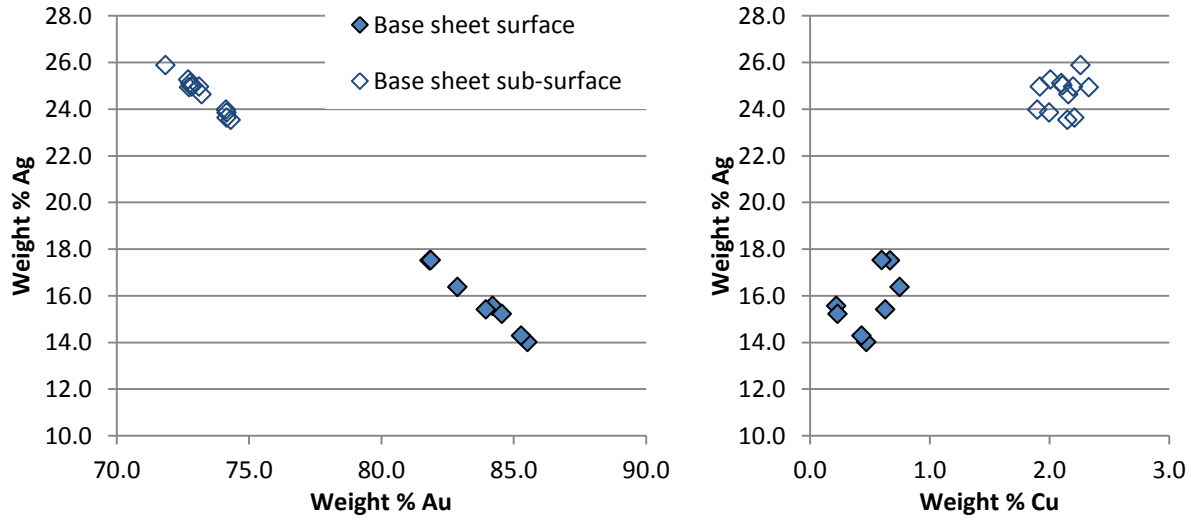
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the back of the gold sheet to which the wire was attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	83.8	15.7	0.5
		Standard Deviation	*1.43*	*1.32*	*0.20*
Sub-surface	12	Average	73.2	24.7	2.1
		Standard Deviation	*0.77*	*0.73*	*0.13*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 72-74 wt% gold, 24-26 wt% silver, the rest being copper. The analysis revealed a *c.*8.9 wt% loss of silver from the surface (a difference of *c.*36% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K292: results of SEM-EDX analysis

Object Type Pommel
Date 600-630

Decoration Filigree ☐ Glass ☐
Garnet ✓ Other ☐

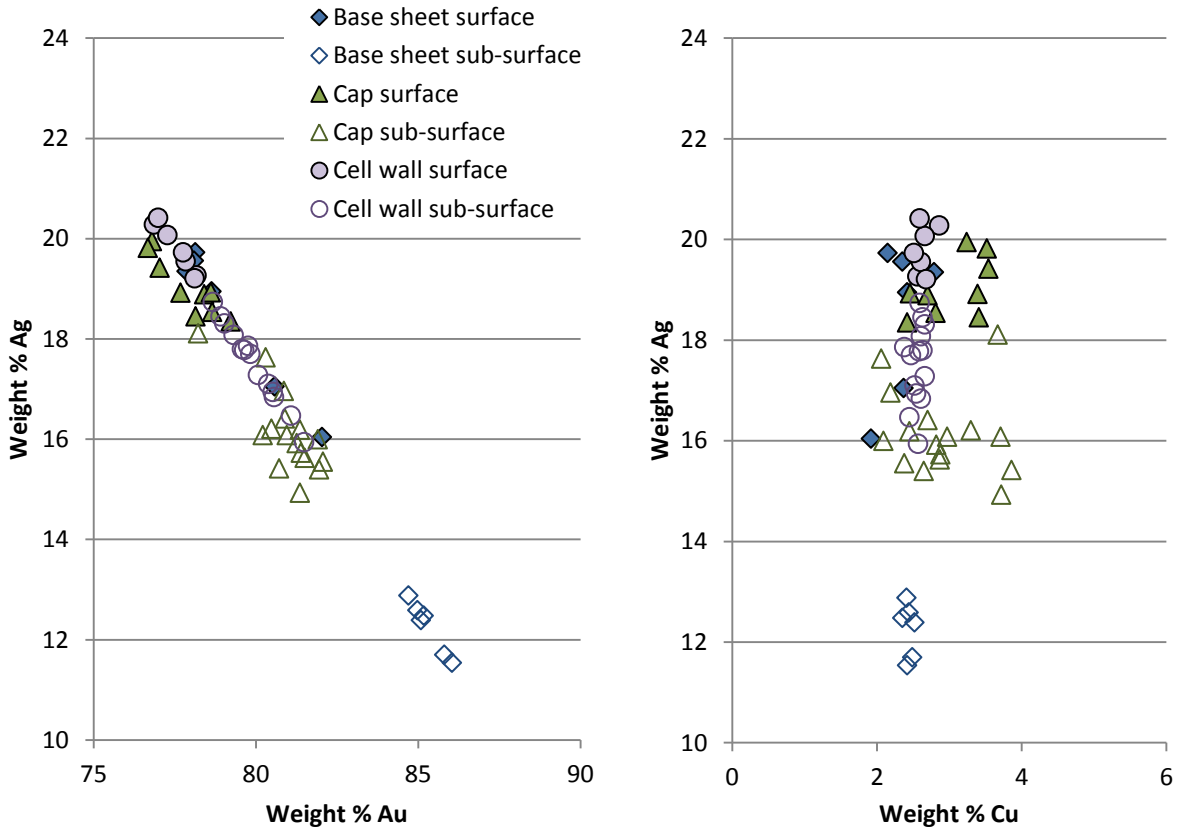
SEM-EDX analysis was undertaken on a range of components, including two types of filigree wire, the separate cap and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	6	Average	79.3	18.4	2.3
		Standard Deviation	*1.70*	*1.53*	*0.29*
Base sheet sub-surface	6	Average	85.3	12.3	2.4
		Standard Deviation	*0.52*	*0.53*	*0.06*
Top of cap surface	9	Average	77.9	19.0	3.1
		Standard Deviation	*0.91*	*0.58*	*0.46*
Top of cap sub-surface	16	Average	81.0	16.1	2.9
		Standard Deviation	*0.92*	*0.83*	*0.60*
Cell wall surface	7	Average	77.6	19.8	2.6
		Standard Deviation	*0.53*	*0.48*	*0.11*
Cell wall sub-surface	14	Average	79.9	17.5	2.6
		Standard Deviation	*0.82*	*0.80*	*0.08*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

Comparison of the sub-surface compositions suggests that the backing sheet was most likely from a different gold alloy to the cap and cell walls.

The sub-surface and surface analysis revealed no loss of either silver or copper from the surface of the object, instead there was an increase in both copper and silver at the surface. This may derive from the solder used or could be re-deposited silver from nearby corroding silver objects in the burial environment.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed August 2013

Gold enrichment in Staffordshire Hoard K294: results of SEM-EDX analysis

Object Type Pommel
Date 620-650

Decoration

Filigree	✓	Glass		
Garnet	✓	Other		

SEM-EDX analysis was undertaken on a number of components including the sheet that was used as a base for the filigree, the large filigree wire, twisted wire and the cell walls.

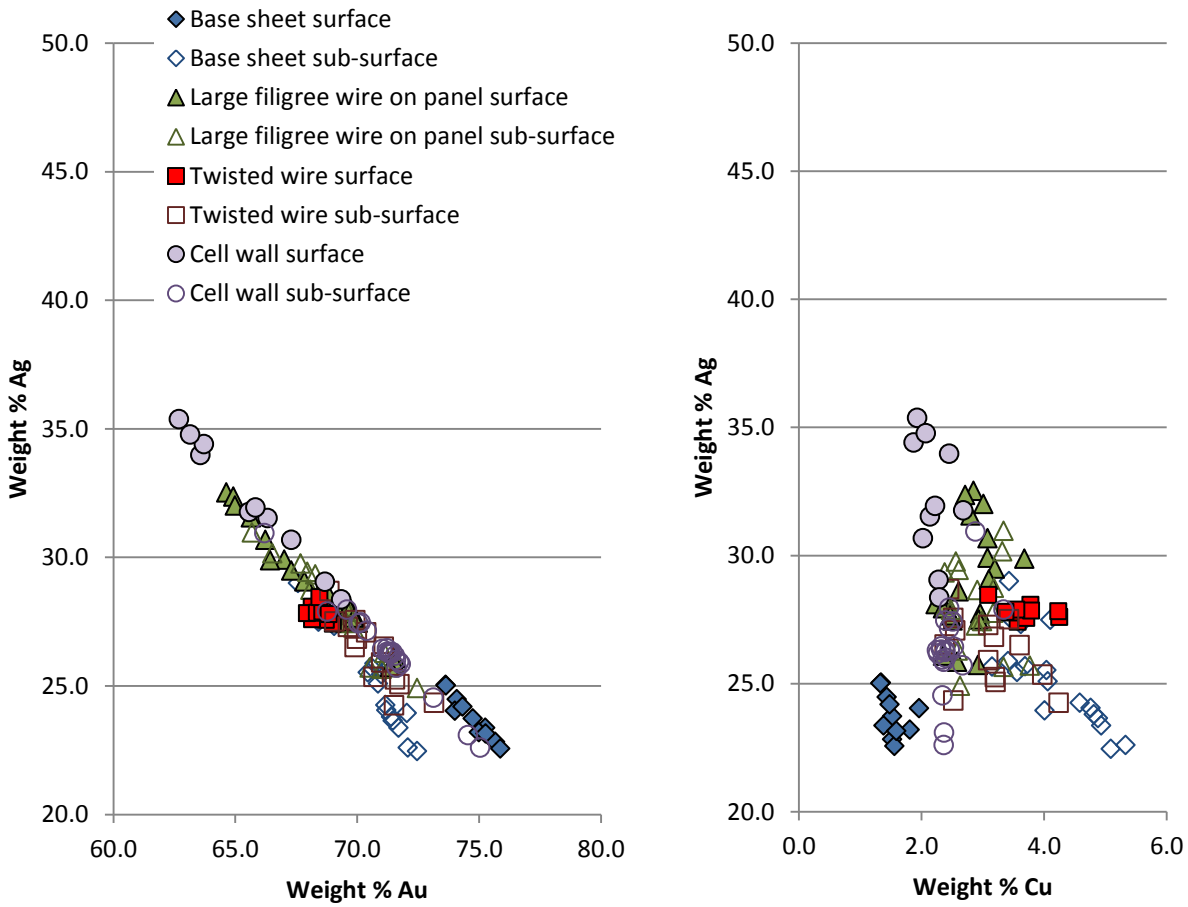
Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	11	Average	74.7	23.8	1.5
		Standard Deviation	*0.79*	*0.84*	*0.19*
Base sheet sub-surface	18	Average	70.2	26.0	3.8
		Standard Deviation	*1.36*	*1.54*	*0.45*
Large filigree wire surface	20	Average	68.3	28.9	2.8
		Standard Deviation	*2.27*	*2.10*	*0.36*
Large filigree wire sub-surface	16	Average	69.1	28.0	2.9
		Standard Deviation	*1.75*	*1.74*	*0.41*
Twisted wire surface	10	Average	68.5	27.8	3.7
		Standard Deviation	*0.35*	*0.29*	*0.36*
Twisted wire sub-surface	14	Average	70.5	26.6	2.9
		Standard Deviation	*1.11*	*1.18*	*0.44*
Cell wall surface	10	Average	67.5	30.3	2.2
		Standard Deviation	*1.50*	*1.55*	*0.11*
Cell wall sub-surface	21	Average	71.2	26.4	2.4
		Standard Deviation	*0.83*	*0.81*	*0.11*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

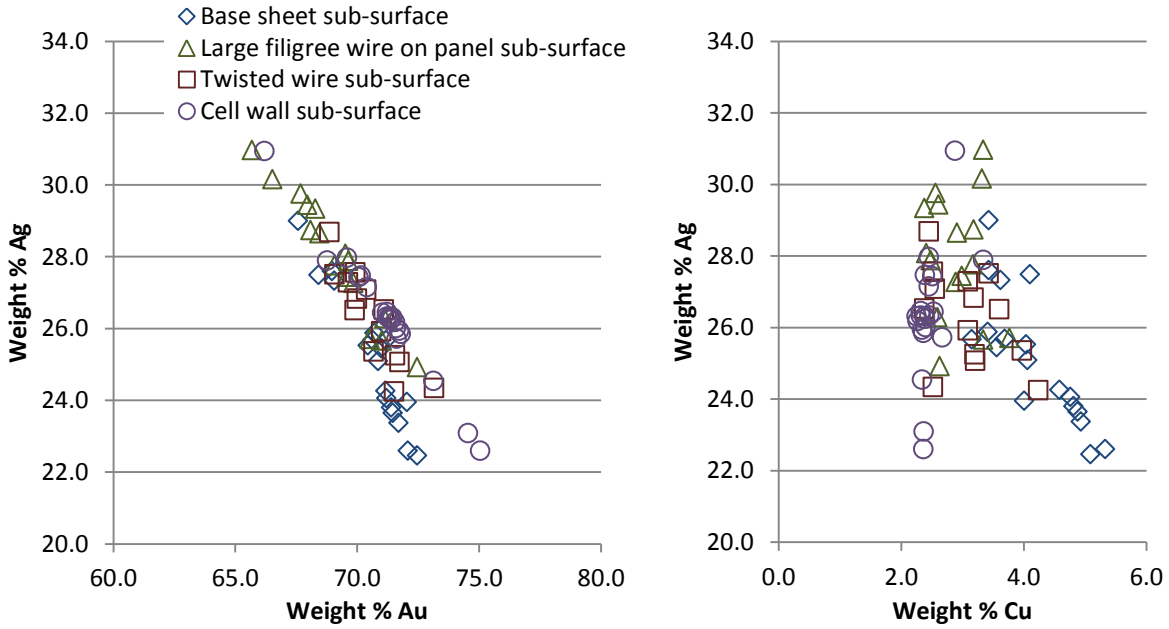
The analysis revealed a *c.*2.3 wt% loss of silver from the surface (a difference of *c.*9% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The other components had an increase of copper and silver at the surface compared to the sub-surface which could be contamination from the solder used to attach them to the gold base sheet, or re-deposited silver from close contact to corroding silver alloy objects in the burial environment.

Comparison of the sub-surface compositions of each component suggests that all the components may have used the same, or a similar, gold alloy. The possible exception is the base sheet which had a slightly lower silver content. The base sheet is the only component showing gold enrichment and therefore this suggests that the sheet was treated separately before being incorporated into the pommel.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed June 2013

Gold enrichment in Staffordshire Hoard K297: results of SEM-EDX analysis

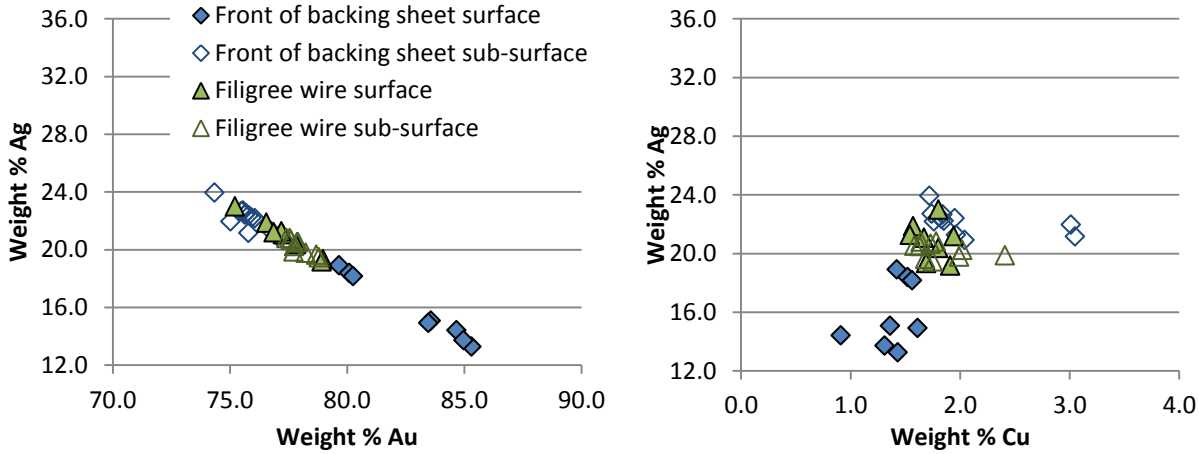
Object Type Mount
Date 625-650

Decoration Filigree ✓ Glass
Garnet Other

SEM-EDX analysis was undertaken on the filigree wires and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	82.7	15.9	1.4
		Standard Deviation	*2.37*	*2.27*	*0.22*
Base sheet sub-surface	20	Average	75.8	22.2	2.0
		Standard Deviation	*0.70*	*0.82*	*0.47*
Filigree wire surface	8	Average	77.4	20.9	1.7
		Standard Deviation	*1.24*	*1.27*	*0.15*
Filigree wire sub-surface	10	Average	78.0	20.2	1.8
		Standard Deviation	*0.47*	*0.51*	*0.25*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The sub-surface composition of both components is similar suggesting the same, or a similar, gold alloy was used. The analysis revealed a *c.*6.3 wt% loss of silver from the surface of the base sheet (a difference of *c.*29% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the filigree wire revealed a loss of copper from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K300: results of SEM-EDX analysis

Object Type Hilt-collar
Date 580-610

Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on a number of components including, the sheet that was used as a base for the filigree, the large filigree wire, small filigree wire and a granule.

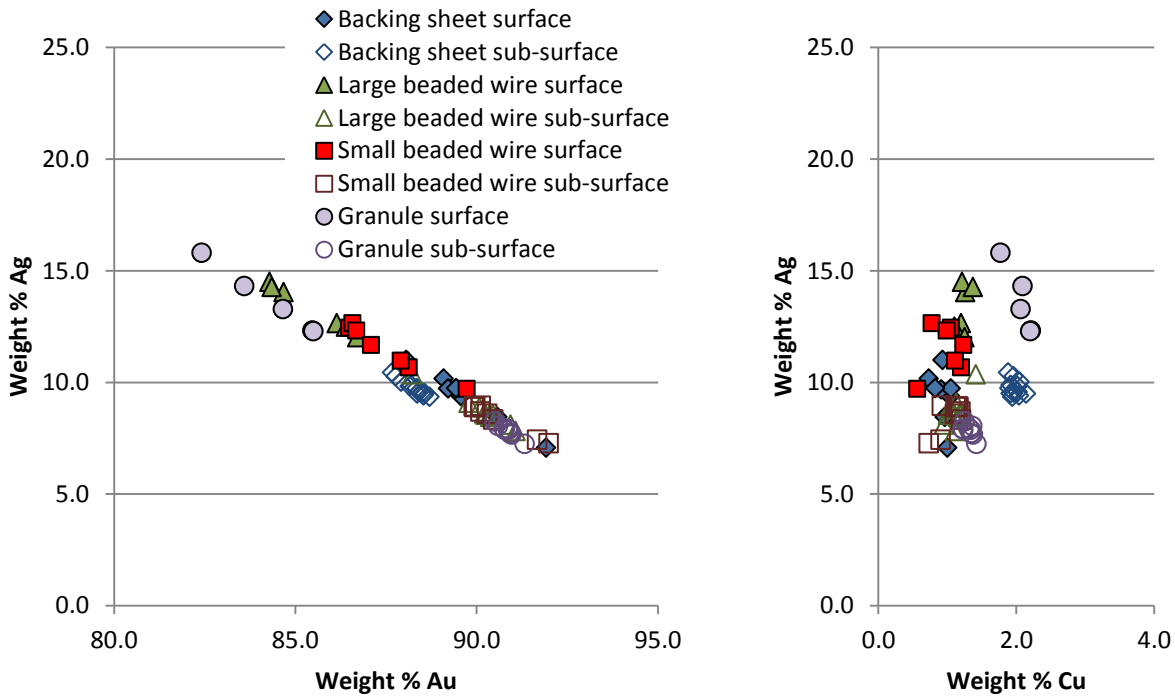
Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	89.7	9.4	0.9
		Standard Deviation	*1.14*	*1.18*	*0.11*
Base sheet sub-surface	12	Average	88.2	9.8	2.0
		Standard Deviation	*0.33*	*0.35*	*0.08*
Large filigree wire surface	6	Average	85.5	13.3	1.2
		Standard Deviation	*1.11*	*1.06*	*0.09*
Large filigree wire sub-surface	11	Average	90.2	8.7	1.1
		Standard Deviation	*1.23*	*1.15*	*0.12*
Small filigree wire surface	7	Average	87.5	11.5	1.0
		Standard Deviation	*1.17*	*1.09*	*0.24*
Small filigree wire sub-surface	10	Average	90.4	8.5	1.1
		Standard Deviation	*0.76*	*0.63*	*0.16*
Granule surface	5	Average	84.3	13.6	2.1
		Standard Deviation	*1.32*	*1.49*	*0.18*
Granule sub-surface	10	Average	90.9	7.8	1.3
		Standard Deviation	*0.23*	*0.26*	*0.07*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

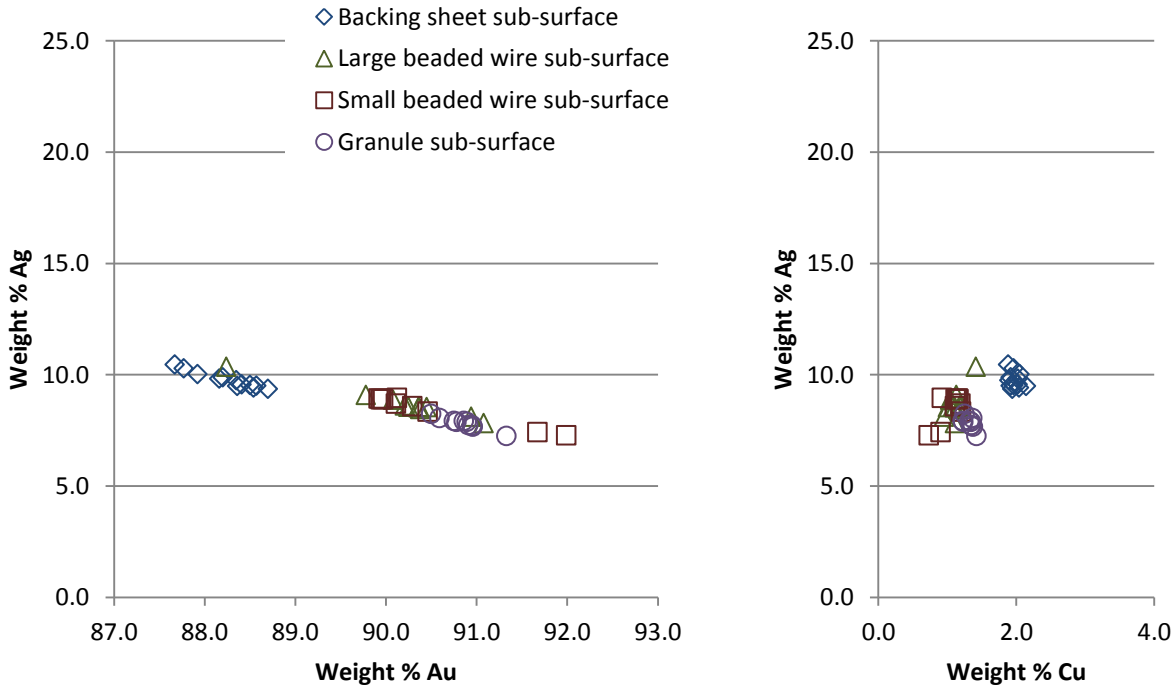
SEM-EDX analysis of the sub-surface of the base sheet indicated a composition of approximately 87-89 wt% gold, 9-11 wt% silver, the rest being copper. The analysis revealed a loss of copper and only a small loss of silver from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

The analysis revealed a small loss of copper at the surface of the wires and granule, again indicative of corrosion during burial. There was a small increase in silver at the surface which is most likely from close contact to corroding silver objects in the burial environment.

Comparison of the sub-surface compositions of the wires and granule suggests that they were all probably made from the same, or a similar, gold alloy. The backing sheet had a higher copper content suggesting it is a different gold alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K301: results of SEM-EDX analysis

Object Type Pommel
Date 630-670

Decoration				
	Filigree	✓	Glass	✓
	Garnet	✓	Other	✓

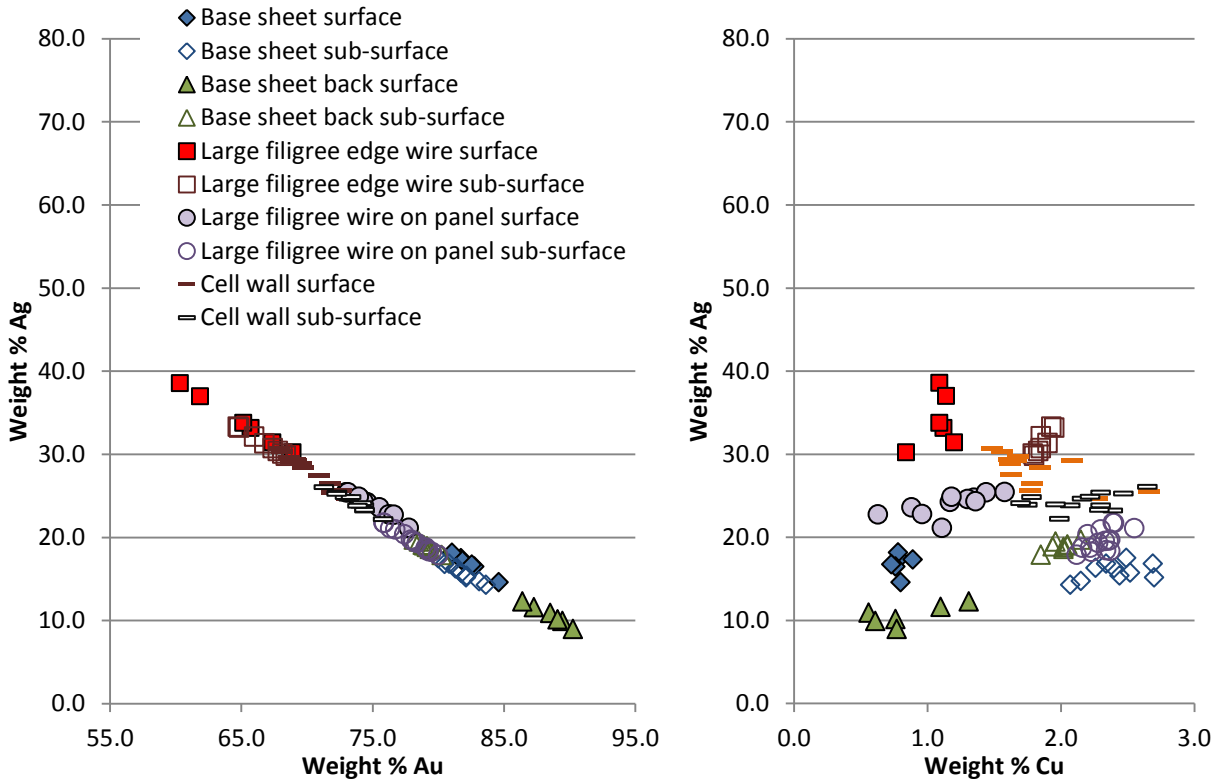
SEM-EDX analysis was undertaken on a range of components, including two types of filigree wire, the cell wall and the base sheet to which the applied decoration were attached were all analysed. The back of the panel was also analysed.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	6	Average	82.4	16.8	0.8
		Standard Deviation	*1.23*	*1.23*	*0.05*
Base sheet sub-surface	10	Average	81.7	15.9	2.4
		Standard Deviation	*1.13*	*1.02*	*0.21*
Base sheet back surface	6	Average	88.4	10.7	0.9
		Standard Deviation	*1.43*	*1.21*	*0.29*
Base sheet back sub-surface	8	Average	79.0	19.0	2.0
		Standard Deviation	*0.63*	*0.56*	*0.09*
Large filigree edge wire surface	6	Average	64.9	34.0	1.1
		Standard Deviation	*3.26*	*3.21*	*0.12*
Large filigree edge wire sub-surface	8	Average	66.7	31.4	1.9
		Standard Deviation	*1.43*	*1.38*	*0.06*
Large filigree wire on panel surface	11	Average	74.8	24.0	1.2
		Standard Deviation	*1.52*	*1.32*	*0.27*
Large filigree wire on panel sub-surface	15	Average	78.1	19.6	2.3
		Standard Deviation	*1.35*	*1.28*	*0.11*
Cell wall surface	13	Average	70.1	28.1	1.8
		Standard Deviation	*1.75*	*1.97*	*0.33*
Cell wall sub-surface	14	Average	73.7	24.2	2.1
		Standard Deviation	*1.15*	*1.01*	*0.28*

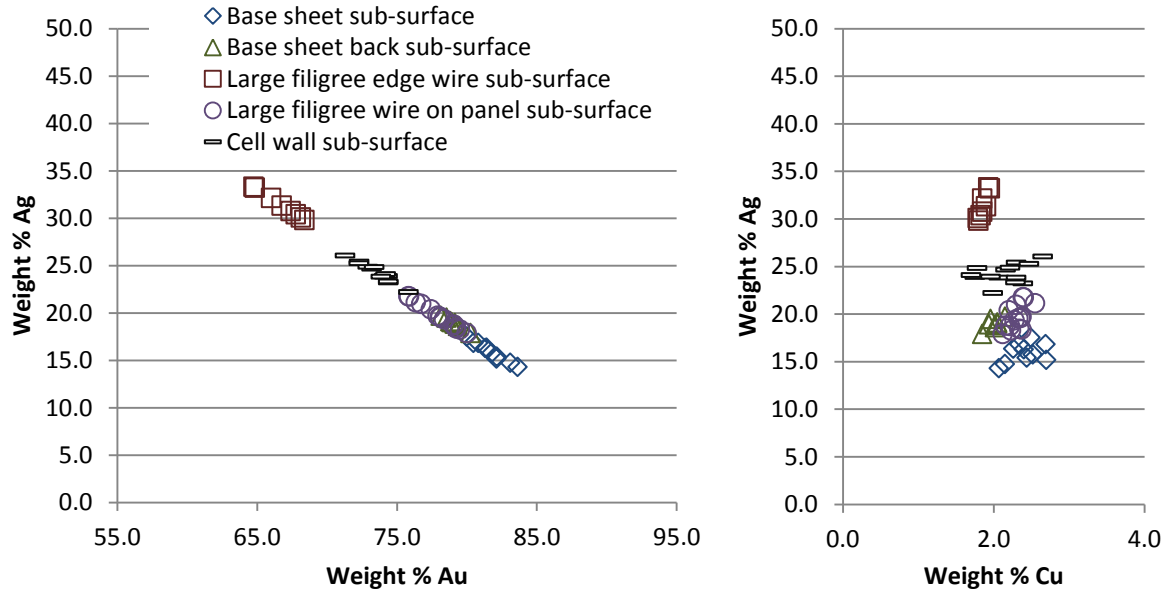
SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis of the back of this panel revealed a *c.*8.3 wt% loss of silver from the surface (a difference of *c.*44% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. All the other components of this piece had a loss of copper from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Comparison of the sub-surface compositions of each component suggests that the majority of the components may have been made with a similar gold alloy. The possible exception is the large filigree wire used on the edge of the piece and the cell walls, these both had a generally higher silver content. The back of the base sheet is the only component showing significant gold enrichment and therefore this suggests that the sheet was treated separately before being incorporated into the pommel.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed May 2013

Gold enrichment in Staffordshire Hoard K302: results of SEM-EDX analysis

Object Type Sword pyramid
Date 625-650

Decoration

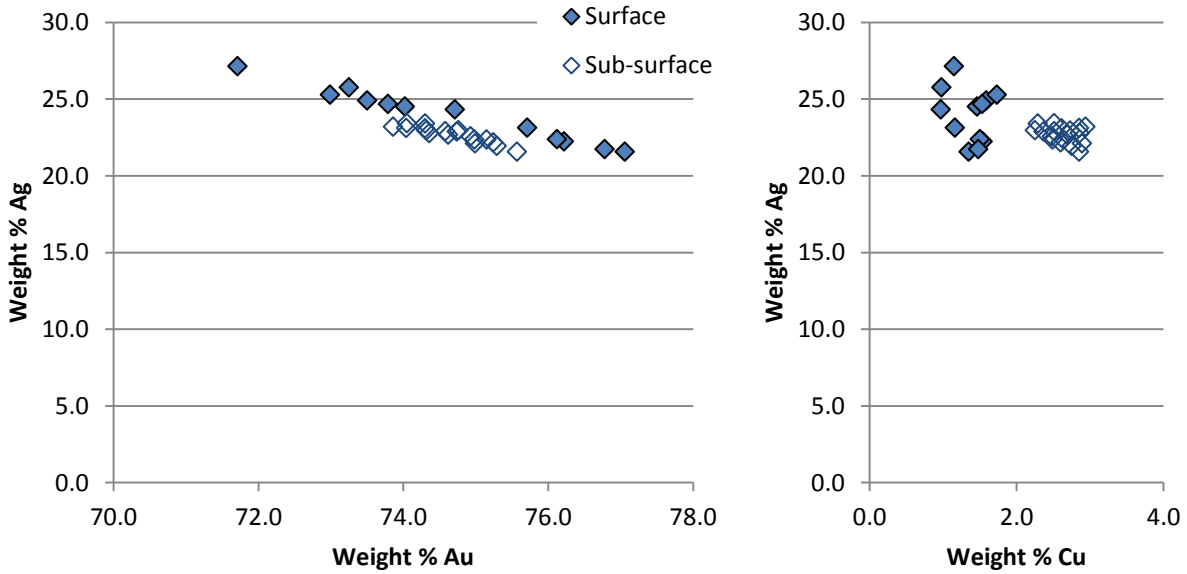
Filigree	✓	Glass	
Garnet	✓	Other	

SEM-EDX analysis was undertaken on the gold panel sheet to which the filigree wire was attached, and on the silver residue.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	12	Average	74.6	24.0	1.4
		Standard Deviation	*1.70*	*1.75*	*0.25*
Base sheet sub-surface	18	Average	74.7	22.7	2.6
		Standard Deviation	*0.48*	*0.51*	*0.21*
Silver residue area	6	Average	27.9	71.5	0.7
		Standard Deviation	*1.29*	*1.32*	*0.09*

SEM-EDX surface and sub-surface compositions (the results are normalised).

SEM-EDX analysis of the sub-surface indicated a composition of approximately 74-76 wt% gold, 22-24 wt% silver, the rest being copper. The analysis revealed a small loss of copper at the surface of most components, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. There was a small increase in silver at the surface is which most likely from close contact to silver objects in the burial environment. The analysis of areas with an observable silver residue confirmed the presence of high silver.



Silver/copper and silver/gold plots of the SEM-EDX data showing the differences between the sub-surface and surface analyses of the backing sheet.

Eleanor Blakelock
Analysed November 2013

Gold enrichment in Staffordshire Hoard K303: results of SEM-EDX analysis

Object Type Pectoral cross
Date 600-635

Decoration

Filigree	✓	Glass		
Garnet	✓	Other		

SEM-EDX analysis was undertaken on a range of components including two types of filigree wire and the base sheet to which the wires were attached. The back of the cross was also analysed.

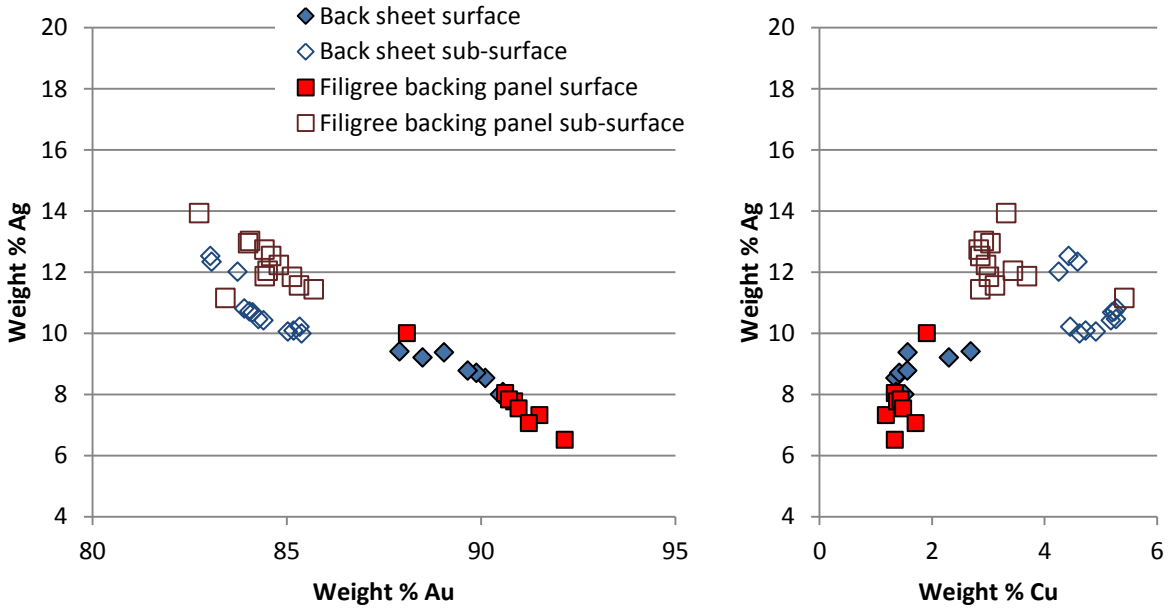
Area analysed	**No of analyses**		**Wt% Au**	**Wt% Ag**	**Wt% Cu**
Back of cross surface	8	Average	89.5	8.8	1.7
		Standard Deviation	*0.96*	*0.55*	*0.50*
Back of cross sub-surface	12	Average	84.3	10.9	4.8
		Standard Deviation	*0.81*	*0.91*	*0.38*
Backing sheet of panel surface	8	Average	90.7	7.8	1.5
		Standard Deviation	*1.19*	*1.03*	*0.23*
Backing sheet of panel sub-surface	12	Average	84.4	12.3	3.3
		Standard Deviation	*0.81*	*0.79*	*0.72*
Panel filigree wire surface	8	Average	84.0	12.8	3.2
		Standard Deviation	*1.04*	*1.09*	*0.18*
Panel filigree wire sub-surface	12	Average	86.8	10.6	2.6
		Standard Deviation	*0.81*	*0.95*	*0.25*
Large border filigree surface	7	Average	85.3	12.2	2.5
		Standard Deviation	*1.75*	*1.71*	*0.15*
Large border filigree sub-surface	12	Average	86.6	11.0	2.4
		Standard Deviation	*0.19*	*0.17*	*0.07*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

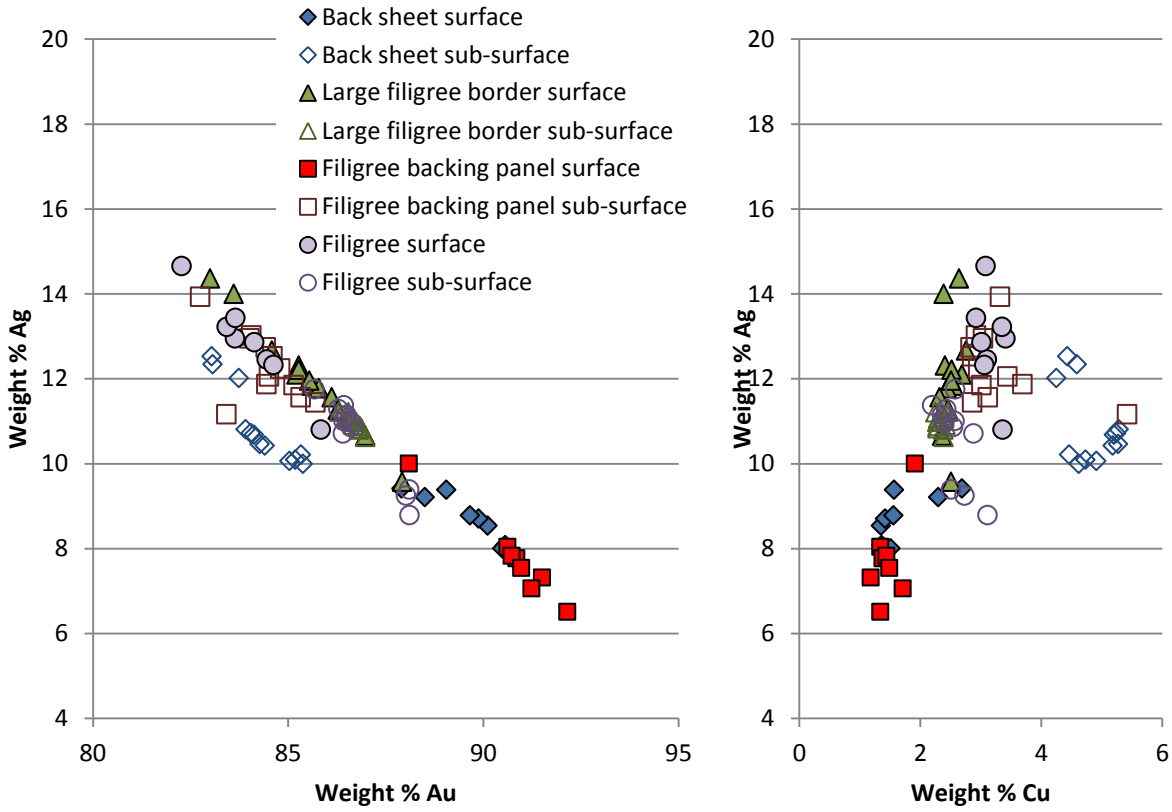
The analysis of the sheet used to construct the cross and the sheet that was used as a base for the filigree revealed a similar composition, suggesting they may have been from the same or a similar gold alloy.

The analysis of the back of the cross revealed a *c.*2.1 wt% loss of silver from the surface (a difference of *c.*19% from surface to core) whereas the backing sheet for the filigree had a *c.*4.5 wt% loss of silver from the surface (a difference of *c.*37% from surface to core). Both results are indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The analysis of both filigree wires revealed a small increase in copper and silver at the surface so these results may include contributions from the solder used to attach them to the gold base sheet. Or it may be re-deposited from close contact to corroding silver alloy objects in the burial environment. The composition of the wires had a similar composition to the sub-surface of the sheets, possibly suggesting they were made with a similar gold alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed October 2012

Gold enrichment in Staffordshire Hoard K306: results of SEM-EDX analysis

Object Type Pommel
Date 620-650

Decoration

Filigree	✓	Glass	
Garnet		Other	

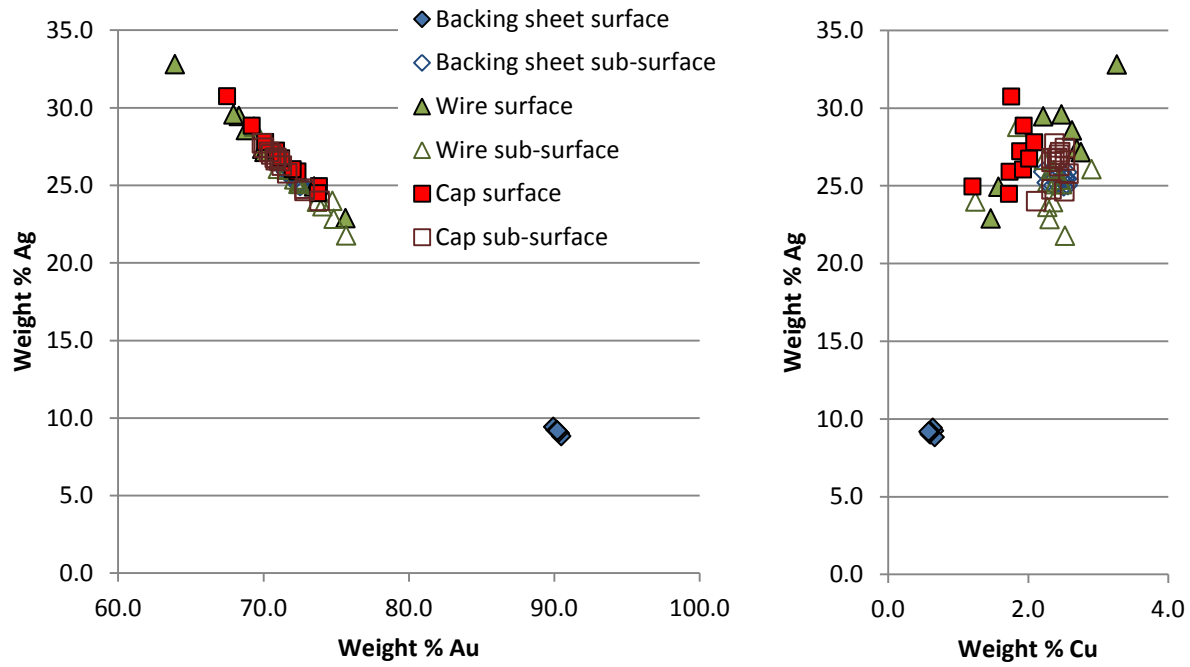
SEM-EDX analysis was undertaken on a range of components, including the filigree wire, the separate cap and the base sheet to which the wires were attached.

Area analysed	**No of analyses**		**Wt% Au**	**Wt% Ag**	**Wt% Cu**
Base sheet surface	5	Average	90.3	9.1	0.6
		Standard Deviation	*0.18*	*0.18*	*0.03*
Base sheet sub-surface	8	Average	72.1	25.4	2.5
		Standard Deviation	*0.35*	*0.34*	*0.12*
Top of cap surface	9	Average	71.2	27.0	1.8
		Standard Deviation	*2.08*	*1.96*	*0.26*
Top of cap sub-surface	14	Average	71.3	26.3	2.4
		Standard Deviation	*1.16*	*1.11*	*0.12*
Large filigree wire on panel surface	6	Average	69.8	27.8	2.4
		Standard Deviation	*3.57*	*3.04*	*0.61*
Large filigree wire on panel sub-surface	8	Average	72.7	25	2.3
		Standard Deviation	*1.75*	*1.74*	*0.37*

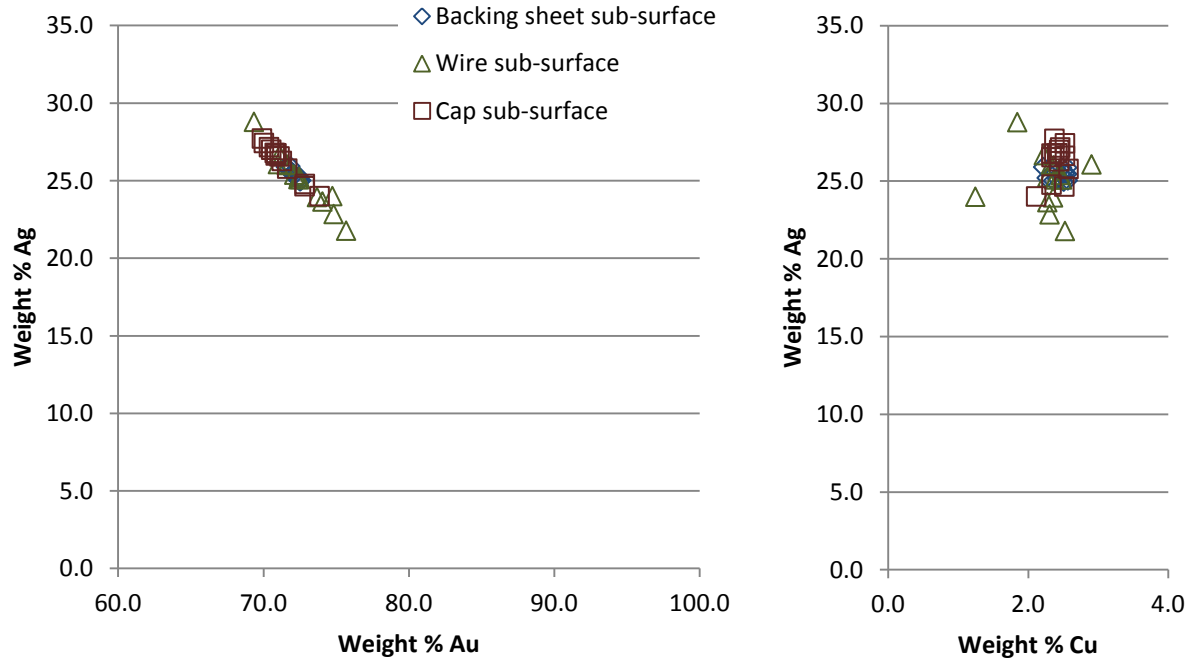
SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a *c.*16.3 wt% loss of silver from the surface of the base sheet (a difference of *c.*64% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the other components revealed a small increase in silver and copper at the surface which is most likely from close contact to corroding silver objects in the burial environment or contamination from the solder.

Comparison of the sub-surface compositions of each component suggests that they may have been made using the same gold alloy. The base sheet is the only component showing gold enrichment; this therefore this suggests that the sheet was treated separately before being incorporated into the pommel.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed December 2013

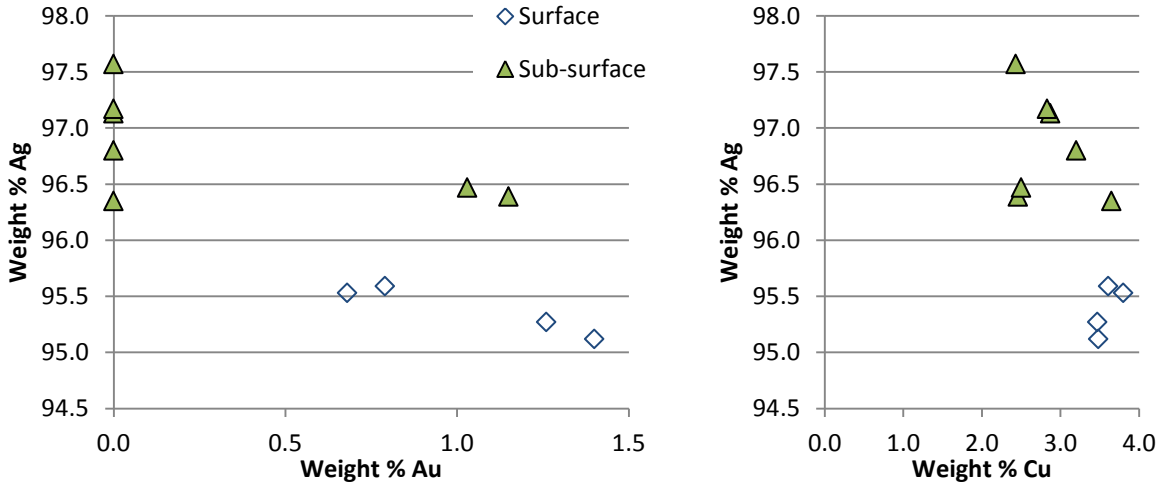
Gold enrichment in Staffordshire Hoard K309: results of SEM-EDX analysis

Object Type Pommel
Date 600-620
Decoration Filigree ✓ Glass
Garnet Other

SEM-EDX analysis was undertaken on the base beneath the wires.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	4	Average	1.0	95.4	3.6
		Standard Deviation	0.35	0.22	0.15
Sub-surface	7	Average	0.3	96.9	2.8
		Standard Deviation	0.53	0.47	0.45

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 96-97.5 wt% silver, 2-3 wt% copper, with the remainder being gold.

Eleanor Blakelock
Analysed December 2012

Gold enrichment in Staffordshire Hoard K347: results of SEM-EDX analysis

Object Type Pommel
Date 625-650

Decoration				
	Filigree	✓	Glass	
	Garnet		Other	✓

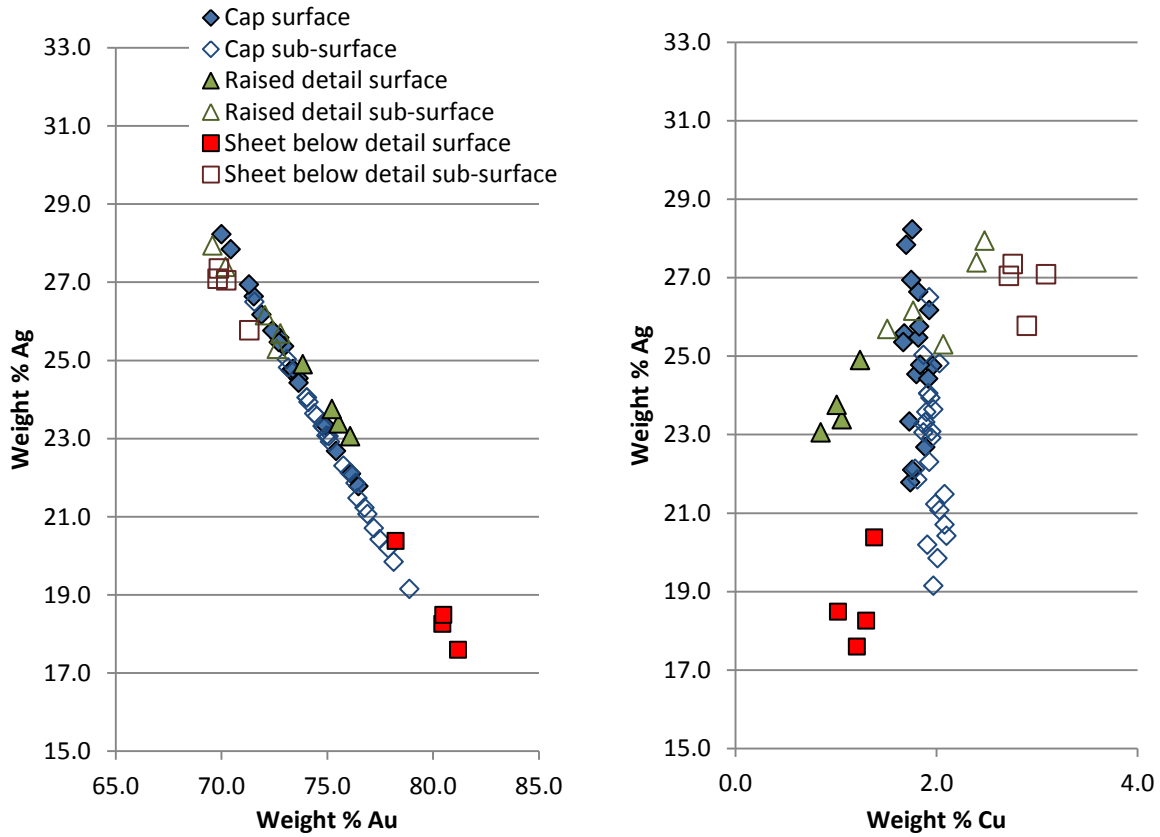
SEM-EDX analysis was undertaken on the separate cap, the base sheet and the raised gold decoration attached to the base sheet. XRD analysis identified the black inlay as silver sulphide niello (La Niece 2013).

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Top of cap surface	18	Average	75.1	23.1	1.8
		Standard Deviation	*1.61*	*1.58*	*0.07*
Top of cap sub-surface	24	Average	75.5	22.6	1.9
		Standard Deviation	*1.78*	*1.81*	*0.08*
Base sheet surface	4	Average	80.1	18.7	1.2
		Standard Deviation	*1.28*	*1.19*	*0.15*
Base sheet sub-surface	4	Average	70.3	26.8	2.9
		Standard Deviation	*0.70*	*0.71*	*0.17*
Detail on sheet surface	4	Average	75.2	23.8	1.0
		Standard Deviation	*0.96*	*0.80*	*0.16*
Detail on sheet sub-surface	5	Average	71.5	26.5	2.0
		Standard Deviation	*1.47*	*1.13*	*0.41*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis of the base sheet under the raised decoration revealed a *c.*8.1 wt% loss of silver from the surface (a difference of *c.*30% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Analysis of the raised detail also revealed a *c.*2.7 wt% loss of silver from the surface (a difference of *c.*10% from surface to core), which may also indicate a treatment was carried out as only copper and small amounts of silver are normally lost from the surface during burial.

The analysis of the cap revealed a loss of copper from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed August 2013

Reference

La Niece, S., 2013. The scientific analysis of niello inlays from the Staffordshire Hoard. British Museum, London. Science Report PR07444-3.

Gold enrichment in Staffordshire Hoard K349: results of SEM-EDX analysis

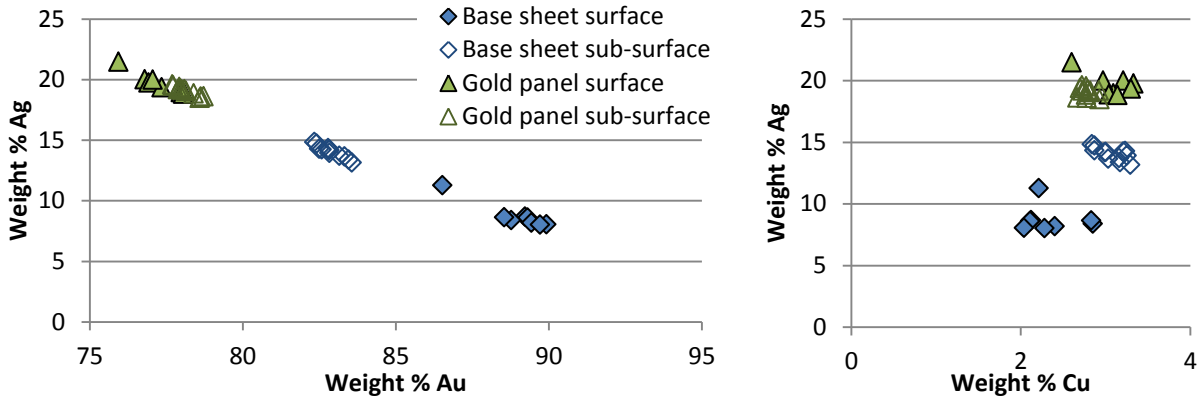
Object Type Pommel
Date 610-630

Decoration				
	Filigree	✓	Glass	
	Garnet		Other	✓

SEM-EDX analysis was undertaken on the base sheet to which the wires were attached and also the cell walls of the panel with the green inlay.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	88.9	8.7	2.4
		Standard Deviation	*1.07*	*1.06*	*0.32*
Base sheet sub-surface	12	Average	82.9	14.0	3.1
		Standard Deviation	*0.41*	*0.51*	*0.16*
Gold panel surface	8	Average	77.3	19.6	3.1
		Standard Deviation	*0.75*	*0.88*	*0.23*
Gold panel sub-surface	12	Average	78.1	19.1	2.8
		Standard Deviation	*0.35*	*0.37*	*0.08*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface of the base sheet indicated a composition of approximately 82-84 wt% gold, 13-15 wt% silver, the rest being copper. The analysis revealed a *c.*5.3 wt% loss of silver from the surface of the base sheet (a difference of *c.*38% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

SEM-EDX analysis of the sub-surface of the panel indicated a composition of approximately 77-79 wt% gold, 18-20 wt% silver, the rest being copper. The analysis of the cell walls of the gold panel revealed no loss of either silver or copper from the surface of the object. Both components were made from a different gold alloy.

Eleanor Blakelock
Analysed December 2013

Gold enrichment in Staffordshire Hoard K352: results of SEM-EDX analysis

Object Type Pommel
Date 610-630

Decoration				
	Filigree	✓	Glass	
	Garnet	✓	Other	

SEM-EDX analysis was undertaken on a range of components, including the separate cap, the sheet forming the panel and the base sheet to which the applied decoration were attached.

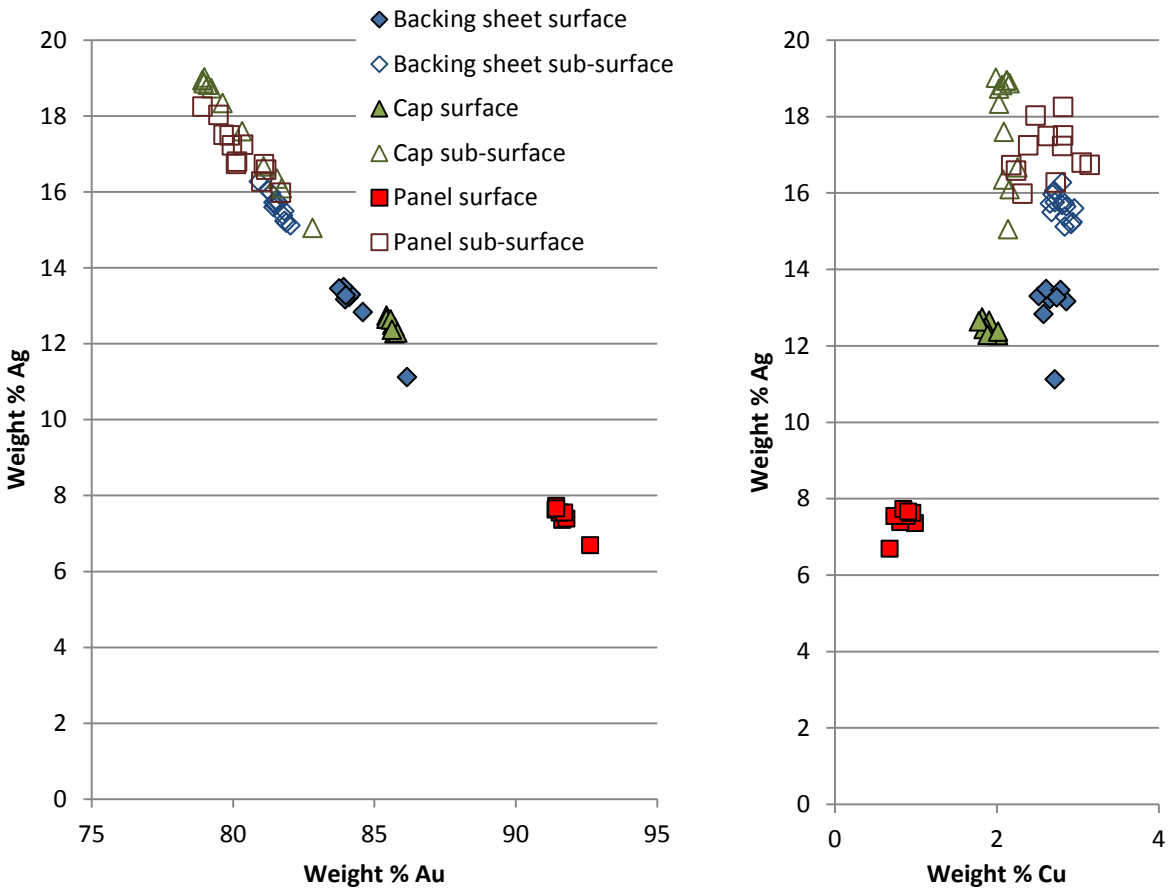
Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	84.3	13.0	2.7
		Standard Deviation	*0.78*	*0.78*	*0.11*
Base sheet sub-surface	14	Average	81.6	15.6	2.8
		Standard Deviation	*0.30*	*0.33*	*0.10*
Top of cap surface	8	Average	85.6	12.5	1.9
		Standard Deviation	*0.14*	*0.18*	*0.09*
Top of cap sub-surface	12	Average	80.1	17.8	2.1
		Standard Deviation	*1.36*	*1.39*	*0.07*
Panel sheet surface	8	Average	91.7	7.4	0.9
		Standard Deviation	*0.40*	*0.33*	*0.11*
Panel sheet sub-surface	12	Average	80.3	17.1	2.6
		Standard Deviation	*0.81*	*0.68*	*0.32*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

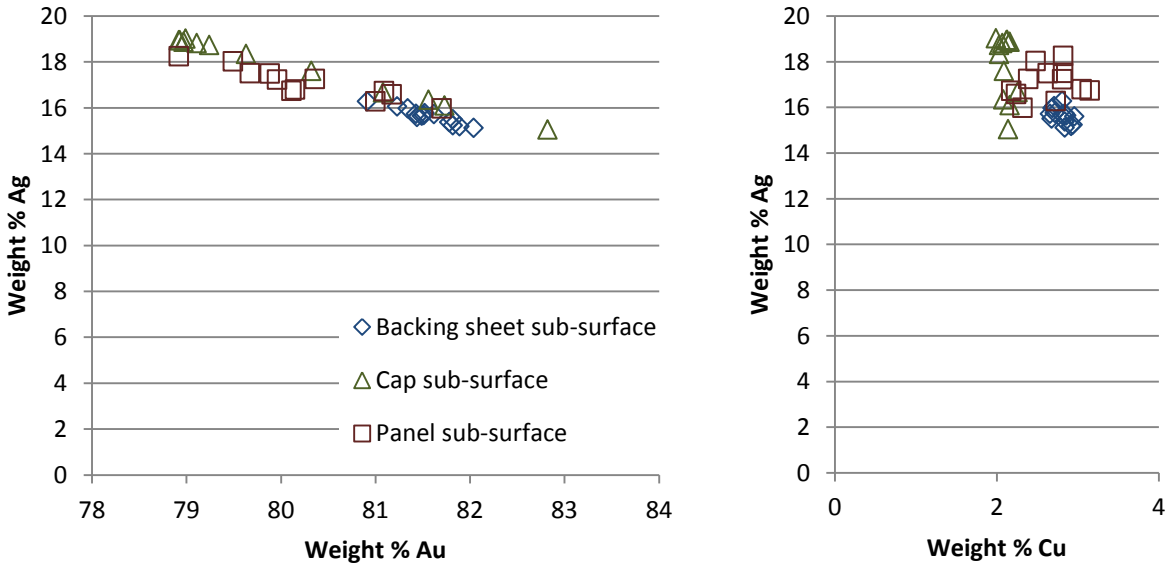
The analysis revealed a *c.*2.7 wt% loss of silver from the surface of the base sheet (a difference of *c.*17% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The sheet that formed the cap also had a *c.*5.3 wt% loss of silver from the surface of the base sheet (a difference of *c.*30% from surface to core). The inset panels revealed the biggest loss of silver (*c.*9.6 wt% loss of silver from the surface of the base sheet which was a difference of *c.*56% from surface to core)

Comparison of the sub-surface compositions of each component suggests that all the components may have used the same, or a similar, gold alloy stock. All the sheets were enriched in gold, but to varying degrees, and therefore this suggests that the sheet was treated separately before being incorporated into the pommel.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K354: results of SEM-EDX analysis

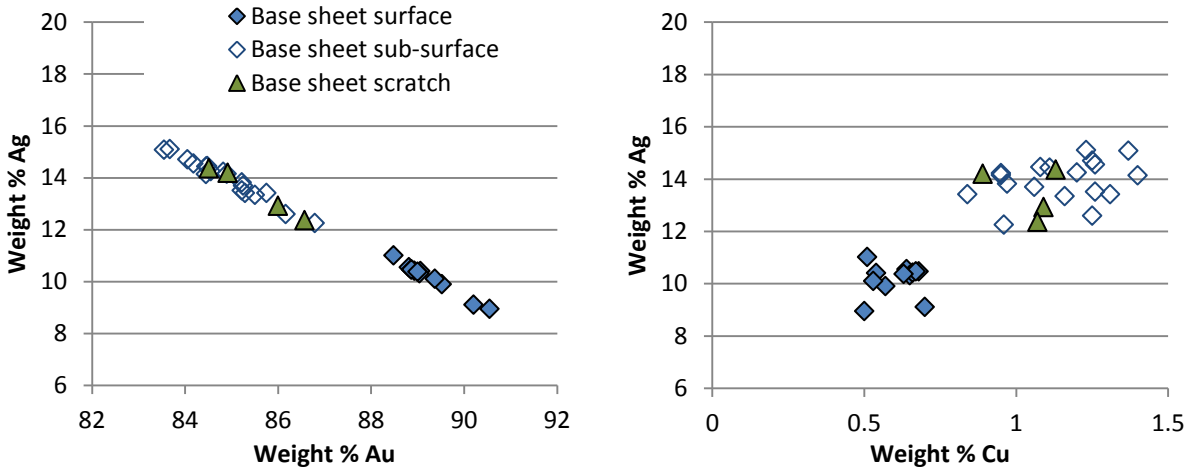
Object Type Hilt Collar
Date 620-650

Decoration Filigree ☐ Glass ☐
Garnet ☑ Other ☐

SEM-EDX analysis was undertaken on the gold sheet at the base of the hilt collar.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	12	Average	89.2	10.2	0.6
		Standard Deviation	*0.60*	*0.60*	*0.07*
Scratch	4	Average	85.5	13.5	1.0
		Standard Deviation	*0.95*	*0.97*	*0.11*
Sub-surface	18	Average	85.0	13.9	1.1
		Standard Deviation	*0.84*	*0.78*	*0.16*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 84-86 wt% gold, 13-15 wt% silver, the rest being copper. The analysis revealed a *c.*3.7 wt% loss of silver from the surface (a difference of *c.*27% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The surface of the scratch had a similar composition to the sub-surface, with a relatively small loss in copper most likely due to corrosion, confirming that the treatment was carried out prior to burial.

Eleanor Blakelock
Analysed July 2013

Gold enrichment in Staffordshire Hoard K356: results of SEM-EDX analysis

Object Type Mount
Date 600-635

Decoration Filigree ✓ Glass
Garnet ✓ Other

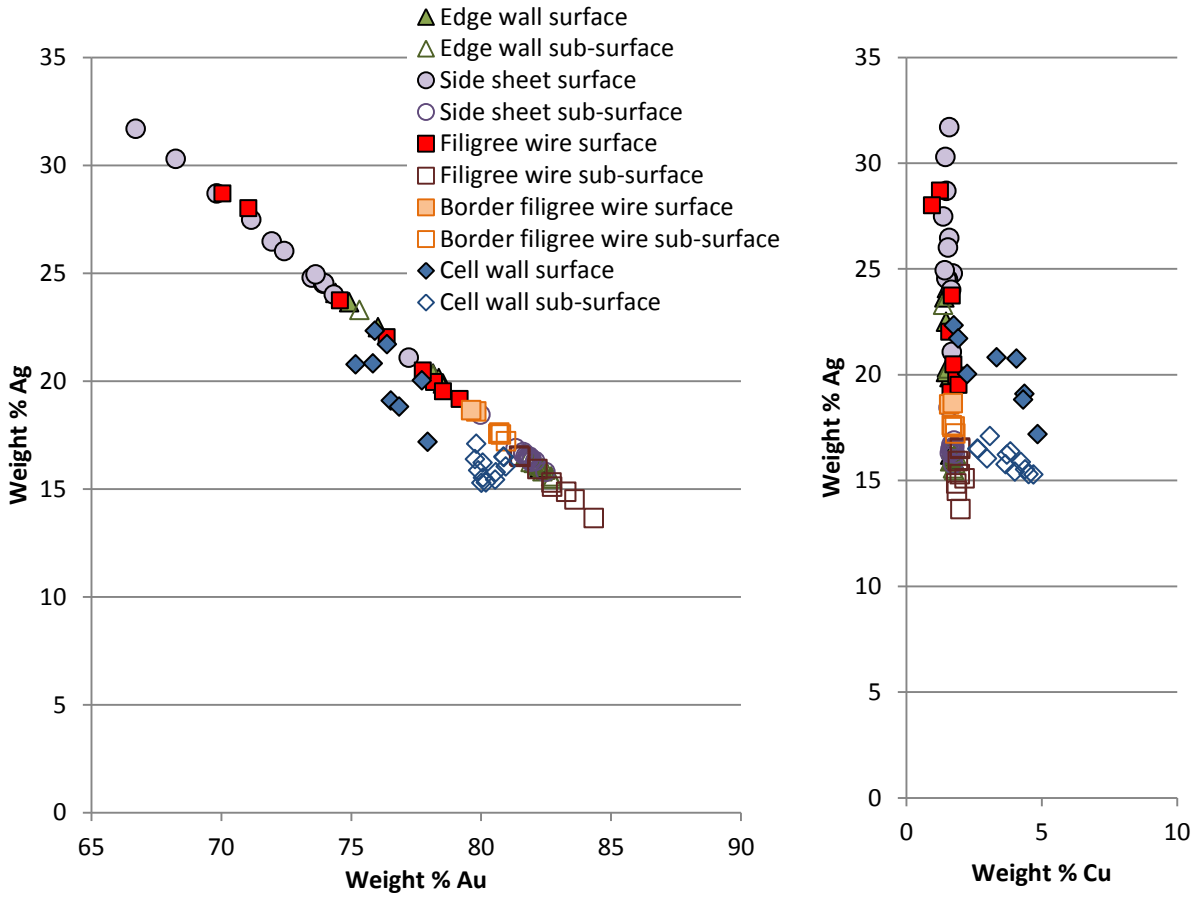
SEM-EDX analysis was undertaken on a range of components, including the sheet used to construct the border, the side sheet, two types of filigree wire and a cell wall.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Edge wall sheet surface	8	Average	78.2	20.3	1.5
		Standard Deviation	*2.97*	*3.07*	*0.11*
Edge wall sheet sub-surface	13	Average	81.4	16.9	1.7
		Standard Deviation	*2.16*	*2.27*	*0.12*
Side sheet surface	12	Average	72.3	26.2	1.5
		Standard Deviation	*2.89*	*2.94*	*0.11*
Side sheet sub-surface	14	Average	81.7	16.6	1.7
		Standard Deviation	*0.56*	*0.59*	*0.07*
Cell wall surface	8	Average	76.5	20.1	3.4
		Standard Deviation	*0.94*	*1.68*	*1.23*
Cell wall sub-surface	12	Average	80.3	16.0	3.7
		Standard Deviation	*0.44*	*0.56*	*0.72*
Filigree wire surface	8	Average	75.7	22.7	1.6
		Standard Deviation	*3.50*	*3.79*	*0.33*
Filigree wire sub-surface	8	Average	82.7	15.3	2.0
		Standard Deviation	*1.00*	*0.99*	*0.10*
Border filigree wire surface	2	Average	79.7	18.6	1.7
		Standard Deviation	*0.13*	*0.04*	*0.09*
Border filigree wire sub-surface	4	Average	80.7	17.5	1.8
		Standard Deviation	*0.13*	*0.18*	*0.06*

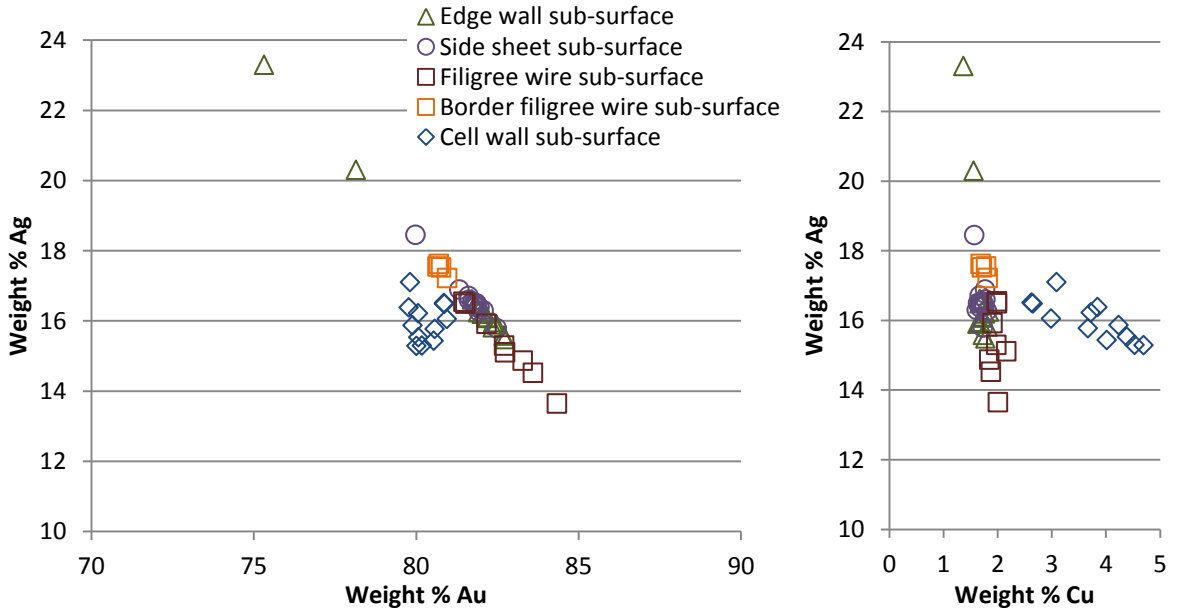
SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a small loss of copper on the surface of all components analysed, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. There was a small increase in silver at the surface of all the components which is most likely from close contact with corroding silver objects in the burial environment.

Comparison of the sub-surface compositions of each component suggests that the majority of the components may have used the same, or a similar, gold alloy. The exception is the cell wall which had a distinctly higher copper content.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed November 2013

Gold enrichment in Staffordshire Hoard K358: results of SEM-EDX analysis

Object Type Pommel
Date 620-650

Decoration				
	Filigree	☐	Glass	☐
	Garnet	☐	Other	✓

SEM-EDX analysis was undertaken on a range of components as well as the base gold. The gold of the niello panel was examined along with the panel frame. XRD analysis identified the black inlay as silver sulphide niello (La Niece 2013).

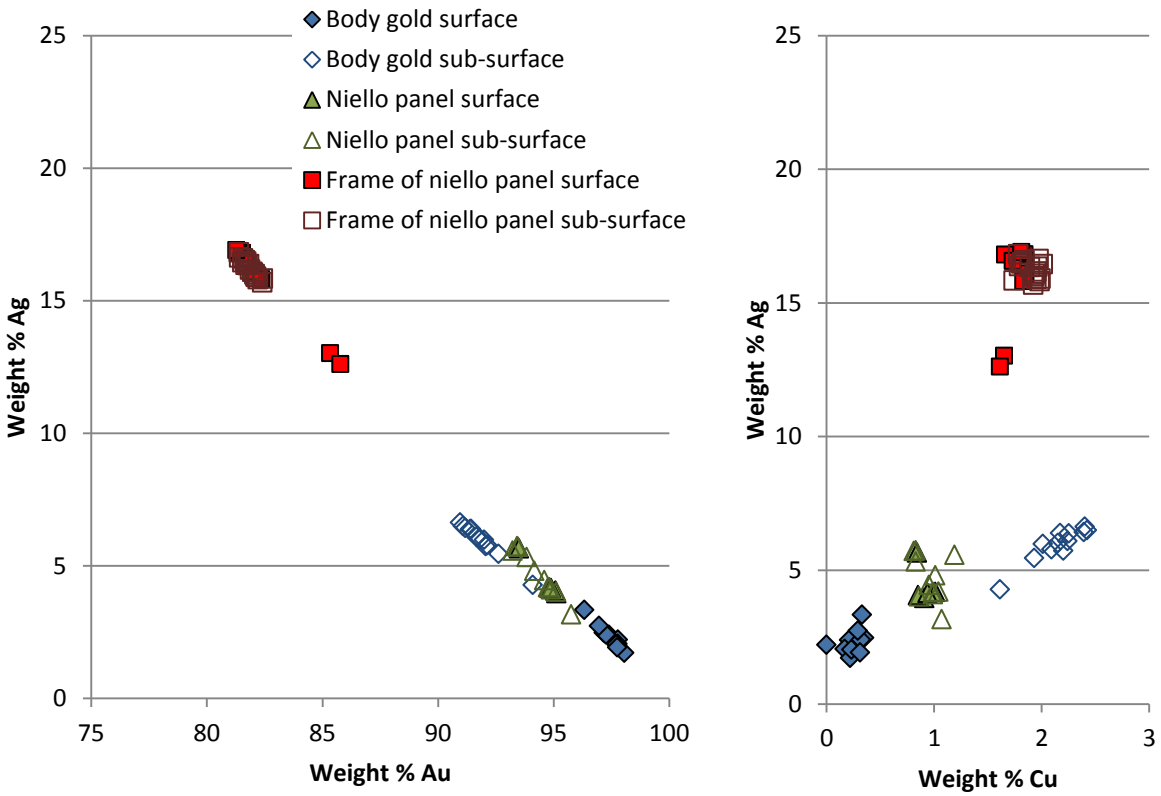
Area analysed	**No of analyses**		**Wt% Au**	**Wt% Ag**	**Wt% Cu**
Base gold surface	10	Average	97.5	2.3	0.2
		Standard Deviation	*0.51*	*0.46*	*0.10*
Base gold sub-surface	12	Average	91.8	6.0	2.2
		Standard Deviation	*0.86*	*0.64*	*0.23*
Niello panel surface	5	Average	94.7	4.4	0.9
		Standard Deviation	*0.67*	*0.70*	*0.07*
Niello panel sub-surface	11	Average	94.9	4.1	1.0
		Standard Deviation	*0.81*	*0.50*	*0.07*
Frame of niello panel surface	8	Average	82.7	15.6	1.7
		Standard Deviation	*1.82*	*1.75*	*0.10*
Frame of niello panel sub-surface	18	Average	81.9	16.2	1.9
		Standard Deviation	*0.31*	*0.33*	*0.08*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a *c.*3.6 wt% loss of silver from the surface of the base gold (a difference of *c.*61% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The analysis of the gold frame around the gold and niello panels revealed a loss of *c.*0.6 wt% silver from the surface, and a difference of less than 10% from surface to core, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment but may also indicate some deliberate treatment. The analysis revealed a loss of copper and only a small loss of silver from the surface of the gold and niello panel, in quantities typical of corrosion which results in natural surface enrichment that can occur during burial.

Comparison of the sub-surface compositions of each component suggests that all the components derived from different gold alloys.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed August 2013

Reference

La Niece, S., 2013. The scientific analysis of niello inlays from the Staffordshire Hoard. British Museum, London. Science Report PR07444-3.

Gold enrichment in Staffordshire Hoard K360: results of SEM-EDX analysis

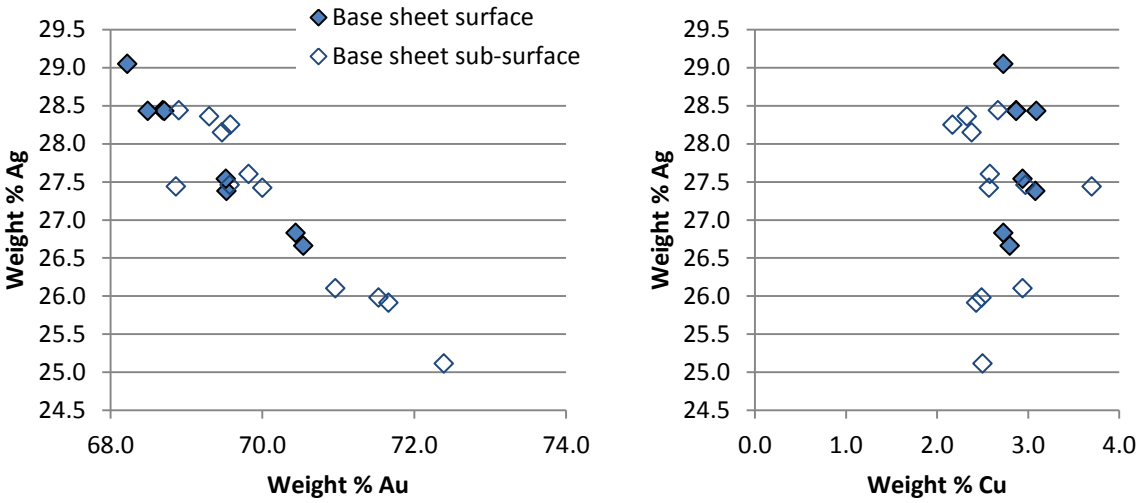
Object Type Pommel
Date 600-630

Decoration				
	Filigree	✓	Glass	
	Garnet		Other	✓

SEM-EDX analysis was undertaken on the gold sheet at the base of the pommel.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	69.3	27.8	2.9
		Standard Deviation	*0.88*	*0.86*	*0.14*
Sub-surface	12	Average	70.2	27.2	2.6
		Standard Deviation	*1.17*	*1.13*	*0.40*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 69-72 wt% gold, 26-29 wt% silver, the rest being copper. The analysis revealed no loss of either silver or copper from the surface of the object, instead there was a very small increase in silver and copper at the surface which may indicate the use of solder in this area or derive from close contact to corroding silver objects in the burial environment.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K365: results of SEM-EDX analysis

Object Type Hilt-mount
Date 610-630

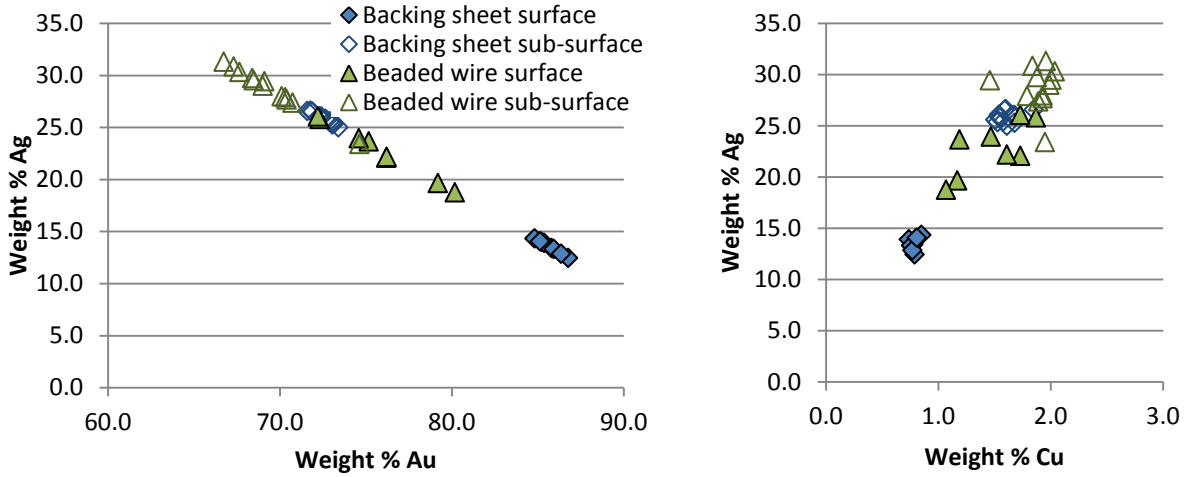
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the filigree wires and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	85.7	13.5	0.8
		Standard Deviation	0.66	0.65	0.03
Base sheet sub-surface	12	Average	72.6	25.8	1.6
		Standard Deviation	0.58	0.54	0.09
Filigree wire surface	8	Average	75.7	22.8	1.5
		Standard Deviation	2.87	2.64	0.30
Filigree wire sub-surface	12	Average	69.4	28.7	1.9
		Standard Deviation	2.09	2.09	0.15

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Comparison of the sub-surface compositions of each component suggests that both components may have been made from a similar gold alloy. The analysis revealed a *c.*12.3 wt% loss of silver from the surface of the base sheet (a difference of *c.*48% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. There was also a loss of silver from the surface of the wire (*c.*5.9 wt% loss of silver a difference of *c.*21% from surface to core) also indicating deliberate treatment.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K370: results of SEM-EDX analysis

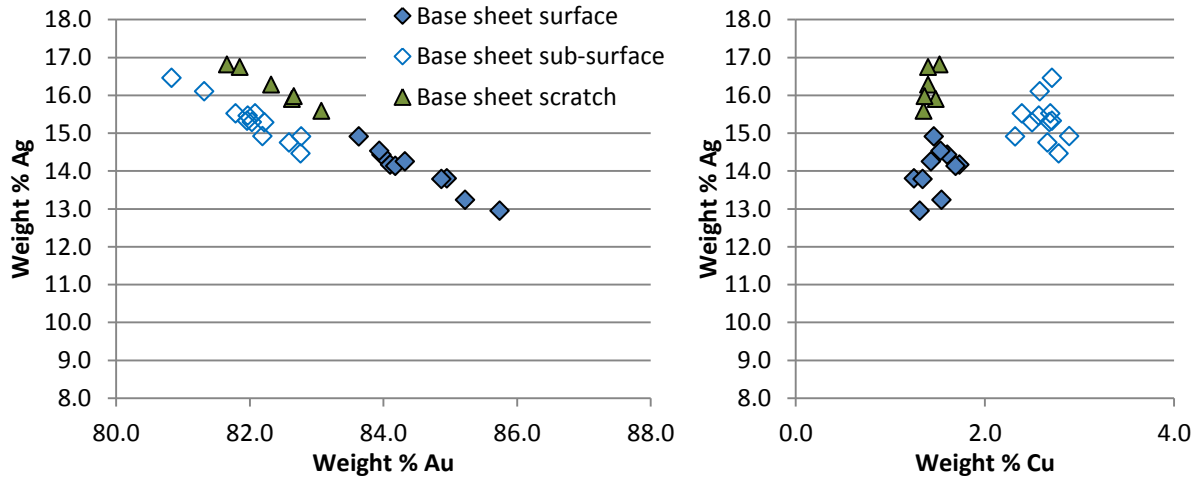
Object Type Hilt Collar
Date 620-650

Decoration				
	Filigree		Glass	✓
	Garnet	✓	Other	

SEM-EDX analysis was undertaken on the gold sheet at the base of the hilt collar which is part of a set of fittings from a seax handle.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	10	Average	84.5	14.0	1.5
		Standard Deviation	*0.67*	*0.59*	*0.16*
Scratch	6	Average	82.4	16.2	1.4
		Standard Deviation	*0.53*	*0.49*	*0.07*
Sub-surface	12	Average	82.1	15.3	2.6
		Standard Deviation	*0.56*	*0.56*	*0.16*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 81-83 wt% gold, 14-16 wt% silver, the rest being copper. The analysis revealed a *c.*1.3 wt% loss of silver from the surface (a difference of *c.*9% from surface to core), which could be indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The surface of the scratch had a similar composition to the subsurface, but with a similar loss in copper to the other surface analyses, which is likely due to corrosion, confirming that the treatment was carried out prior to burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K375: results of SEM-EDX analysis

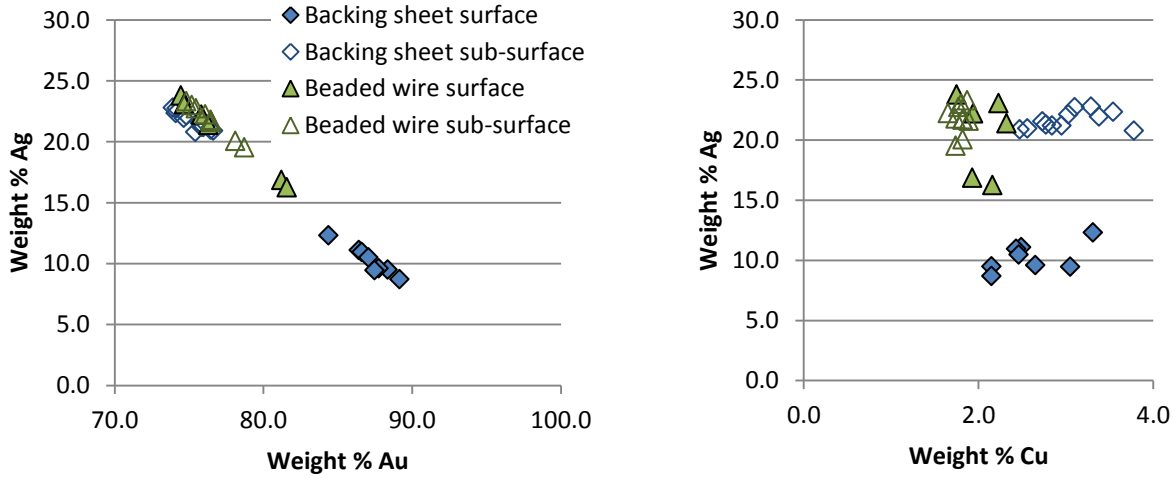
Object Type Pommel
Date 580-610

Decoration Filigree ✓ Glass
Garnet Other

SEM-EDX analysis was undertaken on the filigree wires and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Backing sheet surface	8	Average	87.1	10.3	2.6
		Standard Deviation	*1.44*	*1.17*	*0.41*
Backing sheet sub-surface	12	Average	75.3	21.7	3.0
		Standard Deviation	*0.94*	*0.71*	*0.40*
Beaded wire surface	6	Average	77.3	20.6	2.1
		Standard Deviation	*3.22*	*3.24*	*0.22*
Beaded wire sub-surface	10	Average	76.4	21.8	1.8
		Standard Deviation	*1.21*	*1.20*	*0.07*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The sub-surface composition of both components is similar, although the sheet had a higher copper content. The analysis revealed a *c.*11.4 wt% loss of silver from the surface of the base sheet (a difference of *c.*53% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the filigree wire revealed a small loss of silver from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K376: results of SEM-EDX analysis

Object Type Pommel
Date 620-650

Decoration

Filigree		Glass	
Garnet	✓	Other	

SEM-EDX analysis was undertaken on the sheet of the base, the thick surrounding cell wall and the thin cell walls. The pommel is part of a set of fittings from a seax handle.

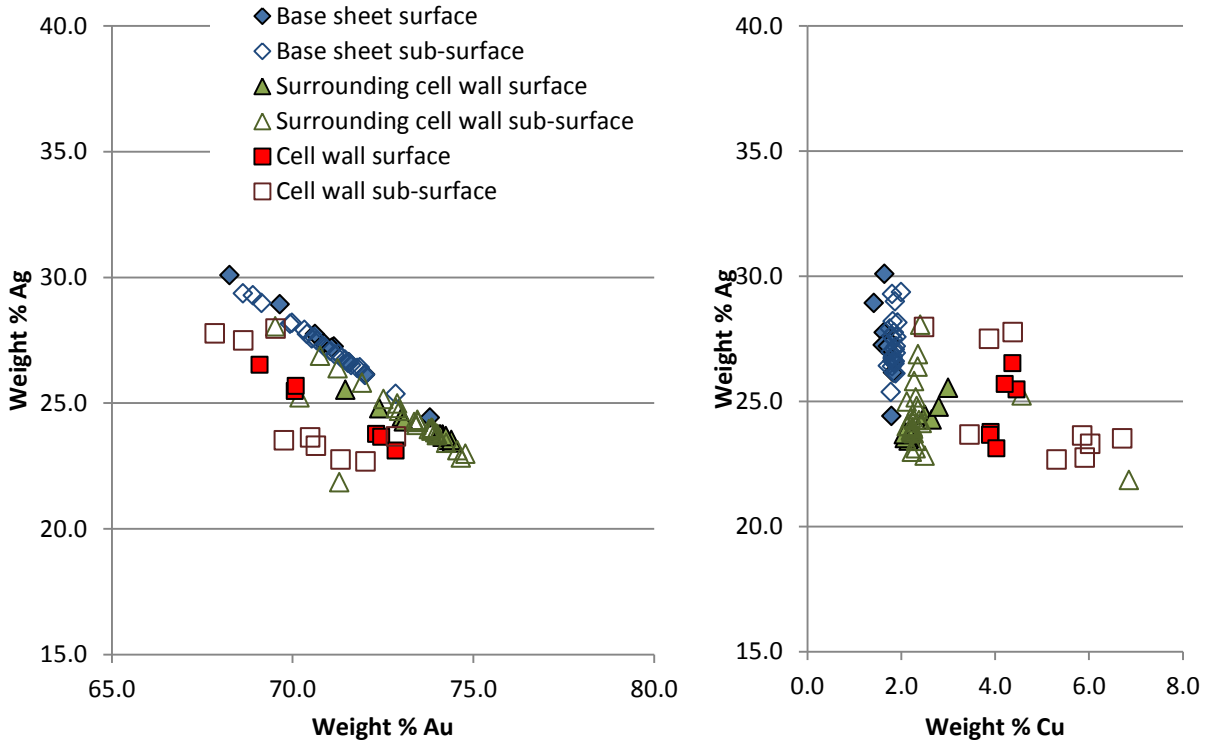
Area analysed	**No of analyses**		**Wt % Au**	**Wt % Ag**	**Wt % Cu**
Base sheet surface	10	Average	71.5	26.8	1.7
		Standard Deviation	*1.01*	*1.06*	*0.09*
Base sheet sub-surface	24	Average	70.4	27.8	1.8
		Standard Deviation	*1.04*	*1.01*	*0.06*
Surrounding cell wall surface	12	Average	73.7	24.0	2.3
		Standard Deviation	*0.94*	*0.63*	*0.32*
Surrounding cell wall sub-surface	25	Average	73.0	24.4	2.6
		Standard Deviation	*1.42*	*1.34*	*1.01*
Cell wall surface	6	Average	71.2	24.7	4.1
		Standard Deviation	*1.58*	*1.37*	*0.24*
Cell wall sub-surface	9	Average	70.3	24.8	4.9
		Standard Deviation	*1.60*	*2.27*	*1.41*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

SEM-EDX analysis of the sub-surface of the base sheet indicated a composition of approximately 69-71 wt% gold, 26-29 wt% silver, the rest being copper. The analysis of the base sheet and surrounding cell wall revealed a *c.*1.1-1.3 wt% loss of silver from the surface (a difference of *c.*4-5% from surface to core), most likely indicative of corrosion that can occur during burial which results in natural surface enrichment but could also be the result of some deliberate surface treatment.

SEM-EDX analysis of the sub-surface of the cell wall indicated a composition of approximately 69-71 wt% gold, 22-27 wt% silver, the rest being copper. Analysis of the cell wall revealed no loss of silver, and a small loss of copper at the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Comparison of the sub-surface compositions of each component suggests that all the components were made from different gold alloys.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed June 2013

Gold enrichment in Staffordshire Hoard K377: results of SEM-EDX analysis

Object Type Sword pyramid
Date 600-635

Decoration				
	Filigree		Glass	✓
	Garnet	✓	Other	

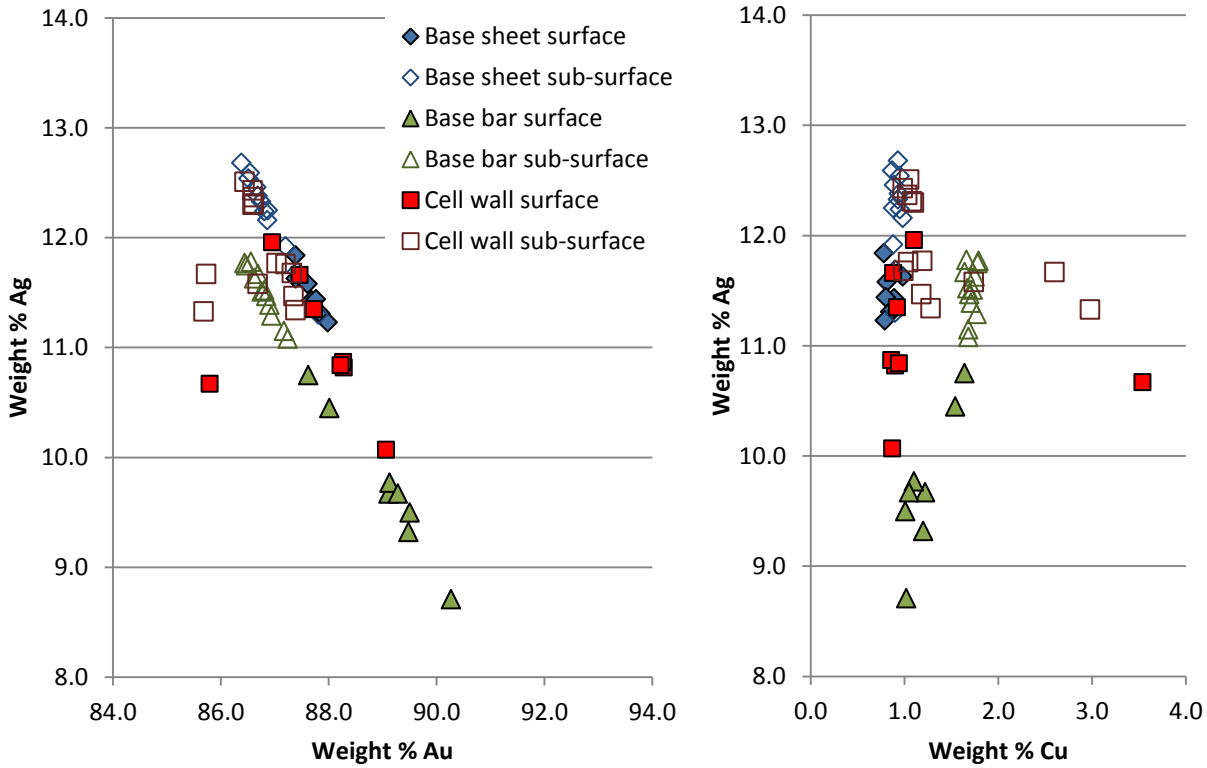
SEM-EDX analysis was undertaken on a range of components, including the base of the pyramid, the suspending bar and a cell wall.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base surface	8	Average	87.7	11.5	0.8
		Standard Deviation	*0.21*	*0.20*	*0.07*
Base sub-surface	12	Average	86.9	12.2	0.9
		Standard Deviation	*0.41*	*0.40*	*0.03*
Suspending bar surface	8	Average	89.1	9.7	1.2
		Standard Deviation	*0.85*	*0.64*	*0.24*
Suspending bar sub-surface	13	Average	86.8	11.5	1.7
		Standard Deviation	*0.25*	*0.24*	*0.05*
Cell wall surface	8	Average	87.9	11.2	0.9
		Standard Deviation	*0.80*	*0.72*	*0.10*
Cell wall sub-surface	12	Average	86.7	11.9	1.4
		Standard Deviation	*0.58*	*0.43*	*0.67*

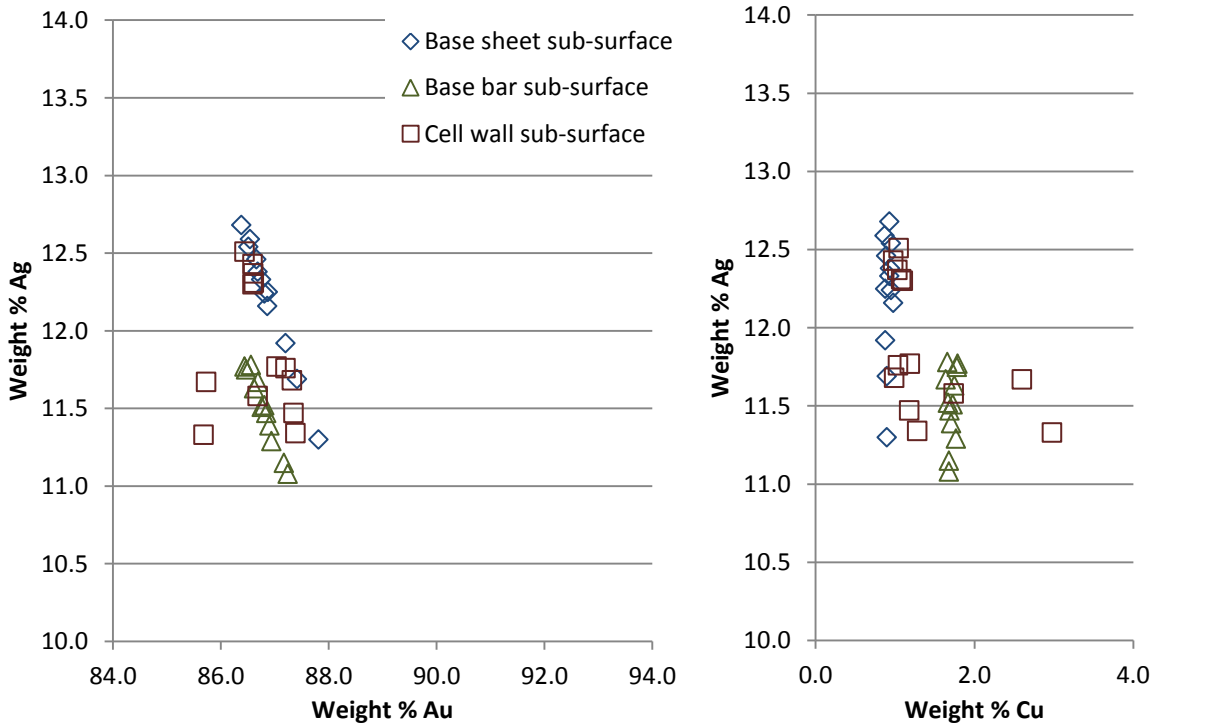
SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a *c.*0.6-0.7 wt% loss of silver from the surface of the base sheet and cell wall, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. The suspending bar had a loss of *c.*1.8 wt% from the surface (a difference of *c.*15% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Comparison of the sub-surface compositions of the base sheet and the cell walls suggests they were probably made from a similar gold alloy. The suspension bar appears to be a different alloy, with more copper present.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Silver/copper and silver/gold plots of the SEM-EDX data showing the differences between the sub-surface analyses of the different components.

Eleanor Blakelock
Analysed November 2013

Gold enrichment in Staffordshire Hoard K379: results of SEM-EDX analysis

Object Type Hilt-mount
Date 630-660

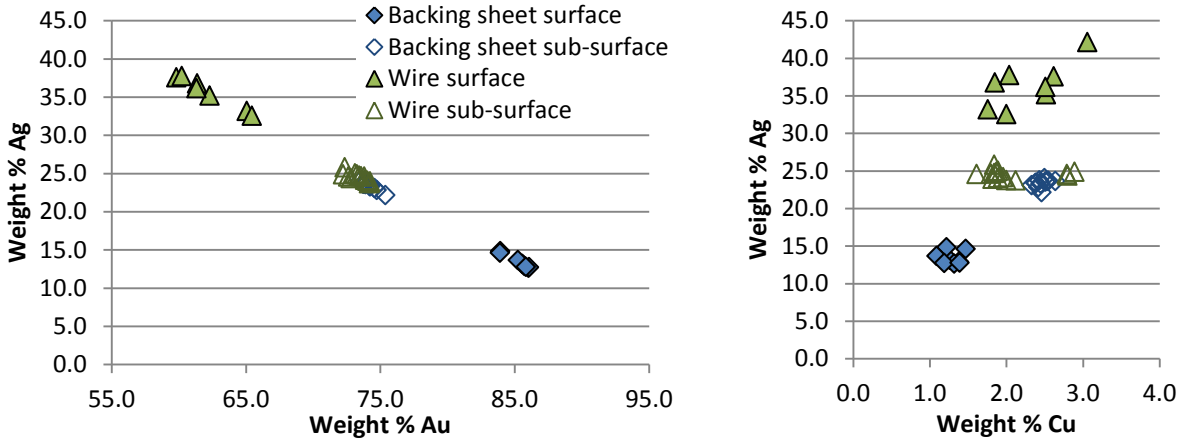
Decoration

Filigree	✓	Glass	
Garnet	✓	Other	

SEM-EDX analysis was undertaken on the filigree wires and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	85.3	13.4	1.3
		Standard Deviation	*0.88*	*0.87*	*0.12*
Base sheet sub-surface	12	Average	74.2	23.4	2.5
		Standard Deviation	*0.53*	*0.49*	*0.09*
Filigree wire surface	8	Average	61.3	36.4	2.3
		Standard Deviation	*3.33*	*2.99*	*0.45*
Filigree wire sub-surface	14	Average	73.4	24.5	2.1
		Standard Deviation	*0.70*	*0.56*	*0.42*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Comparison of the sub-surface compositions suggests that both components may have been made from the same gold alloy. The analysis revealed a *c.*10.0 wt% loss of silver from the surface of the base sheet (a difference of *c.*43% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. There was an increase in silver at the surface of the wire which is most likely from close contact to corroding silver objects in the burial environment.

Eleanor Blakelock
Analysed December 2013

Gold enrichment in Staffordshire Hoard K381: results of SEM-EDX analysis

Object Type Pommel
Date 610-630

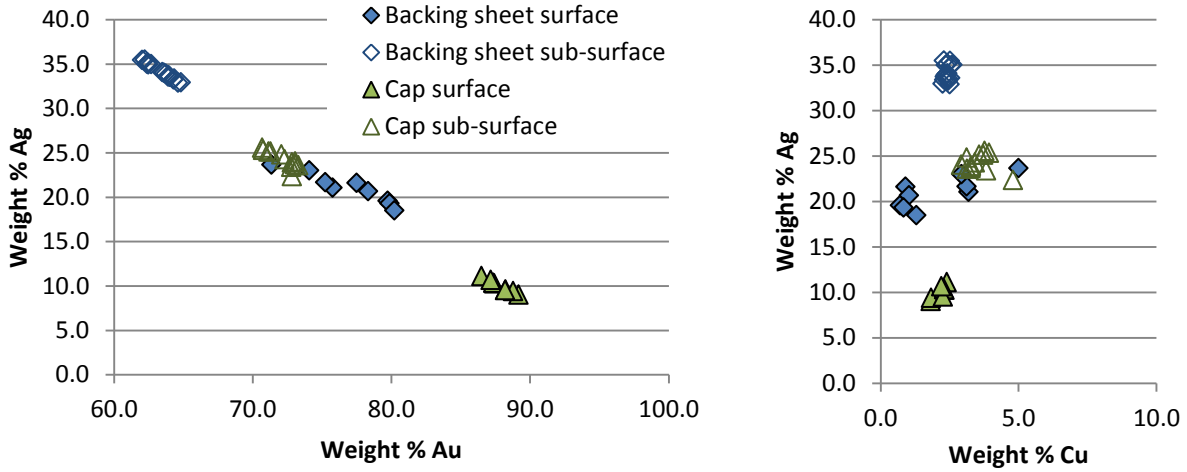
Decoration
Filigree ✓ Glass
Garnet Other

SEM-EDX analysis was undertaken on the base sheet and the cap.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	9	Average	76.9	21.0	2.1
		Standard Deviation	3.02	1.70	1.50
Base sheet sub-surface	16	Average	63.5	34.1	2.4
		Standard Deviation	0.93	0.89	0.10
Top of cap surface	8	Average	87.8	10.0	2.2
		Standard Deviation	0.89	0.71	0.22
Top of cap sub-surface	12	Average	72.1	24.3	3.6
		Standard Deviation	0.96	0.95	0.50

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a *c.*13.1 wt% loss of silver from the surface of the base sheet (a difference of *c.*39% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the cap also revealed it was treated with a *c.*14.3 wt% loss of silver from the surface of the base sheet (a difference of *c.*59% from surface to core). Comparison of the sub-surface compositions revealed that both components were made of a distinct gold alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed December 2013

Gold enrichment in Staffordshire Hoard K399: results of SEM-EDX analysis

Object Type Hilt-collar/hilt plate
Date 600-650
Decoration Filigree ✓ Glass
Garnet Other

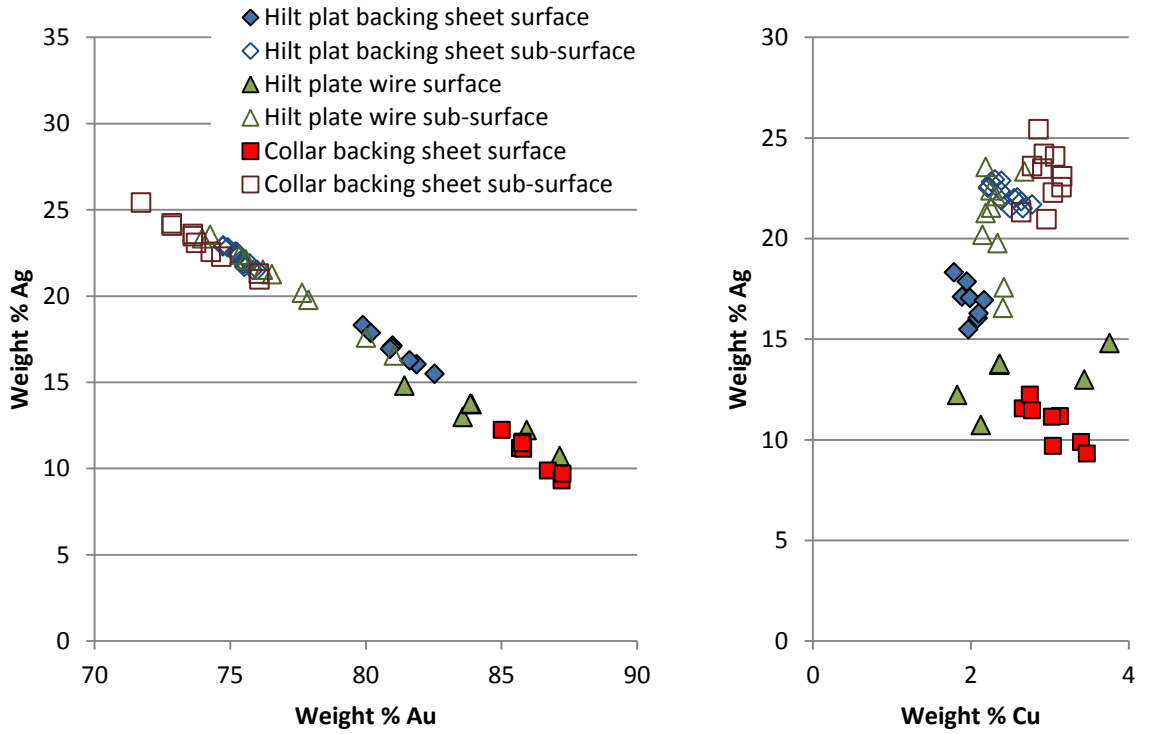
SEM-EDX analysis was undertaken on a range of components, including the backing sheet of both the collar and hilt plate, and the filigree wire on the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Backing sheet hilt plate surface	8	Average	81.1	16.9	2.0
		Standard Deviation	*0.87*	*0.94*	*0.12*
Backing sheet hilt plate sub-surface	13	Average	75.3	22.2	2.5
		Standard Deviation	*0.39*	*0.51*	*0.18*
Backing sheet hilt-collar surface	8	Average	86.2	10.8	3.0
		Standard Deviation	*0.81*	*1.04*	*0.30*
Backing sheet hilt-collar sub-surface	10	Average	73.9	23.1	3.0
		Standard Deviation	*1.39*	*1.36*	*0.16*
Filigree wire surface	6	Average	84.4	13	2.6
		Standard Deviation	*2*	*1.42*	*0.77*
Filigree wire sub-surface	10	Average	76.9	20.8	2.3
		Standard Deviation	*2.32*	*2.33*	*0.16*

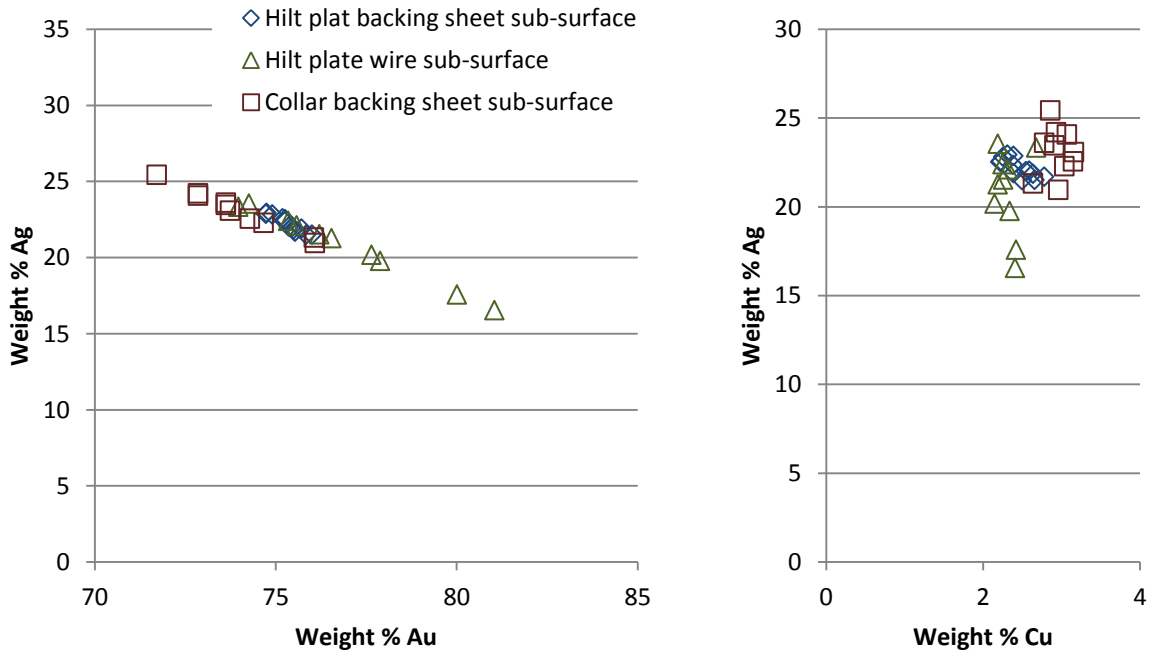
SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a *c.*5.3 wt% loss of silver from the surface of the base sheet of the hilt plate (a difference of *c.*24% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the other components also revealed evidence for deliberate treatment but to different degrees. The wire had a *c.*7.8 wt% loss of silver from the surface (a difference of *c.*37% from surface to core) and the base sheet of the collar had a *c.*12.3 wt% loss of silver from the surface (a difference of *c.*53% from surface to core).

Comparison of the sub-surface compositions of each component suggests that all the components may have been made using the same, or a similar, gold alloy. The different levels of enrichment suggest that the different components were treated separately before being incorporated into the piece.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed December 2013

Gold enrichment in Staffordshire Hoard K449: results of SEM-EDX analysis

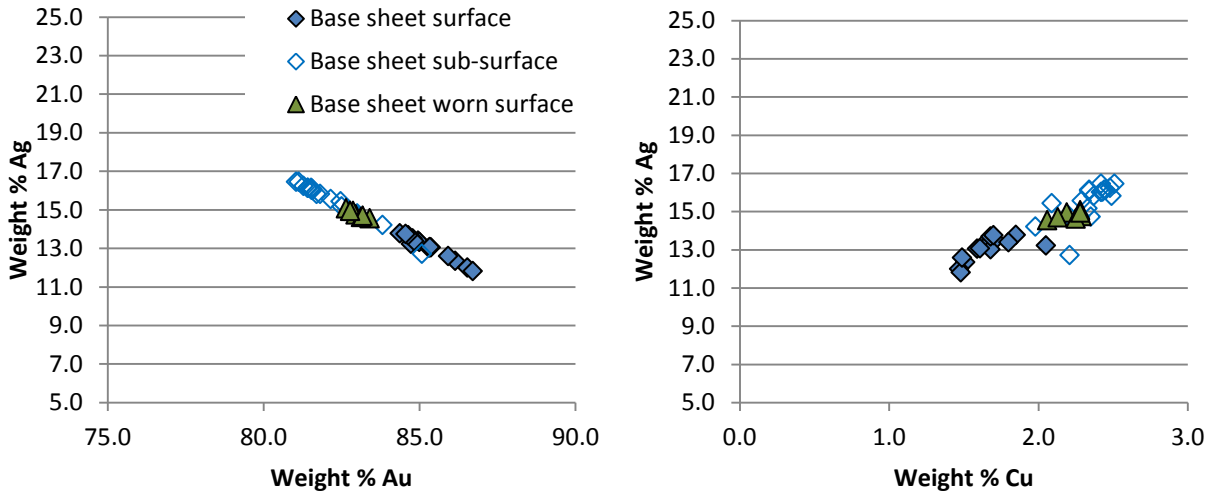
Object Type Hilt collar
Date 620-650

Decoration Filigree [ ] Glass [ ]
Garnet [✓] Other [ ]

SEM-EDX analysis was undertaken on the gold sheet at the base of the hilt collar. This hilt collar is part of a set of fittings from a seax handle.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	15	Average	85.2	13.1	1.7
		Standard Deviation	*0.73*	*0.62*	*0.16*
Worn surface	6	Average	83.0	14.8	2.2
		Standard Deviation	*0.26*	*0.19*	*0.09*
Sub-surface	19	Average	82.2	15.5	2.3
		Standard Deviation	*1.04*	*0.94*	*0.14*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The analysis revealed a *c.*2.4 wt% loss of silver from the surface (a difference of *c.*16% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The worn surface area had a similar composition to the sub-surface, with a relatively small loss in copper most likely due to corrosion, confirming that the treatment was carried out prior to burial.

Eleanor Blakelock
Analysed June 2013

Gold enrichment in Staffordshire Hoard K451: results of SEM-EDX analysis

Object Type Sword pyramid
Date 625-650

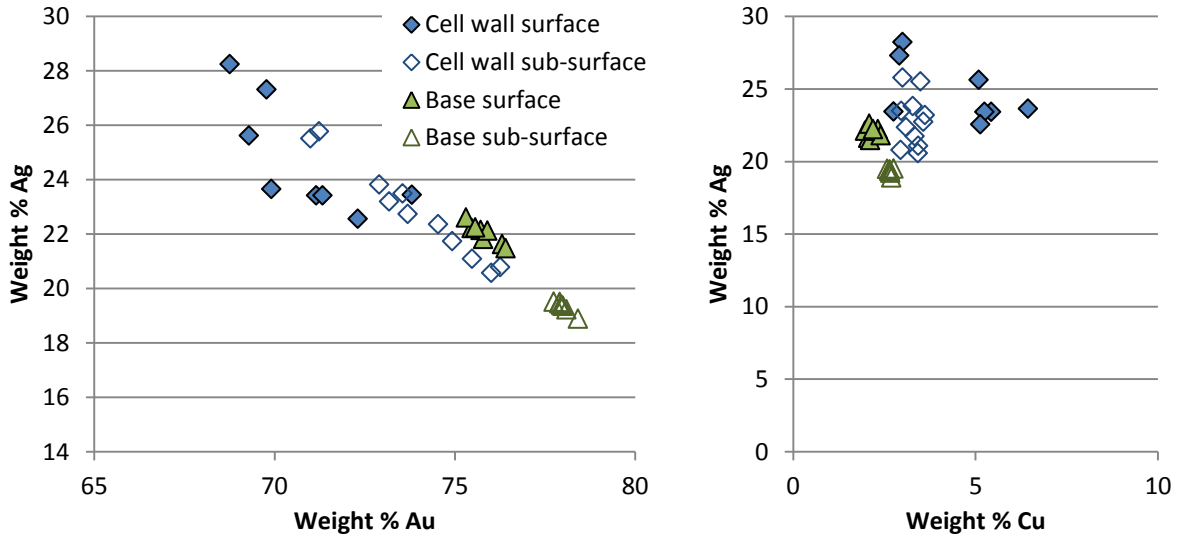
Decoration				
	Filigree		Glass	✓
	Garnet	✓	Other	

SEM-EDX analysis was undertaken on the cell wall on one side of the pyramid as well as the base.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Cell wall surface	8	Average	70.8	24.7	4.5
		Standard Deviation	*1.69*	*2.10*	*1.40*
Cell wall sub-surface	11	Average	73.9	22.8	3.3
		Standard Deviation	*1.77*	*1.76*	*0.25*
Base sheet surface	8	Average	75.8	22.0	2.2
		Standard Deviation	*0.39*	*0.37*	*0.14*
Base sheet sub-surface	8	Average	78.0	19.3	2.7
		Standard Deviation	*0.20*	*0.20*	*0.05*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a small loss of copper on the surface of the base sheet, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. There was a small increase in silver at the surface, and of copper on the surface of the cell wall, which may be contributions from the solder or from close contact to corroding silver objects in the burial environment. Comparison of the sub-surface compositions of the cell wall and base suggests that these components were most likely made from different gold alloys.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K454: results of SEM-EDX analysis

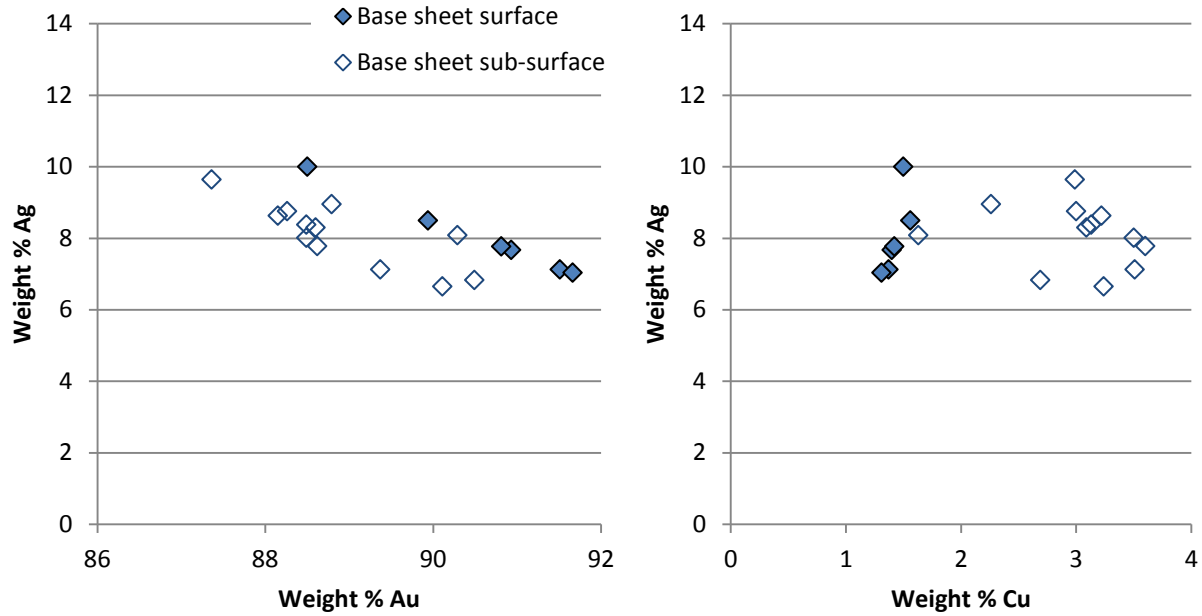
Object Type Mount
Date 625-650

Decoration				
	Filigree	✓	Glass	
	Garnet	✓	Other	

SEM-EDX analysis was undertaken on the base sheet to which the filigree wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	6	Average	90.6	8.0	1.4
		Standard Deviation	*1.18*	*1.11*	*0.09*
Sub-surface	12	Average	88.9	8.1	3.0
		Standard Deviation	*0.95*	*0.89*	*0.57*

SEM-EDX surface and sub-surface compositions (the results are normalised)



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 88-89 wt% gold, 7-9 wt% silver, the rest being copper. The analysis revealed a loss of copper and only a small loss of silver from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K455: results of SEM-EDX analysis

Object Type Pommel
Date 600-620

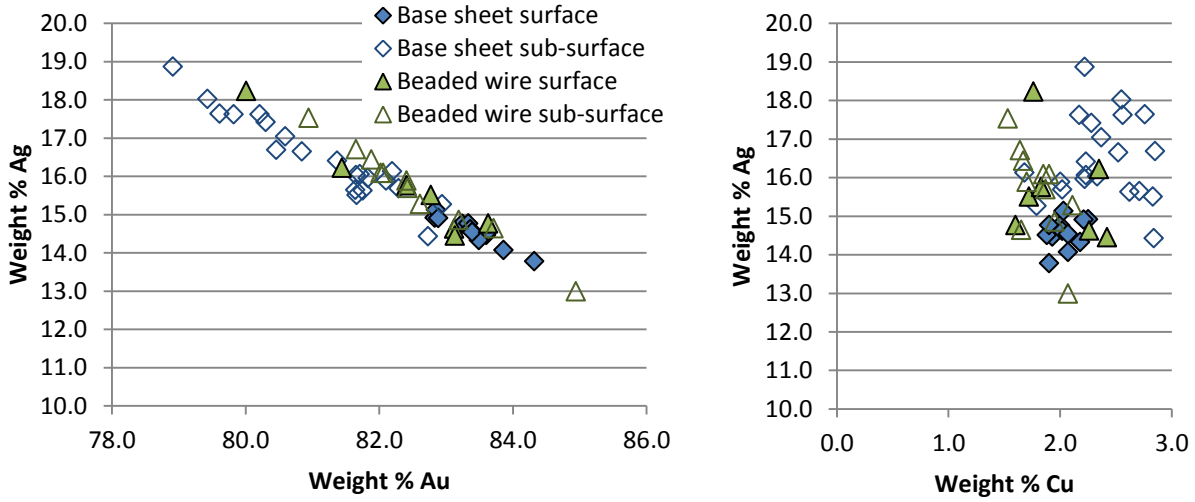
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the filigree wires and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	12	Average	83.4	14.6	2.0
		Standard Deviation	*0.43*	*0.38*	*0.13*
Base sheet sub-surface	21	Average	81.1	16.5	2.4
		Standard Deviation	*1.13*	*1.07*	*0.34*
Beaded wire surface	7	Average	82.3	15.7	2.0
		Standard Deviation	*1.25*	*1.31*	*0.34*
Beaded wire sub-surface	11	Average	82.5	15.7	1.8
		Standard Deviation	*1.09*	*1.21*	*0.19*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The analysis revealed a *c.*1.9 wt% loss of silver from the surface of the base sheet (a difference of *c.*12% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the beaded wire revealed no loss of either silver or copper from the surface of the object. Comparison of the sub-surface compositions of the base sheet and wire suggests that they may have used a similar gold alloy.

Eleanor Blakelock
Analysed August 2013

Gold enrichment in Staffordshire Hoard K457: results of SEM-EDX analysis

Object Type Pommel
Date 580-610

Decoration

Filigree	✓	Glass	
Garnet		Other	

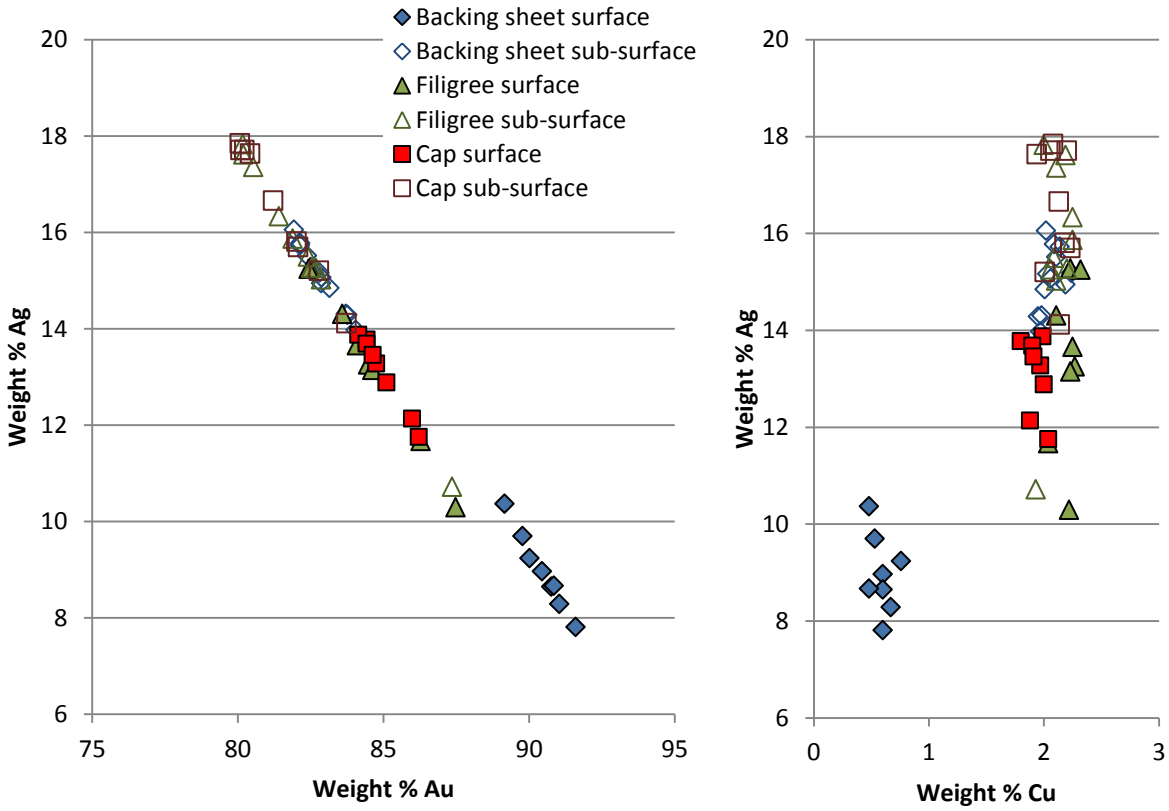
SEM-EDX analysis was undertaken on a range of components, including the filigree wire, the separate cap and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	90.4	9.0	0.6
		Standard Deviation	0.78	0.81	0.10
Base sheet sub-surface	12	Average	82.8	15.1	2.1
		Standard Deviation	0.69	0.65	0.09
Cap surface	8	Average	84.4	13.4	2.2
		Standard Deviation	1.74	1.71	0.09
Cap sub-surface	9	Average	82.2	15.7	2.1
		Standard Deviation	2.08	2.03	0.11
Filigree wire surface	8	Average	85.0	13.1	1.9
		Standard Deviation	0.76	0.79	0.08
Filigree wire sub-surface	10	Average	81.4	16.5	2.1
		Standard Deviation	1.32	1.35	0.09

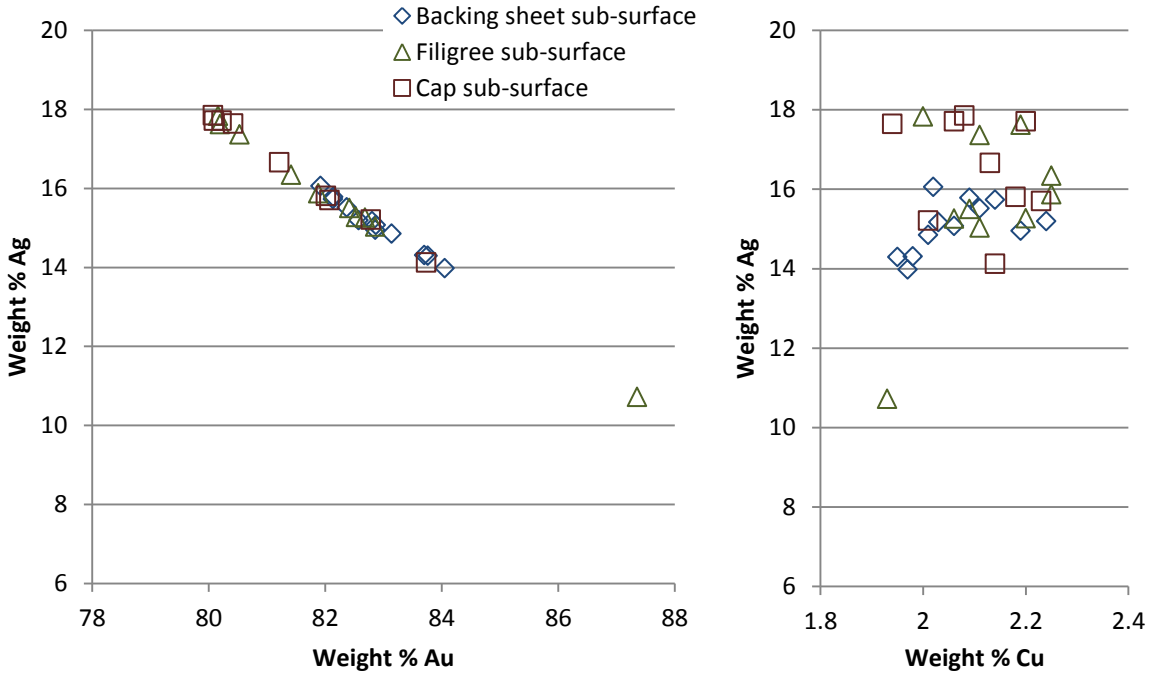
SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed that the sub-surface composition of all the components were similar, and most likely from the same gold alloy. There was a *c.*6.1 wt% loss of silver from the surface of the base sheet (a difference of *c.*41% from surface to core), which is indicative of chemical treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the filigree wire and the cap suggested they may have been treated, the cap had a *c.*2.3 wt% loss of silver (a difference of *c.*15% from surface to core) and the filigree wire had a *c.*3.4 wt% loss of silver (a difference of *c.*20% from surface to core)

Comparison of the sub-surface compositions of each component suggests that all the components may have used the same, or a similar, gold alloy. The possible exception is the base sheet which had a slightly lower silver content. All the components showed evidence for some enrichment, but the base sheet was particularly enriched in gold due to the loss of silver. This suggests that each component is treated separately before being incorporated into the pommel.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed December 2013

Gold enrichment in Staffordshire Hoard K458: results of SEM-EDX analysis

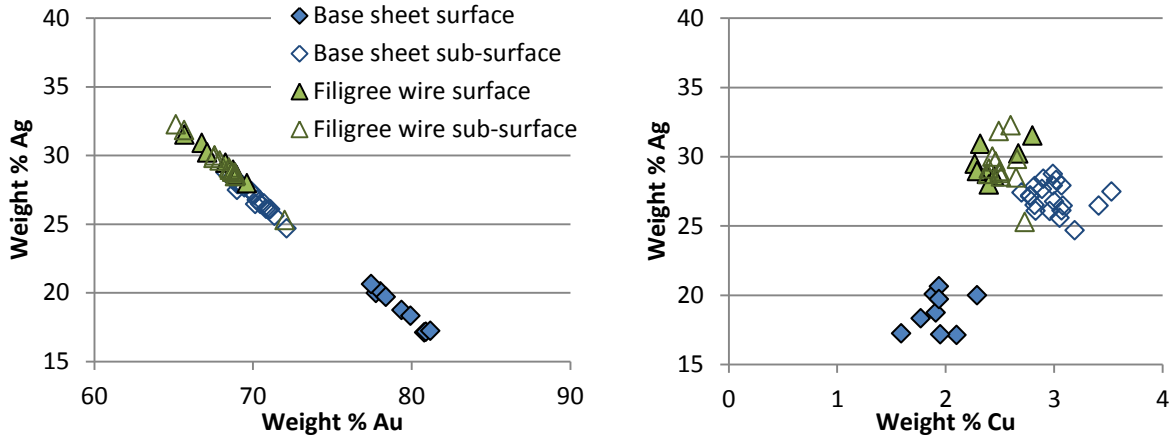
Object Type Pommel
Date 620-650

Decoration Filigree ✓ Glass
Garnet Other

SEM-EDX analysis was undertaken on the filigree wire and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	9	Average	79.3	18.8	1.9
		Standard Deviation	*1.46*	*1.39*	*0.19*
Base sheet sub-surface	20	Average	70.0	27.0	3.0
		Standard Deviation	*1.02*	*1.04*	*0.21*
Filigree wire surface	8	Average	68.1	29.5	2.4
		Standard Deviation	*1.34*	*1.23*	*0.19*
Filigree wire sub-surface	12	Average	68.2	29.3	2.5
		Standard Deviation	*1.73*	*1.76*	*0.11*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The analysis revealed a *c.*8.3 wt% loss of silver from the surface of the base sheet (a difference of *c.*31% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the filigree wire revealed a loss of copper from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. Comparison of the sub-surface compositions of the base sheet and wire suggests that they may have used the same, or a similar, gold alloy. The base sheet is the only component showing gold enrichment and therefore this suggests that the sheet was treated separately before being incorporated into the pommel.

Eleanor Blakelock
Analysed August 2013

Gold enrichment in Staffordshire Hoard K462: results of SEM-EDX analysis

Object Type Sword pyramid
Date 600-635

Decoration

Filigree	✓	Glass	
Garnet		Other	

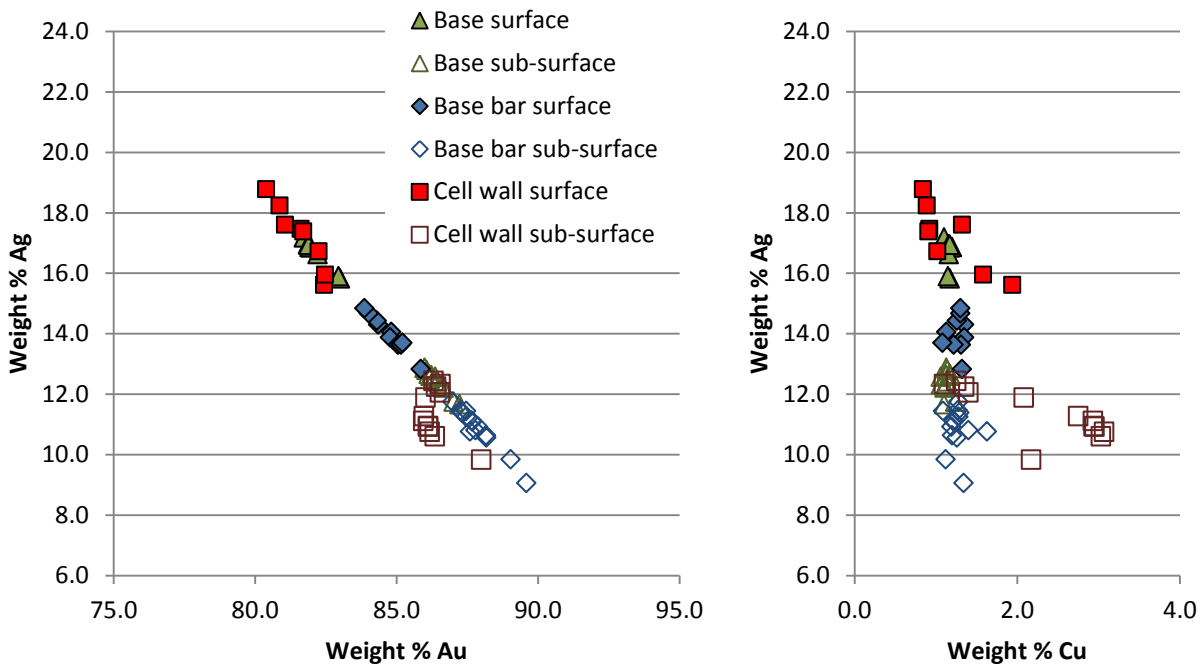
SEM-EDX analysis was undertaken on a range of components including, the base of the pyramid, the suspending bar and a cell wall.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base surface	8	Average	82.2	16.6	1.2
		Standard Deviation	0.50	0.51	0.03
Base sub-surface	12	Average	86.5	12.4	1.1
		Standard Deviation	0.38	0.38	0.05
Suspending bar surface	8	Average	84.7	14.0	1.3
		Standard Deviation	0.61	0.59	0.09
Suspending bar sub-surface	12	Average	87.8	10.9	1.3
		Standard Deviation	0.70	0.71	0.13
Cell wall surface	8	Average	81.6	17.2	1.2
		Standard Deviation	0.77	1.08	0.40
Cell wall sub-surface	12	Average	86.3	11.4	2.3
		Standard Deviation	0.55	0.82	0.79

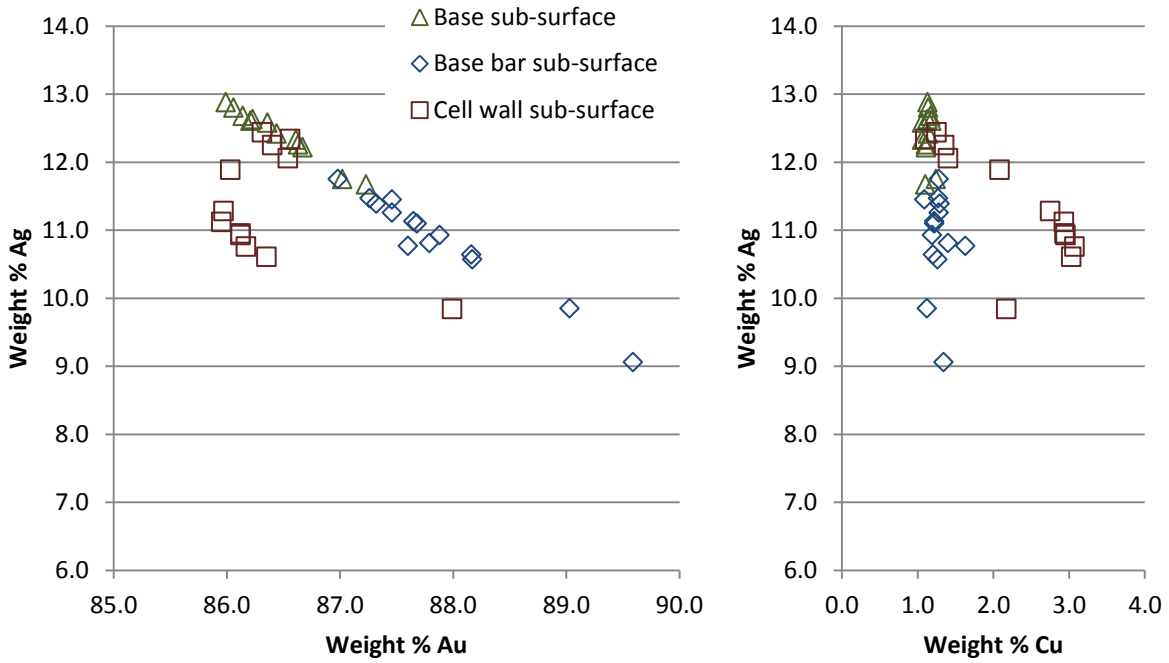
SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a small loss of copper at the surface of most components, which is indicative of natural surface enrichment that can occur during burial. There was an increase in silver at the surface which may have come from the solder used or is perhaps re-deposited silver from close contact to corroding silver objects in the burial environment.

Comparison of the sub-surface compositions suggests that all the components were most likely made from a different gold alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Silver/copper and silver/gold plots of the SEM-EDX data showing the differences between the sub-surface analyses of the different components.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K465: results of SEM-EDX analysis

Object Type Pommel
Date 610-630

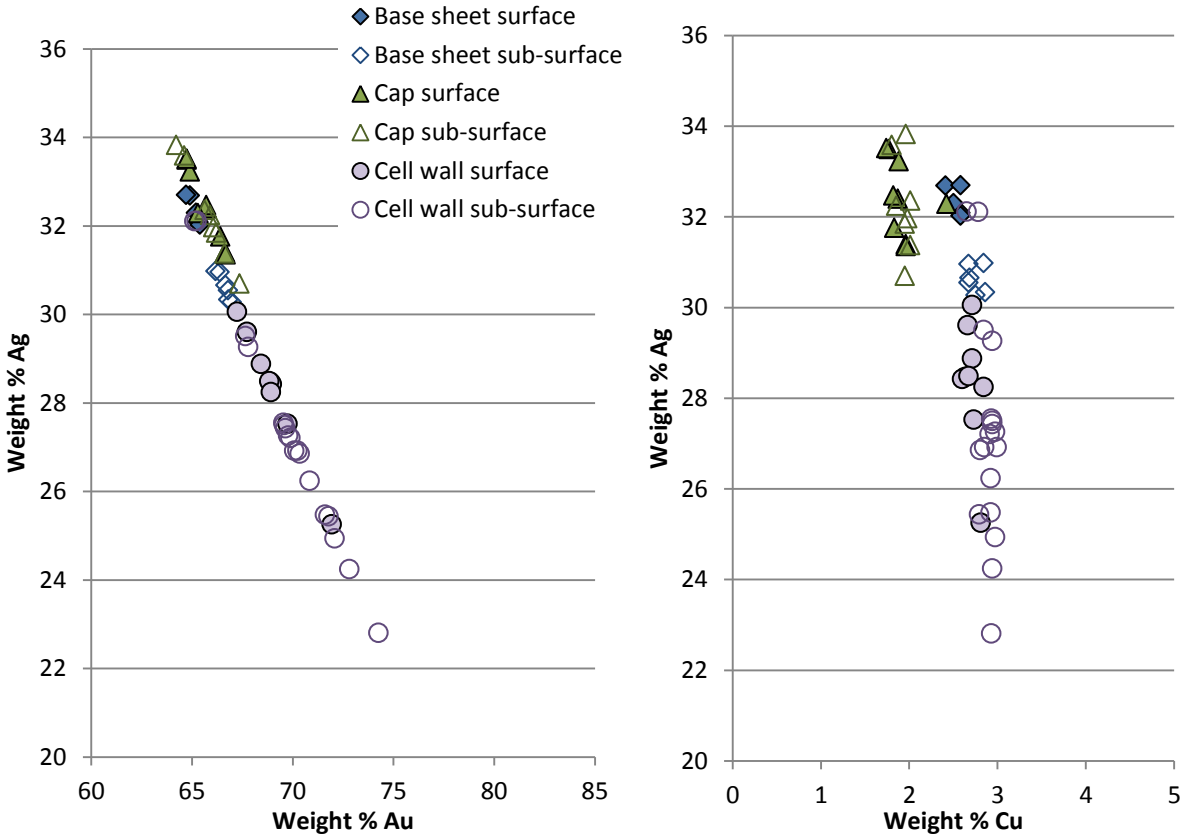
Decoration				
	Filigree	✓	Glass	
	Garnet	✓	Other	

SEM-EDX analysis was undertaken on a range of components, including the cell wall, the separate cap and the base sheet to which all the components were attached.

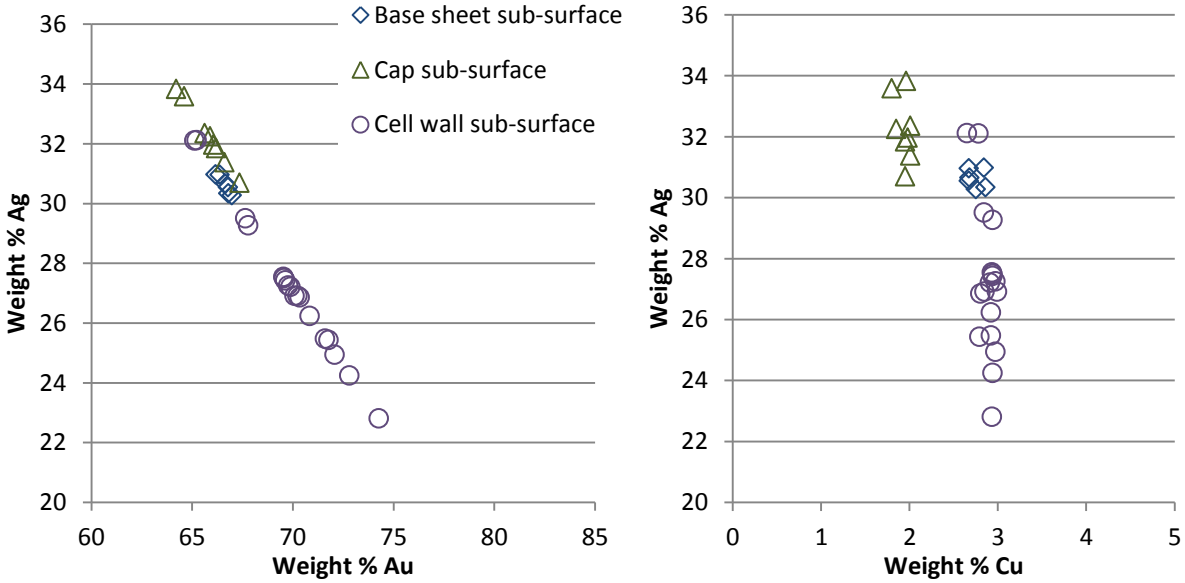
Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	5	Average	65.1	32.4	2.5
		Standard Deviation	*0.29*	*0.32*	*0.08*
Base sheet sub-surface	6	Average	66.7	30.6	2.7
		Standard Deviation	*0.30*	*0.30*	*0.09*
Top of cap surface	9	Average	65.2	32.9	1.9
		Standard Deviation	*0.46*	*0.58*	*0.25*
Top of cap sub-surface	8	Average	65.9	32.2	1.9
		Standard Deviation	*1.02*	*1.05*	*0.08*
Cell wall surface	9	Average	69.0	28.3	2.7
		Standard Deviation	*1.34*	*1.37*	*0.08*
Cell wall sub-surface	18	Average	69.9	27.2	2.9
		Standard Deviation	*2.36*	*2.41*	*0.09*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis of all the components revealed a very small loss of copper from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. Comparison of the sub-surface compositions of the base sheet and cell walls suggests that they may have used a similar gold alloy. The top of the cap on the other hand appears to be a distinctive composition.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses for all components.

Eleanor Blakelock
Analysed August 2013

Gold enrichment in Staffordshire Hoard K468: results of SEM-EDX analysis

Object Type Mount
Date 625-650

Decoration				
	Filigree	✓	Glass	
	Garnet	✓	Other	

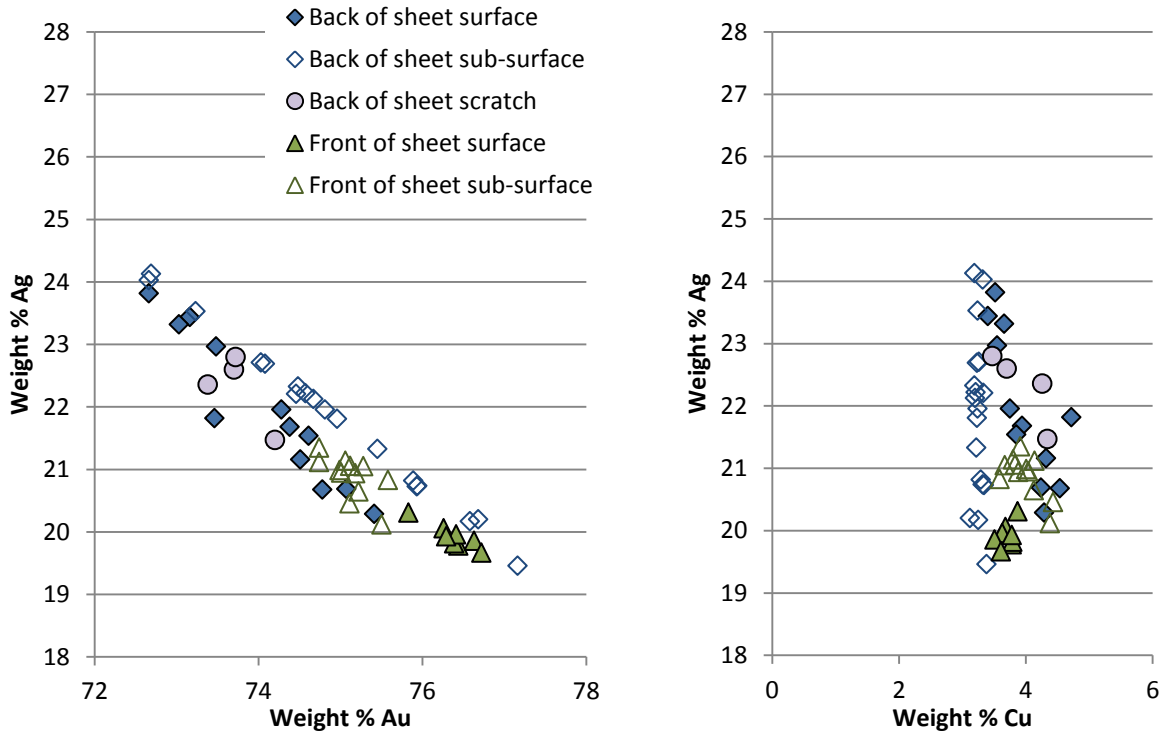
SEM-EDX analysis was undertaken on the front and back of the sheet to which the wires were attached. A scratch on the back was also examined.

Area analysed	**No of analyses**		**Wt% Au**	**Wt% Ag**	**Wt% Cu**
Front base sheet surface	8	Average	76.4	19.9	3.7
		Standard Deviation	*0.27*	*0.20*	*0.12*
Front base sheet sub-surface	12	Average	75.1	20.9	4.0
		Standard Deviation	*0.26*	*0.34*	*0.26*
Back base sheet surface	12	Average	73.9	22.1	4.0
		Standard Deviation	*0.88*	*1.19*	*0.43*
Back base sheet sub-surface	18	Average	74.9	21.8	3.3
		Standard Deviation	*1.31*	*1.33*	*0.07*
Back base sheet scratch	4	Average	73.8	22.3	3.9
		Standard Deviation	*0.34*	*0.59*	*0.42*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a *c.*1.0 wt% loss of silver from the front surface of the base sheet, and a difference of less than 5% from surface to core, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment but could also be the result of some deliberate surface treatment.

The analysis of the back revealed a small increase in copper and silver at the surface which may have come from the solder used, although the analysis of the surface of a scratch from antiquity suggests that this may have occurred post-deposition from close contact with corroding silver objects in the burial environment. The surface of the scratch on the back sheet had a similar composition to the surface, possibly confirming that this sheet had not been enriched.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K513: results of SEM-EDX analysis

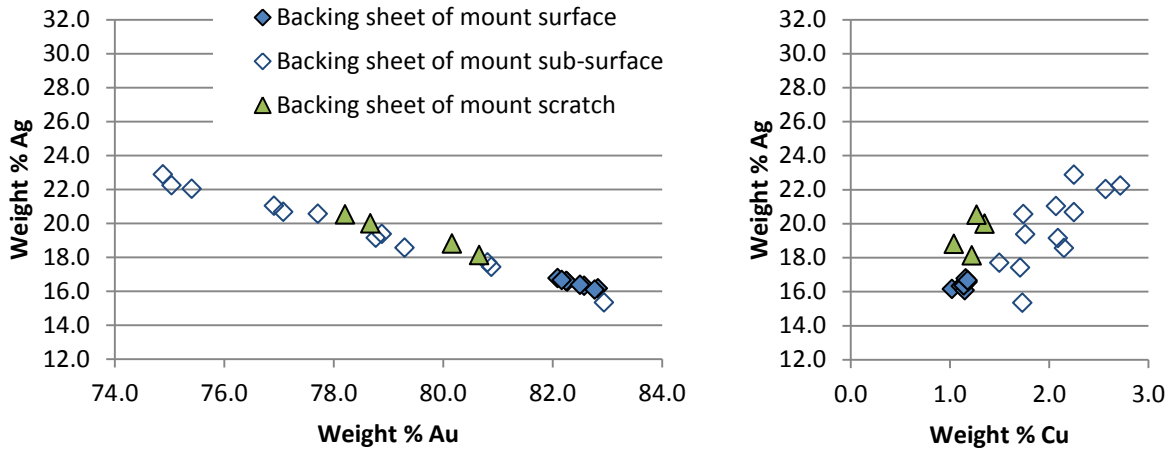
Object Type Mount
Date 600-635

Decoration				
	Filigree	✓	Glass	
	Garnet	✓	Other	

SEM-EDX analysis was undertaken on a range of components, including the main backing sheet to which the panels and garnet cell walls were attached, the backing sheet of the filigree panel, the filigree wire and the panel cell wall.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Backing sheet of mount surface	8	Average	82.5	16.4	1.1
		Standard Deviation	*0.28*	*0.24*	*0.05*
Backing sheet of mount sub-surface	12	Average	78.3	19.7	2.0
		Standard Deviation	*2.53*	*2.24*	*0.37*
Backing sheet of mount scratch	4	Average	79.4	19.4	1.2
		Standard Deviation	*1.17*	*1.09*	*0.13*
Backing sheet of panel surface	8	Average	75.8	22.8	1.4
		Standard Deviation	*2.63*	*2.31*	*0.42*
Backing sheet of panel sub-surface	10	Average	65.3	32.1	2.6
		Standard Deviation	*3.09*	*2.87*	*0.32*
Panel filigree wire surface	12	Average	72.2	25.7	2.1
		Standard Deviation	*0.90*	*1.06*	*0.34*
Panel filigree wire sub-surface	12	Average	73.6	24.3	2.1
		Standard Deviation	*2.85*	*2.87*	*0.05*
Cell wall of panel surface	8	Average	70.6	26.6	2.8
		Standard Deviation	*1.09*	*1.16*	*0.27*
Cell wall of panel sub-surface	15	Average	70.1	27.3	2.6
		Standard Deviation	*2.28*	*2.16*	*0.27*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

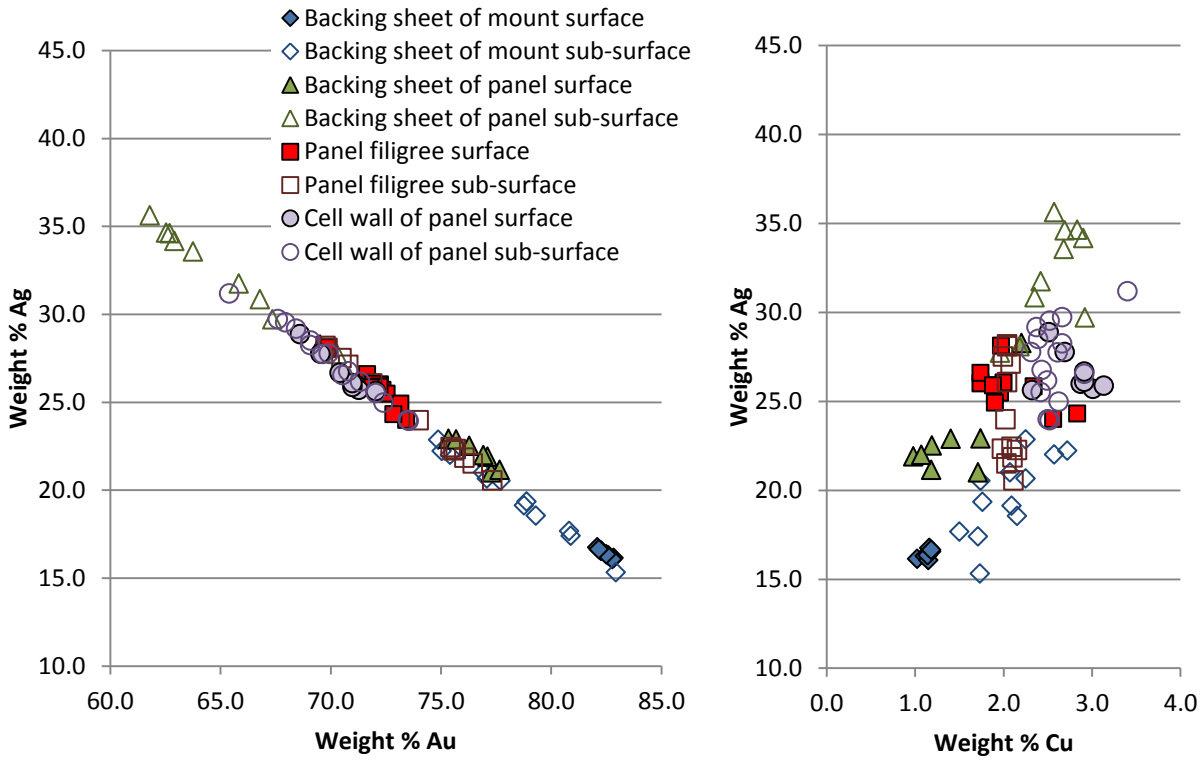


Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface, surface and scratch analyses of the backing sheet.

The analysis of the back of this mount revealed a *c.*3.3 wt% loss of silver from the surface (a difference of *c.*17% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The surface of the scratch had a similar composition to the subsurface, but with a similar loss in copper to the other surface analyses, most likely due to corrosion, confirming that the treatment was carried out prior to burial.

The analysis of the back of the panel revealed a *c.*9.2 wt% loss of silver from the surface (a difference of *c.*29% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The cell wall surrounding the panel had a *c.*0.7 wt% loss of silver from the surface and a difference of less than 5% from surface to core, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment but could also be the result of some deliberate surface treatment. The analysis of the wire revealed a small loss of copper at the surface and a small increase in silver at the surface which may be due to solder or from close contact to corroding silver objects in the burial environment.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Comparison of the sub-surface compositions of the cell wall and filigree wire suggests that they were made with the same, or a similar, gold alloy. The backing sheets on the other hand appear to be a distinctive composition, and are therefore a different gold alloy.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K545: results of SEM-EDX analysis

Object Type Mount
Date 630-670

Decoration				
	Filigree	✓	Glass	✓
	Garnet	✓	Other	

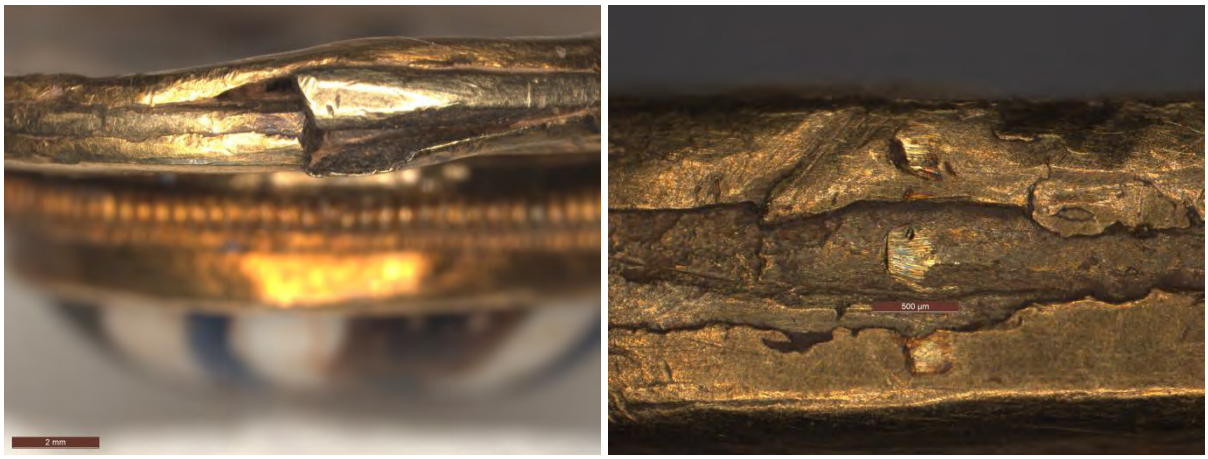
SEM-EDX analysis was undertaken on the side of the circular mount, on the two different sheets and wire used to construct it. A repeat analysis was carried out on the sheet on the back of the mount.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Backing sheet (back) surface	6	Average	85.5	11.8	2.7
		Standard Deviation	*0.70*	*0.64*	*0.07*
Backing sheet (back) sub-surface	10	Average	88.6	8.2	3.2
		Standard Deviation	*0.29*	*0.30*	*0.09*
Centre wire surface	6	Average	68.3	30.7	1.0
		Standard Deviation	*1.33*	*1.36*	*0.10*
Centre wire sub-surface	9	Average	69.9	27.9	2.2
		Standard Deviation	*1.11*	*1.10*	*0.09*
Backing sheet (front) surface	6	Average	86.4	10.9	2.7
		Standard Deviation	*0.35*	*0.44*	*0.09*
Backing sheet (front) sub-surface	10	Average	88.9	8.0	3.1
		Standard Deviation	*0.22*	*0.17*	*0.11*
Back sheet surface	4	Average	85.7	11.7	2.6
		Standard Deviation	*0.52*	*2.45*	*0.36*
Back sheet sub-surface	6	Average	88.2	8.7	3.1
		Standard Deviation	*0.25*	*0.77*	*0.10*
Front cell wall surface	6	Average	85.1	12.0	2.9
		Standard Deviation	*0.21*	*0.19*	*0.05*
Front cell wall sub-surface	6	Average	88.1	8.8	3.1
		Standard Deviation	*0.26*	*0.31*	*0.08*

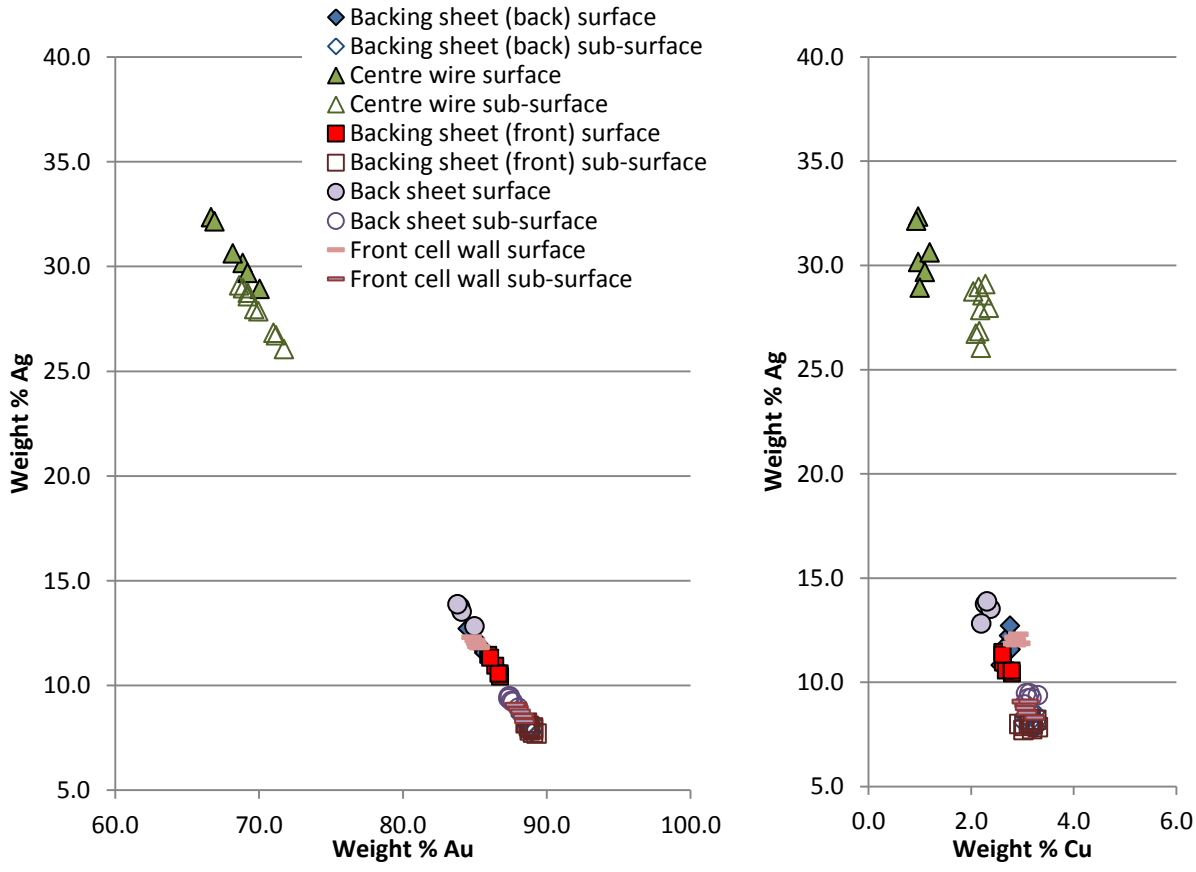
SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis of all the components revealed a small loss of copper at the surface, which is indicative of natural surface enrichment that can occur during burial. There was a small increase in silver at the surface which may have come from the solder used, but since it was also present on all components it is most likely a post depositional effect caused by close contact with corroding silver objects.

Comparison of the sub-surface compositions of the various components suggests that the gold used for the central wire in the construction of this piece was a different composition than the sheets used for the front and back. The rest of the components used the same gold alloy.



Details of the construction of the stud with the front and back sheets and a central wire, right) three sub-surface areas. Scale bar left) 2mm and right) 500µm.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed May 2013

Gold enrichment in Staffordshire Hoard K547: results of SEM-EDX analysis

Object Type Twisted wire panel
Date 600-650

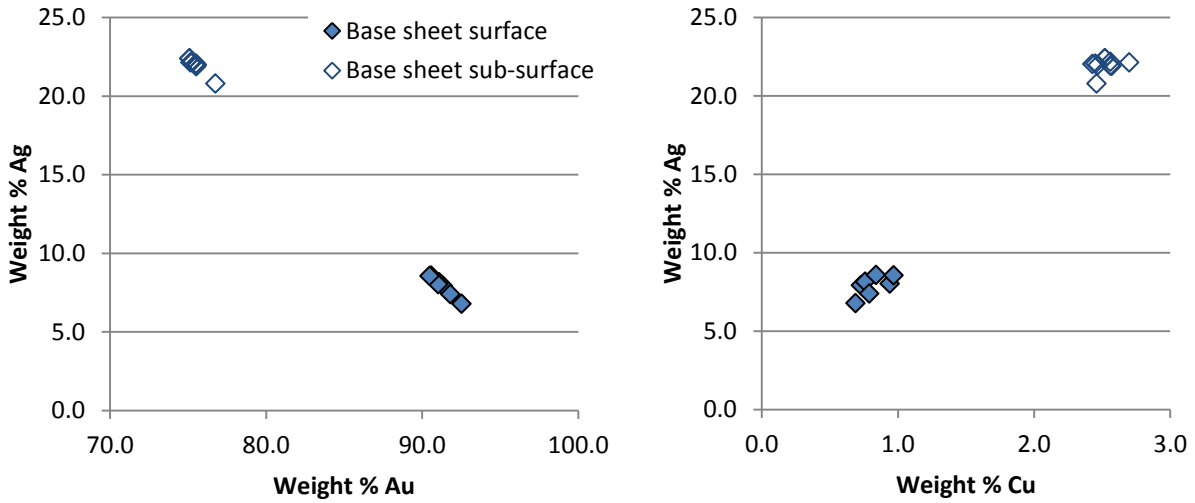
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the back of the gold sheet to which the wire was attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	7	Average	91.3	7.9	0.8
		Standard Deviation	*0.71*	*0.64*	*0.11*
Sub-surface	10	Average	75.5	22.0	2.5
		Standard Deviation	*0.48*	*0.45*	*0.08*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 75-76 wt% gold, 21-23 wt% silver, the rest being copper. The analysis revealed a *c.*14.1 wt% loss of silver from the surface (a difference of *c.*64% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K550: results of SEM-EDX analysis

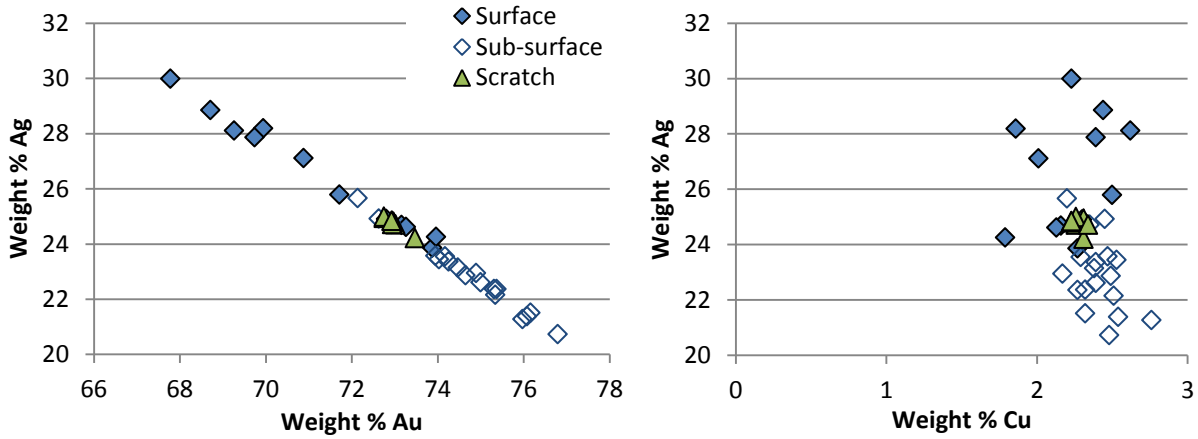
Object Type Inscription
Date 630-670

Decoration				
	Filigree	✓	Glass	
	Garnet		Other	✓

SEM-EDX analysis was undertaken on two areas on the front of this piece.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	12	Average	71.3	26.5	2.2
		Standard Deviation	*2.16*	*2.08*	*0.25*
Scratch	8	Average	74.7	22.9	2.4
		Standard Deviation	*1.26*	*1.31*	*0.14*
Sub-surface	18	Average	72.9	24.8	2.3
		Standard Deviation	*0.22*	*0.24*	*0.04*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The analysis revealed a small loss of copper at the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. There was an increase in silver at the surface which may be contamination from the niello used in the inlays. The surface of the scratch had a similar composition to the subsurface, so may be evidence to confirm that the silver present on the surface results from manufacture rather than post deposition.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K552: results of SEM-EDX analysis

Object Type Hilt-collar
Date 580-610

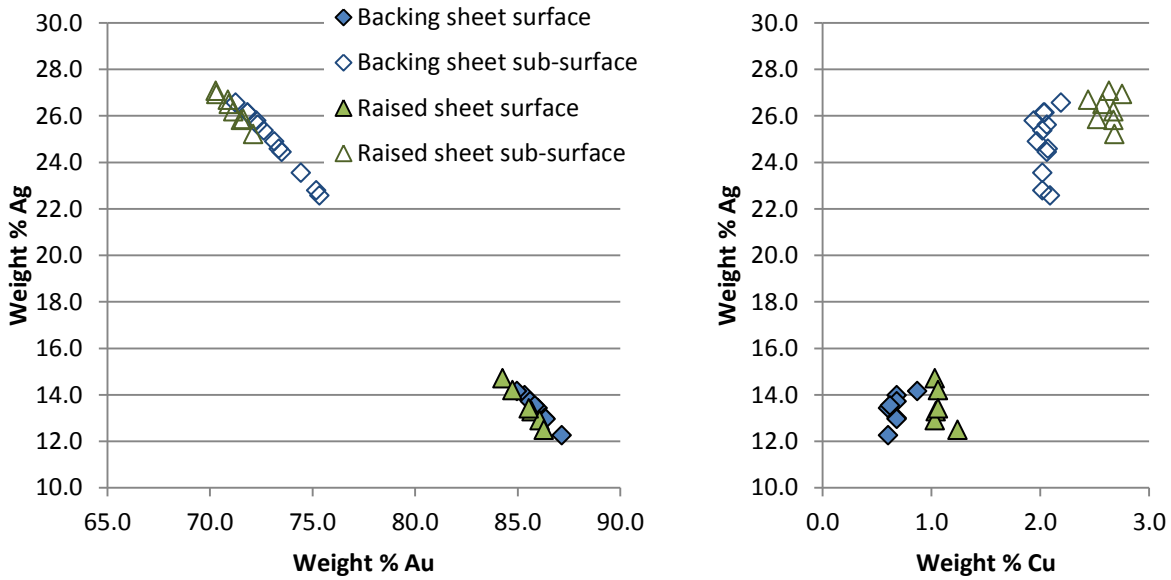
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the base sheet and also on the sheet used to raise the filigree wire.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Backing sheet surface	8	Average	85.9	13.4	0.7
		Standard Deviation	*0.67*	*0.62*	*0.09*
Backing sheet sub-surface	12	Average	73.1	24.9	2.0
		Standard Deviation	*1.33*	*1.33*	*0.06*
Raised sheet surface	6	Average	85.4	13.5	1.1
		Standard Deviation	*0.78*	*0.82*	*0.08*
Raised sheet sub-surface	10	Average	71.1	26.3	2.6
		Standard Deviation	*0.63*	*0.64*	*0.10*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The analysis revealed a *c.*11.5 wt% loss of silver from the surface of the base sheet (a difference of *c.*46% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The sub-surface composition of both sheets is similar suggesting the same, or a similar, gold alloy was used and both had been enriched to the same level.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K554: results of SEM-EDX analysis

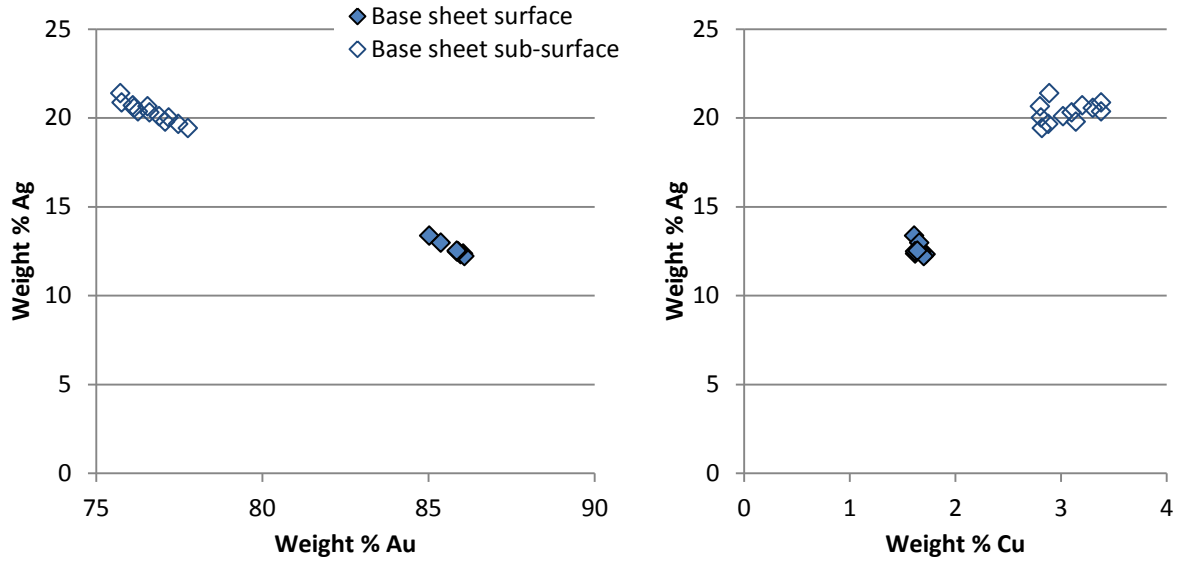
Object Type Pommel
Date 600-635

Decoration				
	Filigree	✓	Glass	
	Garnet		Other	

SEM-EDX analysis was undertaken on the base sheet to which the filigree wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	85.7	12.6	1.7
		Standard Deviation	*0.37*	*0.39*	*0.04*
Sub-surface	12	Average	76.6	20.3	3.1
		Standard Deviation	*0.66*	*0.56*	*0.22*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 76-77 wt% gold, 20-21 wt% silver, the rest being copper. The gold analysis revealed a *c.*7.7 wt% loss of silver from the surface (a difference of *c.*38% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K560: results of SEM-EDX analysis

Object Type Hilt collar
Date 620-630

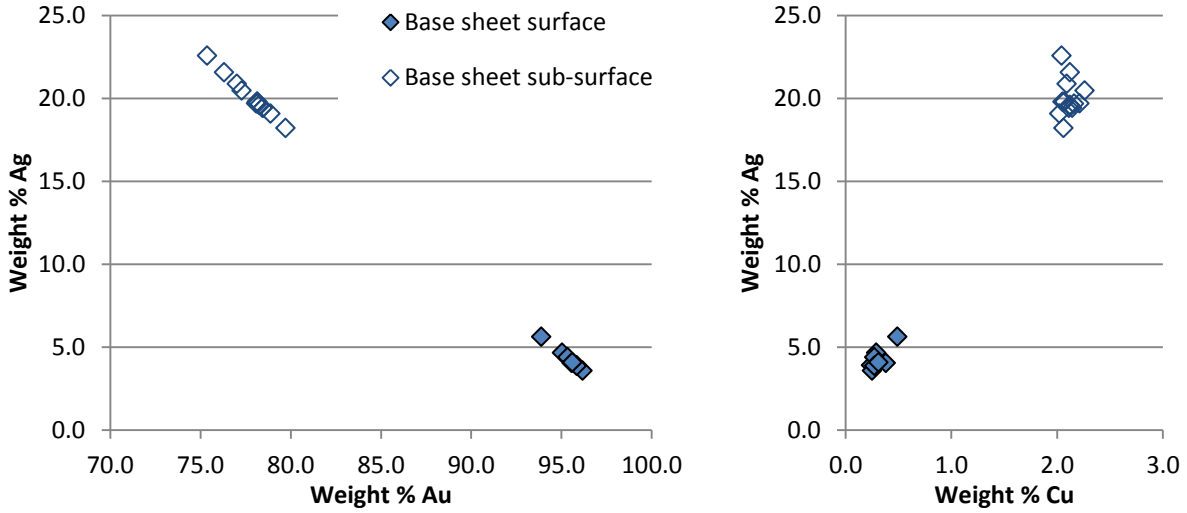
Decoration

Filigree	✓	Glass	
Garnet		Other	

SEM-EDX analysis was undertaken on the back of the gold sheet to which the filigree was attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	95.4	4.3	0.3
		Standard Deviation	*0.71*	*0.64*	*0.08*
Sub-surface	13	Average	77.9	20.0	2.1
		Standard Deviation	*1.13*	*1.13*	*0.07*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 76-79 wt% gold, 19-21 wt% silver, the rest being copper. The analysis revealed a *c.*15.7 wt% loss of silver from the surface (a difference of *c.*79% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K567: results of SEM-EDX analysis

Object Type Hilt Plate
Date 625-650

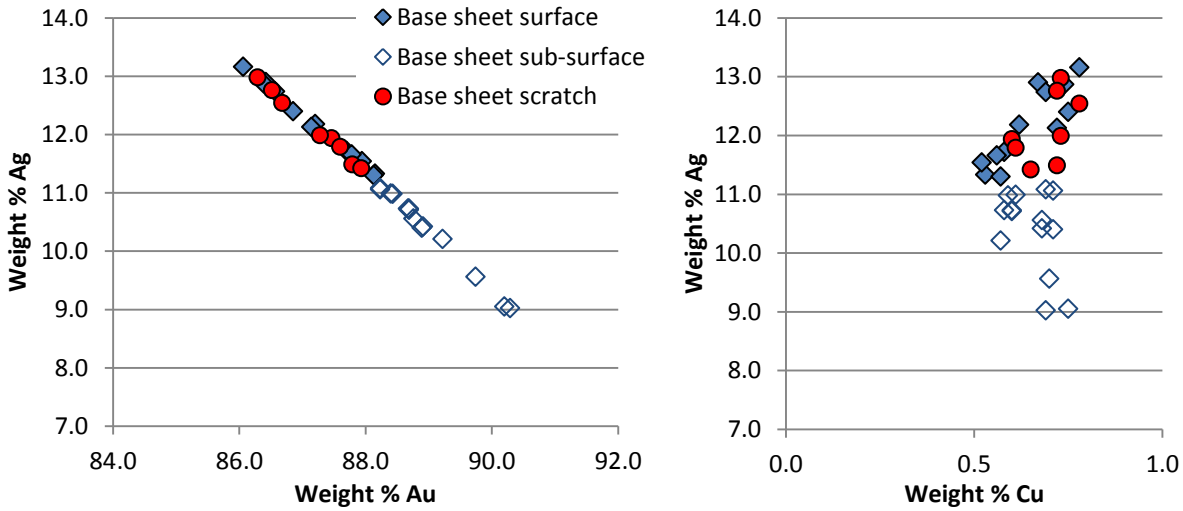
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the front of the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	12	Average	87.5	11.8	0.7
		Standard Deviation	*0.74*	*0.86*	*0.08*
Scratch	6	Average	87.2	12.1	0.7
		Standard Deviation	*0.62*	*0.58*	*0.06*
Sub-surface	14	Average	87.9	11.4	0.7
		Standard Deviation	*0.67*	*0.77*	*0.06*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 87-88 wt% gold, 10-12 wt% silver, the rest being copper. The analysis revealed no loss of copper from the surface of the object. There was an slight increase silver at the surface but this was also present on the surface of a scratch made when removing the hilt plate in antiquity, so is likely to be a post depositional affect perhaps from contact with nearby corroding silver objects.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K652: results of SEM-EDX analysis

Object Type Mount
Date 625-650

Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

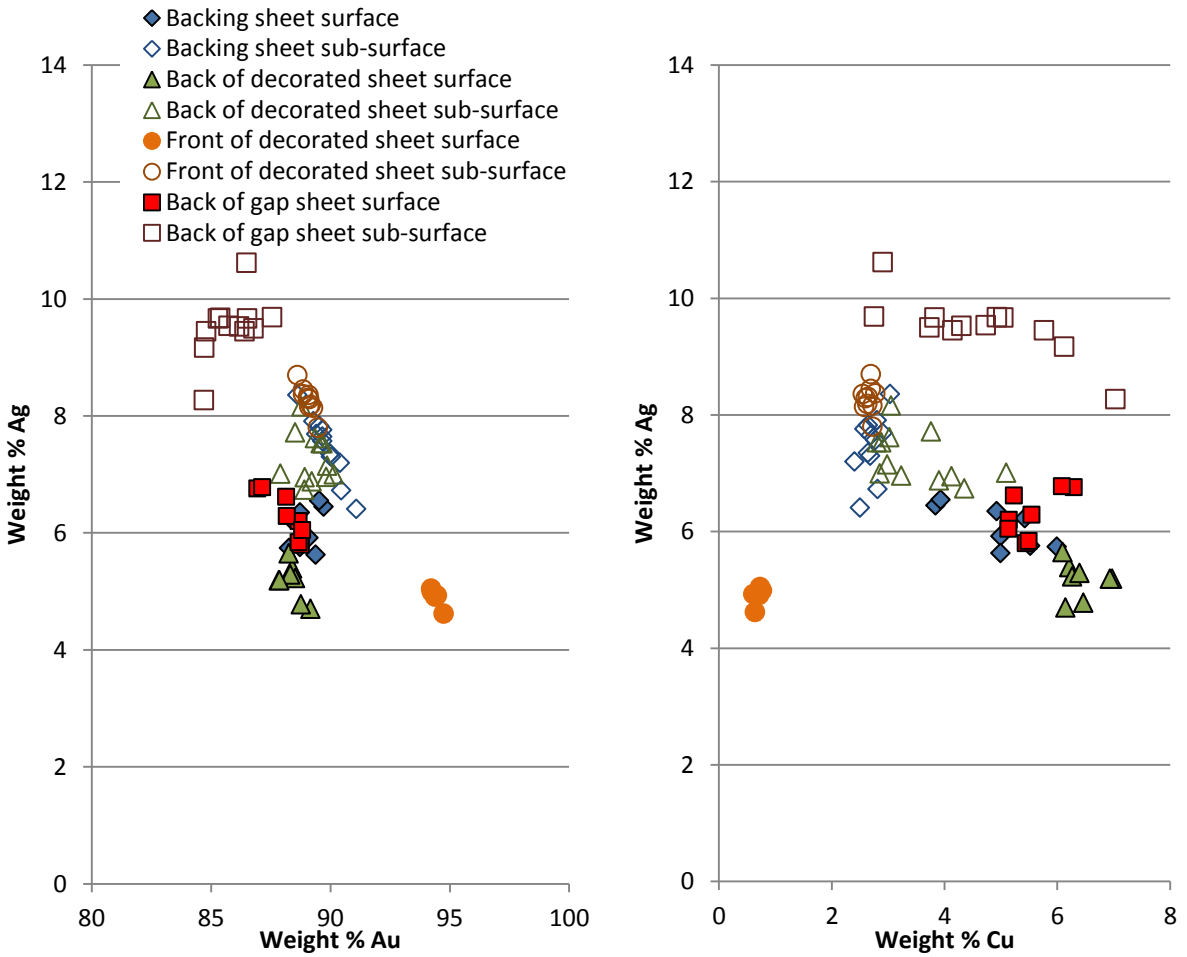
SEM-EDX analysis was undertaken on the backs of the backing sheet, the decorated sheet and the sheet that fills the gaps between motifs.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Backing sheet surface	8	Average	89.5	6.5	4.0
		Standard Deviation	*1.01*	*0.75*	*1.58*
Backing sheet sub-surface	12	Average	89.5	7.2	3.3
		Standard Deviation	*0.50*	*0.82*	*0.88*
Back of decorated sheet surface	8	Average	88.6	6.0	5.4
		Standard Deviation	*0.53*	*0.97*	*1.16*
Back of decorated sheet sub-surface	12	Average	89.1	6.7	4.2
		Standard Deviation	*0.75*	*1.16*	*1.70*
Front of decorated sheet surface	6	Average	94.4	4.9	0.7
		Standard Deviation	*0.19*	*0.15*	*0.06*
Front of decorated sheet sub-surface	10	Average	89.0	8.3	2.7
		Standard Deviation	*0.24*	*0.23*	*0.07*
Back of gap sheet surface	8	Average	86.8	7.9	5.3
		Standard Deviation	*1.55*	*1.78*	*0.63*
Back of gap sheet sub-surface	12	Average	86.8	8.4	4.8
		Standard Deviation	*1.40*	*1.67*	*1.33*

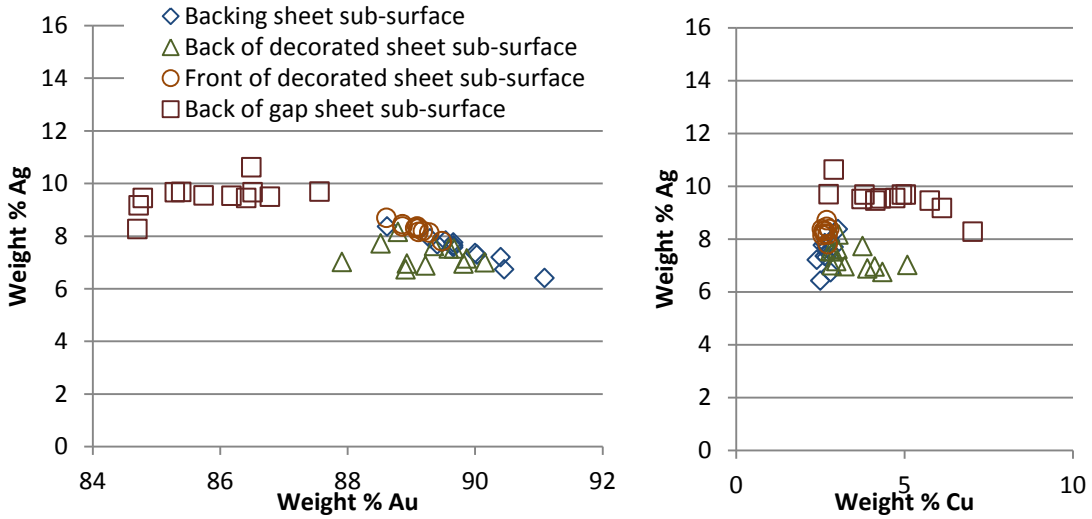
SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed an increase of copper on the back surfaces of the sheets; this is possibly due to the presence of solder. This was confirmed by the repeat analysis of the front of the decorated sheet which showed the typical loss of copper most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. The analysis also revealed a *c.*0.5-0.7 wt% loss of silver from the surface (a difference of 6-10% from surface to core), most likely indicative of corrosion that can occur during burial which results in natural surface enrichment but could also be the result of some deliberate surface treatment.

Comparison of the sub-surface compositions of the backing sheet and the front decorated sheet suggests that they may have used the same, or a similar, gold alloy. The sheets used to fill the gaps on the other hand appear to be a distinctive composition, and are therefore a different gold alloy, and may therefore have been a later modification.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of the different components.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K653: results of SEM-EDX analysis

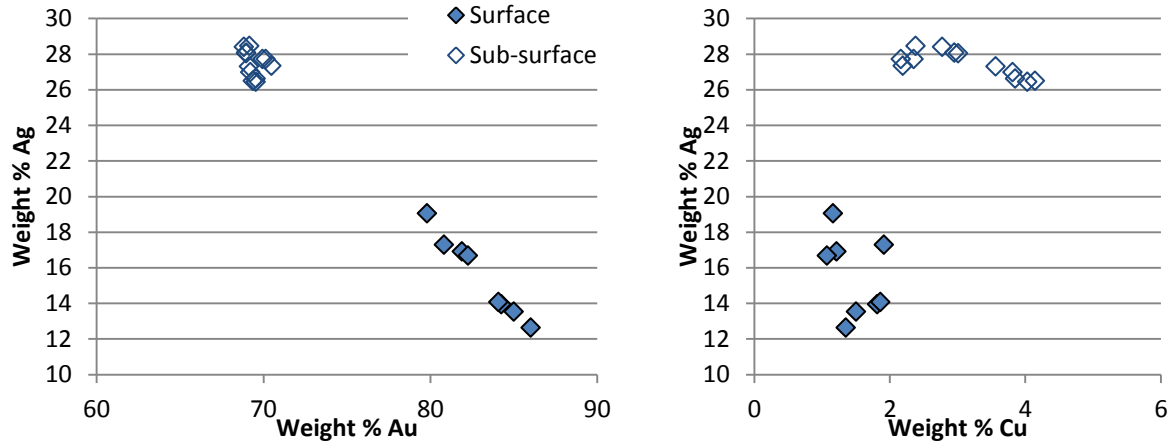
Object Type Mount
Date 625-650

Decoration				
	Filigree	✓	Glass	
	Garnet	✓	Other	✓

SEM-EDX analysis was undertaken on the base sheet on the front of the mount.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	83.0	15.5	1.5
		Standard Deviation	*2.16*	*2.26*	*0.34*
Sub-surface	12	Average	69.4	27.5	3.1
		Standard Deviation	*0.51*	*0.72*	*0.75*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 69-70 wt% gold, 27-28 wt% silver, the rest being copper. The analysis revealed a *c.*12.6 wt% loss of silver from the surface (a difference of *c.*44% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K655: results of SEM-EDX analysis

Object Type Great Gold Cross
Date 630-670

Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

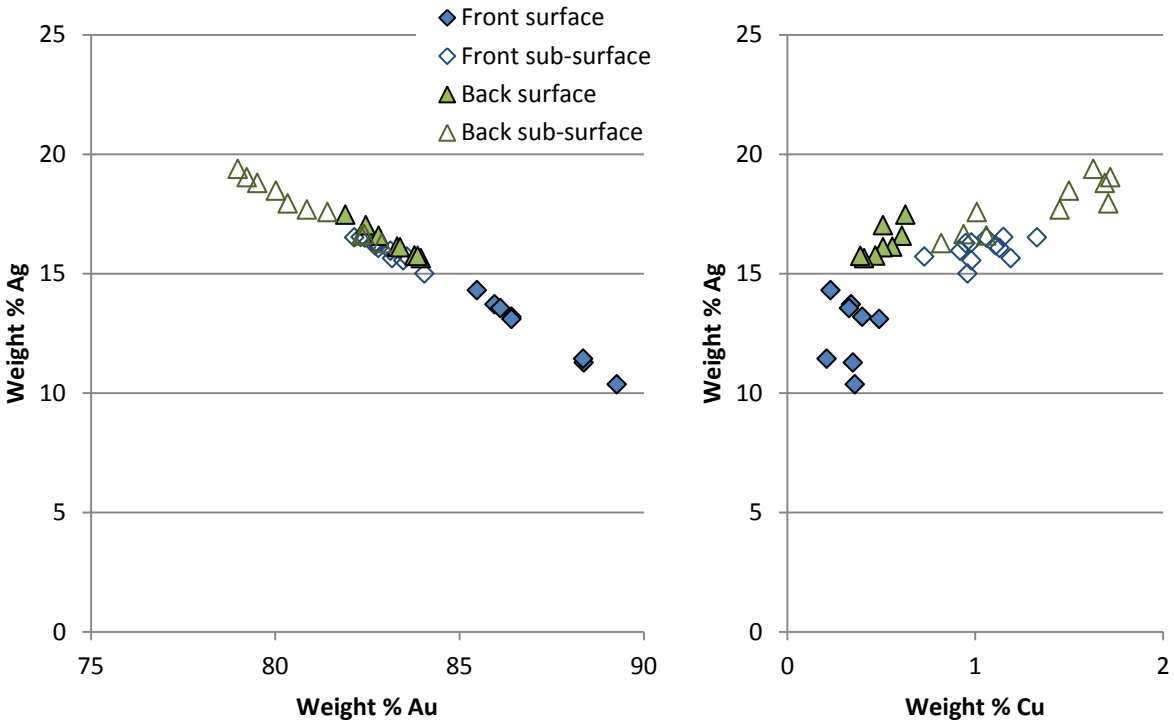
This piece consisted of two sheets, and therefore SEM-EDX analysis was undertaken on both.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Front decorated sheet surface	8	Average	87.1	12.6	0.3
		Standard Deviation	*1.40*	*1.40*	*0.09*
Front decorated sheet sub-surface	12	Average	83.0	16.0	1.0
		Standard Deviation	*0.56*	*0.47*	*0.16*
Back base sheet surface	8	Average	83.2	16.3	0.5
		Standard Deviation	*0.74*	*0.67*	*0.09*
Back base sheet sub-surface	10	Average	80.8	17.8	1.4
		Standard Deviation	*1.41*	*1.09*	*0.36*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a *c.*3.4 wt% loss of silver from the surface of the decorated sheet (a difference of *c.*21% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The back sheet also had a loss of silver (*c.*1.5 wt%, with a difference of *c.*9% from surface to core), most likely indicative of corrosion that can occur during burial which results in natural surface enrichment but could also be the result of some deliberate surface treatment.

Comparison of the sub-surface compositions of both sheets suggests that they may have used a similar gold alloy. The front sheet has been treated differently to create an even more gold enriched surface.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses of both sheets.

Eleanor Blakelock
Analysed November 2013

Gold enrichment in Staffordshire Hoard K656: results of SEM-EDX analysis

Object Type Gem setting for cross
Date 630-670

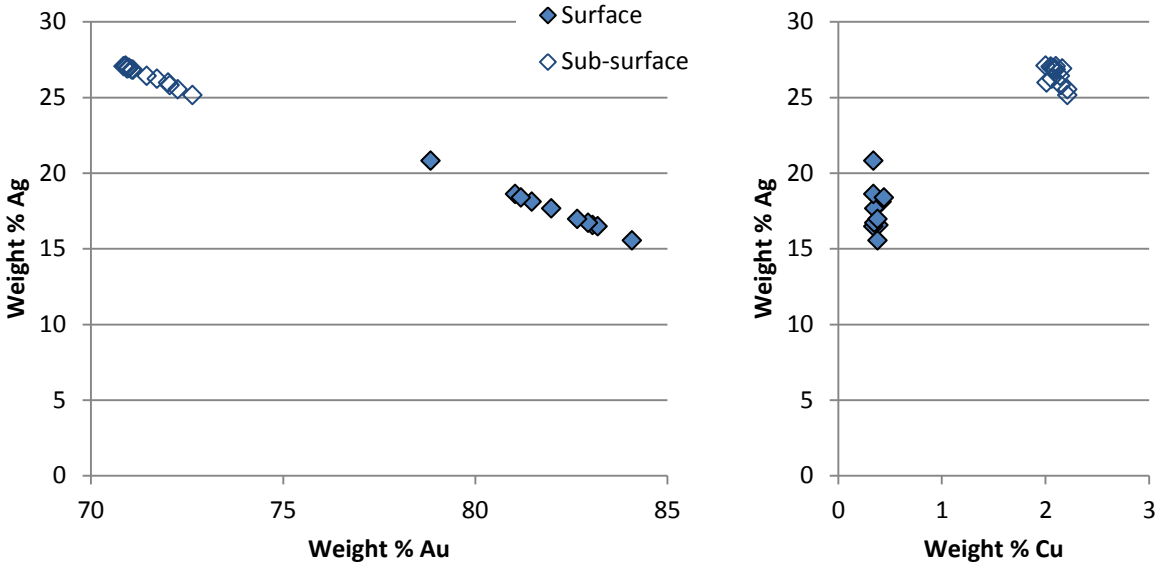
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the back of the sheet of the gem setting.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	10	Average	82.0	17.6	0.4
		Standard Deviation	*1.49*	*1.49*	*0.04*
Sub-surface	14	Average	71.4	26.5	2.1
		Standard Deviation	*0.60*	*0.64*	*0.07*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 70-72 wt% gold, 26-27 wt% silver, the rest being copper. The analysis revealed a *c.*8.9 wt% loss of silver from the surface (a difference of *c.*34% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed November 2013

Gold enrichment in Staffordshire Hoard K657: results of SEM-EDX analysis

Object Type Gem setting for cross
Date 630-670

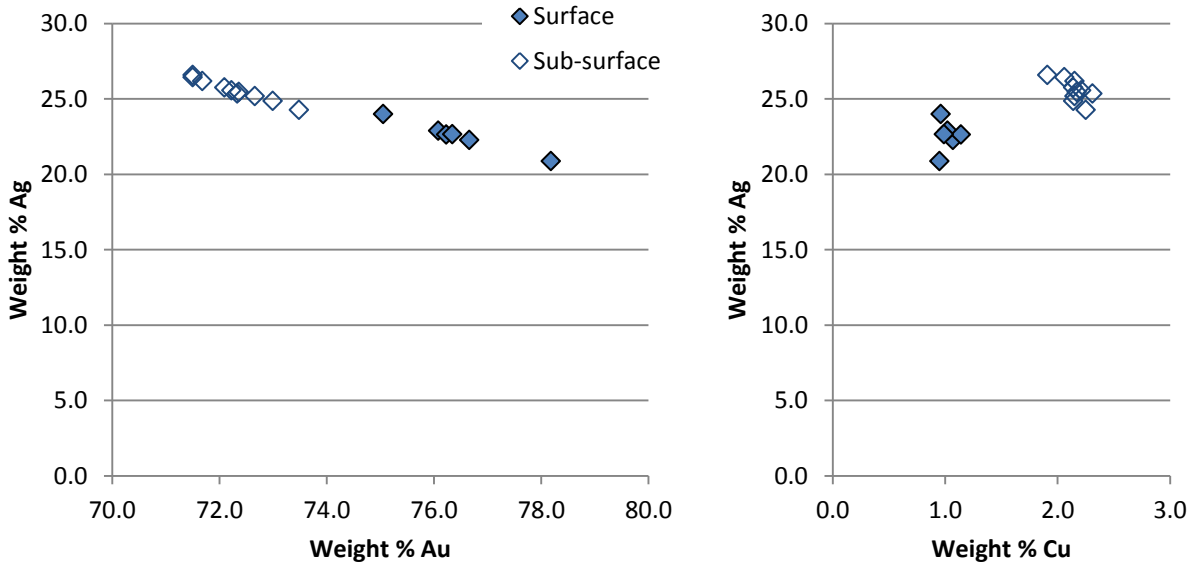
Decoration

Filigree	✓	Glass	
Garnet		Other	

SEM-EDX analysis was undertaken on the back of the sheet of the gem setting.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	6	Average	76.4	22.6	1.0
		Standard Deviation	1.02	1.01	0.07
Sub-surface	10	Average	72.3	25.6	2.1
		Standard Deviation	0.64	0.72	0.11

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 71-73 wt% gold, 25-27 wt% silver, the rest being copper. The analysis revealed a *c.*3.0 wt% loss of silver from the surface (a difference of *c.*12% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed November 2013

Gold enrichment in Staffordshire Hoard K658: results of SEM-EDX analysis

Object Type Gem setting for cross
Date 630-670

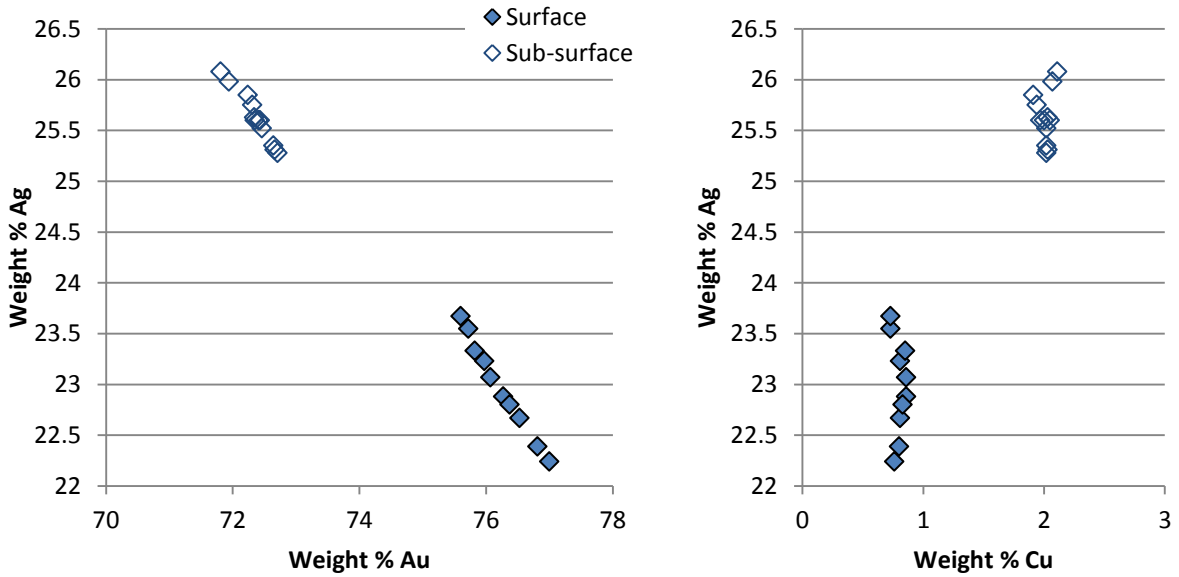
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the back of the sheet of the gem setting.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	10	Average	76.2	23.0	0.8
		Standard Deviation	*0.47*	*0.47*	*0.05*
Sub-surface	12	Average	72.4	25.6	2.0
		Standard Deviation	*0.27*	*0.25*	*0.05*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 71-73 wt% gold, 25-26 wt% silver, the rest being copper. The analysis revealed a *c.*2.6 wt% loss of silver from the surface (a difference of *c.*10% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed November 2013

Gold enrichment in Staffordshire Hoard K659: results of SEM-EDX analysis

Object Type Gem setting for cross
Date 630-670

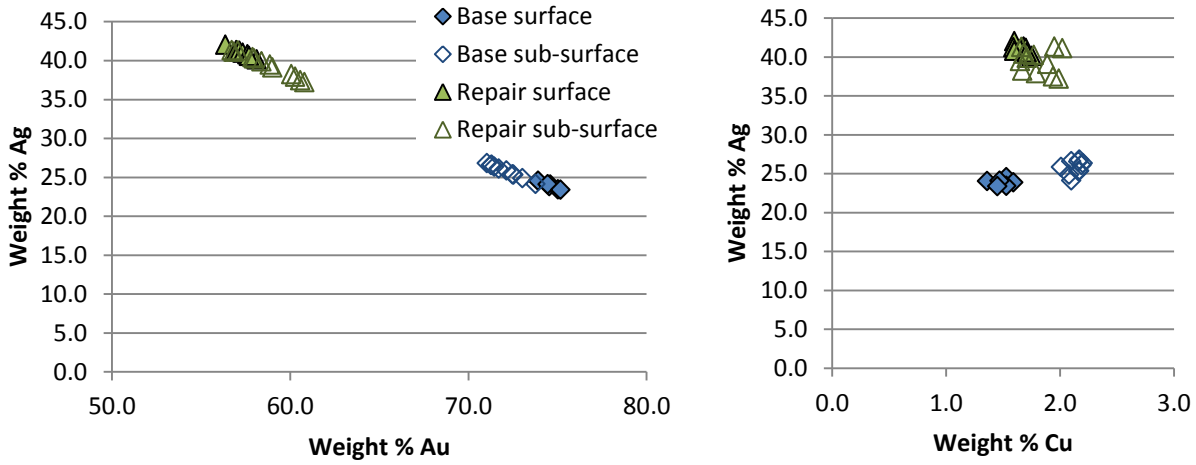
Decoration

Filigree	✓	Glass	
Garnet	✓	Other	

SEM-EDX analysis was undertaken on the back of the sheet of the gem setting and the metal used to repair and fix the garnet.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base surface	10	Average	74.6	23.9	1.5
		Standard Deviation	*0.45*	*0.44*	*0.08*
Base sub-surface	14	Average	72.1	25.8	2.1
		Standard Deviation	*0.88*	*0.86*	*0.06*
Repair surface	8	Average	57.3	41.0	1.7
		Standard Deviation	*0.53*	*0.57*	*0.06*
Repair sub-surface	12	Average	58.7	39.5	1.8
		Standard Deviation	*1.47*	*1.48*	*0.14*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The analysis revealed a *c.*1.9 wt% loss of silver from the surface (a difference of *c.*7% from surface to core), which is most likely indicative of corrosion that can occur during burial which results in natural surface enrichment but could also be the result of some deliberate surface treatment.

The metal used to repair the garnet fitting had a much higher silver content, and there was also more silver detected on the surface which is most likely contamination from solder or from close contact with corroding silver objects in the burial environment.

Eleanor Blakelock
Analysed November 2013

Gold enrichment in Staffordshire Hoard K660: results of SEM-EDX analysis

Object Type Hilt collar
Date 610-630

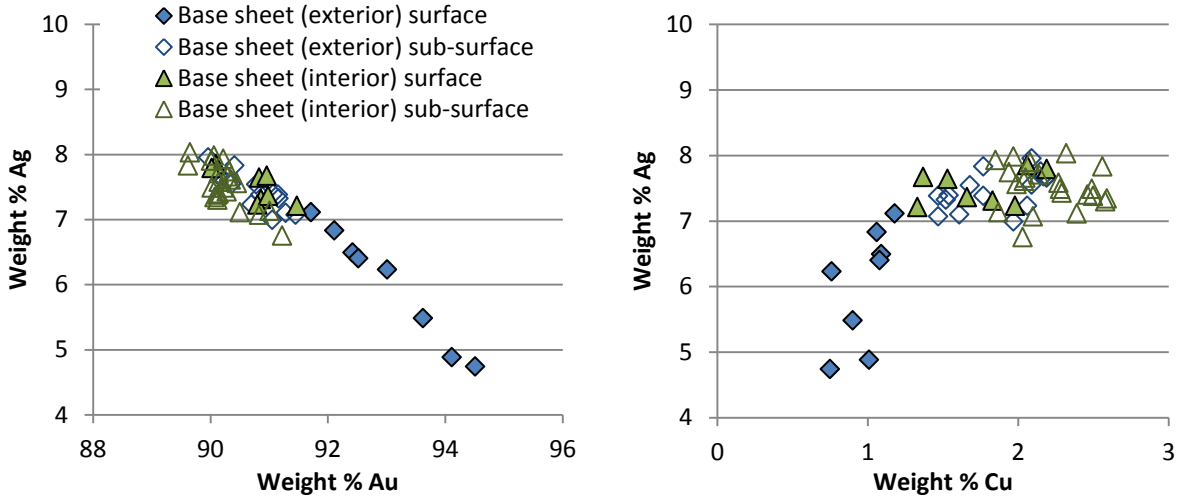
Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☑

SEM-EDX analysis was undertaken on both the interior and exterior gold sheets.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet exterior surface	8	Average	74.6	24.6	0.8
		Standard Deviation	*0.71*	*0.72*	*0.14*
Base sheet exterior sub-surface	16	Average	62.9	33.6	3.5
		Standard Deviation	*1.27*	*1.12*	*0.19*
Base sheet interior surface	8	Average	57.2	39.5	3.3
		Standard Deviation	*1.72*	*1.75*	*0.13*
Base sheet interior sub-surface	22	Average	57.9	38.4	3.7
		Standard Deviation	*1.58*	*1.47*	*0.17*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a *c.*9 wt% loss of silver from the surface of the exterior base sheet (a difference of *c.*27% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The interior base sheet had a loss of copper from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. Comparison of the sub-surface compositions of both sheets suggests that they were made from the same, or a similar, gold alloy. The exterior sheet has been treated to create an even more gold enriched surface while the interior sheet has not been treated.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K669: results of SEM-EDX analysis

Object Type Pommel
Date 600-620

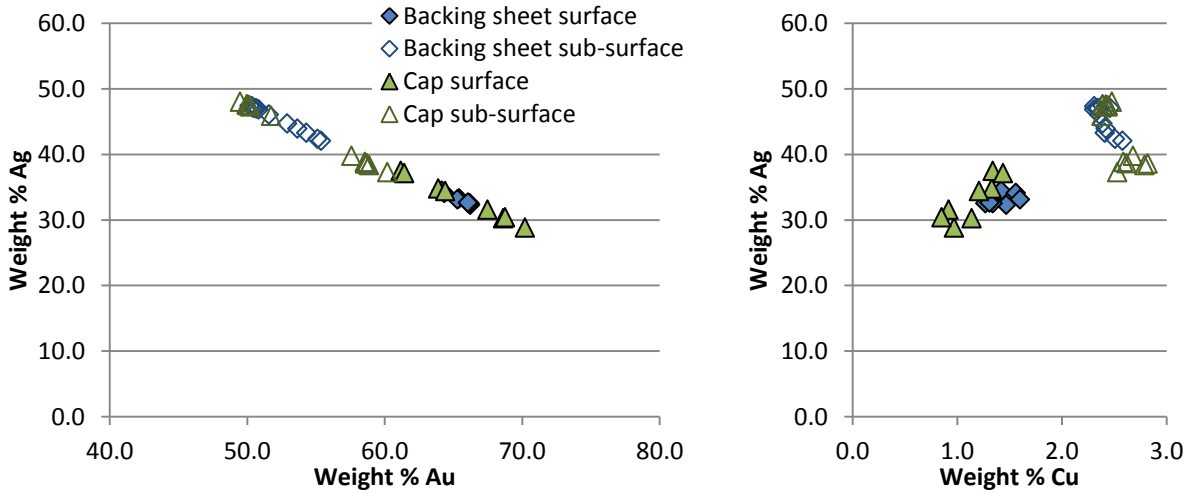
Decoration Filigree ✓ Glass
Garnet Other

SEM-EDX analysis was undertaken on the base sheet and the cap.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	65.5	33.1	1.4
		Standard Deviation	0.84	0.79	0.12
Base sheet sub-surface	12	Average	52.2	45.4	2.4
		Standard Deviation	1.99	2.05	0.08
Top of cap surface	8	Average	65.7	33.1	1.2
		Standard Deviation	3.48	3.29	0.22
Top of cap sub-surface	14	Average	53.9	43.6	2.5
		Standard Deviation	4.44	4.56	0.15

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a *c.*12.3 wt% loss of silver from the surface of the base sheet (a difference of *c.*27% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the cap also revealed it was treated with a *c.*10.5 wt% loss of silver from the surface (a difference of *c.*24% from surface to core). Comparison of the sub-surface compositions of both components suggests that they were probably made from the same, or a similar, gold alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K673: results of SEM-EDX analysis

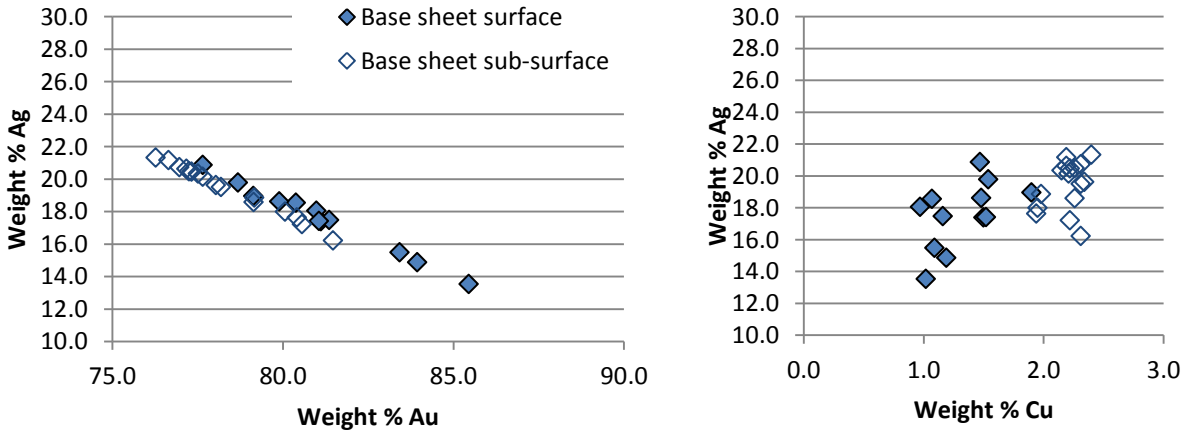
Object Type Mount
Date 600-630

Decoration Filigree ✓ Glass ☐
Garnet ✓ Other ☐

SEM-EDX analysis was undertaken on a range of components, including two types of cell wall, filigree wire and the base sheet to which the wires and cell walls were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	12	Average	81.1	17.6	1.3
		Standard Deviation	*2.26*	*2.09*	*0.28*
Base sheet sub-surface	16	Average	78.4	19.4	2.2
		Standard Deviation	*1.58*	*1.52*	*0.14*
Filigree wire surface	4	Average	72.8	24.9	2.3
		Standard Deviation	*2.35*	*2.57*	*0.21*
Filigree wire sub-surface	17	Average	75.2	22.5	2.3
		Standard Deviation	*0.90*	*0.90*	*0.09*
Thick cell wall surface	8	Average	75.8	22.1	2.1
		Standard Deviation	*0.83*	*0.89*	*0.08*
Thick cell wall sub-surface	16	Average	78.7	19.0	2.3
		Standard Deviation	*0.81*	*0.84*	*0.11*
Thin cell wall surface	8	Average	76.9	21.0	2.1
		Standard Deviation	*0.30*	*0.17*	*0.19*
Thin cell wall sub-surface	16	Average	77.8	19.9	2.3
		Standard Deviation	*0.40*	*0.38*	*0.12*

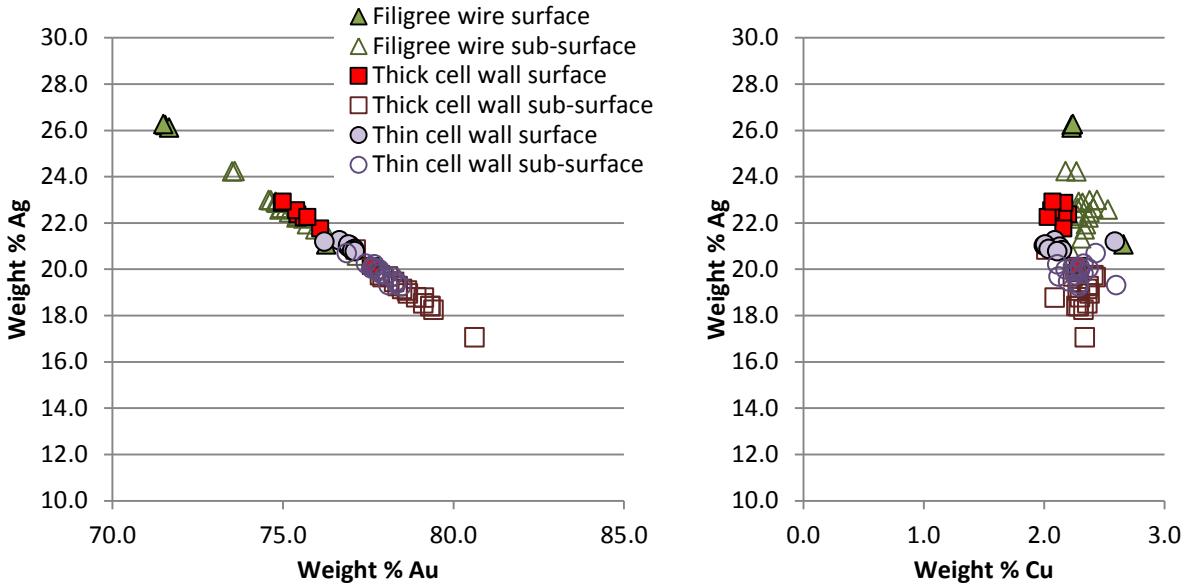
SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

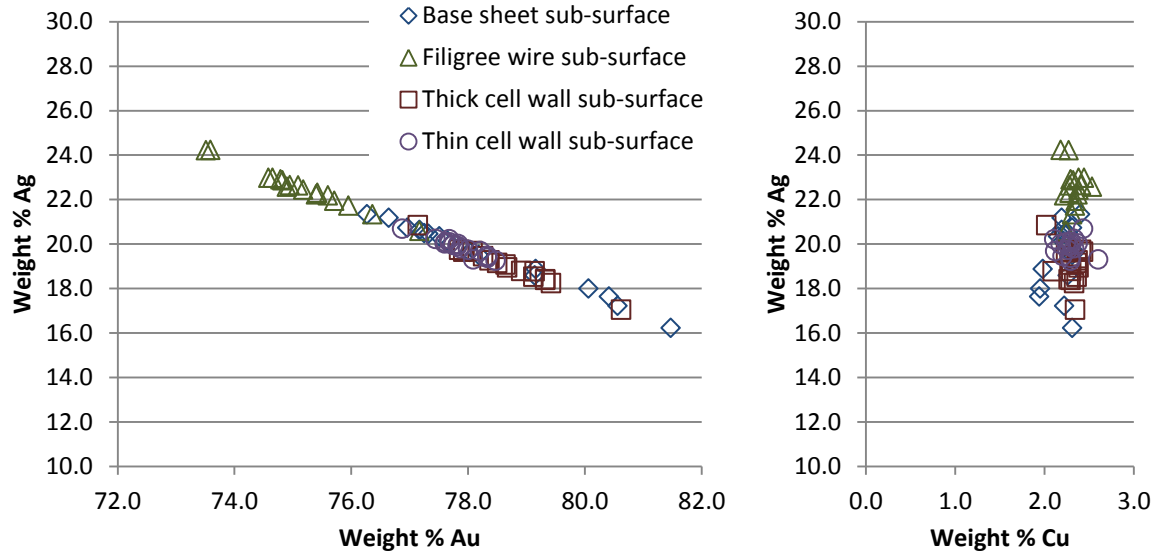
The analysis of the backing sheet revealed a *c.*1.8 wt% loss of silver from the surface (a difference of *c.*10% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The analysis of the other components revealed a loss of copper from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. They all had a slight increase in silver which may be due to the solder used to attach them to the gold backing sheet.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses of all the other components.

Comparison of the sub-surface compositions of each component suggests that the majority of the components were made with the same, or a similar, gold alloy. The possible exception is the filigree wire which had a generally higher copper and silver content.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K674: results of SEM-EDX analysis

Object Type Pommel
Date 610-630

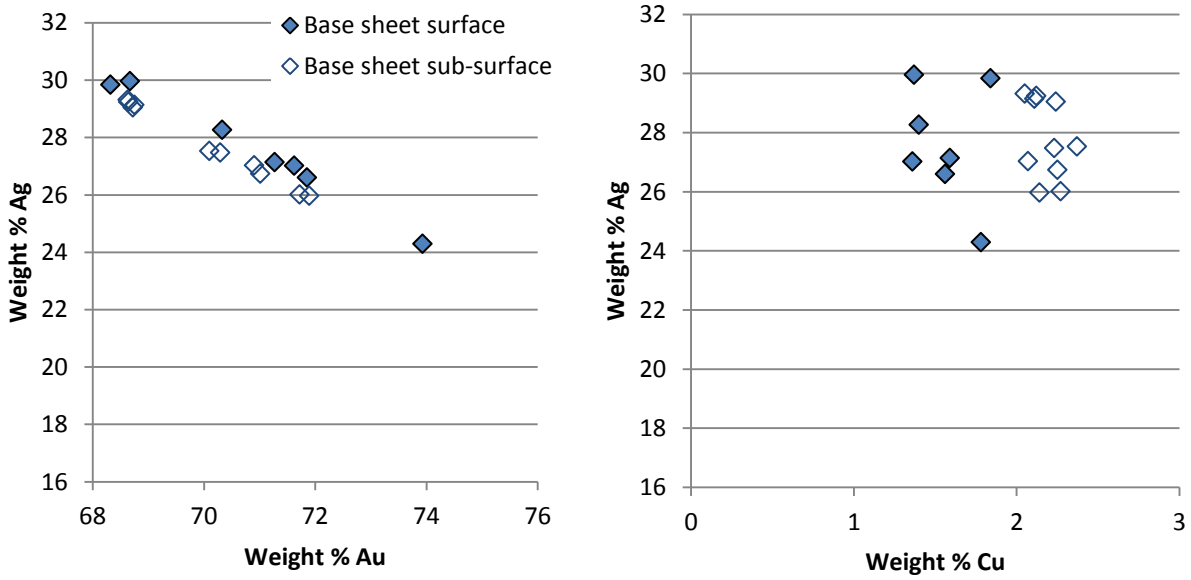
Decoration

Filigree	✓	Glass	
Garnet	✓	Other	

SEM-EDX analysis was undertaken on the gold sheet at the base of the pommel.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	10	Average	70.8	27.6	1.6
		Standard Deviation	*1.94*	*1.98*	*0.20*
Sub-surface	18	Average	70.0	27.8	2.2
		Standard Deviation	*1.31*	*1.34*	*0.10*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 69-71 wt% gold, 26-29 wt% silver, the rest being copper. The analysis revealed a loss of copper and only a small loss of silver from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Eleanor Blakelock
Analysed August 2013

Gold enrichment in Staffordshire Hoard K677: results of SEM-EDX analysis

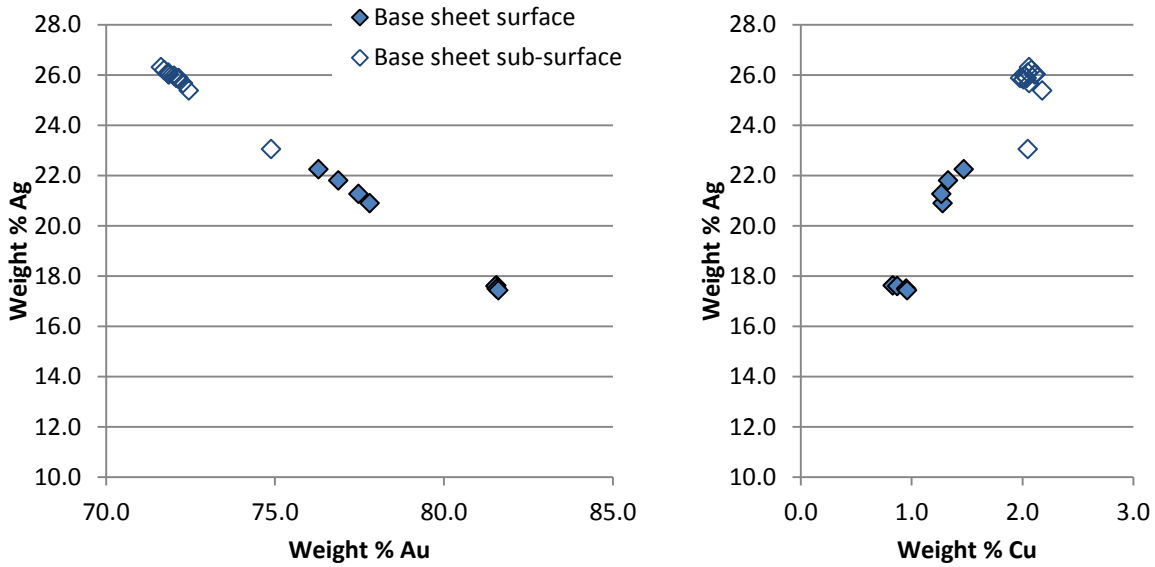
Object Type Mount
Date 625-650

Decoration				
	Filigree	✓	Glass	
	Garnet	✓	Other	

SEM-EDX analysis was undertaken on the base sheet on the back of the mount.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	79.4	20.5	1.3
		Standard Deviation	*2.42*	*2.95*	*0.45*
Sub-surface	12	Average	72.2	25.7	2.1
		Standard Deviation	*0.87*	*0.87*	*0.05*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 71-73 wt% gold, 25-27 wt% silver, the rest being copper. The analysis revealed a *c.*3.9 wt% loss of silver from the surface (a difference of *c.*16% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K679: results of SEM-EDX analysis

Object Type Hilt collar
Date 625-650

Decoration

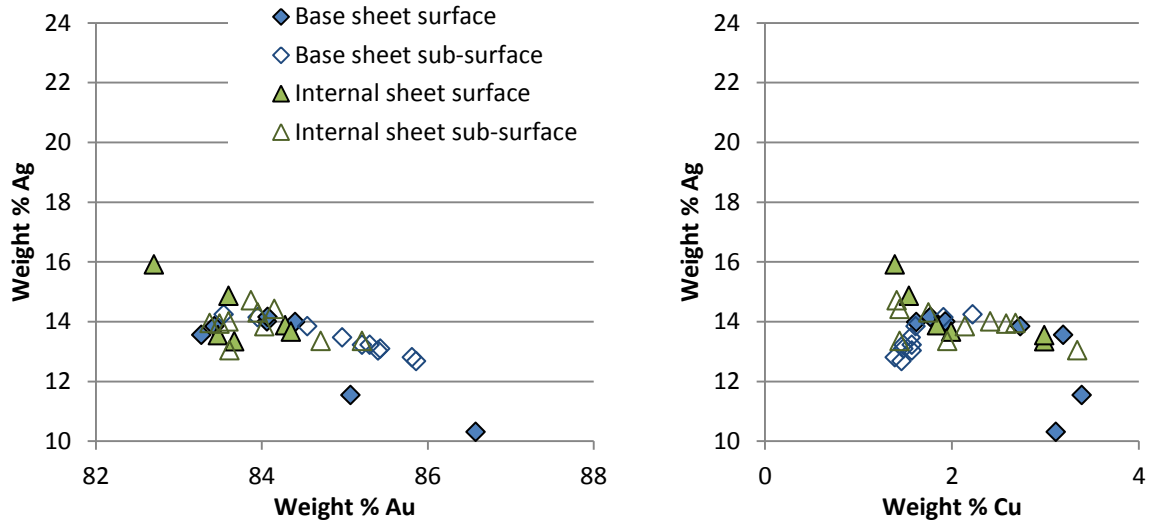
Filigree	✓	Glass		
Garnet	✓	Other		

SEM-EDX analysis was undertaken on the sheet at the base and also the internal sheet.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	7	Average	84.4	13.1	2.5
		Standard Deviation	*1.13*	*1.51*	*0.74*
Base sheet sub-surface	10	Average	85.0	13.4	1.6
		Standard Deviation	*0.77*	*0.54*	*0.25*
Internal sheet surface	6	Average	83.7	14.2	2.1
		Standard Deviation	*0.60*	*0.99*	*0.70*
Internal sheet sub-surface	10	Average	84.0	13.9	2.1
		Standard Deviation	*0.58*	*0.52*	*0.64*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis of the base sheet revealed a loss of *c.*0.3 wt% silver from the surface of the internal sheet, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. There was a slight increase in silver at the surface of the internal sheet, possibly contamination from the solder used. Both sheets appear to have a similar core composition so were probably made with the same alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K680: results of SEM-EDX analysis

Object Type Pommel
Date 600-630

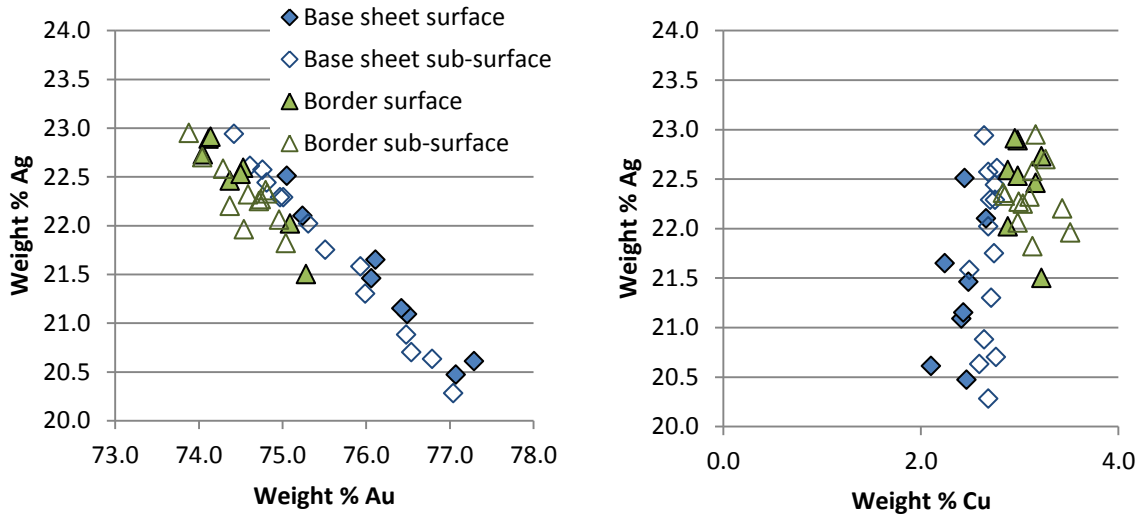
Decoration				
	Filigree	✓	Glass	
	Garnet		Other	✓

SEM-EDX analysis was undertaken on the backing sheet and the border at the top of the cap.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	76.2	21.4	2.4
		Standard Deviation	*0.79*	*0.70*	*0.17*
Base sheet sub-surface	14	Average	75.6	21.7	2.7
		Standard Deviation	*0.87*	*0.85*	*0.08*
Border at top of cap surface	8	Average	74.5	22.5	3.0
		Standard Deviation	*0.46*	*0.48*	*0.14*
Border at top of cap sub-surface	12	Average	74.6	22.3	3.1
		Standard Deviation	*0.36*	*0.31*	*0.21*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis of the base sheet revealed a loss of *c.*0.4 wt% silver from the surface, which is most likely indicative of corrosion that can occur during burial, which results in natural surface enrichment but could also be the result of some deliberate surface treatment. The analysis of the border at the top of the pommel revealed only a loss of copper from the surface, again this is most likely due to corrosion. Comparison of the sub-surface compositions of both components suggests they may have been made from different gold alloys.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K685: results of SEM-EDX analysis

Object Type Buckle
Date 600-650

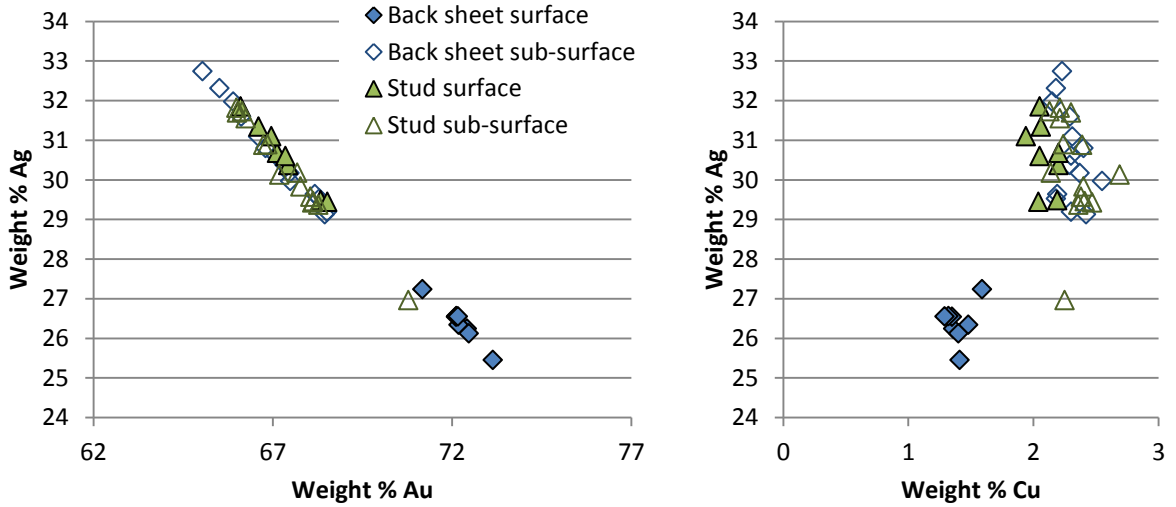
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the back of the buckle and also on one of the studs.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Back surface	8	Average	72.2	26.4	1.4
		Standard Deviation	0.54	0.50	0.10
Back sub-surface	14	Average	67.0	30.7	2.3
		Standard Deviation	1.12	1.16	0.11
Stud surface	8	Average	67.3	30.6	2.1
		Standard Deviation	0.81	0.85	0.10
Stud sub-surface	14	Average	67.4	30.3	2.3
		Standard Deviation	1.29	1.32	0.15

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Both components had a very similar core composition suggesting they were made from the same gold alloy. The analysis of the back sheet revealed a *c.*4.3 wt% loss of silver from the surface (a difference of *c.*14% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The stud only revealed a loss of copper from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K686: results of SEM-EDX analysis

Object Type Pommel
Date 600-620

Decoration

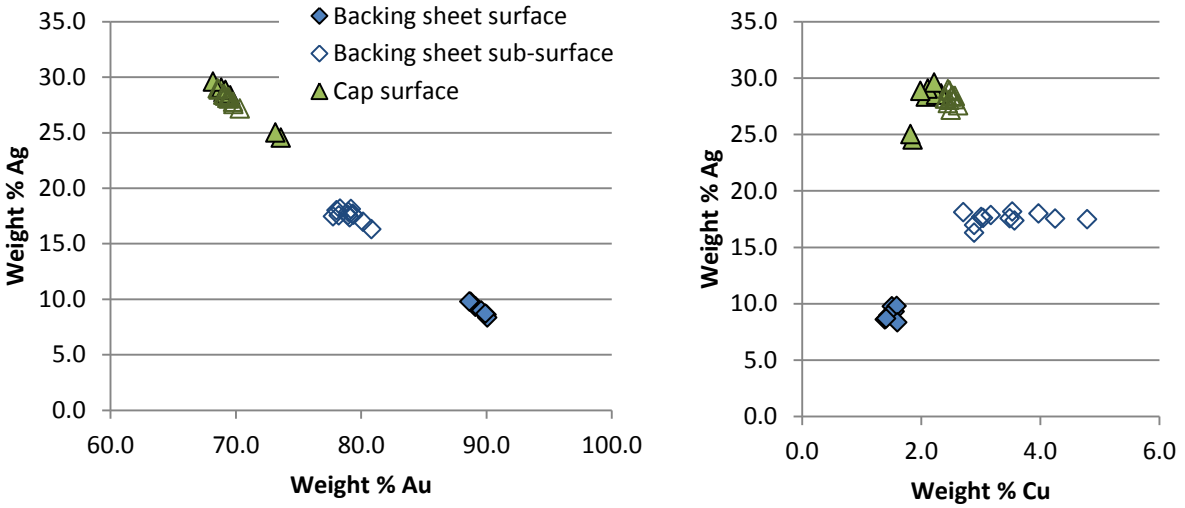
Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the base sheet and cap.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	89.4	9.1	1.5
		Standard Deviation	*0.58*	*0.54*	*0.08*
Base sheet sub-surface	12	Average	79.1	17.5	3.4
		Standard Deviation	*0.88*	*0.52*	*0.63*
Top of cap surface	8	Average	70.1	27.8	2.1
		Standard Deviation	*2.07*	*1.92*	*0.19*
Top of cap sub-surface	12	Average	69.3	28.2	2.5
		Standard Deviation	*0.50*	*0.51*	*0.06*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a *c.*8.5 wt% loss of silver from the surface of the base sheet (a difference of *c.*48% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis revealed a loss of copper and only a small loss of silver from the surface of the cap, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. Comparison of the sub-surface compositions revealed that each component was made of a distinct gold alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed January

Gold enrichment in Staffordshire Hoard K689: results of SEM-EDX analysis

Object Type Pommel
Date 600-650

Decoration				
	Filigree	✓	Glass	
	Garnet		Other	

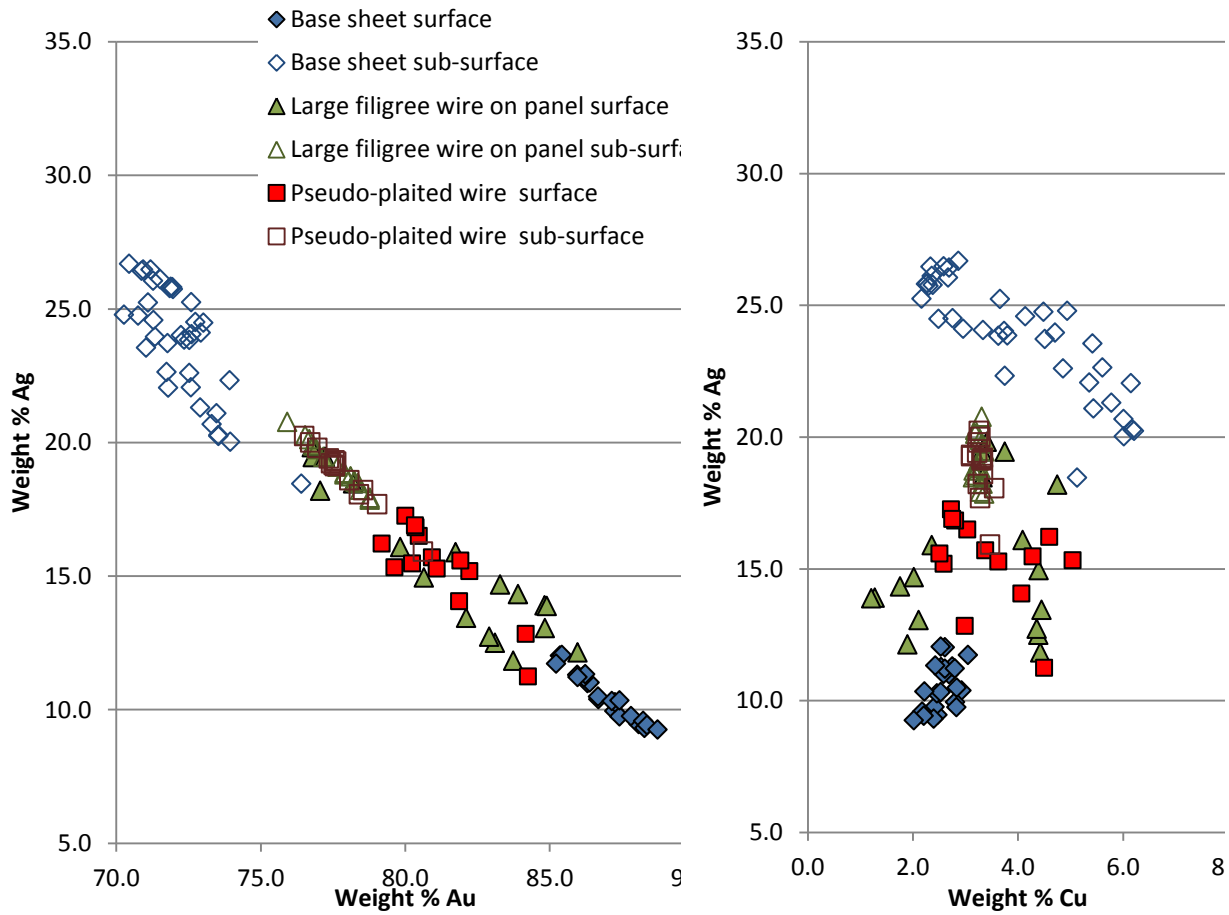
SEM-EDX analysis was undertaken on a number of components, including the sheet that was used as a base for the filigree, the large filigree wire on the edge of the piece and the pseudo-plaited wire.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	23	Average	86.9	10.5	2.6
		Standard Deviation	1.04	0.88	0.26
Base sheet sub-surface	37	Average	72.1	23.9	4.0
		Standard Deviation	0.99	1.98	1.41
Large filigree wire surface	14	Average	81.2	15.3	3.5
		Standard Deviation	1.55	1.65	0.85
Large filigree wire sub-surface	14	Average	77.8	18.9	3.3
		Standard Deviation	1.06	1.12	0.12
Pseudo-plaited wire surface	18	Average	82.4	14.5	3.1
		Standard Deviation	2.84	2.47	1.30
Pseudo-plaited wire sub-surface	15	Average	78.0	18.7	3.3
		Standard Deviation	0.60	0.59	0.08

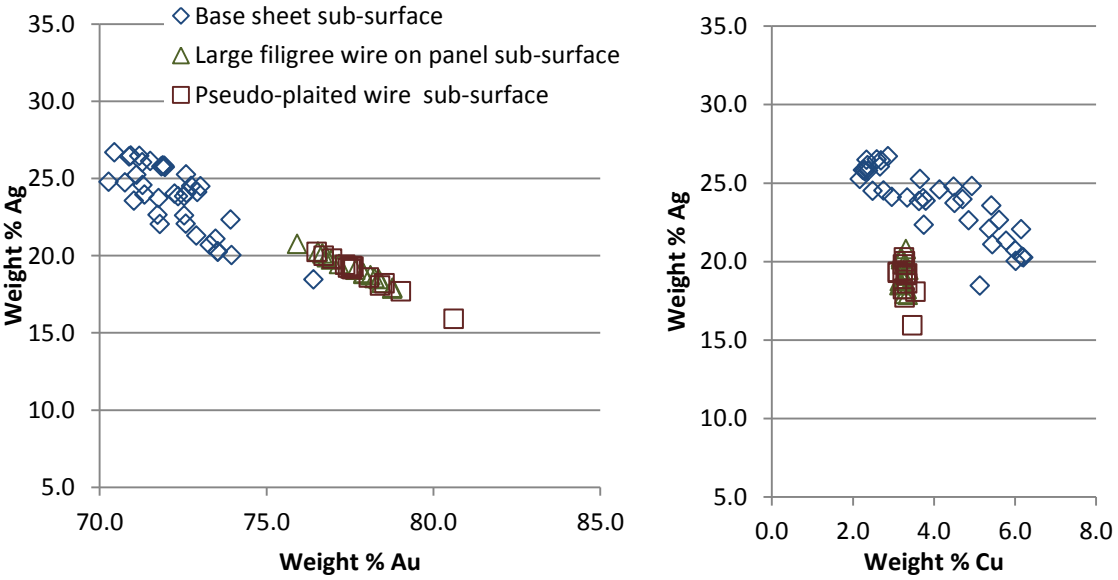
SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis of the base sheet revealed a *c.*13.4 wt% loss of silver from the surface (a difference of *c.*56% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. The filigree and pseudo-plaited wire also showed depletion of silver at the surface (beaded wire *c.*3.5 wt% and pseudo-plaited wire *c.*4.2 wt%) with a difference of between 19-23% from the surface to core. Only copper and small amounts of silver are normally lost from the surface during burial.

Comparison of the sub-surface compositions of the components suggests that the beaded and pseudo-plaited wire may have been made using the same, or a similar, gold alloy. The base sheet on the other hand shows a distinct composition and the surface has most likely been deliberately treated to create a gold enriched surface.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed July 2013

Gold enrichment in Staffordshire Hoard K690: results of SEM-EDX analysis

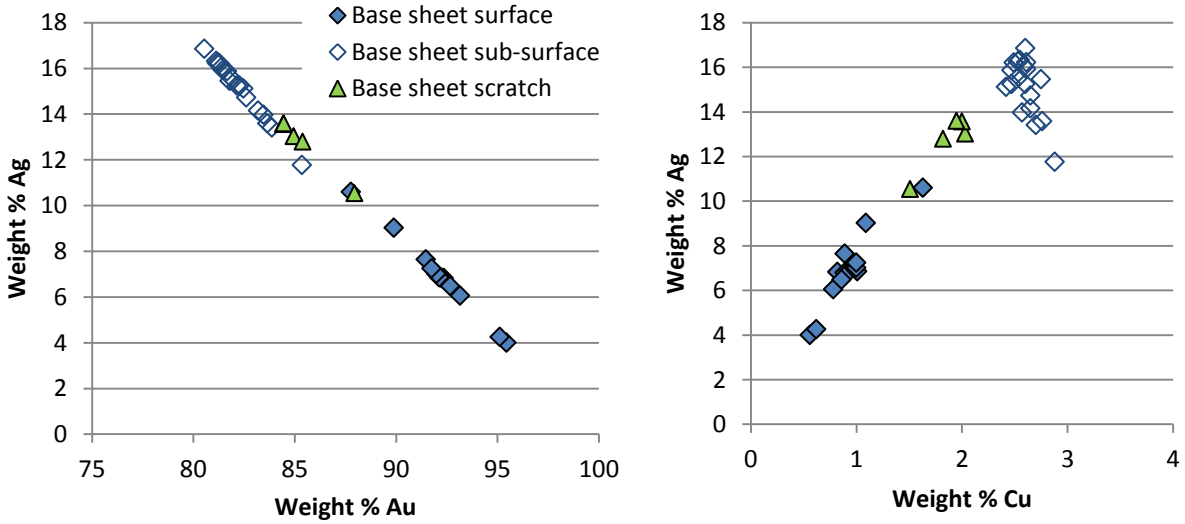
Object Type Hilt-ring
Date 620-650

Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the base of the hilt-ring which is part of a set of fittings from a seax handle.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	14	Average	92.2	6.9	0.9
		Standard Deviation	*1.88*	*1.65*	*0.25*
Scratch	5	Average	85.4	12.7	1.9
		Standard Deviation	*1.46*	*1.26*	*0.21*
Sub-surface	19	Average	82.2	15.2	2.6
		Standard Deviation	*1.21*	*1.28*	*0.11*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a surface composition of approximately 81-84 wt% gold, 14-17 wt% silver, the rest being copper. The analysis revealed a *c.*8.3 wt% loss of silver from the surface (a difference of *c.*54% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The surface of the scratch had a similar composition to the subsurface, but with a similar loss in copper to the other surface analyses, most likely due to corrosion, confirming that the treatment was carried out prior to burial.

Eleanor Blakelock
Analysed August 2013

Gold enrichment in Staffordshire Hoard K697: results of SEM-EDX analysis

Object Type Pommel
Date 620-650

Decoration

Filigree	✓	Glass	
Garnet		Other	

SEM-EDX analysis was undertaken on a range of components, including the filigree wire, the separate cap and the base sheet to which the wires and cap were attached.

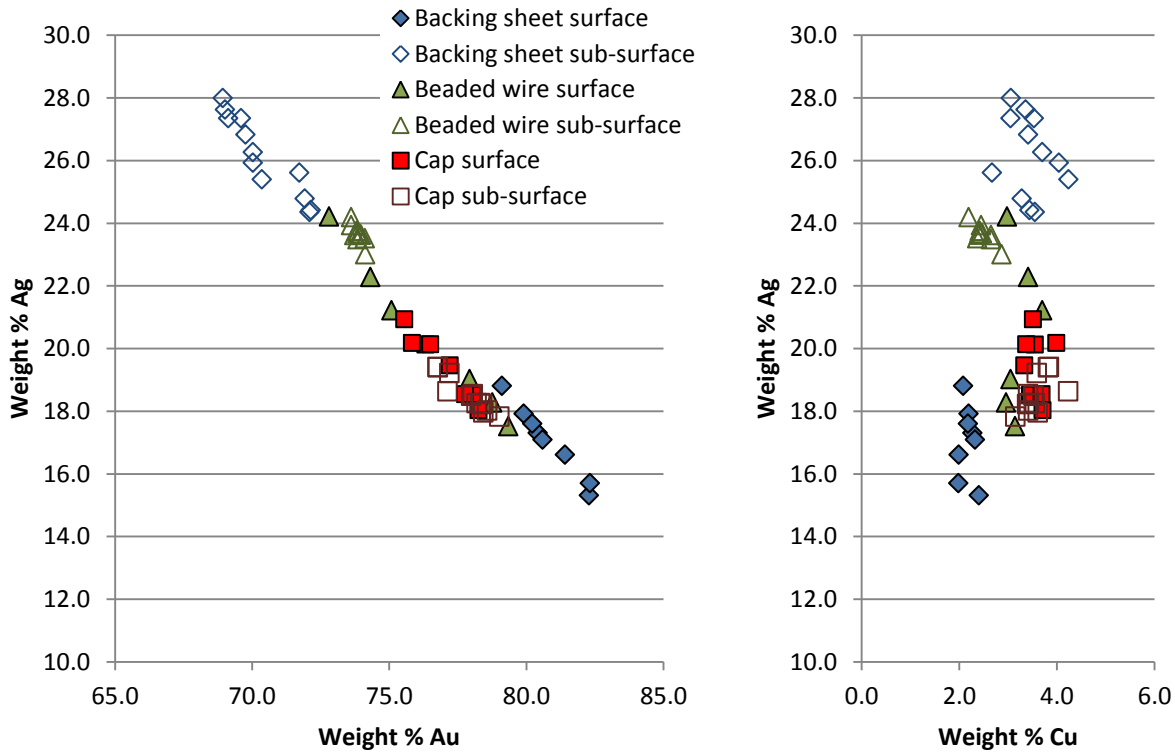
Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	80.8	17.0	2.2
		Standard Deviation	1.14	1.15	0.15
Base sheet sub-surface	12	Average	70.4	26.2	3.4
		Standard Deviation	1.24	1.28	0.43
Top of cap surface	8	Average	76.9	19.5	3.6
		Standard Deviation	1.03	1.03	0.22
Top of cap sub-surface	12	Average	77.9	18.5	3.6
		Standard Deviation	0.75	0.55	0.28
Wire surface	6	Average	76.4	20.4	3.2
		Standard Deviation	2.67	2.59	0.29
Wire sub-surface	10	Average	73.8	23.7	2.5
		Standard Deviation	0.18	0.31	0.19

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

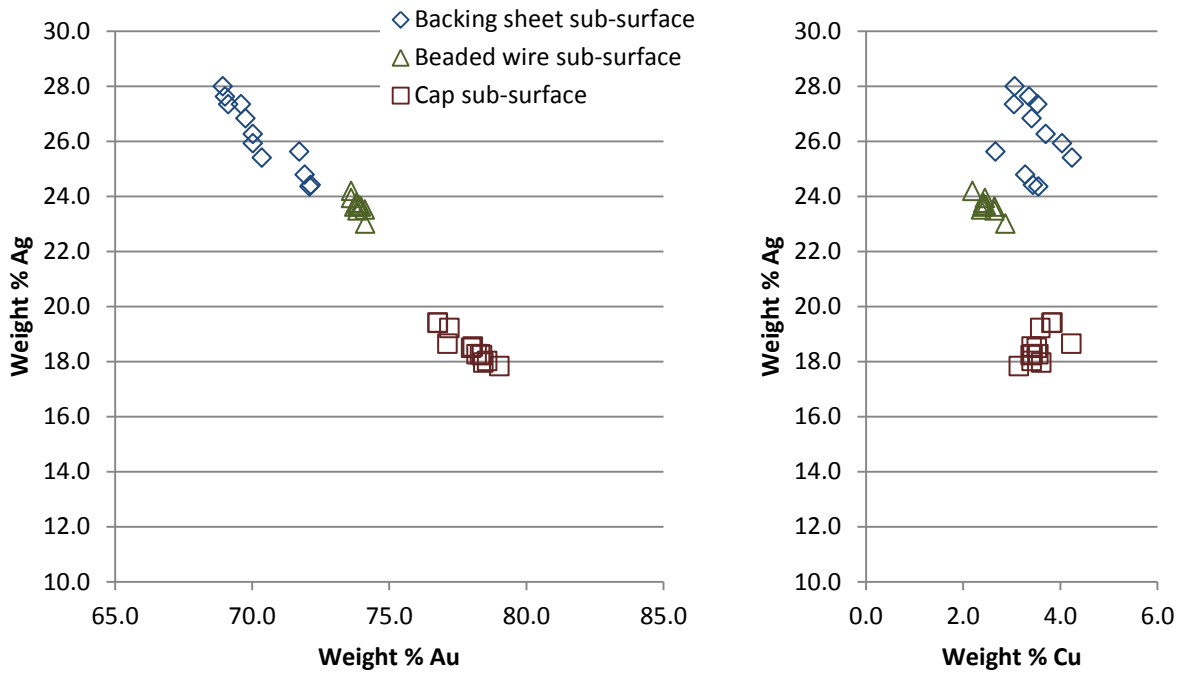
The analysis revealed a *c.*9.1 wt% loss of silver from the surface of the base sheet (a difference of *c.*35% from surface to core), which is indicative of treatment to deliberately enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The analysis of the beaded wire revealed a *c.*3.2 wt% loss of silver from the surface of the base sheet (a difference of *c.*14% from surface to core), suggesting treatment to deliberately enhance the gold colour of the metal. The cap had no loss of copper and an increase of silver at the surface which is most likely from close contact to corroding silver objects in the burial environment or contamination from the solder used.

Comparison of the sub-surface compositions revealed that each component was made of a distinct gold alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K699: results of SEM-EDX analysis

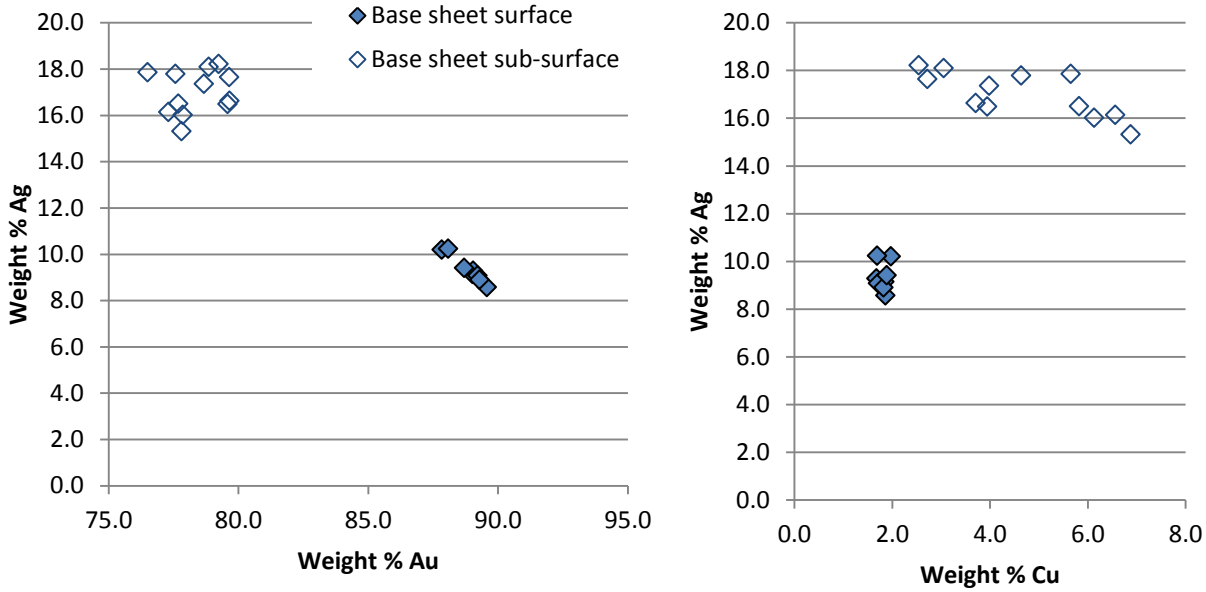
Object Type Hilt collar
Date 620-630

Decoration				
	Filigree	✓	Glass	
	Garnet		Other	

SEM-EDX analysis was undertaken on the gold sheet to which the wire was attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	88.8	9.4	1.8
		Standard Deviation	*0.60*	*0.59*	*0.10*
Sub-surface	12	Average	78.4	17.0	4.6
		Standard Deviation	*1.05*	*0.94*	*1.53*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a surface composition of approximately 77-80 wt% gold, 16-18 wt% silver, the rest being copper. The analysis revealed a *c.*7.6 wt% loss of silver from the surface (a difference of *c.*45% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K714: results of SEM-EDX analysis

Object Type Pommel
Date 610-630

Decoration

Filigree	✓	Glass	
Garnet		Other	

SEM-EDX analysis was undertaken on a number of components, including the sheet that was used as a base for the filigree, the large filigree wire and small filigree wire.

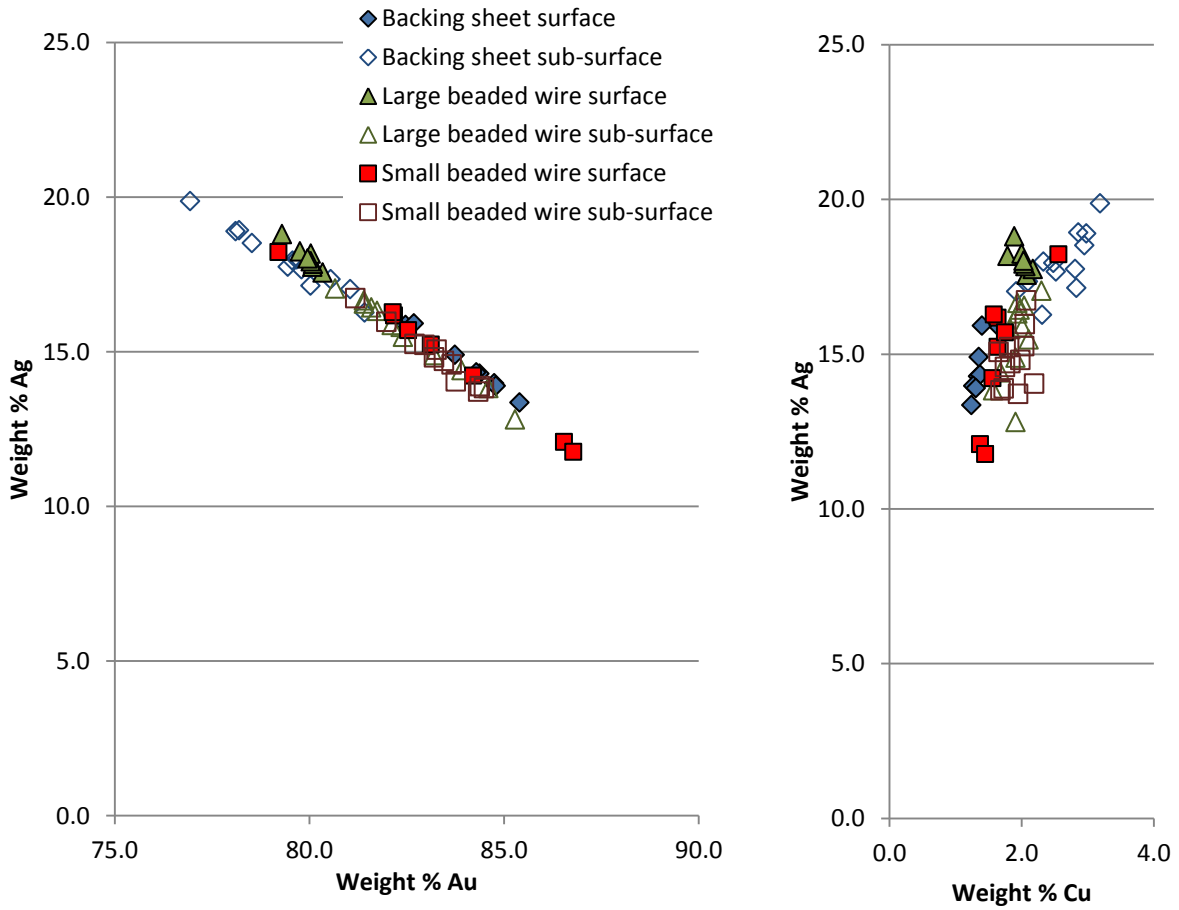
Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	84.0	14.6	1.4
		Standard Deviation	1.03	0.93	0.13
Base sheet sub-surface	12	Average	79.5	17.9	2.6
		Standard Deviation	1.30	0.99	0.39
Large filigree wire surface	8	Average	80.0	18.0	2.0
		Standard Deviation	0.31	0.38	0.12
Large filigree wire sub-surface	12	Average	82.6	15.5	1.9
		Standard Deviation	1.41	1.29	0.19
Small filigree wire surface	8	Average	83.3	15.0	1.7
		Standard Deviation	2.49	2.19	0.37
Small filigree wire sub-surface	12	Average	83.3	14.8	1.9
		Standard Deviation	0.99	0.91	0.18

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

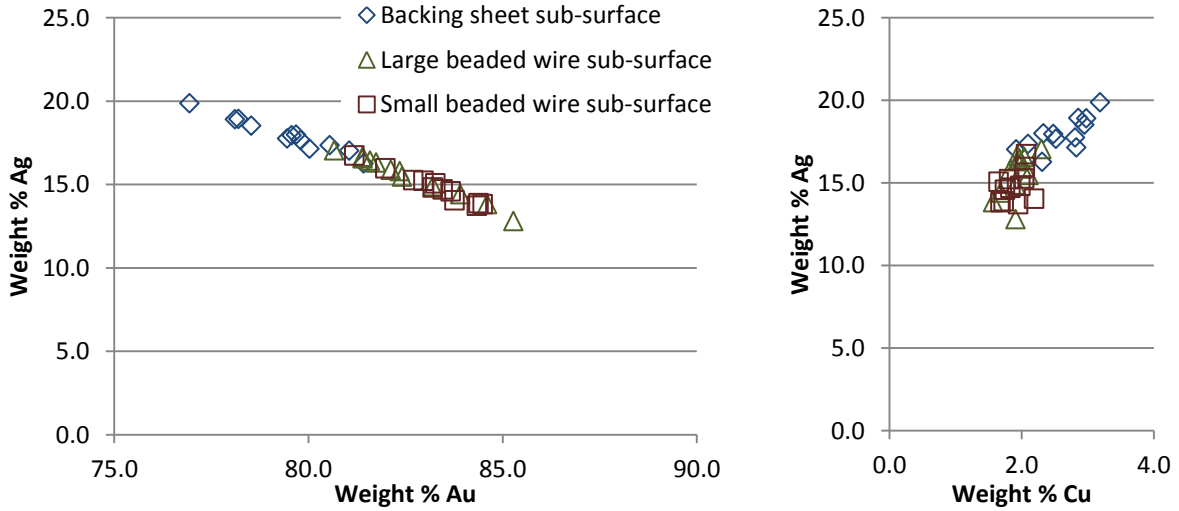
SEM-EDX analysis of the sub-surface of the base sheet indicated a composition of approximately 77-81 wt% gold, 17-19 wt% silver, the rest being copper. The analysis revealed a *c.*3.4 wt% loss of silver from the surface (a difference of *c.*19% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The analysis revealed no, or a small, loss of copper at the surface of the wires, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. There was also a small increase in silver at the surface which is most likely from close contact to corroding silver objects in the burial environment.

Comparison of the sub-surface compositions suggests that the beaded wires were probably made from the same gold alloy. The backing sheet however was more distinctive but was still a similar gold alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K796: results of SEM-EDX analysis

Object Type Mount
Date 625-650

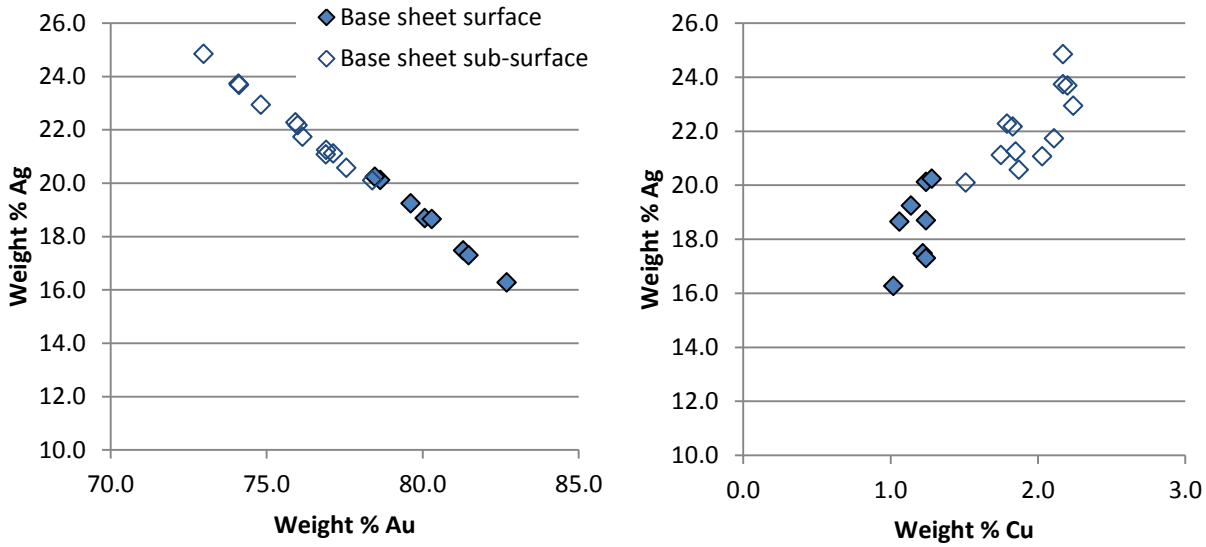
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the base sheet on the back of the mount.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	80.3	18.5	1.2
		Standard Deviation	*1.45*	*1.40*	*0.10*
Sub-surface	12	Average	75.9	22.1	2.0
		Standard Deviation	*1.61*	*1.44*	*0.23*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a surface composition of approximately 74-78 wt% gold, 20-24 wt% silver, the rest being copper. The analysis revealed a *c.*3.6 wt% loss of silver from the surface (a difference of *c.*16% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K811: results of SEM-EDX analysis

Object Type Hilt-collar
Date 620-650

Decoration

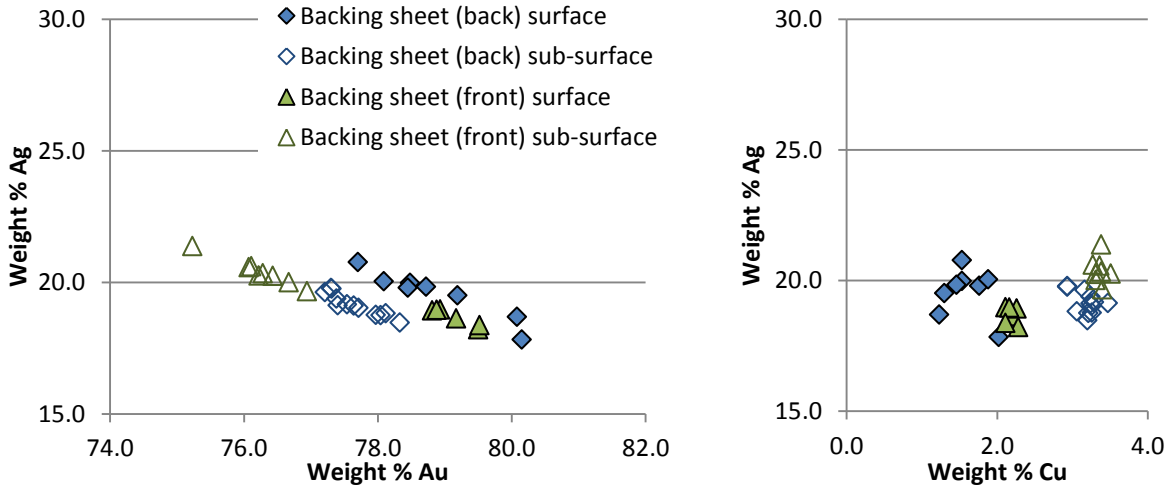
Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the back and front of the base sheet to which the filigree wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Backing sheet (back) Surface	6	Average	78.8	19.6	1.6
		Standard Deviation	*0.89*	*0.91*	*0.28*
Backing sheet (back) Sub-surface	12	Average	77.6	19.2	3.2
		Standard Deviation	*0.37*	*0.42*	*0.15*
Backing sheet (front) Surface	6	Average	79.1	18.7	2.2
		Standard Deviation	*0.31*	*0.33*	*0.07*
Backing sheet (front) Surface	8	Average	76.2	20.4	3.4
		Standard Deviation	*0.50*	*0.50*	*0.07*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

Analysis of the front revealed a *c.*1.7 wt% loss of silver from the surface, and a difference of less than 10% from surface to core, which could be indicative of corrosion that can occur during burial which results in natural surface enrichment but could also be the result of some deliberate surface treatment. The analysis of the back of the hilt collar revealed a small loss of copper at the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. There was a small increase in silver at the surface which may be due to the solder or could have occurred from close contact to corroding silver objects in the burial environment.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed September 2013

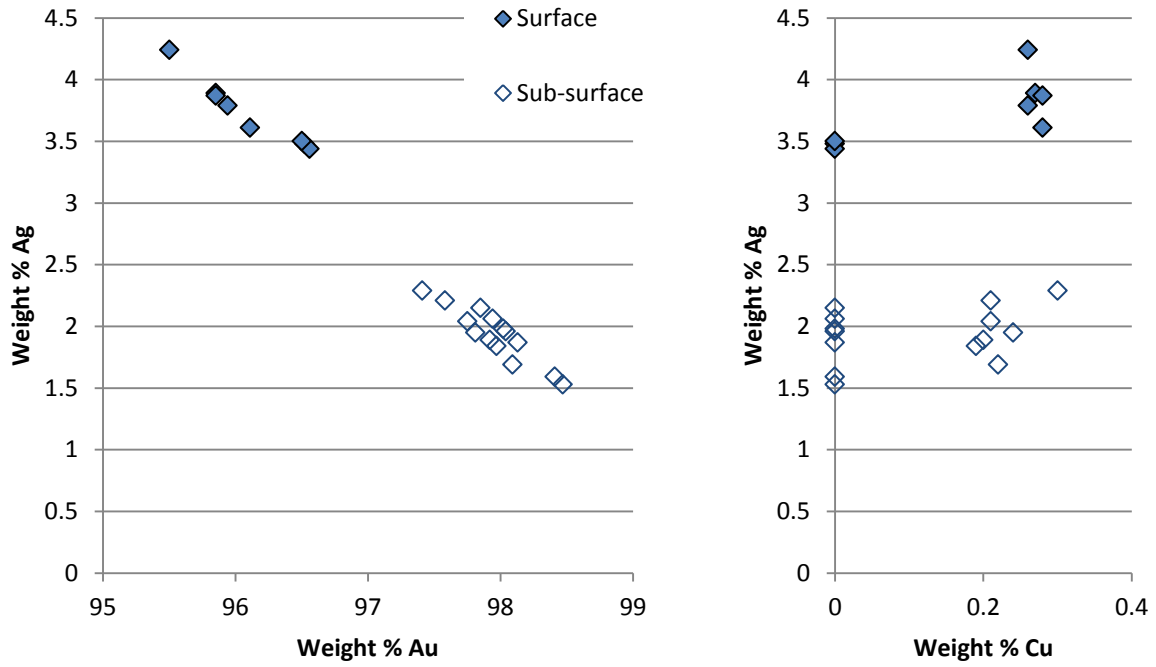
Gold enrichment in Staffordshire Hoard K816: results of SEM-EDX analysis

Object Type Serpent mount
Date 620-650
Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the body of the serpent.

Area analysed	No. of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	96.1	3.7	0.2
		Standard Deviation	0.39	0.27	0.14
Sub-surface	14	Average	98.0	1.9	0.1
		Standard Deviation	0.28	0.22	0.12

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 97.5-98.5 wt% gold, 1.5-2.5 wt% silver, the rest being copper. There was a small increase in silver at the surface which is most likely from close contact to corroding silver objects in the burial environment.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K833: results of SEM-EDX analysis

Object Type Hilt-mount
Date 600-650

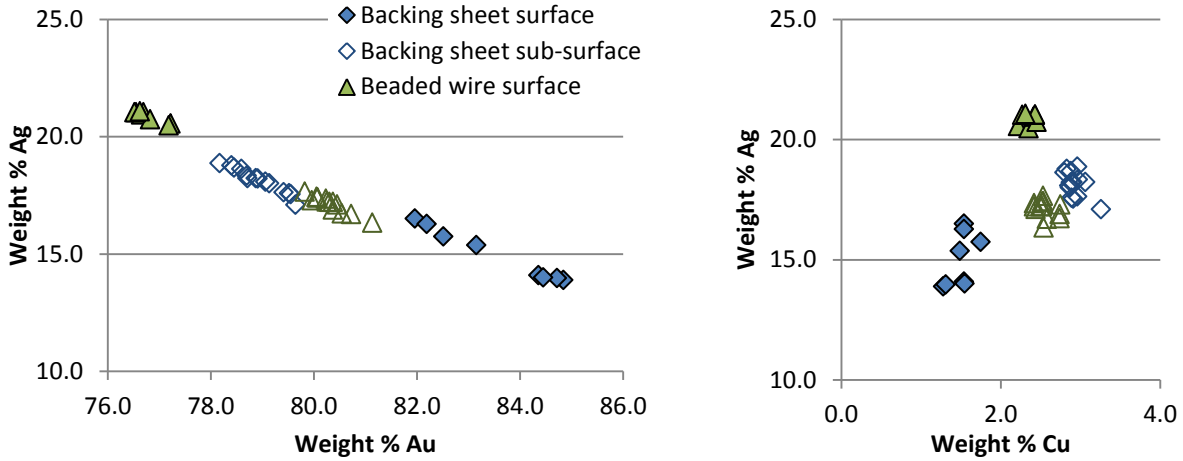
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on a filigree wire and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	83.5	15.0	1.5
		Standard Deviation	1.20	1.11	0.15
Base sheet sub-surface	14	Average	79.0	18.1	2.9
		Standard Deviation	0.47	0.52	0.12
Filigree wire surface	8	Average	76.7	20.9	2.4
		Standard Deviation	0.27	0.24	0.09
Filigree wire sub-surface	14	Average	80.3	17.1	2.6
		Standard Deviation	0.34	0.36	0.11

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Comparison of the sub-surface compositions of each component suggests that both components may have been made from a similar gold alloy. The analysis revealed a *c.*3.2 wt% loss of silver from the surface of the base sheet (a difference of *c.*17% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the wire revealed a small loss of copper at the surface, most likely indicative of corrosion that results in natural surface enrichment in gold that can occur during burial. There was an increase in silver at the surface of the wire which is most likely from close contact to corroding silver objects in the burial environment.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K843: results of SEM-EDX analysis

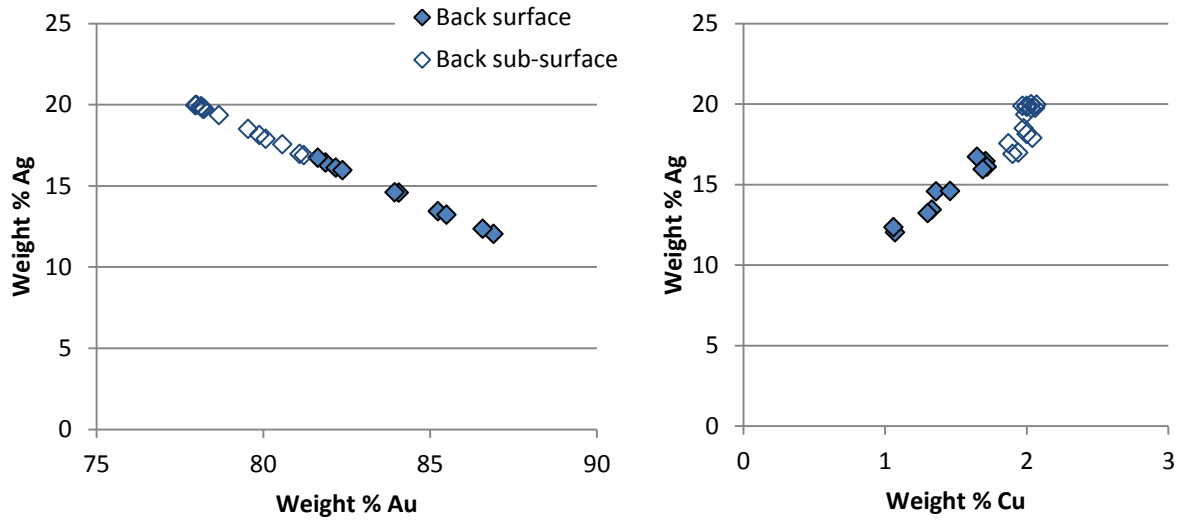
Object Type Mount
Date 625-650

Decoration				
	Filigree	✓	Glass	
	Garnet	✓	Other	

SEM-EDX analysis was undertaken on the base sheet on the back of the mount.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	10	Average	84.1	14.5	1.4
		Standard Deviation	*1.97*	*1.73*	*0.25*
Sub-surface	14	Average	79.1	18.9	2.0
		Standard Deviation	*1.22*	*1.18*	*0.06*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a surface composition of approximately 78-81 wt% gold, 17-20 wt% silver, the rest being copper. The analysis revealed a *c.*4.3 wt% loss of silver from the surface (a difference of *c.*23% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K855: results of SEM-EDX analysis

Object Type Hilt-collar
Date 610-630

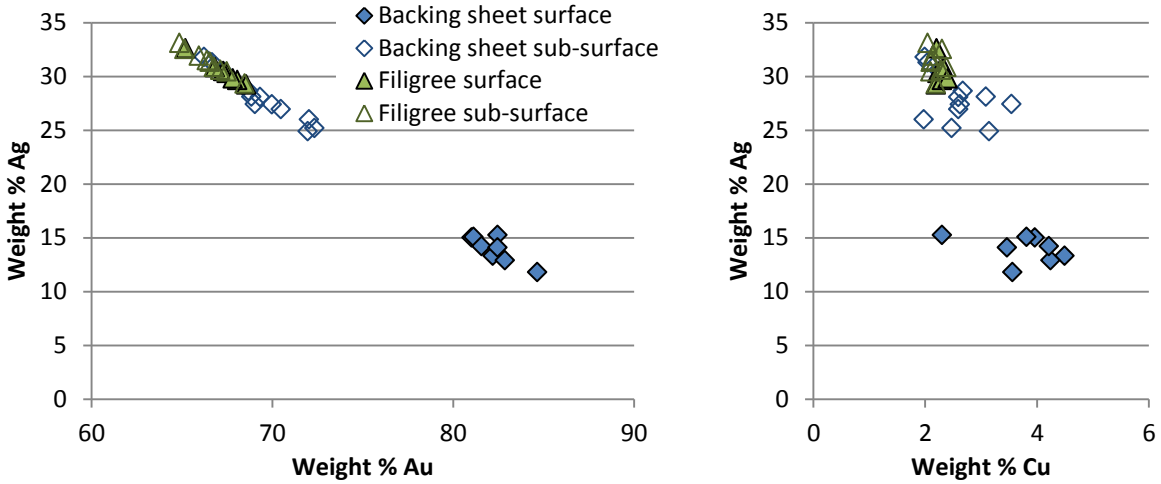
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the filigree wires and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Backing sheet surface	8	Average	82.2	14.0	3.8
		Standard Deviation	*1.16*	*1.21*	*0.68*
Backing sheet sub-surface	12	Average	69.4	28.0	2.6
		Standard Deviation	*2.06*	*2.23*	*0.49*
Filigree wire surface	7	Average	67.3	30.4	2.3
		Standard Deviation	*1.09*	*1.11*	*0.08*
Filigree wire sub-surface	9	Average	66.5	31.3	2.2
		Standard Deviation	*1.13*	*1.15*	*0.12*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The sub-surface composition of both components is similar suggesting a similar gold alloy was used. The analysis revealed a *c.*14.1 wt% loss of silver from the surface of the base sheet (a difference of *c.*50% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the wire revealed a loss of copper and only a small loss of silver from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Eleanor Blakelock
Analysed December 2013

Gold enrichment in Staffordshire Hoard K865: results of SEM-EDX analysis

Object Type Mount
Date 630-670

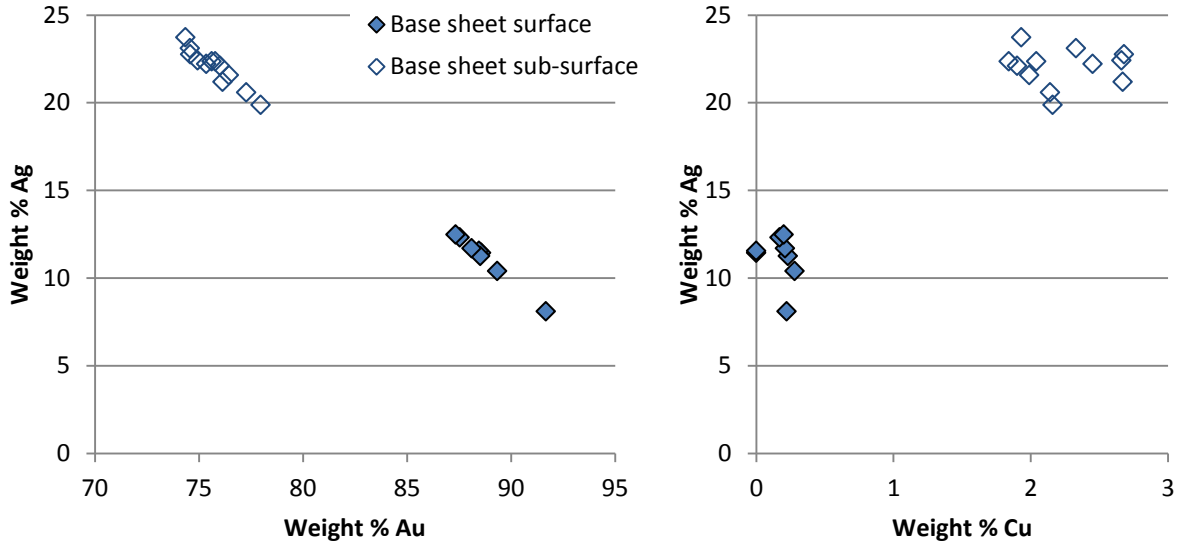
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the base sheet on the back of the mount.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	88.6	11.2	0.2
		Standard Deviation	*1.36*	*1.39*	*0.11*
Sub-surface	12	Average	75.8	22.0	2.2
		Standard Deviation	*1.11*	*1.07*	*0.32*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a surface composition of approximately 74-77 wt% gold, 21-23 wt% silver, the rest being copper. The analysis revealed a *c.*10.8 wt% loss of silver from the surface (a difference of *c.*49% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K878: results of SEM-EDX analysis

Object Type Mount
Date 600-635

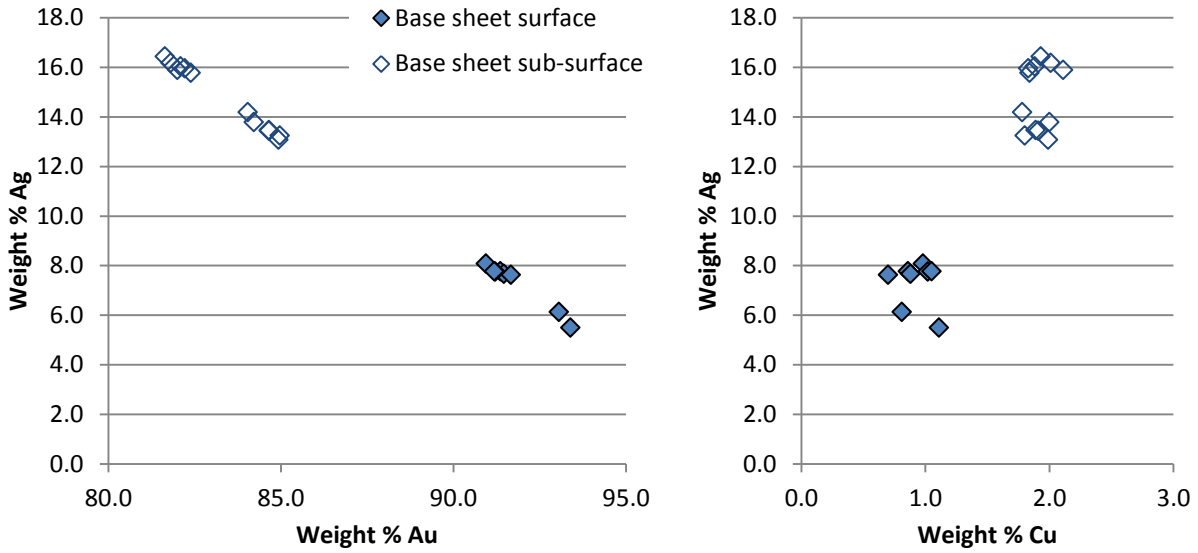
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the gold sheet to which the filigree was attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	91.8	7.3	0.9
		Standard Deviation	*0.92*	*0.93*	*0.14*
Sub-surface	12	Average	83.3	14.8	1.9
		Standard Deviation	*1.37*	*1.35*	*0.10*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a surface composition of approximately 82-85 wt% gold, 13-16 wt% silver, the rest being copper. The analysis revealed a *c.*7.5 wt% loss of silver from the surface (a difference of *c.*51% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K920: results of SEM-EDX analysis

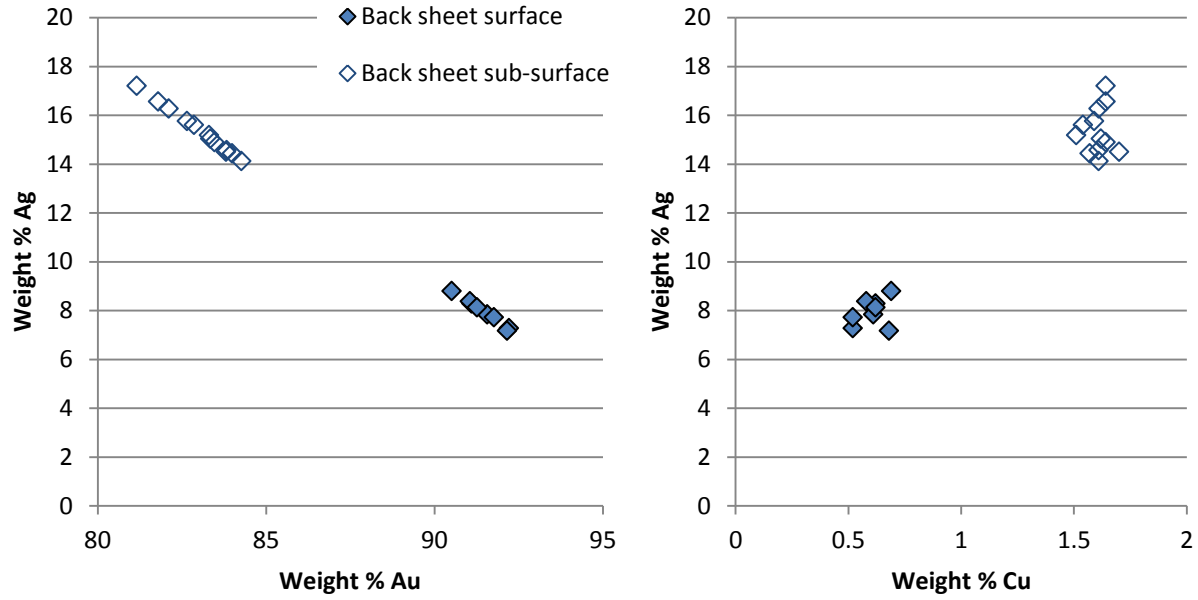
Object Type Mount
Date 600-650

Decoration Filigree ✓ Glass
Garnet Other

SEM-EDX analysis was undertaken on the base sheet on the back of the mount.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	91.5	7.9	0.6
		Standard Deviation	*0.58*	*0.55*	*0.06*
Sub-surface	12	Average	83.1	15.3	1.6
		Standard Deviation	*0.96*	*0.95*	*0.05*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a surface composition of approximately 82-84 wt% gold, 14-17 wt% silver, the rest being copper. The analysis revealed a *c.*7.4 wt% loss of silver from the surface (a difference of *c.*48% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K992: results of SEM-EDX analysis

Object Type Hilt-mount
Date 600-650

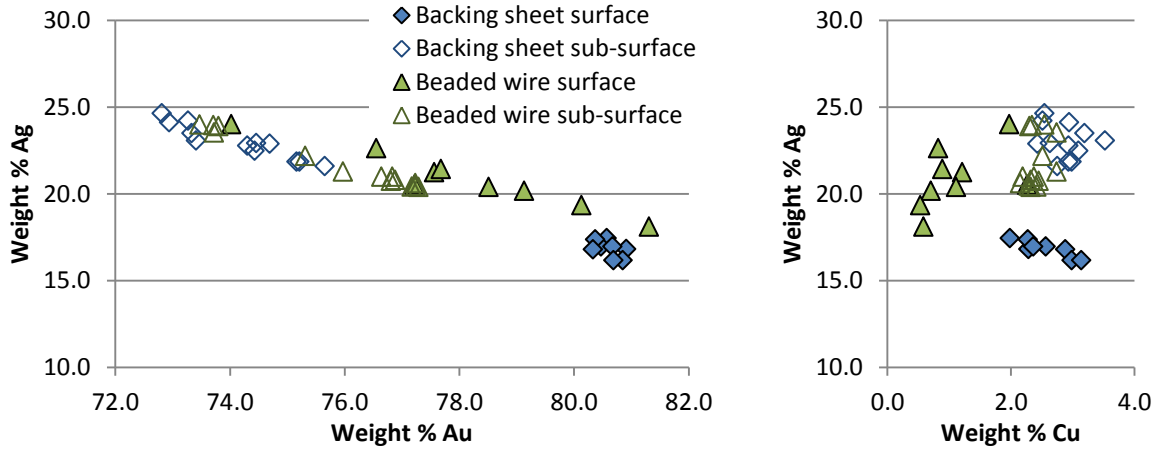
Decoration

Filigree	✓	Glass	
Garnet		Other	

SEM-EDX analysis was undertaken on the filigree wires and the base sheet to which the wires were attached.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Backing sheet surface	8	Average	80.6	16.8	2.6
		Standard Deviation	*0.21*	*0.47*	*0.41*
Backing sheet sub-surface	12	Average	74.1	23.0	2.9
		Standard Deviation	*0.96*	*0.98*	*0.32*
Filigree wire surface	9	Average	77.9	20.9	1.2
		Standard Deviation	*2.40*	*1.80*	*0.71*
Filigree wire sub-surface	14	Average	76.0	21.6	2.4
		Standard Deviation	*1.56*	*1.49*	*0.18*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The sub-surface composition of both components is similar suggesting the same, or a similar, gold alloy was used. The analysis revealed a *c.*6.2 wt% loss of silver from the surface of the base sheet (a difference of *c.*50% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The analysis of the wire revealed a loss of copper and only a small loss of silver from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Eleanor Blakelock
Analysed January 2013

Gold enrichment in Staffordshire Hoard K1004: results of SEM-EDX analysis

Object Type Pommel
Date 610-630

Decoration

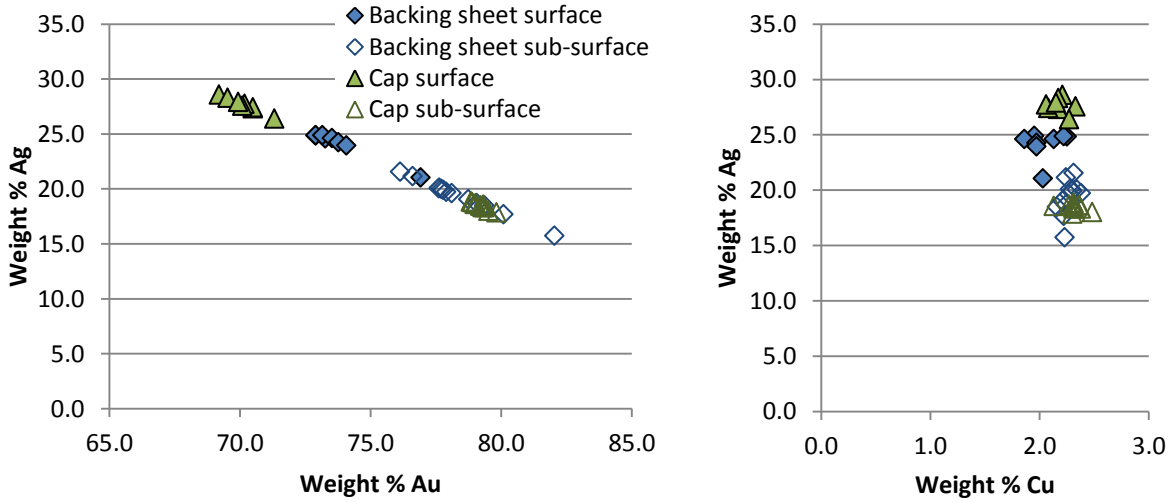
Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on a the base sheet and the cap.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	73.9	24.1	2.0
		Standard Deviation	1.32	1.29	0.14
Base sheet sub-surface	13	Average	78.3	19.4	2.3
		Standard Deviation	1.54	1.51	0.06
Top of cap surface	8	Average	70.1	27.7	2.2
		Standard Deviation	0.65	0.67	0.09
Top of cap sub-surface	12	Average	79.2	18.5	2.3
		Standard Deviation	0.28	0.30	0.08

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

Comparison of the sub-surface compositions of both components suggests that they were probably made from the same, or a similar, gold alloy. The analysis revealed a small loss of copper at the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment in gold. There was a small increase in silver at the surface which is most likely from close contact to corroding silver objects in the burial environment.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K1048: results of SEM-EDX analysis

Object Type Hilt plate
Date 600-650

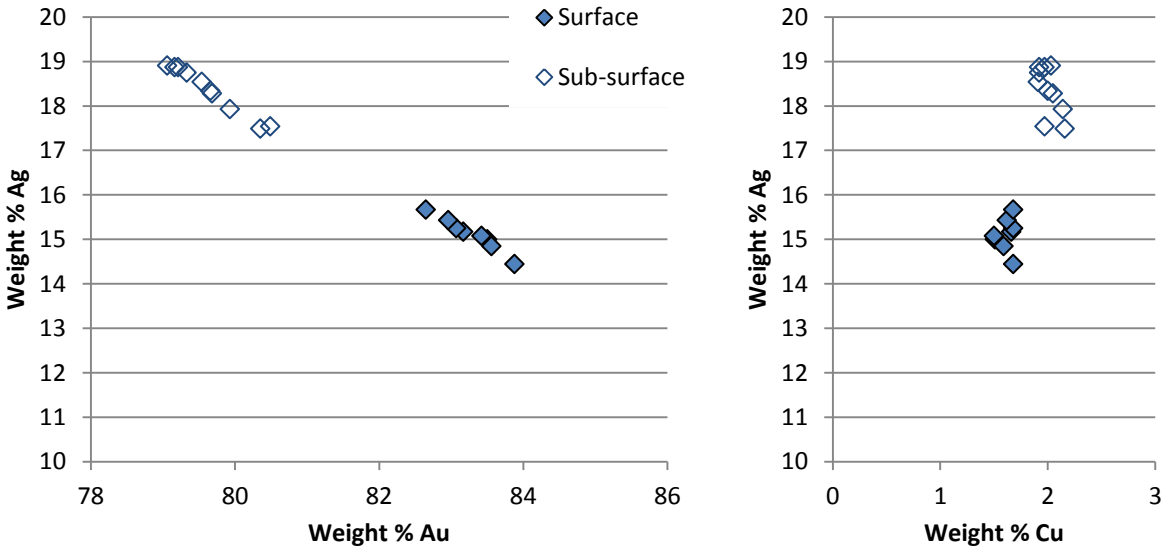
Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on the base sheet on the front of the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	83.3	15.1	1.6
		Standard Deviation	*0.39*	*0.37*	*0.08*
Sub-surface	10	Average	79.6	18.4	2.0
		Standard Deviation	*0.49*	*0.54*	*0.09*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a surface composition of approximately 79-81 wt% gold, 17-19 wt% silver, the rest being copper. The analysis revealed a *c.*3.2 wt% loss of silver from the surface (a difference of *c.*18% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed January 2013

Gold enrichment in Staffordshire Hoard K1055: results of SEM-EDX analysis

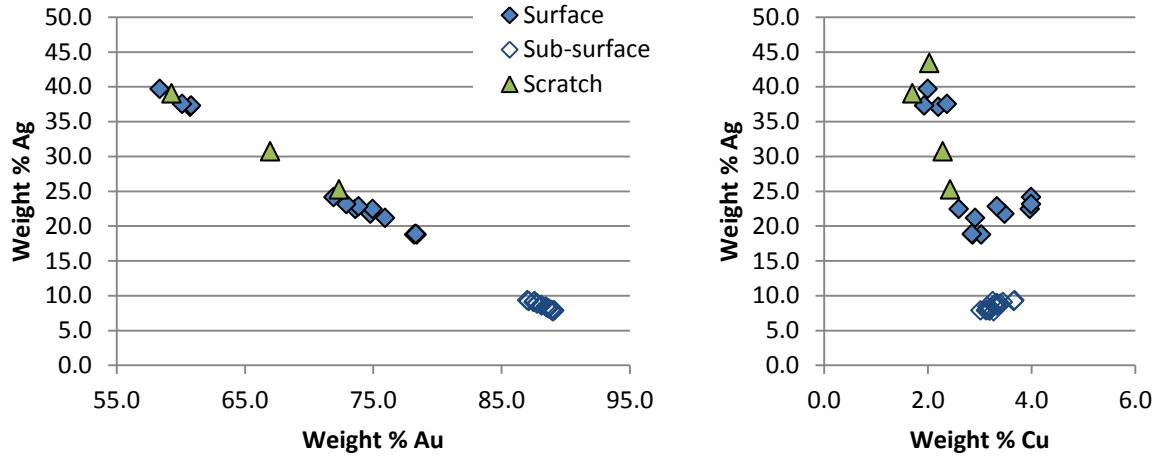
Object Type Cylinder
Date 630-670

Decoration Filigree ☐ Glass ☐
Garnet ☑ Other ☐

SEM-EDX analysis was undertaken on the side of the cylinder.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	14	Average	75.3	21.4	3.3
		Standard Deviation	*2.36*	*1.98*	*0.53*
Scratch	5	Average	63.3	34.6	2.1
		Standard Deviation	*7.91*	*8.16*	*0.32*
Sub-surface	19	Average	88.2	8.5	3.3
		Standard Deviation	*0.71*	*0.56*	*0.18*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a surface composition of approximately 87-89 wt% gold, 8-9 wt% silver, the rest being copper. The analysis revealed no loss of copper at the surface. There was a large (*c.*12.9 wt%) increase in silver at the surface which may have come from the solder used or re-deposited silver from corroding silver alloy objects. The surface of the scratch also had an increased silver content, suggesting that the silver present on the surface most likely occurred during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K1072: results of SEM-EDX analysis

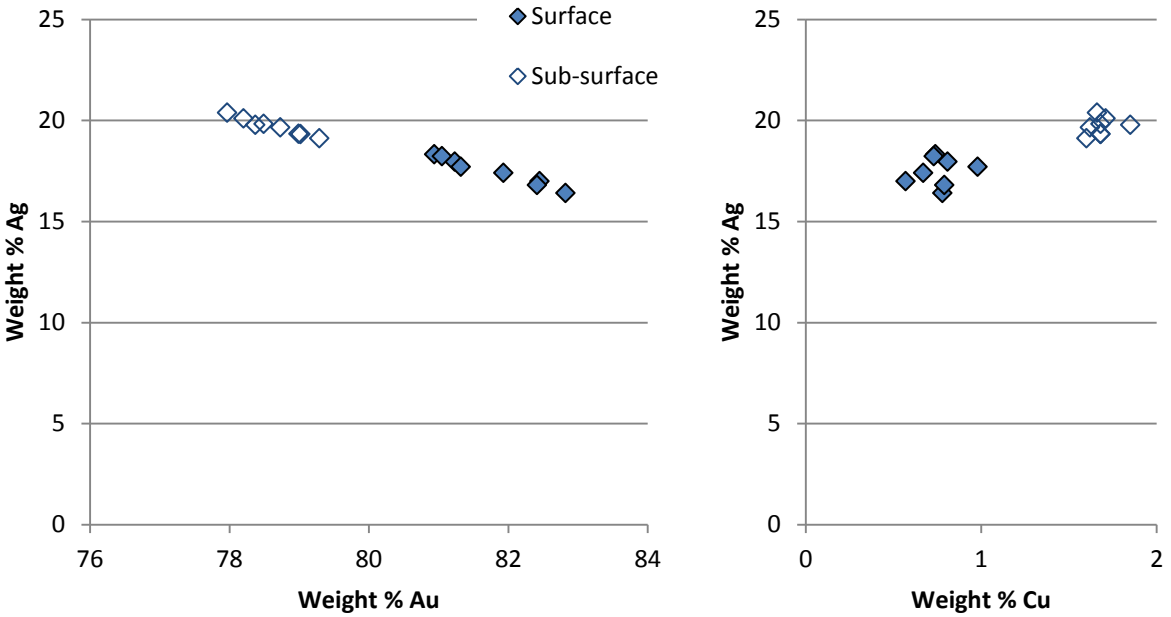
Object Type Hilt plate
Date 600-650

Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the base sheet on the back of the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	81.7	17.5	0.8
		Standard Deviation	*0.73*	*0.70*	*0.12*
Sub-surface	8	Average	78.6	19.7	1.7
		Standard Deviation	*0.45*	*0.42*	*0.08*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a surface composition of approximately 78-79 wt% gold, 19-21 wt% silver, the rest being copper. The analysis revealed a *c.*2.1 wt% loss of silver from the surface (a difference of *c.*11% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed January 2013

Gold enrichment in Staffordshire Hoard K1073: results of SEM-EDX analysis

Object Type Pommel
Date 620-650

Decoration

Filigree	✓	Glass		
Garnet		Other		

SEM-EDX analysis was undertaken on a number of components, including the sheet that was used as a base for the filigree, the large filigree wire, small filigree wire and the cap.

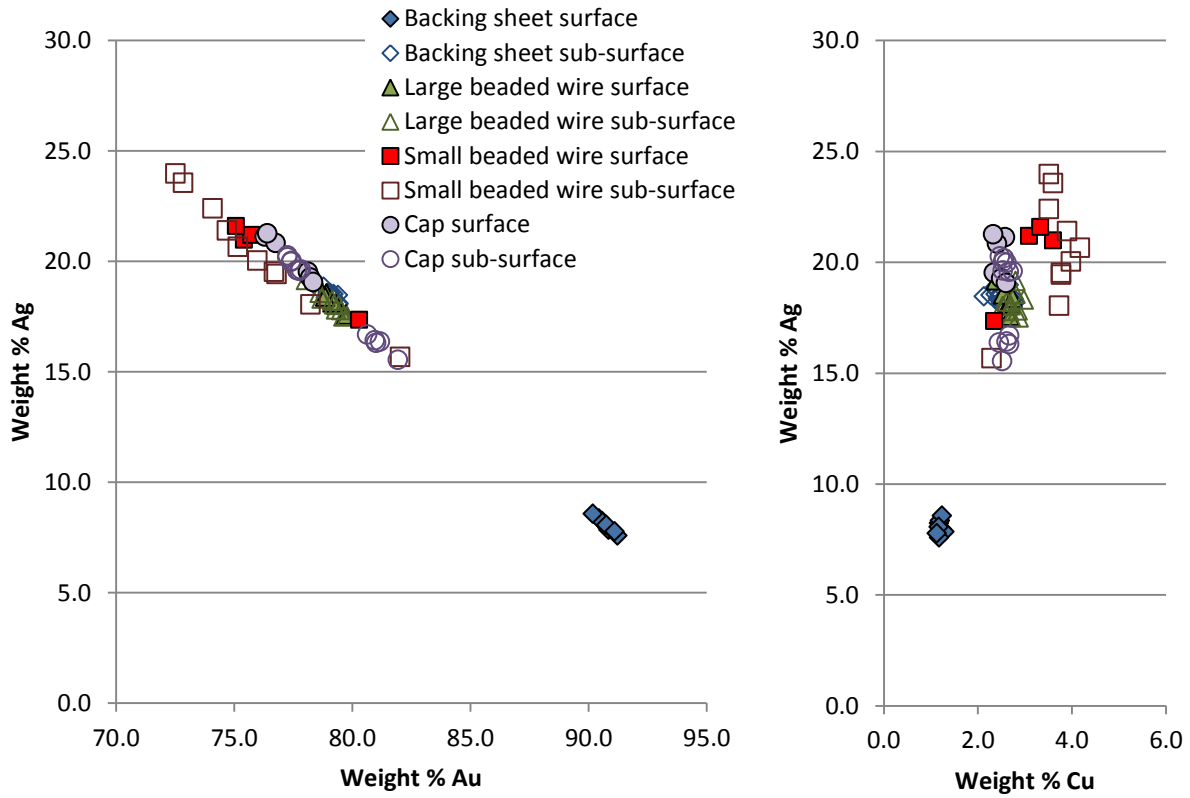
Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	90.7	8.1	1.2
		Standard Deviation	*0.34*	*0.33*	*0.05*
Base sheet sub-surface	12	Average	79.0	18.5	2.5
		Standard Deviation	*0.30*	*0.28*	*0.19*
Large filigree wire surface	6	Average	79.1	18.3	2.6
		Standard Deviation	*0.45*	*0.54*	*0.13*
Large filigree wire sub-surface	10	Average	79.1	18.1	2.8
		Standard Deviation	*0.54*	*0.50*	*0.13*
Small filigree wire surface	4	Average	76.6	20.3	3.1
		Standard Deviation	*2.46*	*1.97*	*0.54*
Small filigree wire sub-surface	10	Average	75.9	20.5	3.6
		Standard Deviation	*2.80*	*2.53*	*0.51*
Cap surface	6	Average	77.3	20.2	2.5
		Standard Deviation	*0.97*	*1.00*	*0.12*
Cap sub-surface	12	Average	79.0	18.4	2.6
		Standard Deviation	*1.90*	*1.90*	*0.09*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

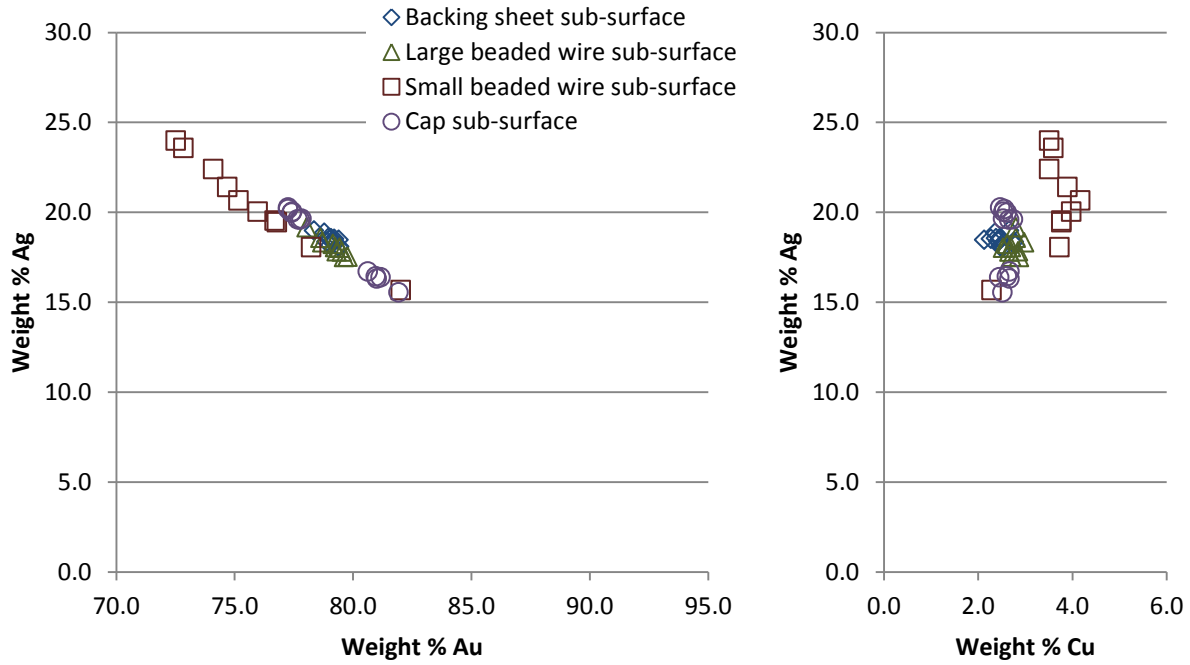
SEM-EDX analysis of the sub-surface of the base sheet indicated a composition of approximately 78-80 wt% gold, 18-19 wt% silver, the rest being copper. The analysis revealed a *c.*10.4 wt% loss of silver from the surface (a difference of *c.*56% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The analysis revealed a small loss of copper at the surface of the wires and cap, most likely indicative of corrosion which results in natural surface enrichment in gold that can occur during burial. There was a small increase in silver at the surface of which is either due to contamination from the solder or from close contact to corroding silver objects in the burial environment.

Comparison of the sub-surface compositions of each component suggests that the majority were probably made from the same, or a similar, gold alloy. The only exception was the small beaded wire which had a higher copper and silver content.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K1118: results of SEM-EDX analysis

Object Type Hilt-collar
Date 620-650

Decoration				
	Filigree	✓	Glass	
	Garnet		Other	

SEM-EDX analysis was undertaken on a number of components, including the sheet that was used as a base for the filigree, the large filigree wire and small filigree wire.

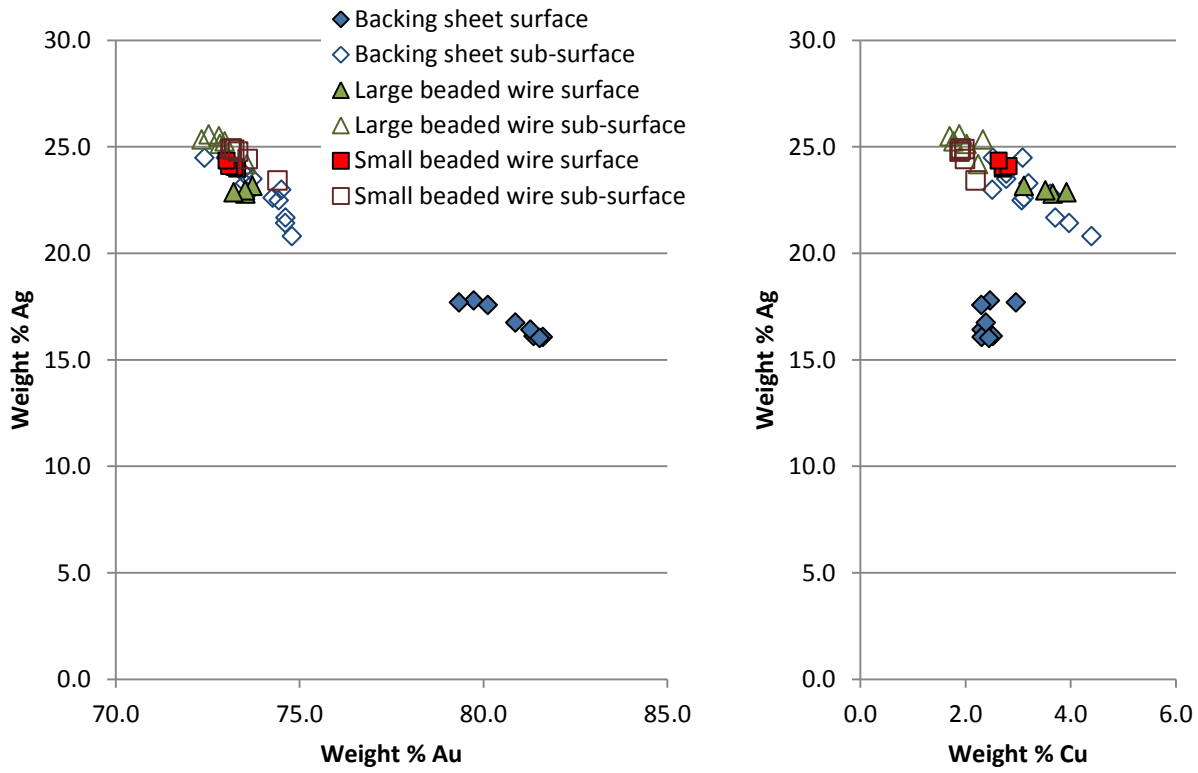
Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	80.7	16.8	2.5
		Standard Deviation	*0.88*	*0.77*	*0.22*
Base sheet sub-surface	12	Average	73.9	22.9	3.2
		Standard Deviation	*0.74*	*1.15*	*0.59*
Large filigree wire surface	4	Average	73.4	23.0	3.6
		Standard Deviation	*0.21*	*0.16*	*0.34*
Large filigree wire sub-surface	6	Average	72.8	25.2	2.0
		Standard Deviation	*0.42*	*0.51*	*0.25*
Small filigree wire surface	4	Average	73.2	24.1	2.7
		Standard Deviation	*0.13*	*0.16*	*0.08*
Small filigree wire sub-surface	6	Average	73.4	24.6	2.0
		Standard Deviation	*0.48*	*0.58*	*0.11*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

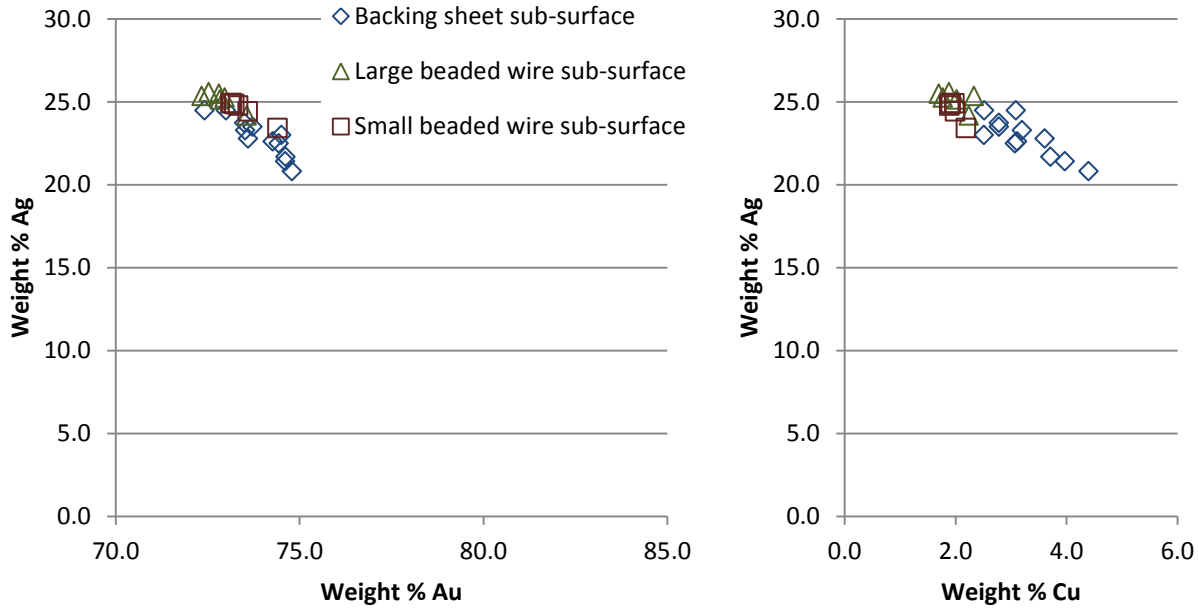
SEM-EDX analysis of the sub-surface of the base sheet indicated a composition of approximately 73-75 wt% gold, 21-24 wt% silver, the rest being copper. The analysis revealed a *c.*6.1 wt% loss of silver from the surface (a difference of *c.*26% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The analysis of the larger wire revealed a loss of *c.*2.2 wt% silver from the surface, and a difference of less than 10% from surface to core, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment but could also be the result of some deliberate surface treatment. The analysis also revealed a small loss of silver at the surface of the small wire, most likely indicative of corrosion which results in natural surface enrichment in gold that can occur during burial. There was also a small increase in copper at the surface of both wires, most likely due to contamination from solder.

Comparison of the sub-surface compositions suggests that all the components were probably made from the same, or a similar, gold alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Staffordshire Hoard K1136: results of SEM-EDX analysis

Object Type Hilt-plate
Date 600-650

Decoration

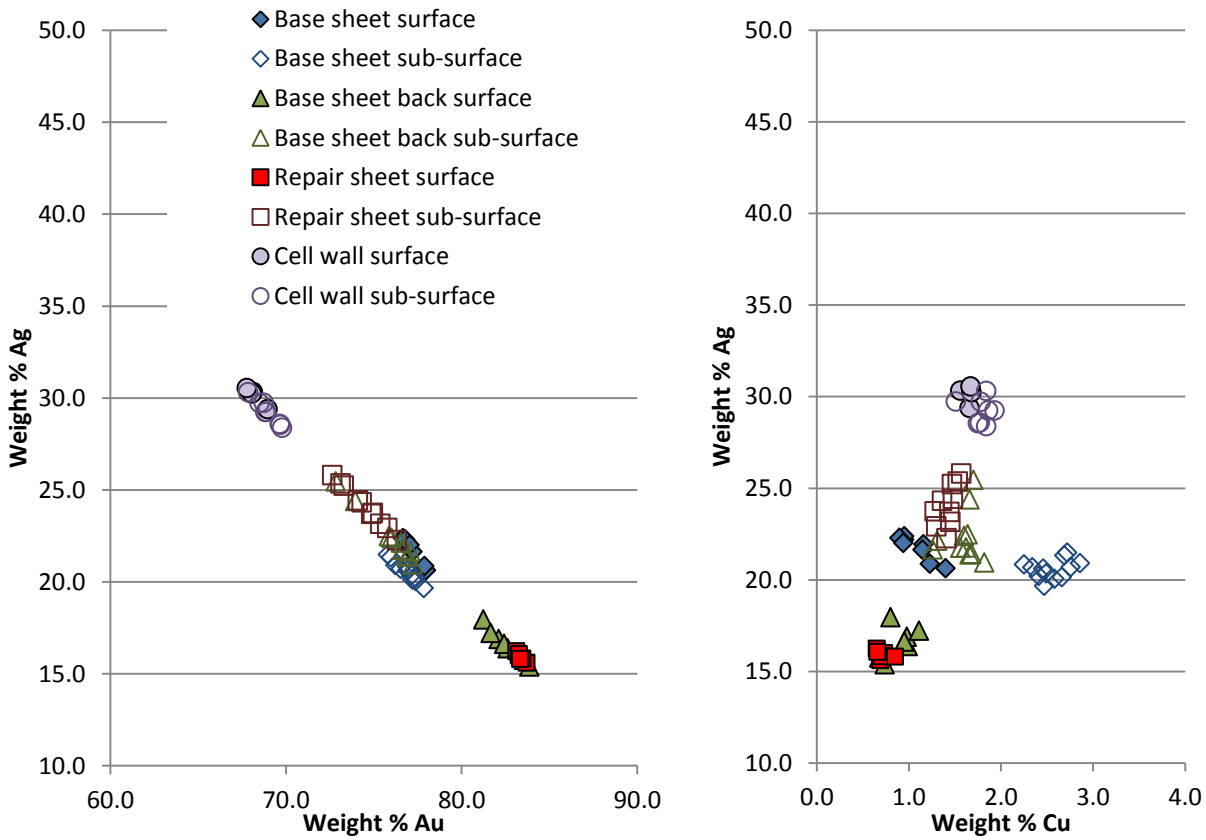
Filigree	✓	Glass		
Garnet	✓	Other		

SEM-EDX analysis was undertaken on the possible repair patch, both sides of the sheet and a cell wall.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	80.7	18.3	1.0
		Standard Deviation	*0.47*	*0.55*	*0.13*
Base sheet sub-surface	12	Average	76.8	20.6	2.6
		Standard Deviation	*0.61*	*0.53*	*0.18*
Base sheet back surface	7	Average	82.5	16.6	0.9
		Standard Deviation	*0.95*	*0.87*	*0.16*
Base sheet back sub-surface	11	Average	76.1	22.3	1.6
		Standard Deviation	*1.40*	*1.37*	*0.17*
Repair sheet surface	6	Average	83.4	15.9	0.7
		Standard Deviation	*0.20*	*0.22*	*0.07*
Repair sheet sub-surface	10	Average	74.5	24.1	1.4
		Standard Deviation	*1.20*	*1.14*	*0.09*
Cell wall surface	4	Average	68.3	30.1	1.6
		Standard Deviation	*0.50*	*0.51*	*0.06*
Cell wall subsurface	8	Average	69.0	29.2	1.8
		Standard Deviation	*0.67*	*0.68*	*0.13*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis of the front of the hilt-plate revealed a *c.*2.2 wt% loss of silver from the surface (a difference of *c.*11% from surface to core) and the back revealed a *c.*5.7 wt% loss of silver from the surface (a difference of *c.*26% from surface to core). This is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The sub-surface compositions of the two sides are similar suggesting they may be the same gold alloy that has been treated differently.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The analysis of the repair sheet on the hilt-plate revealed a *c.*8.2 wt% loss of silver from the surface (a difference of *c.*34% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. This meant that the composition closely matched that of the surface of the base sheet.

Analysis revealed a small loss of copper from the surface of the cell wall, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. The cell wall composition was significantly different from the sheets suggesting a different gold alloy was used.

Eleanor Blakelock
Analysed January and June 2013

Gold enrichment in Staffordshire Hoard K1137: results of SEM-EDX analysis

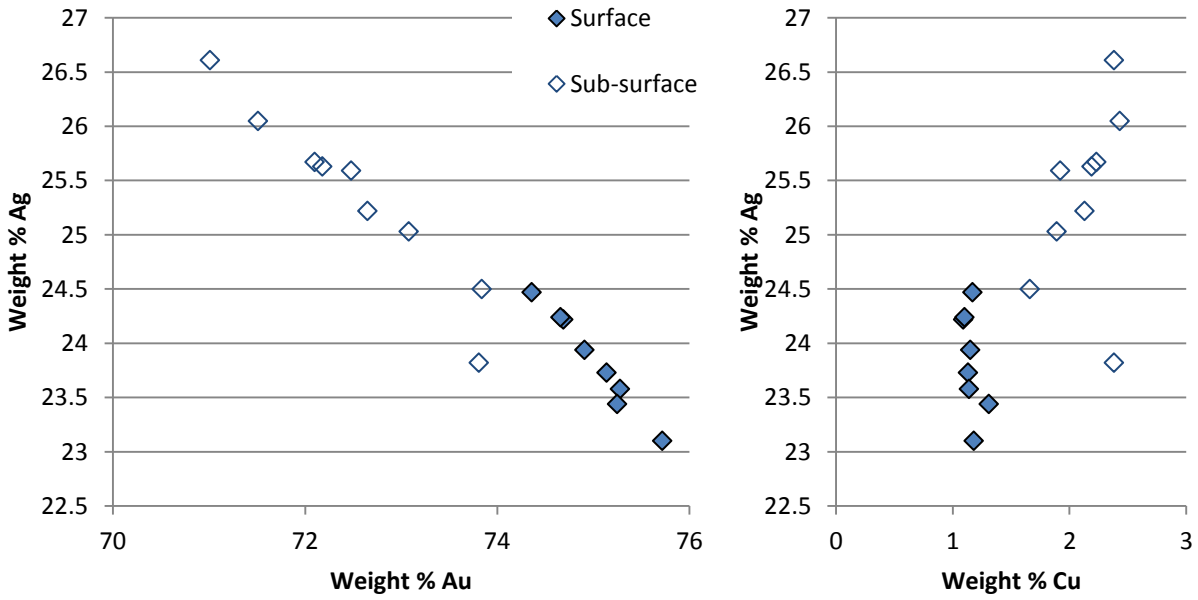
Object Type Hilt plate
Date 600-650

Decoration Filigree ✓ Glass
Garnet Other

SEM-EDX analysis was undertaken on the base sheet on the front of the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	75.0	23.8	1.2
		Standard Deviation	*0.43*	*0.46*	*0.07*
Sub-surface	9	Average	72.6	25.3	2.1
		Standard Deviation	*0.96*	*0.83*	*0.26*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a surface composition of approximately 71-74 wt% gold, 24-26 wt% silver, the rest being copper. The analysis revealed a *c.*1.4 wt% loss of silver from the surface (a difference of *c.*6% from surface to core), which is most likely indicative of corrosion that can occur during burial which results in natural surface enrichment but could also be the result of some deliberate surface treatment.

Eleanor Blakelock
Analysed January 2013

Gold enrichment in Staffordshire Hoard K1143: results of SEM-EDX analysis

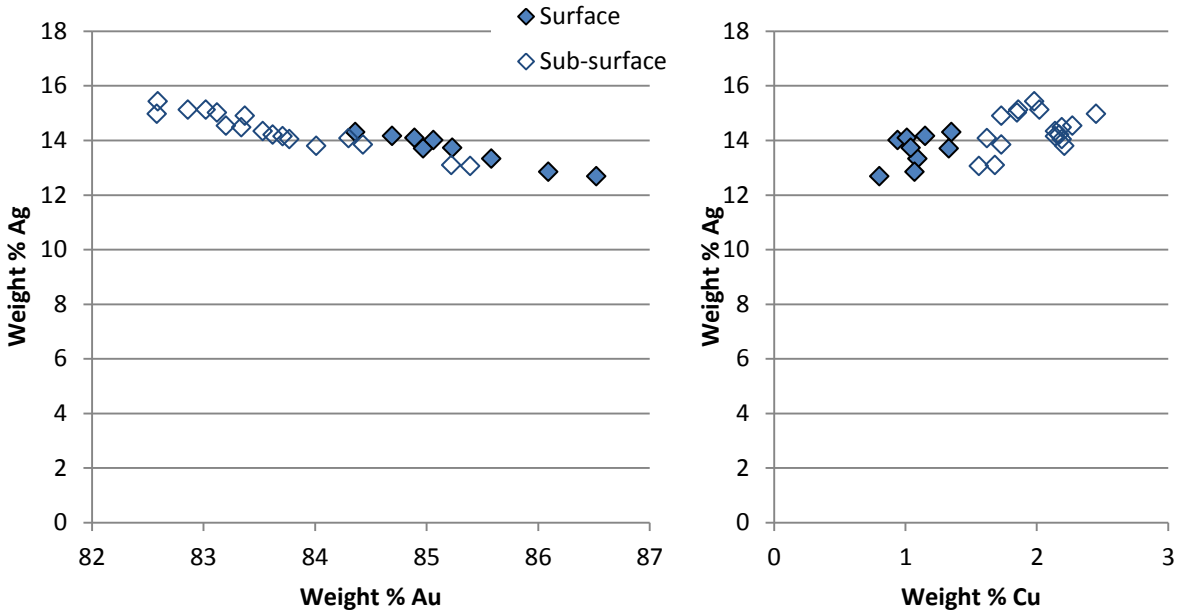
Object Type Hilt plate
Date 600-650

Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the base sheet on the back of the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	85.3	13.6	1.1
		Standard Deviation	*0.69*	*0.58*	*0.17*
Sub-surface	8	Average	83.6	14.4	2.0
		Standard Deviation	*0.82*	*0.69*	*0.26*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a surface composition of approximately 82-84 wt% gold, 13-15 wt% silver, The analysis revealed a *c.*0.7 wt% loss of silver from the surface (a difference of only *c.*5% from surface to core), which is most likely indicative of corrosion that can occur during burial which results in natural surface enrichment but could also be the result of some deliberate surface treatment. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed January 2013

Gold enrichment in Staffordshire Hoard K1150: results of SEM-EDX analysis

Object Type Hilt-plate
Date 600-650

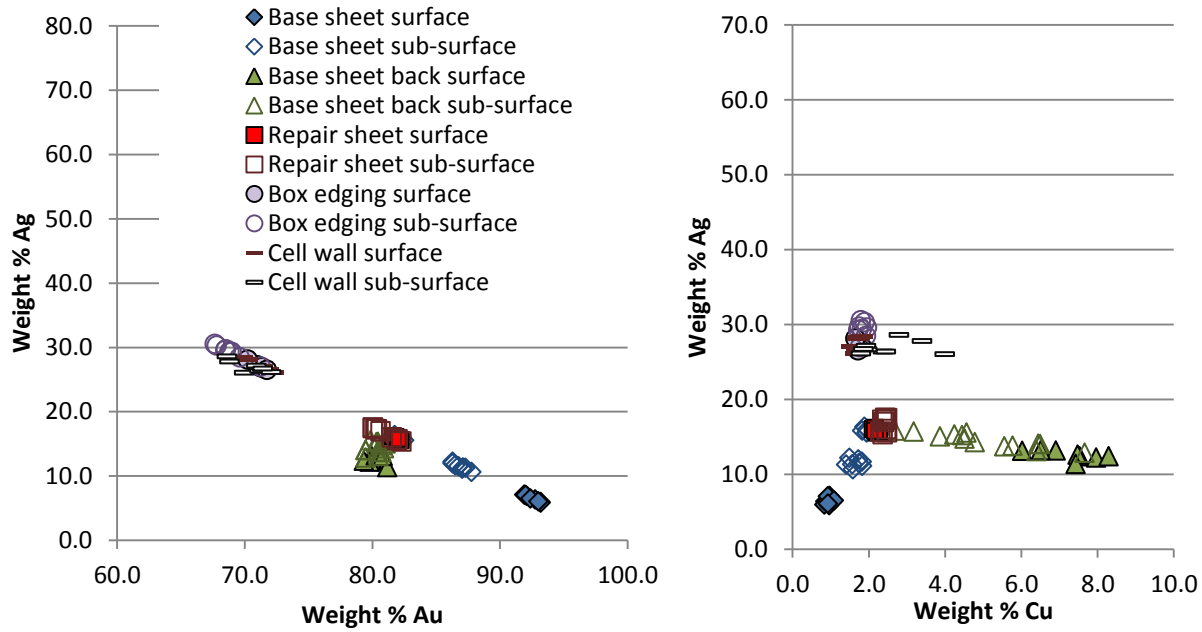
Decoration
- Filigree [ ]
- Garnet [✓]
- Glass [ ]
- Other [ ]

SEM-EDX analysis was undertaken on a range of components, including the cell wall and sheet used for the edge. In addition analysis was undertaken on the repair patch, and both sides of the sheet.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	92.6	6.5	0.9
		Standard Deviation	*0.53*	*0.50*	*0.08*
Base sheet sub-surface	12	Average	82.2	15.9	1.9
		Standard Deviation	*0.32*	*0.33*	*0.06*
Base sheet back surface	8	Average	80.1	12.6	7.3
		Standard Deviation	*0.59*	*0.62*	*0.75*
Base sheet back sub-surface	14	Average	80.5	14.5	5.0
		Standard Deviation	*0.65*	*0.96*	*1.40*
Repair sheet surface	6	Average	82.0	15.8	2.2
		Standard Deviation	*0.23*	*0.26*	*0.06*
Repair sheet sub-surface	9	Average	81.0	16.6	2.4
		Standard Deviation	*0.91*	*0.89*	*0.06*
Box edging surface	5	Average	71.2	27.1	1.7
		Standard Deviation	*0.56*	*0.60*	*0.07*
Box edging sub-surface	8	Average	68.9	29.3	1.8
		Standard Deviation	*1.14*	*1.12*	*0.09*
Cell wall surface	6	Average	70.9	27.4	1.7
		Standard Deviation	*1.02*	*0.96*	*0.09*
Cell wall subsurface	9	Average	70.6	26.9	2.5
		Standard Deviation	*1.22*	*0.84*	*0.76*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

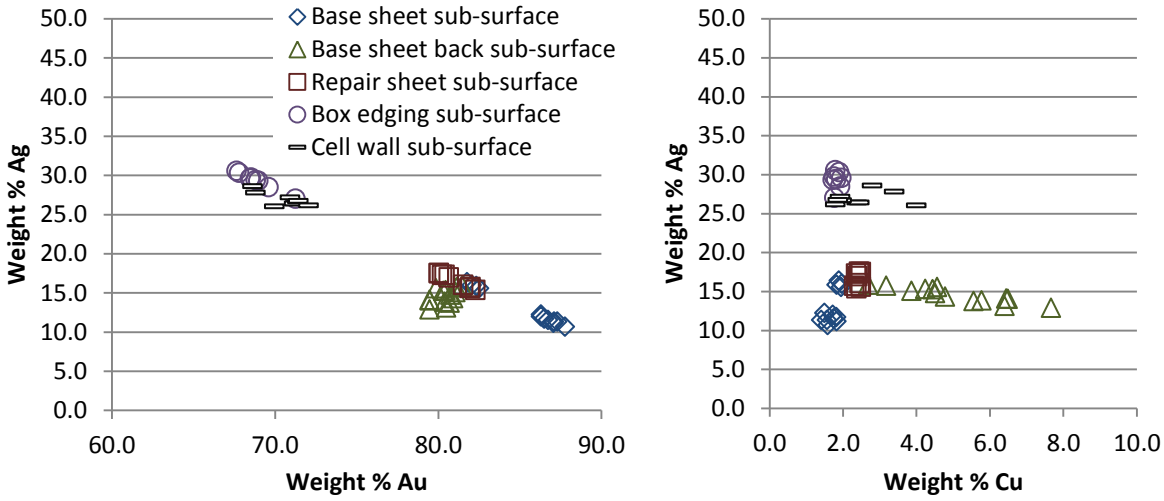
The analysis of the front of the base sheet revealed a *c.*9.4 wt% loss of silver from the surface (a difference of *c.*59% from surface to core) while the back of the sheet revealed a *c.*2 wt% loss of silver from the surface (a difference of *c.*13% from surface to core). This is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The difference between the composition of the front and back of the hilt plate indicates that two different sheets were used, and these were a distinct alloy from the other components.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The analysis of the repair plate revealed a loss of *c.*0.7 wt% silver from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. The sub-surface composition is similar to the back of the hilt plate.

Analysis of the sheet used to create the box edging revealed a loss of *c.*2.1 wt% silver from the surface, and a difference of less than 10% from surface to core, which is most likely indicative of corrosion that can occur during burial which results in natural surface enrichment but could also be the result of some deliberate surface treatment. The analysis of the cell wall suggested a loss of copper from the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface analyses of each component analysed.

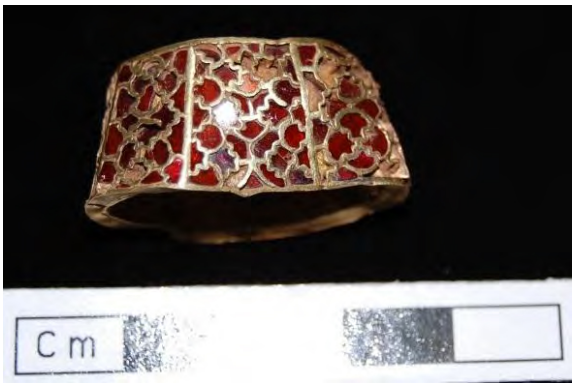
Eleanor Blakelock
Analysed February and May 2013

Gold enrichment in Staffordshire Hoard K1155: results of SEM-EDX analysis

Object Type Hilt collar
Date 600-635

Decoration				
	Filigree		Glass	
	Garnet	✓	Other	

SEM-EDX analysis was undertaken on the sheet at the base and also the internal sheet.



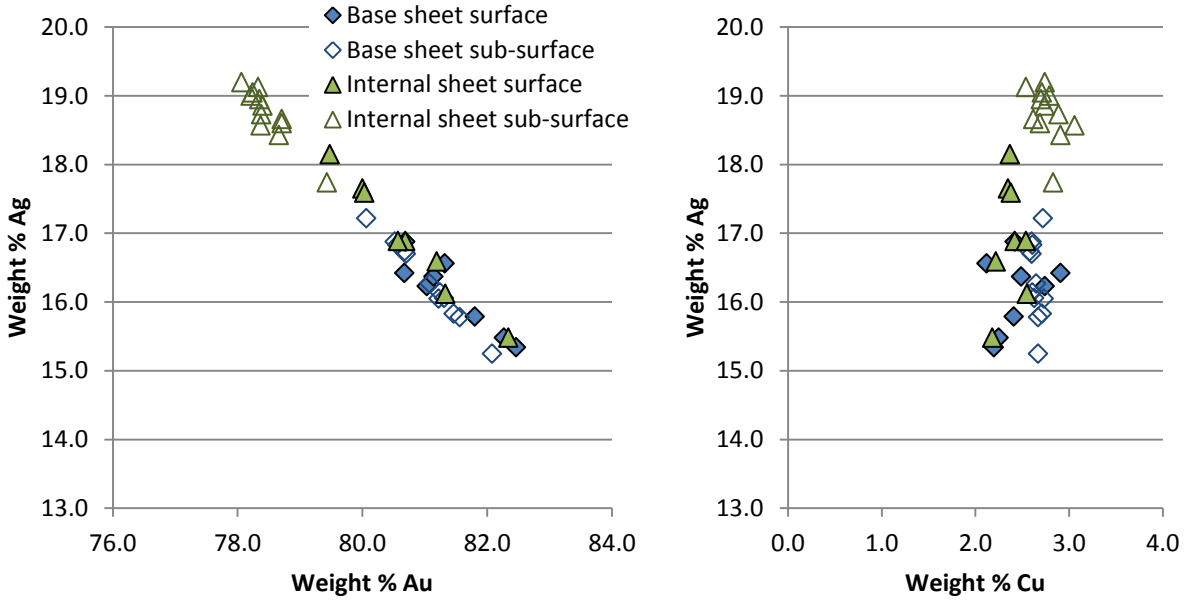
Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	8	Average	81.5	16.1	2.4
		Standard Deviation	*0.68*	*0.54*	*0.27*
Base sheet sub-surface	12	Average	81.1	16.3	2.6
		Standard Deviation	*0.55*	*0.57*	*0.05*
Internal sheet surface	9	Average	80.7	16.9	2.4
		Standard Deviation	*0.91*	*0.87*	*0.13*
Internal sheet sub-surface	12	Average	78.5	18.7	2.8
		Standard Deviation	*0.36*	*0.40*	*0.14*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis of the internal sheet revealed a *c.*1.8 wt% loss of silver from the surface of the base sheet (a difference of *c.*10% from surface to core), which is perhaps indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The analysis of the base sheet revealed a loss of *c.*0.2 wt% silver from the surface, and a difference of less than 1% from surface to core, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Both sheets appear to have a similar core composition so were probably made from a similar gold alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K1163: results of SEM-EDX analysis

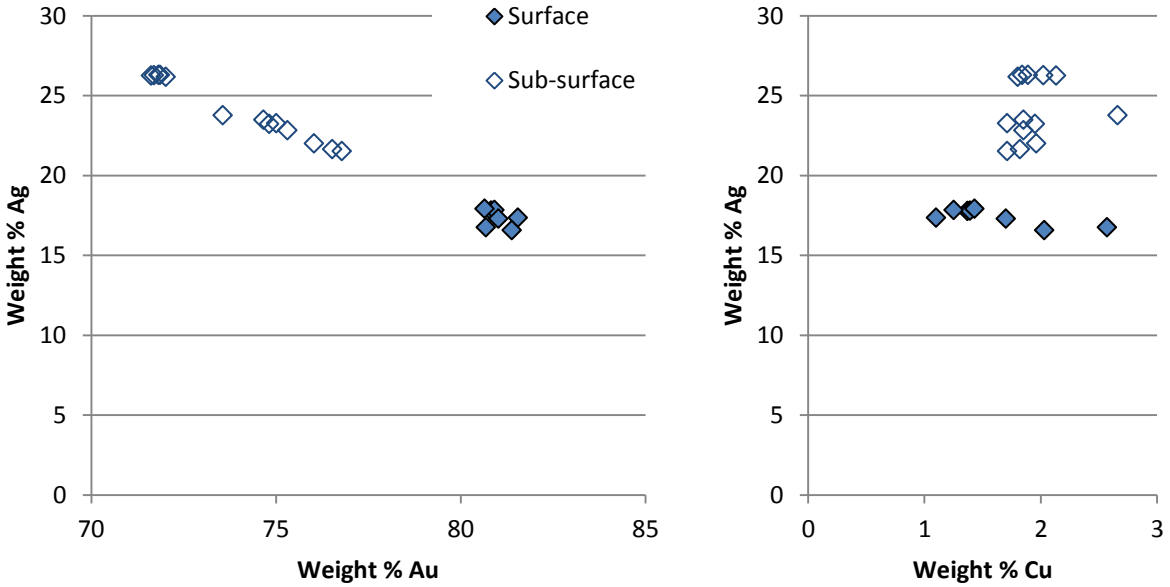
Object Type Hilt plate
Date 600-650

Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the base sheet on the inside of the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	81.0	17.4	1.6
		Standard Deviation	*0.32*	*0.52*	*0.48*
Sub-surface	13	Average	74.0	24.1	1.9
		Standard Deviation	*1.97*	*1.91*	*0.25*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 73-75 wt% gold, 24-26 wt% silver, the rest being copper. The analysis revealed a *c.*6.7 wt% loss of silver from the surface (a difference of *c.*28 % from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed February 2013

Gold enrichment in Staffordshire Hoard K1167: results of SEM-EDX analysis

Object Type Pommel
Date 620-650

Decoration				
	Filigree		Glass	✓
	Garnet	✓	Other	

SEM-EDX analysis was undertaken on a range of components including the cell wall, the separate cap and the base sheet.

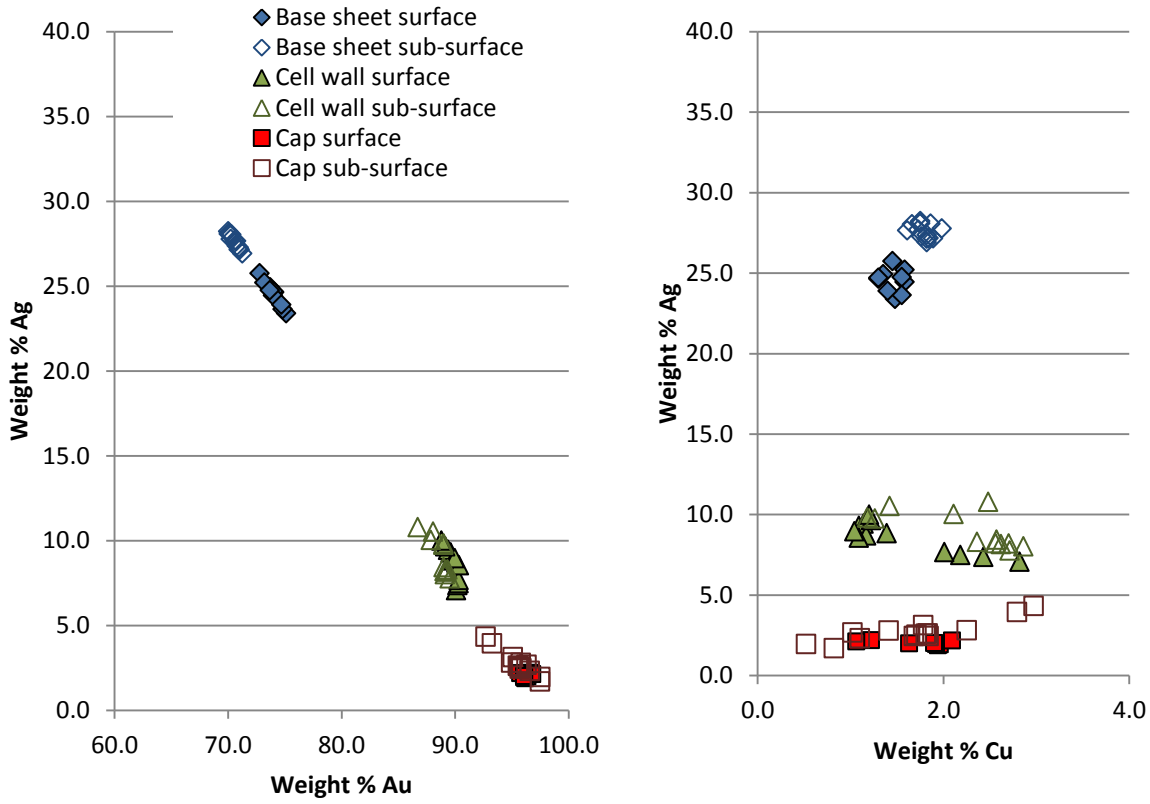
Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Base sheet surface	10	Average	74.0	24.5	1.5
		Standard Deviation	0.72	0.72	0.11
Base sheet sub-surface	14	Average	70.6	27.6	1.8
		Standard Deviation	0.42	0.44	0.09
Top of cap surface	8	Average	96.4	2.1	1.5
		Standard Deviation	0.36	0.11	0.45
Top of cap sub-surface	12	Average	95.7	2.6	1.7
		Standard Deviation	0.45	0.17	0.34
Cell wall surface	12	Average	89.8	8.6	1.6
		Standard Deviation	0.51	0.97	0.62
Cell wall sub-surface	14	Average	88.8	9.0	2.2
		Standard Deviation	0.81	1.09	0.60

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

The analysis revealed a *c.*3.1 wt% loss of silver from the surface of the base sheet (a difference of *c.*11% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The analysis of the other components also revealed a loss of both copper and silver. The cap had a loss of *c.*0.7 wt% silver and the cell walls had a loss of *c.*0.4 wt% silver from the surface, a difference of less than 10% from surface to core. This is most likely indicative of corrosion that can occur during burial which results in natural surface enrichment.

Comparison of the sub-surface compositions revealed that each component was made of a distinct gold alloy.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed June 2013

Gold enrichment in Staffordshire Hoard K1221: results of SEM-EDX analysis

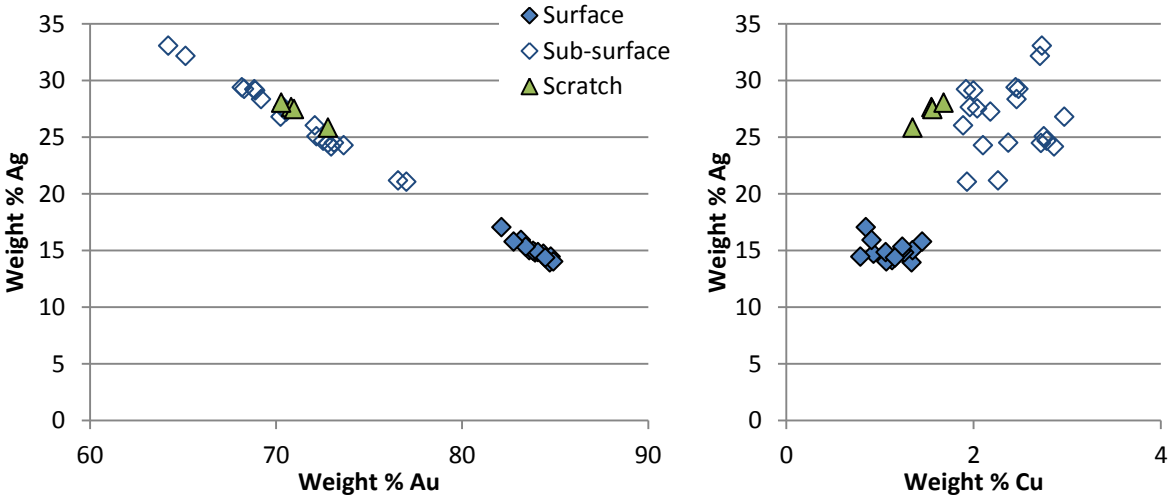
Object Type Hilt plate
Date 600-650

Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the base sheet on the back of the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	9	Average	83.9	15.0	1.1
		Standard Deviation	*0.83*	*0.85*	*0.20*
Scratch	4	Average	71.2	27.3	1.5
		Standard Deviation	*1.10*	*0.96*	*0.14*
Sub-surface	12	Average	70.8	26.8	2.4
		Standard Deviation	*3.24*	*3.18*	*0.36*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 67-74 wt% gold, 23-29 wt% silver, the rest being copper. The analysis revealed a *c.*11.8 wt% loss of silver from the surface (a difference of *c.*44% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The surface of the scratch had a similar composition to the sub-surface, with a relatively small loss in copper most likely due to corrosion, confirming that the treatment was carried out prior to burial.

Eleanor Blakelock
Analysed February 2013

Gold enrichment in Staffordshire Hoard K1234: results of SEM-EDX analysis

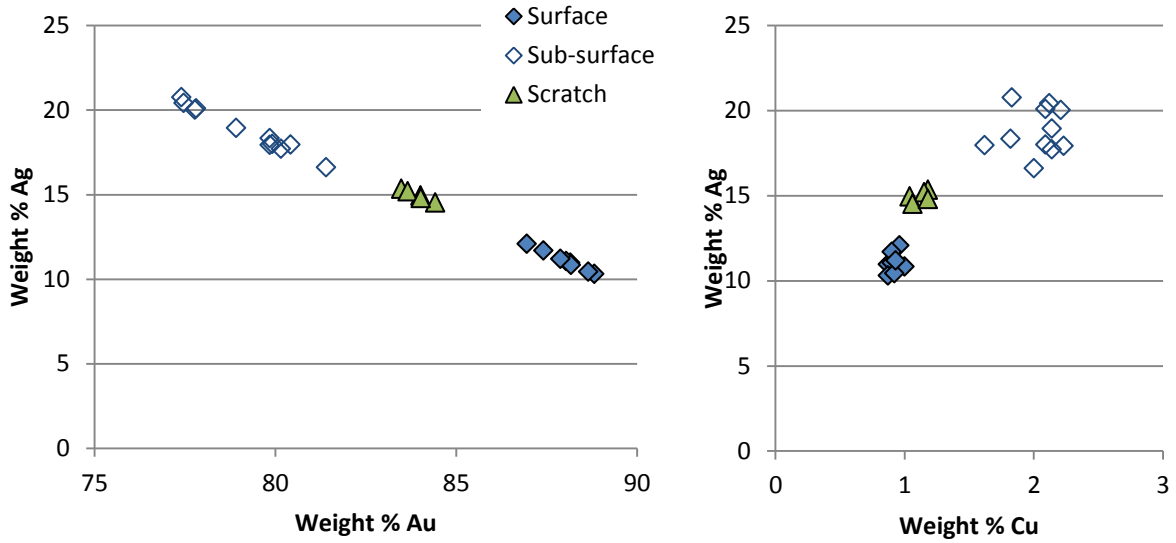
Object Type Hilt plate
Date 600-650

Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the base sheet on the back of the hilt plate.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	9	Average	88.0	11.1	0.9
		Standard Deviation	*0.61*	*0.59*	*0.04*
Scratch	4	Average	83.9	15.0	1.1
		Standard Deviation	*0.36*	*0.36*	*0.07*
Sub-surface	12	Average	79.7	18.2	2.1
		Standard Deviation	*1.37*	*1.42*	*0.09*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 78-81 wt% gold, 17-20 wt% silver, the rest being copper. The analysis revealed a *c.*7.0 wt% loss of silver from the surface (a difference of *c.*39% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial. The data from the analysis of the surface of a shallow scratch plotted half way between the surface and sub-surface results, this suggests that the treatment was carried out prior to burial.

Eleanor Blakelock
Analysed January 2013

Gold enrichment in Staffordshire Hoard K1272: results of SEM-EDX analysis

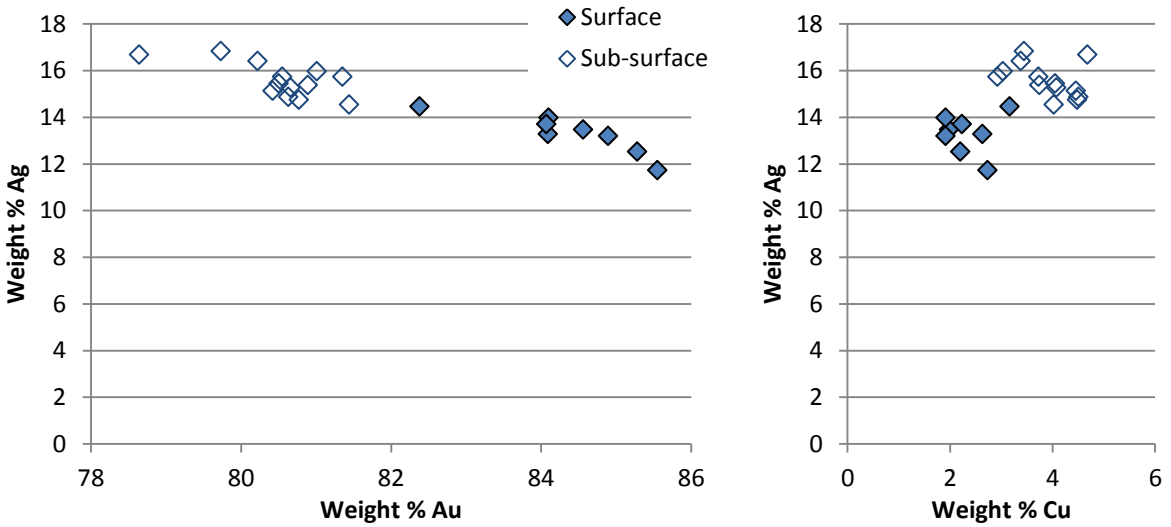
Object Type Fitting
Date 600-650

Decoration Filigree ☐ Glass ☐
Garnet ☐ Other ☐

SEM-EDX analysis was undertaken on the base sheet on the front panel of the fitting.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	84.4	13.3	2.3
		Standard Deviation	*0.98*	*0.85*	*0.45*
Sub-surface	13	Average	80.5	15.6	3.9
		Standard Deviation	*0.72*	*0.72*	*0.57*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 79-81 wt% gold, 14-17 wt% silver, the rest being copper. The analysis revealed a *c.*2.3 wt% loss of silver from the surface (a difference of *c.*15 % from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed January 2013

Gold enrichment in Staffordshire Hoard K1314: results of SEM-EDX analysis

Object Type Gem setting for cross K655 or inscription K550
Date 630-670

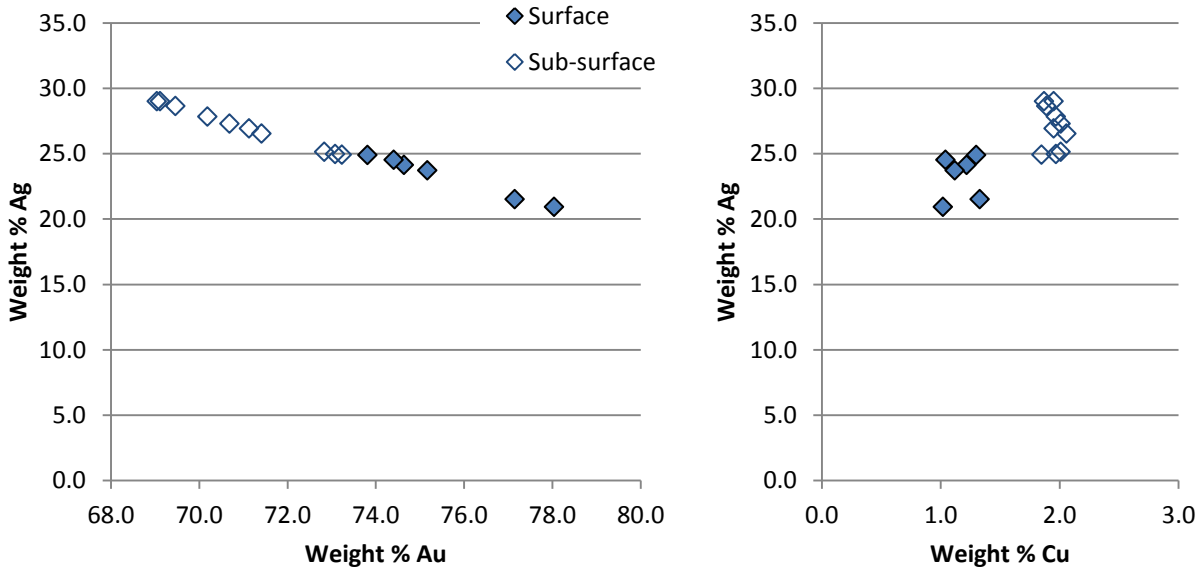
Decoration

Filigree	✓	Glass	
Garnet		Other	

SEM-EDX analysis was undertaken on the back of the sheet of the gem setting.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	6	Average	75.5	23.3	1.2
		Standard Deviation	*1.68*	*1.66*	*0.13*
Sub-surface	10	Average	71.0	27.0	2.0
		Standard Deviation	*1.61*	*1.62*	*0.07*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 69-73 wt% gold, 25-29 wt% silver, the rest being copper. The analysis revealed a *c.*3.7 wt% loss of silver from the surface (a difference of *c.*14% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed November 2013

Gold enrichment in Staffordshire Hoard K1403: results of SEM-EDX analysis

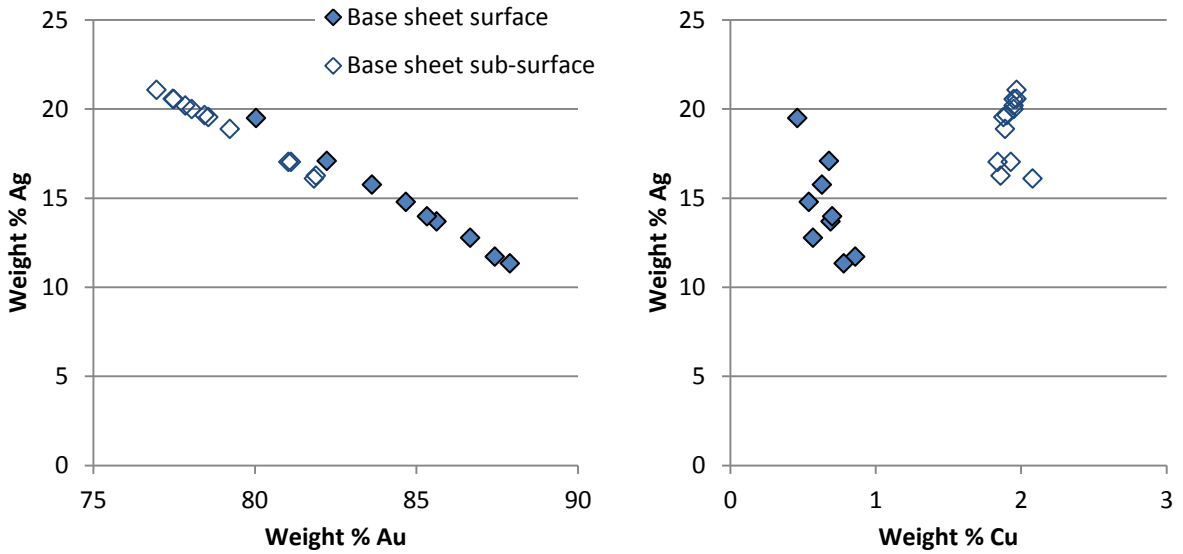
Object Type Mount
Date 630-670

Decoration Filigree ✓ Glass
Garnet Other

SEM-EDX analysis was undertaken on the base sheet on the back of the mount.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	9	Average	84.8	14.5	0.7
		Standard Deviation	*2.54*	*2.62*	*0.12*
Sub-surface	12	Average	79.2	18.9	1.9
		Standard Deviation	*1.82*	*1.81*	*0.06*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 77-81 wt% gold, 17-21 wt% silver, the rest being copper. The analysis revealed a *c.*4.4 wt% loss of silver from the surface (a difference of *c.*23% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Gold enrichment in Staffordshire Hoard K1425: results of SEM-EDX analysis

Object Type Sword button
Date 600-635

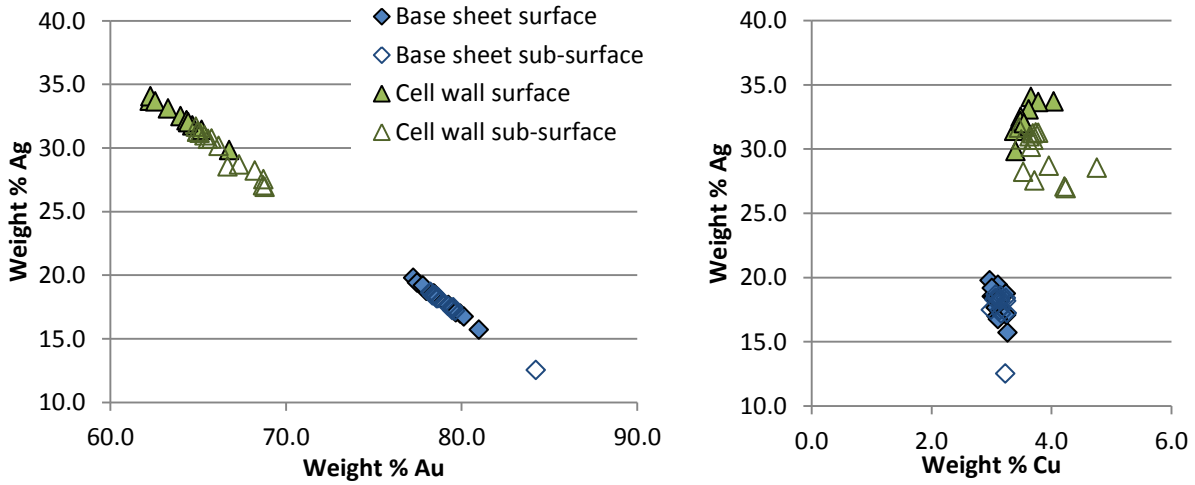
Decoration

Filigree	✓	Glass	
Garnet	✓	Other	

SEM-EDX analysis was undertaken on the cell walls and the serrated sheet surrounding the central garnet panel.

Area analysed	No of analyses		Au	Ag	Cu
Base sheet surface	12	Average	78.9	18.0	3.1
		Standard Deviation	*1.18*	*1.24*	*0.10*
Base sheet sub-surface	14	Average	79.3	17.6	3.1
		Standard Deviation	*1.53*	*1.55*	*0.08*
Cell wall surface	9	Average	64.1	32.3	3.6
		Standard Deviation	*1.43*	*1.21*	*0.19*
Cell wall sub-surface	14	Average	66.6	29.5	3.9
		Standard Deviation	*1.54*	*1.67*	*0.37*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

The analysis revealed that the cell wall and the serrated base sheet were constructed from different gold alloys. There was a very small loss of copper at the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. There was a small increase in silver at the surface which may be due to contamination from solder or from close contact to corroding silver objects in the burial environment.

Eleanor Blakelock
Analysed October 2013

Gold enrichment in Staffordshire Hoard K1497: results of SEM-EDX analysis

Object Type Mount
Date 625-650

Decoration

Filigree	✓	Glass	
Garnet		Other	

SEM-EDX analysis was undertaken on the filigree wire as well as the back and front of the base sheet to which the filigree wires were attached.

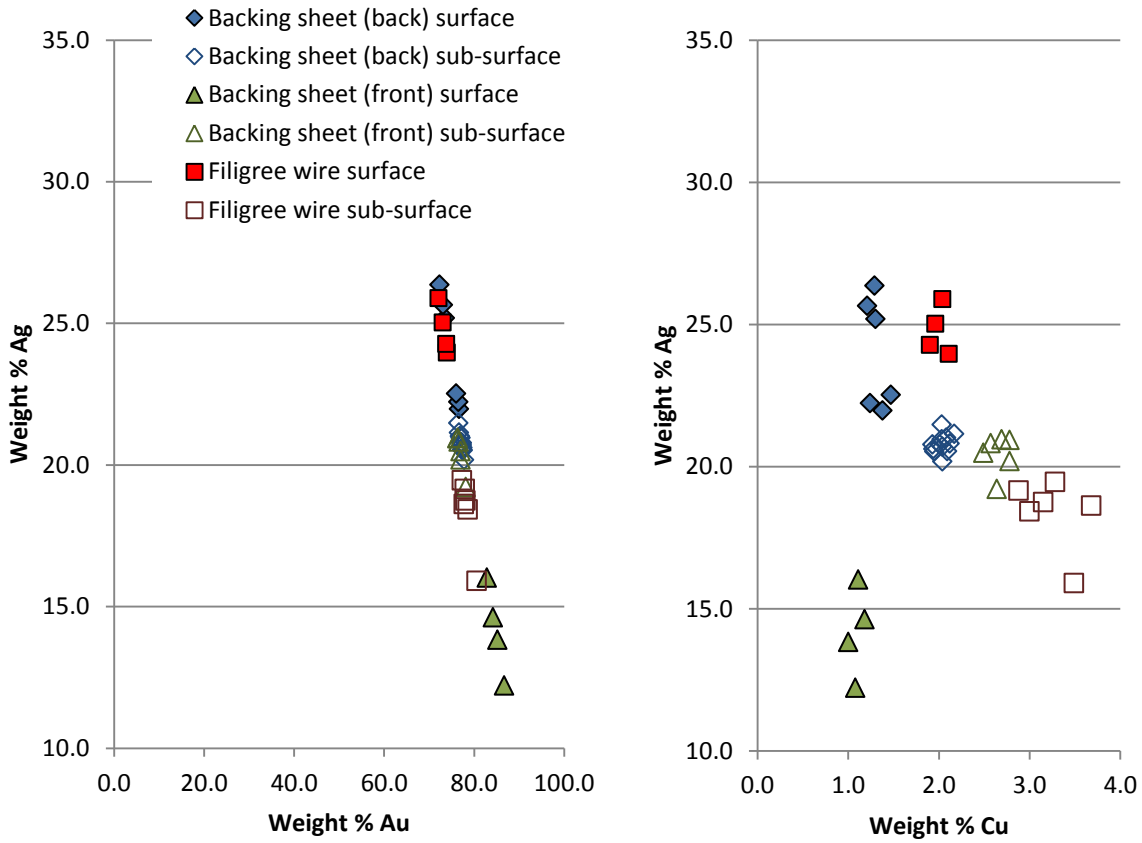
Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Backing sheet (back) Surface	6	Average	74.7	24.0	1.3
		Standard Deviation	*1.91*	*1.96*	*0.10*
Backing sheet (back) Sub-surface	12	Average	77.2	20.8	2.0
		Standard Deviation	*0.36*	*0.33*	*0.07*
Backing sheet (front) Surface	4	Average	84.7	14.2	1.1
		Standard Deviation	*1.62*	*1.59*	*0.07*
Backing sheet (front) Sub-surface	6	Average	76.9	20.4	2.7
		Standard Deviation	*0.68*	*0.67*	*0.12*
Filigree wire Surface	4	Average	73.2	24.8	2.0
		Standard Deviation	*0.85*	*0.86*	*0.09*
Filigree wire Sub-surface	6	Average	78.4	18.4	3.2
		Standard Deviation	*1.18*	*1.27*	*0.30*

SEM-EDX surface and sub-surface compositions for each component analysed (the results are normalised).

Analysis of the front revealed a *c.*6.3 wt% loss of silver from the surface (a difference of *c.*31% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

The analysis of the back of the mount and the filigree wires revealed a small loss of copper at the surface, most likely indicative of corrosion that can occur during burial which results in natural surface enrichment. There was a small increase in silver at the surface which may be contamination from the solder or could have occurred from close contact to corroding silver objects in the burial environment.

Comparison of the sub-surface compositions of the components suggests that they were made using different gold alloys. The front of the sheet has been treated to create a surface even more enriched in gold.



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

Eleanor Blakelock
Analysed September 2013

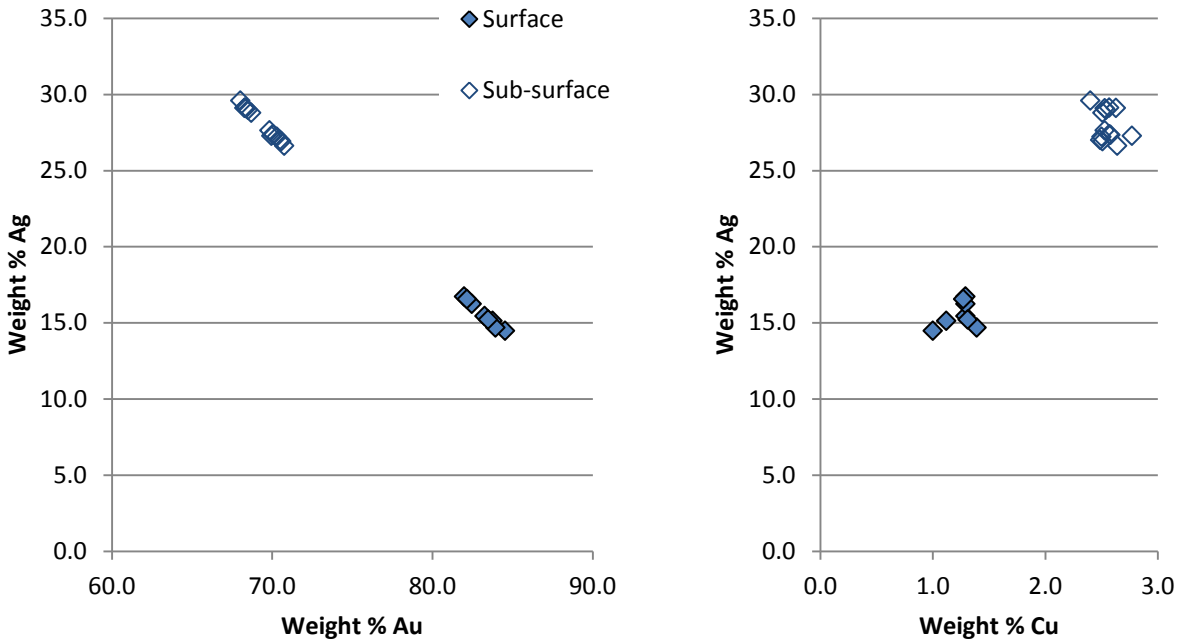
Gold enrichment in Staffordshire Hoard K5008: results of SEM-EDX analysis

Object Type Cross mount
Date 620-650
Decoration Filigree ✓ Glass
Garnet Other

SEM-EDX analysis was undertaken on the base sheet of the cross.

Area analysed	No. of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	83.2	15.6	1.2
		Standard Deviation	*0.91*	*0.86*	*0.12*
Sub-surface	14	Average	69.4	28.0	2.6
		Standard Deviation	*1.01*	*1.04*	*0.09*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 68-71 wt% gold, 27-29 wt% silver, the rest being copper. The analysis revealed a *c.*12.4 wt% loss of silver from the surface (a difference of *c.*44% from surface to core), which is indicative of deliberate treatment to enhance the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed January 2014

Gold enrichment in Stoke-on-Trent Potteries Museum and Art Gallery Pendant 2006.LH.67: results of SEM-EDX analysis

Object Type Pendant
Date 7th century

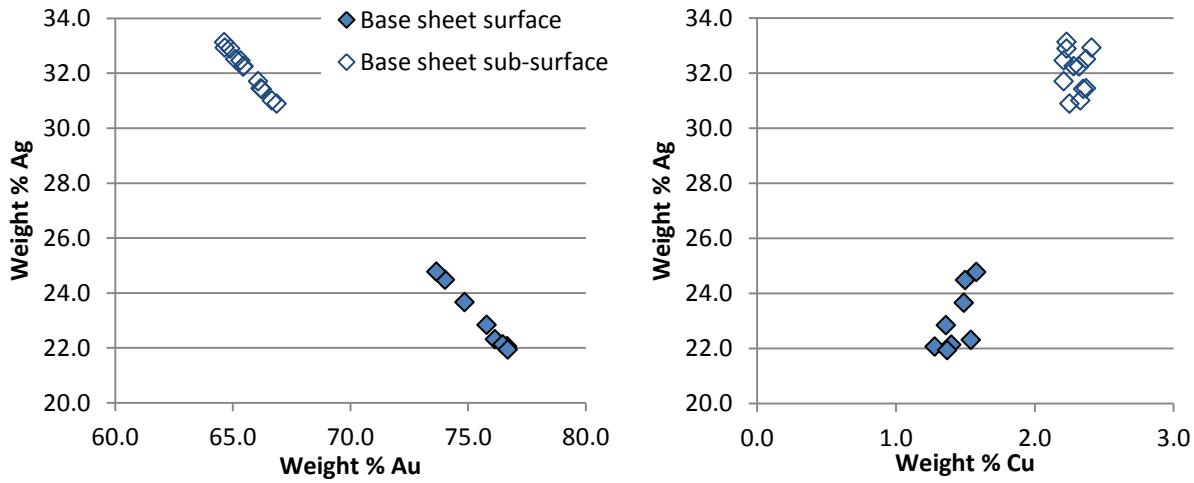
Decoration

Filigree	✓	Glass	
Garnet	✓	Other	

SEM-EDX analysis was undertaken on the gold sheet on the back of the pendant.

Area analysed	No of analyses		Wt% Au	Wt% Ag	Wt% Cu
Surface	8	Average	75.6	23.0	1.4
		Standard Deviation	*1.21*	*1.14*	*0.10*
Sub-surface	12	Average	65.6	32.1	2.3
		Standard Deviation	*0.76*	*0.76*	*0.07*

SEM-EDX surface and sub-surface compositions (the results are normalised).



Plots of gold *vs* silver and copper *vs* silver contents, based on SEM-EDX analysis, showing the differences between the sub-surface and surface analyses.

SEM-EDX analysis of the sub-surface indicated a composition of approximately 64-67 wt% gold, 31-33 wt% silver, the rest being copper. The analysis revealed a *c.*9.1 wt% loss of silver from the surface (a difference of *c.*28% from surface to core), which is indicative of treatment to deliberately enrich the gold colour of the metal. Only copper and small amounts of silver are normally lost from the surface during burial.

Eleanor Blakelock
Analysed September 2013

Appendix 4 - Other tables and graphs

	Wt% Au	Wt% Ag	Wt% Cu	Wt% Sn
Certified Value	**74.7**	**19.2**	**5.1**	**1.0**
10/12/2012	74.7	19.2	5.1	1.0
14/12/2012	74.6	19.3	5.3	0.9
08/01/2013	74.6	19.3	5.1	1.0
11/01/2013	74.7	19.3	5.0	1.1
17/01/2013	74.5	19.4	5.1	1.0
28/01/2013	74.6	19.3	5.1	1.0
07/02/2013	74.6	19.4	5.1	1.0
22/05/2013	74.4	19.5	5.1	1.0
05/06/2013	74.6	19.4	5.1	0.9
21/06/2013	74.5	19.4	5.1	0.9
26/06/2013	74.7	19.2	5.1	1.0
03/07/2013	74.6	19.4	5.0	1.0
15/07/2013	74.9	19.1	5.1	0.9
24/07/2013	74.6	19.3	5.1	1.0
28/08/2013	74.5	19.5	5.1	1.0
02/09/2013	74.7	19.2	5.1	0.9
04/10/2013	74.5	19.3	5.2	1.0
28/10/2013	74.9	19.1	5.1	0.9
11/12/2013	75.0	19.2	5.0	0.8
08/01/2014	74.4	19.5	5.1	1.0

Table 16. SEM-EDX normalised results from regular analysis of MAC2 certified standard. After the 07/02/2013 the analysis was carried out on three locations on the standard and normalised.

K95	K301	K451	K714	K1073
K140	K303	K462	K816	K1425
K292	K306	K545	K833	K1497
K294	K356	K550	K1004	1879,0714.1
K300	K379	K673	K1055	1894,1103.1.a

Table 17. List of pieces with silver enrichment present on the surface of at least one component.

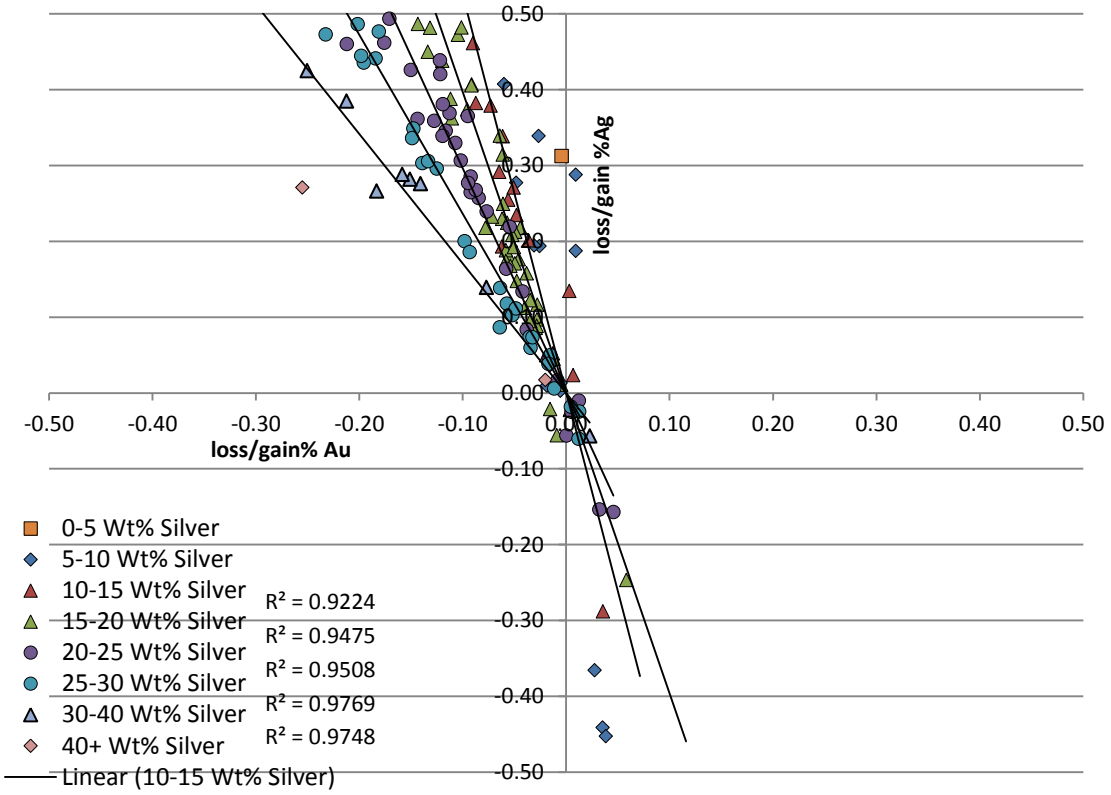


Figure 44. Plot showing that the degree of gold enrichment and silver depletion may be related to the alloy chosen, with objects with higher silver contents being more easily enriched.

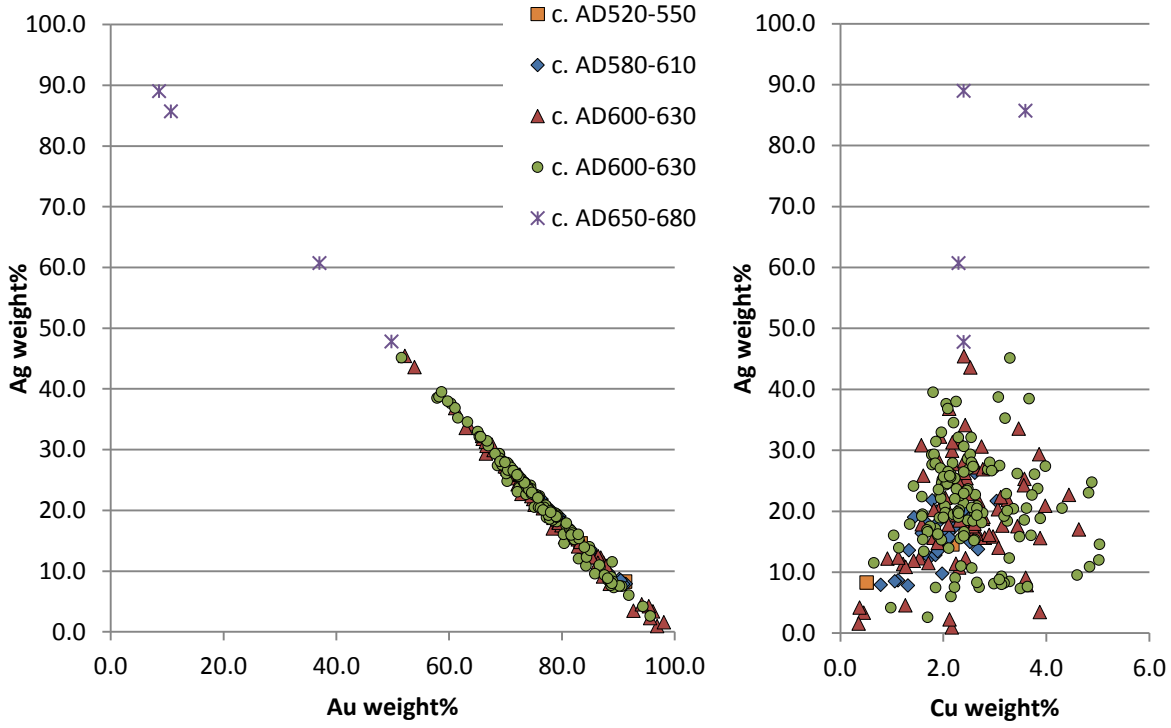


Figure 45. Plots of sub-surface gold *vs* silver and copper *vs* silver contents for the Staffordshire Hoard and British Museum Anglo-Saxon objects that could be firmly placed in a date range/phase.

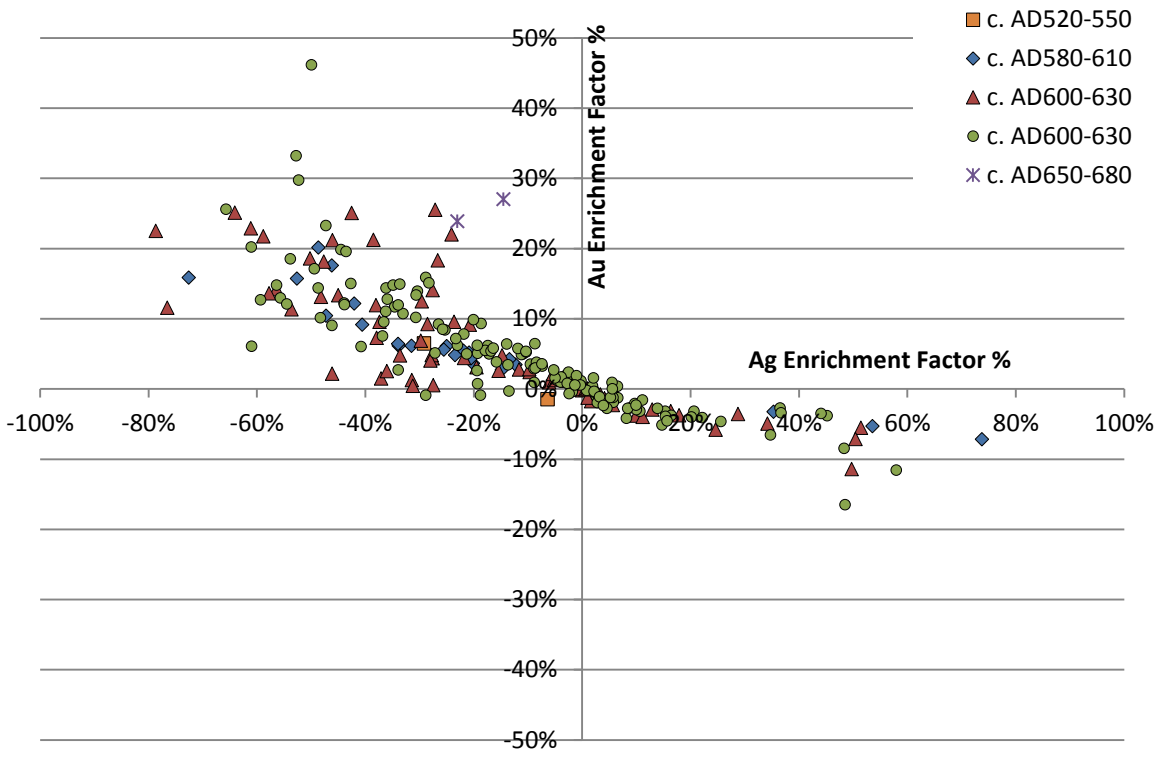


Figure 46. Plot showing the levels of gold enrichment and silver depletion for all components over time.

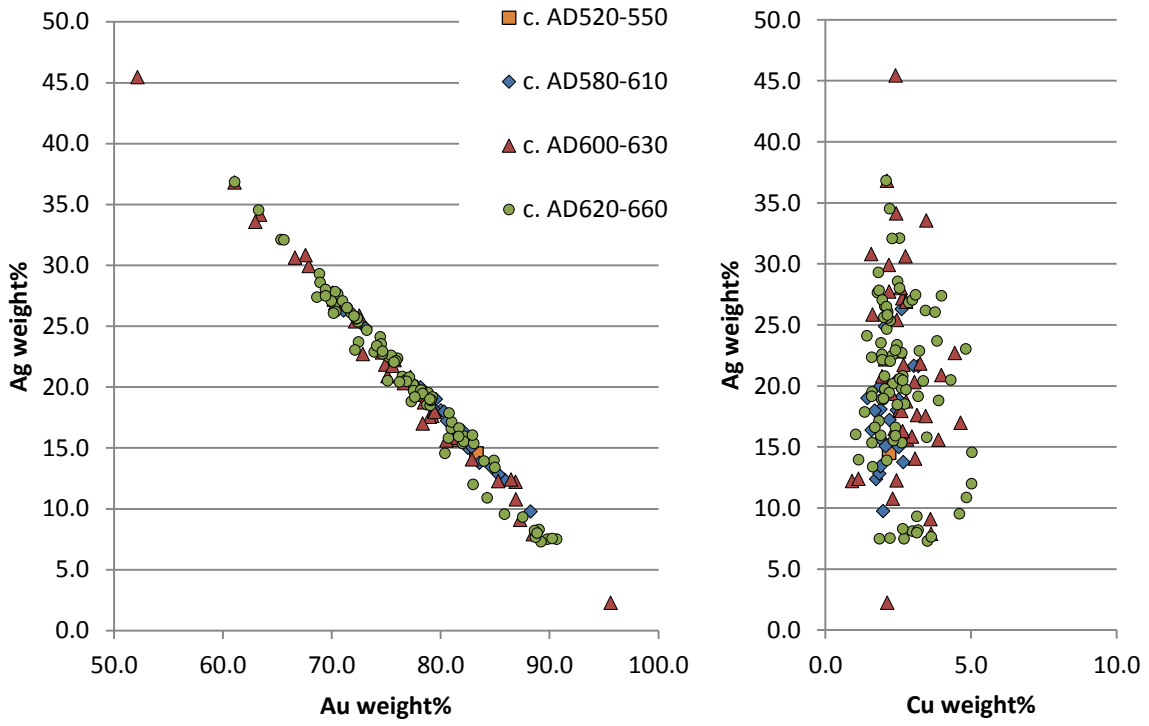


Figure 47. Plots of surface gold *vs* silver and copper *vs* silver contents distributed by phase for the sheets used in the construction of the Staffordshire Hoard and British Museum Anglo-Saxon objects analysed.

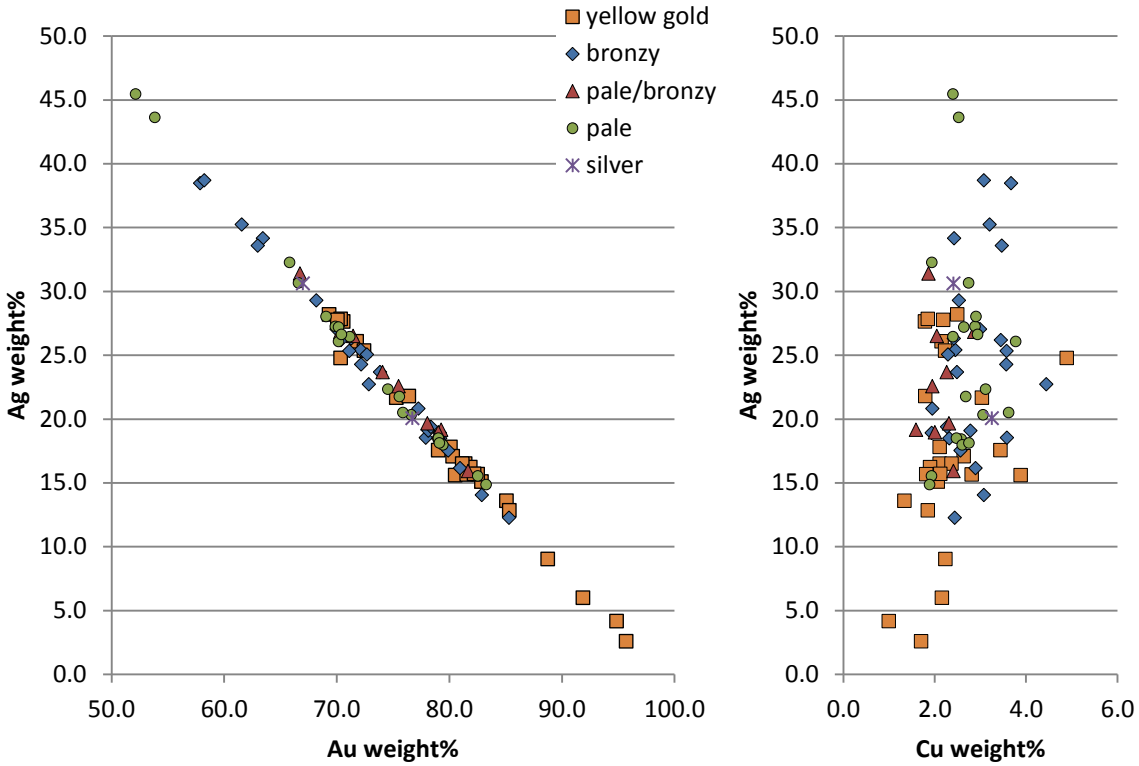


Figure 48. Plots of sub-surface gold *vs* silver and copper *vs* silver contents of the pommels from the Staffordshire Hoard based on the colour categories.

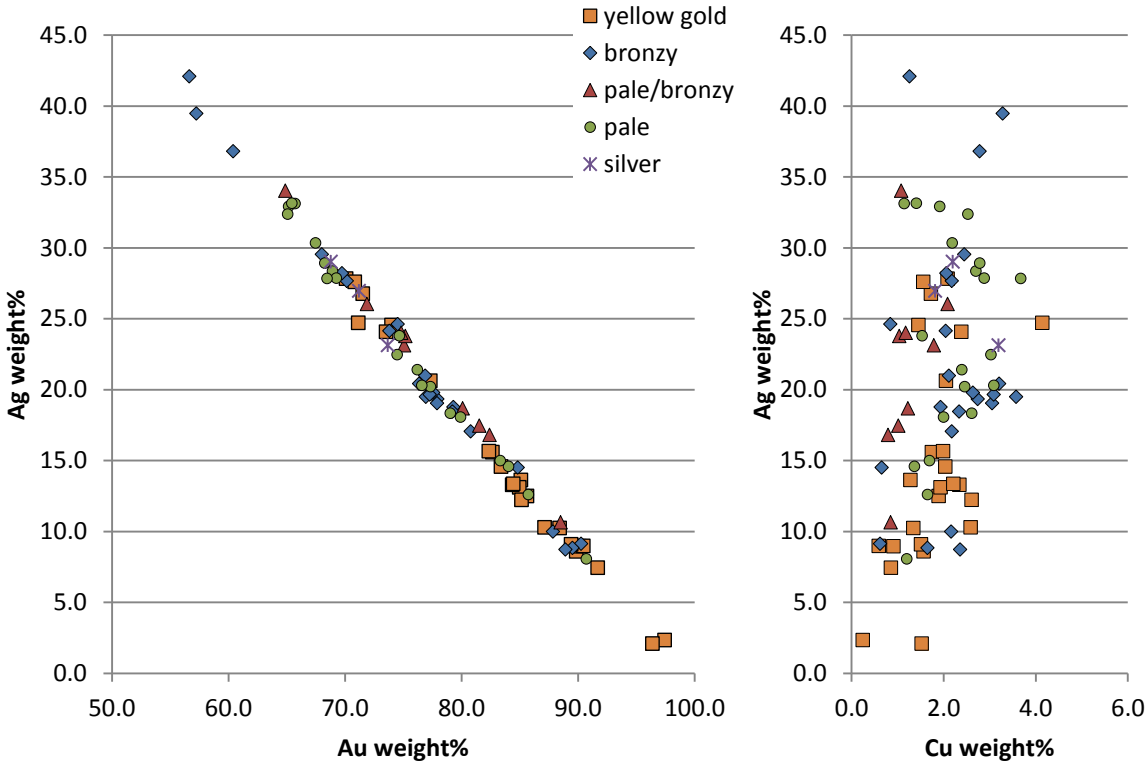


Figure 49. Plots of surface gold *vs* silver and copper *vs* silver contents of the pommels from the Staffordshire Hoard based on the colour categories.

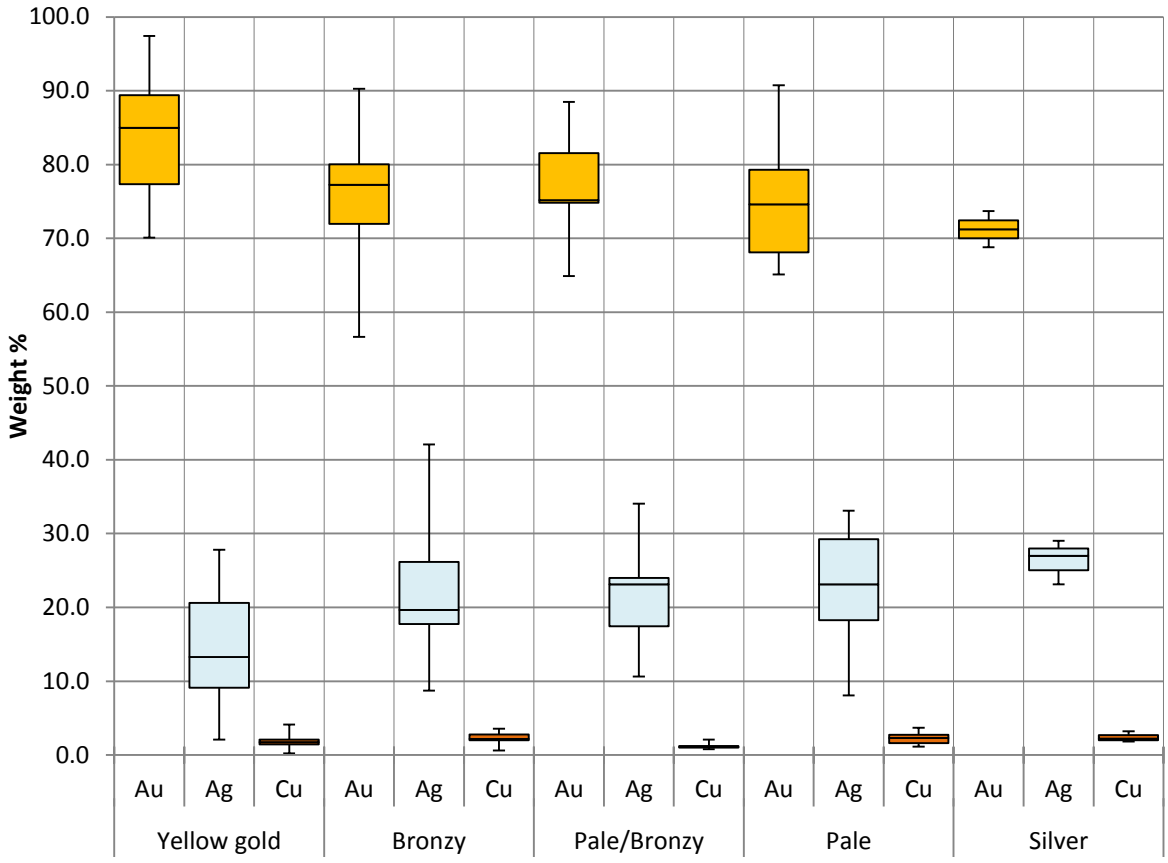


Figure 50. Box and whisker plot of surface composition of the pommels from the Staffordshire Hoard based on the colour categories.

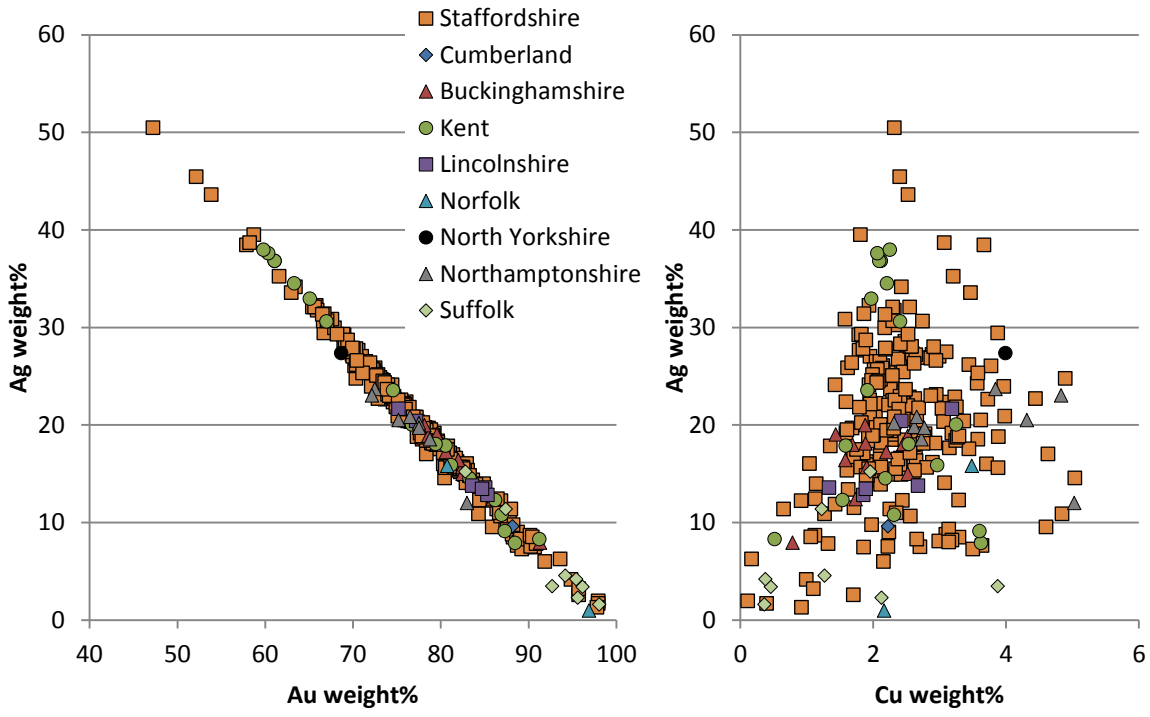


Figure 51. Plots of sub-surface gold *vs* silver and copper *vs* silver contents of all objects based on find location.

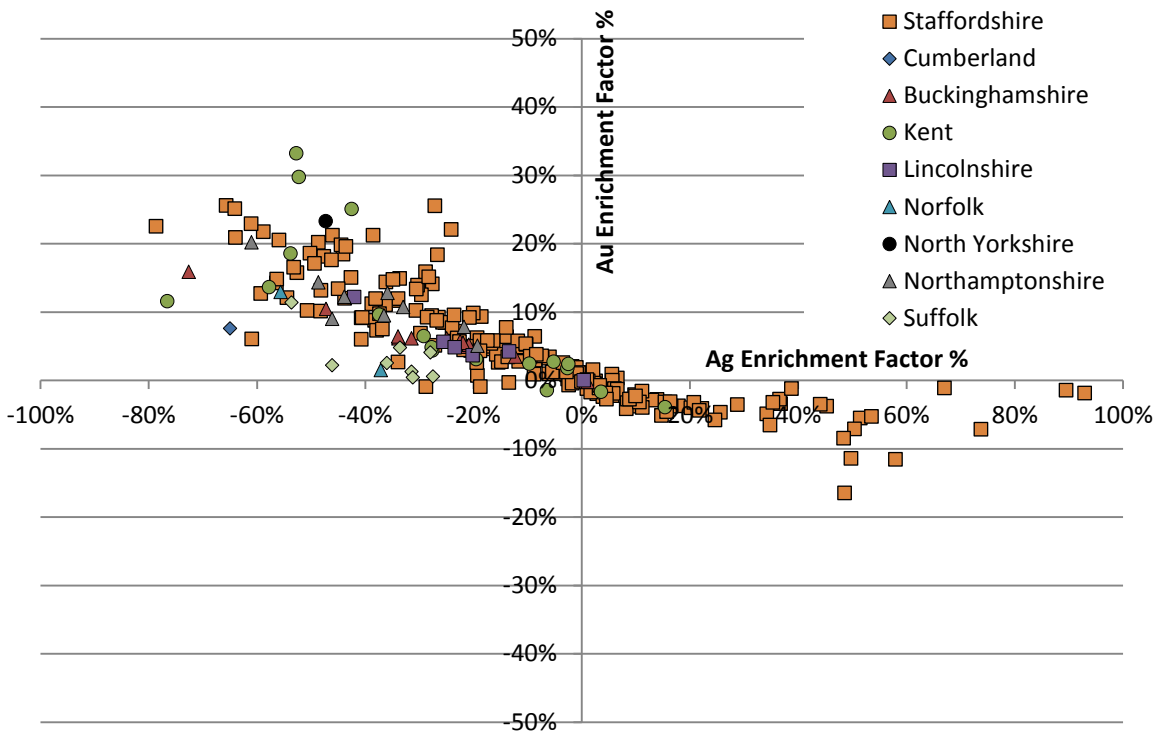


Figure 52. Plot showing the levels of gold enrichment and silver depletion of all objects based on find location.

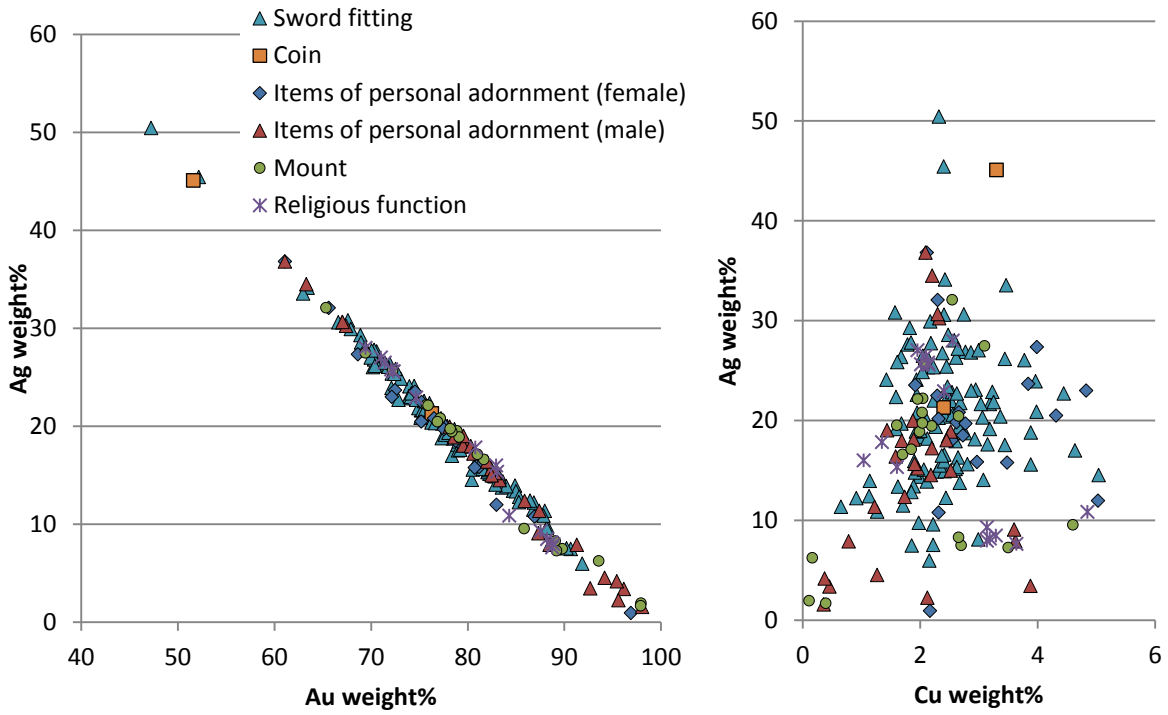


Figure 53. Plots of sub-surface gold *vs* silver and copper *vs* silver contents of the sheets and bodies of the pieces based on the function.

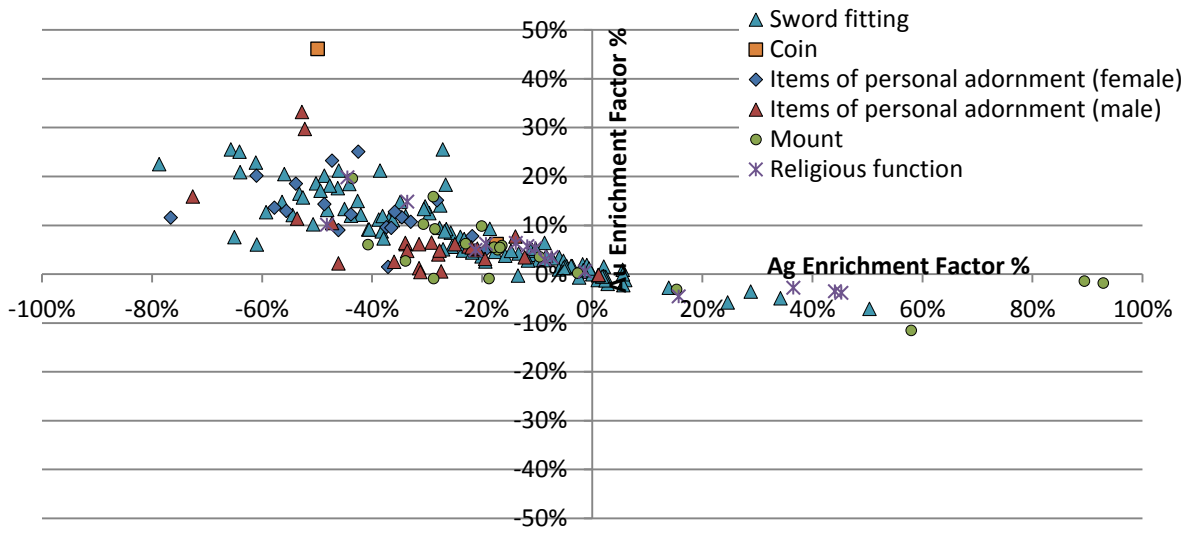


Figure 54. Plot showing the levels of gold enrichment and silver depletion for the sheets and bodies of the pieces based on the function.

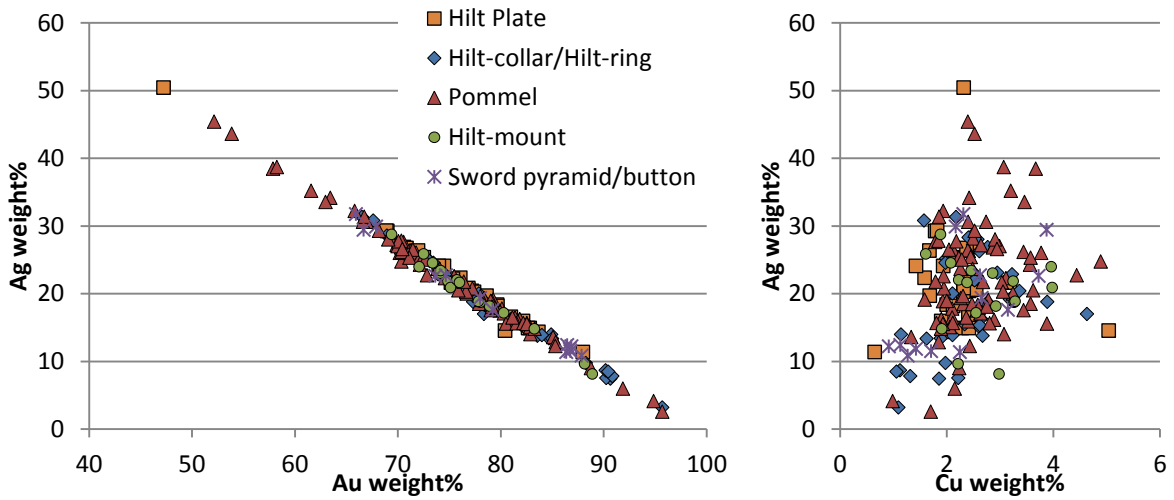


Figure 55. Plots of sub-surface gold *vs* silver and copper *vs* silver contents of all components based on the different weapon fittings.

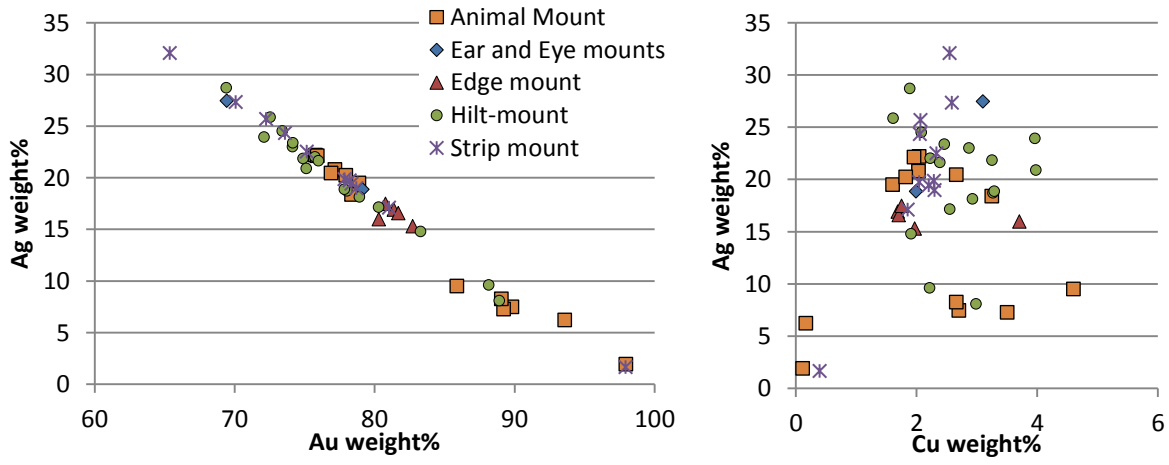


Figure 56. Plots of sub-surface gold *vs* silver and copper *vs* silver contents of all components based on the different mounts.

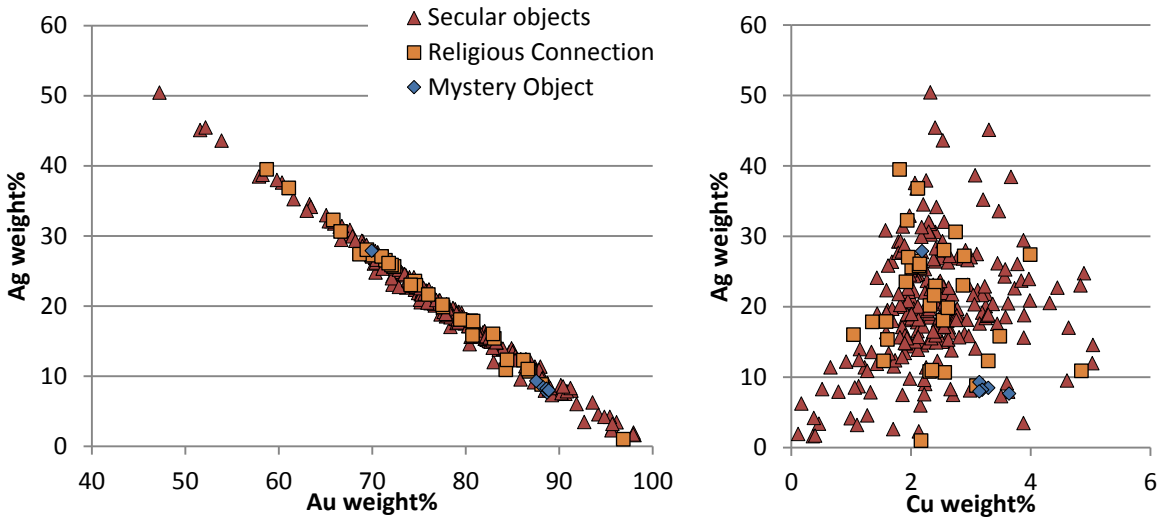


Figure 57. Plots of sub-surface gold *vs* silver and copper *vs* silver contents of all components comparing religious and secular objects.

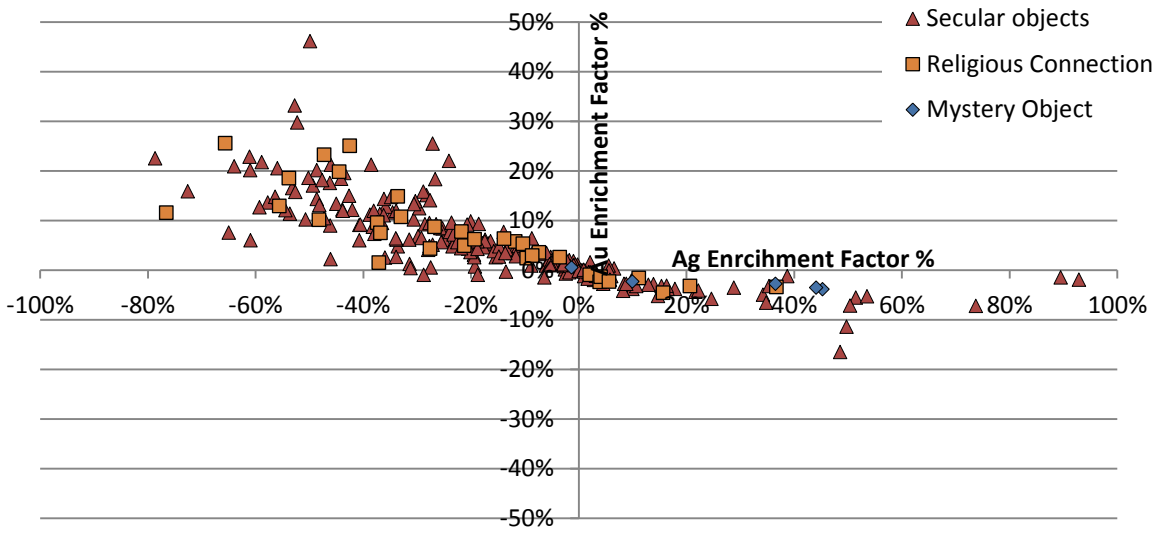


Figure 58. Plot showing the levels of gold enrichment and silver depletion of all components comparing religious and secular objects.

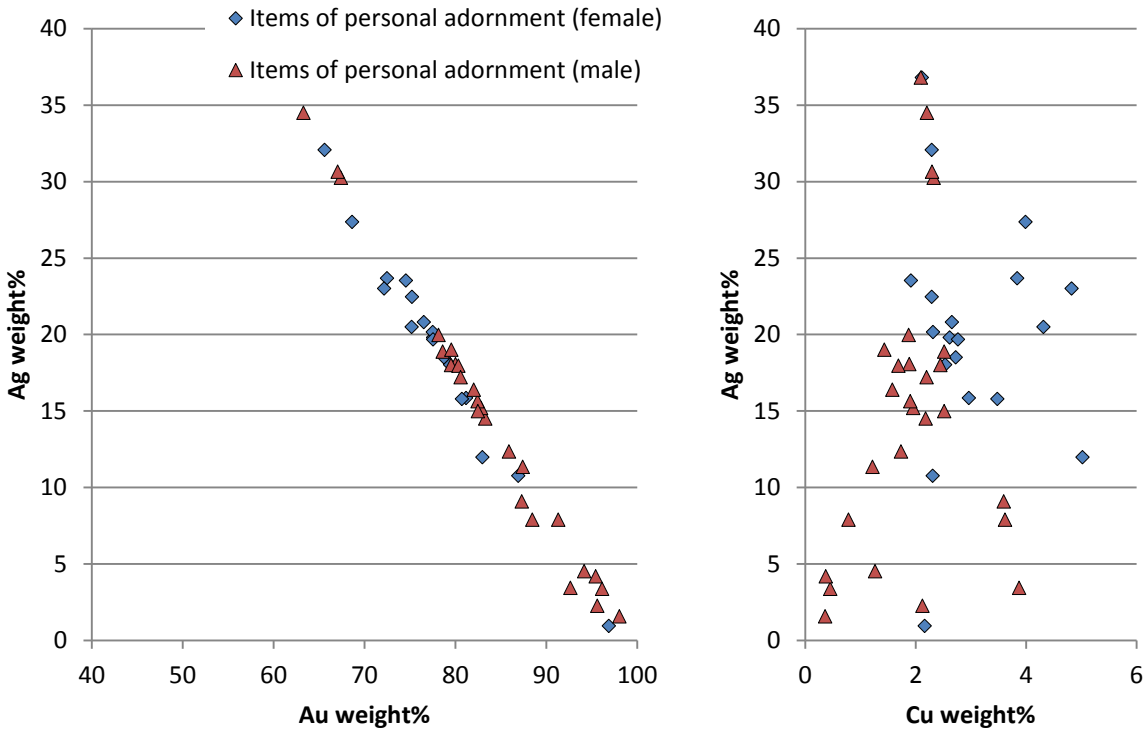


Figure 59. Plots of sub-surface gold *vs* silver and copper *vs* silver contents of sheets and bodies that form the male and female items of personal adornment.

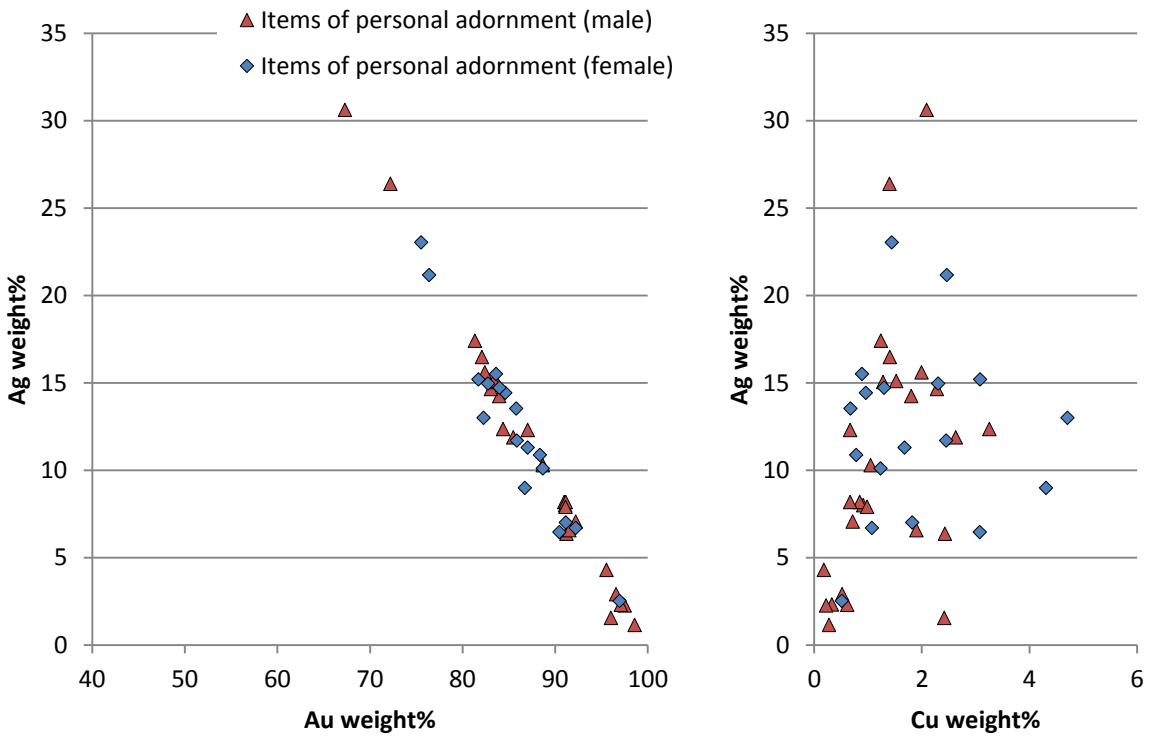


Figure 60. Plots of surface gold *vs* silver and copper *vs* silver contents of sheets and bodies that form the male and female items of personal adornment.

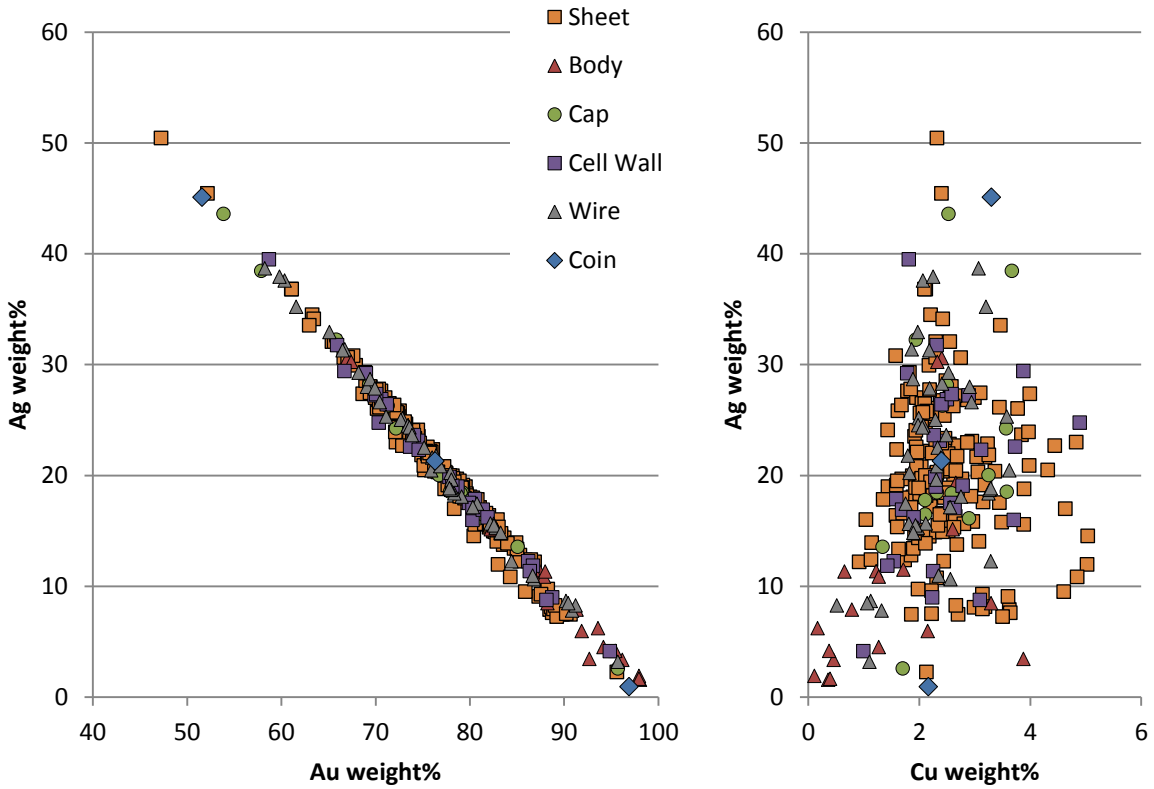


Figure 61. Plots of sub-surface gold *vs* silver and copper *vs* silver content of the different components analysed.

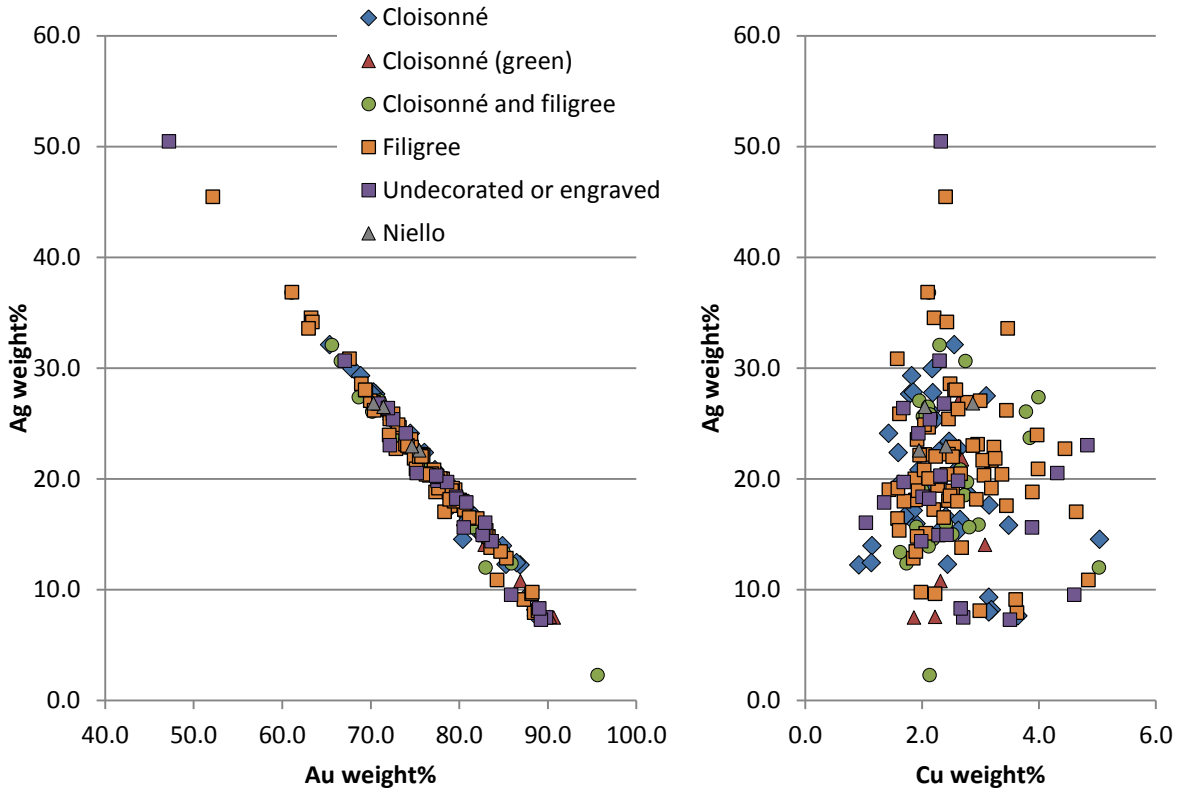


Figure 62. Plots of sub-surface gold *vs* silver and copper *vs* silver contents of the sheets used in pieces with different styles of decoration.

References

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Staffordshire Hoard Research Reports

Staffordshire Hoard Research Reports were produced by the project

Contextualising Metal-Detected Discoveries: Staffordshire Anglo-Saxon Hoard

Historic England Project 5892

The Staffordshire Hoard is owned by the Birmingham City Council and the Stoke-on-Trent City Council and cared for on their behalf by Birmingham Museums Trust and The Potteries Museum & Art Gallery.

The Staffordshire Hoard research project was conducted by Barbican Research Associates Ltd and funded by Historic England and the owners.

This report was funded in part by the British Museum.

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