Crimean Metalwork : Analysis and Technical Examination

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Compositional analysis

Techniques

Two analytical techniques were used in the investigation of the jewellery: energy dispersive X-ray fluorescence (XRF) and X-ray diffraction (XRD). X-ray fluorescence (XRF) was used to determine the metal composition of the artefacts and, since many of the artefacts are composite, in some cases the individual components were analysed to establish their integrity. X-ray diffraction analysis was used to identify the inlay materials.

The instrument used for XRF analysis was a modified Link Analytical 290 spectrometer incorporating a molybdenum target X-ray tube operated at 45kV which analyses an area about 1.5 mm in diameter on the artefact.[1] XRF is essentially a surface method since, due to the low penetration of X-rays, the analysed depth rarely exceeds 100 μm (0.1 mm). Hence, to obtain an accurate analysis of an artefact, the exposed surface must be representative of the bulk composition. The surface compositions of most ancient artefacts have usually been altered by corrosion processes, either through leaching of less noble metals (e.g. copper, leading to an apparent *surface enrichment* of the more noble metals, such as silver and gold) or a build-up of corrosion products. Consequently the surfaces are not representative of the bulk. These problems can be overcome by preparing the surface, for example by abrasion, to expose a representative surface, but this was not generally possible with these artefacts. Those analyses carried out with no surface preparation (i.e. non-destructively) are therefore at best semiquantitative (i.e. approximate) or only qualitative.

For the gold jewellery, where corrosion deposits are usually absent, there will be some alteration of the surface composition so that only semiquantitative analysis is possible. The non-destructive analysis results are likely to show an overestimation of the gold and possibly the silver contents and a corresponding under-estimation of the copper. The precision (reproducibility) of these analyses is about ±1-2% relative for the major component (gold) and about ±5-20% relative for silver and copper; the accuracy cannot be defined because of the uncertain surface enrichment effects. In the case of artefacts made of silver or copper-based alloys, the surface alteration may be more extensive so that only a qualitative analysis was justifiable. Thus, only the alloy type was recorded with a note of any traces of other metals. The alloy terminology is as follows:

brass	alloy of copper with zinc.
bronze (or tin bronze)	alloy of copper with tin.
leaded bronze	alloy of copper with tin and lead.
gunmetal	alloy of copper with tin and zinc.
leaded gunmetal	alloy of copper with tin, zinc and lead.

For the limited number of artefacts where a small area could be abraded, the analytical precision is about ±1–2% for the major components (greater than 50%), about ±5–10% for the minor components (5–50%) and ±10–50% for the remaining trace components. The accuracies are expected to be similar.

X-ray diffraction was used to identify the inlay materials where microscopic examination was not conclusive. The technique determines the mineralogy, or the chemical structure of compounds.

Results and discussion of analyses

The fully quantitative, semi-quantitative and qualitative analyses are listed respectively in **Tables 1–3**.

Gold-based alloy artefacts

These artefacts are gold-silver-copper ternary alloys with gold contents generally in excess of 75% and covering a wide range of compositions. The silver content is usually higher than that of the copper which is typical of early gold alloys; some of the backing panels of earrings appear to be rich in copper but this may be due to contamination from a copper-rich solder. Although the artefacts as a whole have a wide range in composition, the components of individual artefacts tend to have similar compositions, as noted in the individual catalogue entries. An exception to this is one of the pendants (**cat. no. 105**) where the composition of the small pyramid component is quite different from that of the main part of the artefact.

The composition of this gold metalwork is not particularly distinctive by comparison with ancient goldwork in general. Most of the gold items which have been analysed are within the range of composition of Late-Roman (e.g. 4th–5th centuries AD) and Byzantine (post-5th century AD) gold coinage and could in theory have used coins for their raw material.[2] However, these analyses can only indicate this as a possibility and cannot prove such a connection.

Silver-based alloy artefacts

Only a limited number of silver items were analysed quantitatively; these are similar in composition being base silver-copper alloys (50–75% silver) with small amounts of lead, zinc, tin and gold. The qualitative analyses are generally consistent with this. This type of alloy is similar to items of jewellery analysed from the Martynivka (Martynovka) hoard.[3] The gold in the alloy is probably derived from the ore from which the silver was extracted and the lead is derived both from the ore type (usually silver-rich galena, lead sulphide) and the method of refining (cupellation). The zinc and tin are probably derived from the use of brass or bronze to alloy with the silver rather than pure copper.

Copper-based alloy artefacts

Only two of the copper-based artefacts were analysed quantitatively. Combined with the qualitative analyses these cover a wide range of alloy types, from almost pure copper to brass, bronze and more complex alloys such as gunmetals (copper-tin-zinc). These are all typical of the period. The metal used for particular components shows that the properties of the alloys were understood; copper was used for backing sheets and rivets, brass may have been used in some jewellery items for its golden colour (for example brooch, **cat. no. 22**). The apparent use of brass and bronze to alloy with the silver (as noted above) is an indication of the wider use of such alloys.

Mercury gilding

Several copper-based and silver-based articles are plated with gold using the technique of mercury or fire-gilding. This was carried out by applying an amalgam of mercury and gold to the surface of the artefact and heating to above 350°C to drive off the mercury, leaving a thin plating of gold. The surface then had to be burnished. This method may be revealed by the detection by XRF of small amounts of mercury which remain in the plating. This technique of gilding was widely used from the Roman period onwards.[4]

Platinum group element (PGE) inclusions

A small number of the gold artefacts (e.g. **cat. nos 1, 11 and 105**) have observable white metal inclusions on the surface. These are platinum group element (PGE) grains, usually alloys of osmium, iridium and ruthenium, which have a high density and melting point;[5] they are not generally dissolved in the gold alloy when this is simply melted for casting although they may be attacked by certain refining operations.[6] The presence of such inclusions is an indication that the gold has originated from an alluvial source rather than mined gold, but as the inclusions on an individual artefact have been found to range widely in composition, in general they cannot be used to locate the gold to a particular source.

Summary of the Technical Examination

Most of the more complex pieces of jewellery were examined microscopically and details of construction of individual items are included in their catalogue entries. Some features are common to many of the pieces and there are a small number of items of jewellery which stand out by reason of manufacturing techniques or materials used. Both these aspects are discussed here.

Restoration

A problem which should be mentioned straight away is the difficulty in establishing how much the pieces were altered or embellished by restoration after excavation, but before entering the British Museum's collection. Some features, such as modern adhesives, are easily recognised, but the use of beeswax or gypsum (plaster of Paris) as adhesives or for reinforcement could be ancient or modern. A specific example of the problem of attributing original workmanship is a gilt-silver buckle (**cat. no. 75**) with a triangular insert of clear glass with three blue blobs. This type of glass decoration was used for vessels during the 4th and 5th centuries[7] and the curvature of the fragment does suggest that it could be re-used vessel glass. Re-use of Roman materials such as glass and intaglio gems was common in the centuries after the collapse of the Roman Empire, but the long edges of this fragment of glass are very smooth and straight, as if cut by a powered cutting-wheel, suggesting the glass may be a modern restoration. A number of the gemstones do not fit their settings, but is this evidence that they are replacements or is it simply poor workmanship? Some pieces may have been in use over long periods, with repairs and embellishments, becoming family heirlooms before they were finally lost or buried. Others acquired the repairs and embellishments after they were taken out of the ground. Without full excavation records, which are not available for this collection, all such information is lost. Where there are obvious doubts about the antiquity of a decorative feature a comment has been inserted in the catalogue entry, but it cannot be assumed that everything else described is an original feature.

A number of pieces show evidence of extensive wear, particularly on the suspension loops of earrings, but sadly there are others which have been so ferociously chemically stripped of their corrosion products (before acquisition by the British Museum) that all evidence of tool marks or wear has been completely obliterated.

Construction Techniques

Most of the items of jewellery in this catalogue are composite: they are made of several components, sometimes of different materials. Joining methods include soldering as well as mechanical joints such as rivets and crimping.

The majority of the cast objects are silver or copper alloys. The techniques employed in the manufacture of the gold jewellery are mostly based on sheet metalwork and wire and, not surprisingly, the shapes of the jewellery were particularly suited to this approach. Where three-dimensional shapes in gold are used, they are hollow. This is for reasons of economy and, in the case of earrings, probably for lightness. For example, the large, hollow bead of gold earring **cat. no. 8** is filled with sulphur. Molten sulphur was commonly used in Hellenistic and Roman hollow gold jewellery and there was continuity of this technique into later periods. The molten sulphur was poured in after all soldering was completed and, when set, it provided support for the thin gold without adding noticeably to the weight.[8]

Wire and granulation

Wire is a common decorative feature, particularly of the gold jewellery. No evidence for drawn wire was found. The simplest forms were the relatively thick, hammered wires used for earring suspension loops. Twisted, square-sectioned wire was used decoratively (e.g. **cat. no. 3**; **Pl. 65**). Round wire was often made by a combination of tightly twisting a thin strip of metal, then rolling it between two blocks of wood or other flat, hard material to smooth the surface.[9] The spiral seam typical of twisted wire can often be seen (e.g. **cat. no. 1**; **Pl. 66**). The commonest form of decorative wire found in this collection is beaded wire. It was made by rolling a round wire under an edged tool and repeating this at regular intervals along the length of the wire. The wire was constricted under the tool and the metal bulged out each side. A tool with two or more edges would be more efficient than a single blade. The regularity of

the spacing and pressure of the beading tool determined the evenness of the finished wire, which was of very variable standard (compare the beading on **cat. nos 29D and 13** in **Pls 67 and 68**). Beaded wire was soldered around the edge of gem settings or the complete object as a collar or frame. An interesting variation on this is seen on a gilt-silver brooch (**cat. no. 15**; **Pl. 69** and on two mounted gems (**cat. no 29G–H**; **Pl. 70**). In these and other examples the frame is made up of a border of granules. Granulation was used decoratively on a number of pieces, mostly gold jewellery (see **Pl. 66**). The granulation and the wire-work all have their origins in antiquity.

Gems and glass

The identification of inlay and backing materials was carried out initially by optical microscopy with up to x50 magnification, and, where necessary, micro-samples were taken for X-ray diffraction analysis using a Debye-Scherrer powder diffraction camera.[10] It was found that the range of inlay materials was limited. The commonest gem material is garnet. Coloured glass, especially green, blue and brown, is found on many items. Enamel is rare (**cat. no. 104**) though this may reflect its fragility rather than lack of use. No niello inlays were found and the only example of faience (a pendant, **cat. no. 9**) is of doubtful origin. Carnelian, which is a variety of microquartz ranging in colour from red to orange, was used for cabochon gem settings (**cat. nos 29I, J, K, 32, 35–37 and 41–43**) and the only intaglio is a carnelian (**cat. no. 108**). **Catalogue no. 83** is a chalcedony ball in a silver sling. This is an opaque, whitish microquartz (the nomenclature used here for the quartz gem materials follows that of Sax).[11] Other gems such as amethyst (**cat. no. 39**) and agate (**cat. no. 138**) may not be original to this assemblage. One interesting inlay material is the square of white cristobalite (SiO_2) in the centre of the bezel of an East Germanic gold and garnet ring (**cat. no. 13**). Cristobalite is a soft, white mineral which is occasionally found as an inlay in Merovingian[12] and Anglo-Saxon garnet jewellery.[13]

Garnets were used, both flat cut and cabochon. The thickness of the flat cut garnets is very variable, though this is difficult to quantify with the garnets *in situ*. There is also considerable variability in the quality of finish of the edges. The finely drilled, circular grooves to take gold inlay, in the garnets of **cat. no. 24A**, are in marked contrast to the poor shaping of their edges which suggest re-use (**Pl. 71**). Many cloisonné garnets have one or more rough edges, suggesting re-use of stones. Well-finished, bevelled edges on well-fitting stones are not common in this assemblage.

Some, but by no means all, cloisonné inlays have foils behind them to improve the reflecting quality of the stones and also to wedge the gems into their settings. Where gold foils are found in this collection they are usually smooth and unpatterned (for example **cat. nos 4, 5, 12, 25, 26, 29A, 29E, 29F, and 70**). Gold foils were only used in the gold jewellery. Gilt-silver foils do not survive well, but were identified under both flat and cabochon garnets on the gold necklace pendants of **cat. no. 9**. On several of the items traces of silver foils were identified, both patterned (e.g. **cat. no. 24**) and plain (e.g. **cat. no. 23**). A red glass inlay on a strap-end (**cat. no. 90**), is backed by a metallic tin foil.

Cloisonnés in this type of jewellery often contained a backing paste which was soft when the stones were being set, allowing the jeweller to level the surfaces of all the stones, whatever their thickness. Access for analysis to the backing pastes behind these gems was only possible in a few cases, for example, the white paste underneath the garnets and foils of the bird-headed mounts (**cat. no. 24**) was identified as calcite ($CaCO_3$), as was the paste under the clear glass cabochons of buckle, **cat. no. 82**. Calcite occurs geologically as chalk, limestone and marble. Backing pastes for gemstones are made from finely crushed calcite, perhaps mixed with an organic binder like beeswax, though no binder could be identified in these pastes.[14]

Coloured glass was common, particularly green, and glass was also used to imitate garnet. An interesting example of this is seen on two belt suspension mounts (**cat. no. 91**) and a strap-end (**cat. no. 90**) which have brownish glass inlays with a layer of red ochre behind them to make the colour more like garnet. The strap-end also has one red glass inlay, probably coloured by manganese. There was no ochre behind this, but it has a foil of metallic tin, as mentioned above. Base metal foils and the use of coloured backings to improve translucent gems rarely survive burial, but there is no reason to doubt their antiquity on these pieces.

Conclusions

The alloys used for the jewellery are typical of the period when compared with Late-Roman and Byzantine artefacts and the alloy types are generally suitable for the methods of manufacture involved. The repertoire of decorative and manufacturing techniques seen on the objects in this collection is not great, but there is considerable variation in the quality of execution. The evidence for re-use of garnets is widespread, and the poor quality and quantity of materials used suggest that economy was an important consideration in the manufacture of most of the pieces. Nevertheless there is obvious continuity in jewellery-making traditions from the classical world.

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Notes

1 Cowell 1998
2 Morrisson *et al.* 1985
3 Pekarskaja and Kidd 1994
4 Oddy 1993
5 Meeks and Tite 1980
6 Bowditch 1973
7 Sazanov 1995
8 Ogden 1982, 40
9 Whitfield 1990; Oddy 1977
10 Azaroff and Buerger 1958
11 Sax 1996, 63–72
12 Arrhenius 1985, 38
13 La Niece 1988
14 Arrhenius 1971, 78–97

Table 1 Semi-quantitative X-ray Fluorescence analyses

Cat. no.	Description	Part	%Au	%Ag	%Cu	Comments
1	Earring	Back sheet	75	22	3	
2	Earring	Backing sheet	91	4	5.4	
2		Loop	91	7	2.0	
3	Earring	Body	88	10	2.0	
3		Twisted wire	88	10	1.3	
4	Earring	Back-plate	93	6	1	
5	Earring	Cell side	91	8	1	
5		Granulation area	90	7	3	May include solder
6	Earring	Hoop	78	19	3	
7	Earring (Inv. no. 64)	Cell side	93	5	2	
7	Earring (Inv. no. 65)	Cell side	62	32	6	Difference between pair
8	Earring	Cell side	86	9	5	
9	Necklace	Sheet around pendants	79	10	11	
9		Spacers	85	11	4	
10	Pendant	Base-plate	90	8	2	
11	Pendant	Base-plate main part	90	8	2	
11		Base-plate addition	90	8	2	
12	Finger-ring	Sheet around cell	83	14	3	
13	Finger-ring	Sheet around cells	85	11	4	
13		Hoop	84	11	5	
14	Brooch	Back hinge	64	32	3	
14		Back catch-plate	64	33	3	
15	Brooch	Back sheet, ungilded	1	68	32	May be contaminated by gilding
23	Mounts	Cell side	99	0.7	0.2	
24	Mount	Bird: gold strip	86	11	3	
26	Strap-attachment	Body, front	79	19	3	
28	Stud	Beaded rim	81	18	2	May include solder
29A	Stud	Cell side	86	12	2	
29B	Stud	Back of cell	74	22	3	
29C	Stud	Back of cell	78	19	3	
29D	Stud	Back of cell	89	10	1	
29E	Stud	Back of cell	79	18	3	
29F	Stud	Back of cell	78	19	3	
29G	Stud	Back of cell	71	25	4	
29H	Stud	Back of cell	40	51	9	Silver solder or gilded ?
29I	Stud	Back of cell	95	1	4	
29J	Stud	Back of cell	94	1	5	
29K	Stud	Back of cell	96	1	3	
70	Buckle	Loop	89	9	2	
70		Side of cell	88	9	2	
71	Buckle-tongue	Body	92	7	1	
72	Buckle	Cell side	84	12	4	
84	Earring	Body	95	4	2	
85	Earring	Body	90	8	2	
86	Pendant	Body	89	7	5	
87	Kolt	Body	97	1	2	
100	Brooch	Body	82	15	2.9	
101	Brooch	Body	91	7	2.2	
102	Brooch	Body	88	10	1.5	
103	Brooch	Body	66	30	3.9	
104	Pendant	Body	83	13	3.9	
104		Loop	81	14	5.0	
105	Pendant	Pyramid	97	3	0.7	
105		Large ring	73	23	4.4	
105		Loop	69	24	7.2	
106	Earring	Body	72	24	4.1	
106		Bead	74	23	2.9	
106		Suspension loop	76	21	2.8	
107	Earring	Back-plate	83	14	2.3	
107		Body	84	14	1.7	
108	Earring	Body	76	19	5.0	
108		Wire hook	76	22	3.0	
109	Earring	Back sheet	92	6	2.0	
109		Twisted wire	95	4	0.8	
109		Wire hook	93	6	1.0	
110	Pendant/Earring	Back-plate	95	4	0.7	
110		Body	93	6	0.7	
111	Earring	Body, side	95	4	1.2	
111		Backing plate	93	5	1.5	
111		Backing plate	94	5	0.8	Abraded
111		Loop	93	7	0.4	

Note: The majority of analyses are on the unabraded surface and are therefore approximate. There may be some bias in the results due to surface enrichment.

Table 2 Quantitative X-ray Fluorescence analyses, on abraded surfaces

Cat. no.	Description	Ag	Cu	Pb	Zn	Sn	Au
19	Brooch (Inv. no. 39)	69	23	3	1	1	3
19	Brooch (Inv. no. 40)	61	32	2	1	2	2
20	Brooch (Inv. no. 41)	58	38	1	2	<0.1	1
20	Brooch (Inv. no. 42)	56	41	0.5	1	<0.1	1
21	Brooch (Inv. no. 43)	57	35	2	3	2	1
21	Brooch (Inv. no. 44)	58	37	0.5	3	0.5	1
22	Brooch	<0.1	81	2	16	0.5	<0.1
44	Mount	75	23	<0.1	0.5	<0.1	0.5
57	Buckle	<0.1	99	0.1	<0.1	0.5	<0.1
80	Buckle	64	27	2	3	2	2
82	Mount	46	46	2	3	1	0.5

The precision of major elements (e.g. Ag, Cu) is 1-2%, others ± 10-25%. The accuracy is similar.

Table3 Silver and copper-based artefacts: Qualitative X-ray fluorescence analyses

Cat. no.	Description	Part	Analysis
16	Brooch	Body	Silver-copper, traces of lead, zinc, gold
17	Armlet	Body	Silver-copper alloy with traces of zinc, tin
18	Armlet	Body	Silver-copper alloy with traces of zinc
19	Brooch (Inv. no. 39)	Body	Base silver-copper, traces of lead, zinc, tin, gold
19	(Inv. no. 40)	Body	Base silver-copper, traces of lead, zinc, tin, gold
20	Brooch (Inv. no. 41)	Body	Base silver-copper, traces of lead, gold
20	Brooch (Inv. no. 42)	Body	Base silver-copper, traces of lead, gold
21	Brooch (Inv. no. 43)	Body	Base silver-copper, traces of lead, zinc, tin, gold
21	Brooch (Inv. no. 44)	Body	Base silver-copper, traces of lead, zinc, tin, gold
22	Brooch	Body (abraded)	Brass with trace of lead
27	Mount	Side panel	Gilded copper
27		Back	Copper with traces of zinc and tin
30	Stud (Inv. no. 99)	Base	Brass
30		Collar	Mercury gilded brass
30	Stud (Inv. no. 100)	Body	Gilded copper
31	Mount	Back-plate	Base silver-copper, traces of zinc and tin
31		Tongue backing	Copper
31		Rivet on tongue	Copper
32	Mount	Back-plate	Copper with traces of lead
32		Front sheet	Mercury gilded silver
32		Domed rivets	Silver-copper alloy, traces of gold
33	Mount	Back-plate	Copper
33		Front sheet	Gilded silver (mercury not detected by XRF)
33		Rivet	Silver
34	Mount	Back-plate	Copper
34		Front sheet	Mercury gilded silver
34		Rivet	Silver
34		Silver sheet	Silver-copper alloy, traces of gold and lead
35	Mount	Back-plate	Copper
35		Rivet	Silver-copper alloy
36	Mount	Back-plate	Copper
36		Rivet	Silver-copper alloy
37	Mount	Back-plate	Copper with traces of tin
38	Mount	Silver sheet	Silver-copper alloy, traces of lead and gold
39	Mount	Silver sheet	Silver-copper alloy, traces of lead and gold
40	Mount	Back-plate	Silver-copper alloy, traces of zinc
40		Rivet	Base silver-copper alloy with zinc
41	Mount	Cell at back	Base silver-copper alloy, traces of lead, zinc, tin
41		Outer base-plate	Base silver-copper, traces of zinc and tin
41		Backing plate	Copper with traces of tin
42	Mount	Inner base-plate	Tin bronze with traces of arsenic
42		Outer back-plate	Base silver-copper, traces of zinc and lead
42		Side joint solder	Tin-lead solder
43	Mount	Underlying base	copper with traces of tin
43		Front sheet	Silver-copper alloy, traces of lead and tin
44	Mount	Front sheet	Silver-copper alloy, traces of zinc and gold
44		Back sheet	Base silver-copper alloy, traces of zinc and gold
45	Buckle	Rivet-head	Gold-silver alloy
45		Loop	Silver-copper alloy, trace of lead and gold
46	Buckle	Rivet-head	Silver-copper alloy, trace of gold
46		Loop	Silver-copper alloy, trace of gold
47	Buckle	Loop	Copper
48	Buckle	Tongue	Silver-copper alloy
48		Loop	Silver-copper alloy
49	Buckle	Body	Brass with trace of tin
49		Tongue	Brass with trace of tin
50	Buckle loop (Inv. no. 138)	Body	Base silver-copper, traces of gold, zinc

Cat. no.	Description	Part	Analysis
50	Buckle loop (Inv. no. 139)	Body	Silver-copper alloy
51	Buckle	Loop	Silver-copper alloy
52	Buckle	Loop	Silver-copper alloy
53	Buckle (Inv. no. 140)	Loop	Silver-copper alloy with gold
53	Buckle (Inv. no. 141)	Loop	Silver-copper alloy with gold
53	Buckle (Inv. no. 141)	Loop attachment	Silver-copper alloy with gold
54	Buckle	Body	Tin bronze
55	Buckle	Body	Tin bronze
56	Buckle	Loop	Copper with trace of tin
57	Buckle	Body	Copper
58	Buckle	Body	Copper
59	Buckle	Loop	Tin bronze
60	Strap-distributor (Inv. no. 122)	Attachment	Silver-copper alloy, traces of lead and gold
60		Ring	Leaded bronze, traces of zinc
60	Strap-distributor (Inv. no. 127)	Attachment	Base silver-copper alloy, traces of tin and gold
61	Strap attachment	Body	Bronze
62	Strap attachment	Body	Brass with trace of tin
63	Mount	Body metal strip	Silver-copper alloy, traces of lead, tin, gold
64	Mount	Body metal strip	Silver-copper alloy, traces of lead, zinc, tin
65	Mount	Body	Silver-copper alloy, traces of lead, tin
66	Mount	Backing sheet	Base silver-copper alloy, traces of lead, tin
67	Mount	Backing sheet	Silver-copper alloy, traces of lead, gold
68	Mount	Sheet strip	Base silver-copper alloy, traces of lead, tin
69	Mount	Sheet strip	Base silver-copper alloy, traces of tin, lead
73	Buckle	Plate	Silver
74	Buckle	Loop front hinge	Base silver-copper, traces of lead, tin
75	Buckle	Front-plate	Mercury gilded silver
75		Back-plate	Base silver-copper alloy, traces of zinc
75		Tongue	Base silver-copper alloy, traces of zinc
76	Buckle	Body	Copper with traces of lead
76		Loop	Leaded gunmetal
77	Buckle	Body, side	Brass
77		Tongue	Brass
78	Buckle	Body	Brass
78		Loop	Brass
79	Buckle	Tongue	Brass with some tin
79		Loop	Mercury gilded silver
80	Buckle	Body	Base silver-copper with zinc, lead and tin
80		Rivet	Brass
81	Buckle	Body	Base silver-copper alloy, traces of tin, lead and zinc
81		Tongue	Gilded silver-copper, traces of tin and lead
81		Garnet setting base	Copper with traces of zinc
81		Folded flap	Copper
83	Sword fitting	Sling	Silver-copper alloy, traces of lead, tin and gold
88	Buckle	Plate	Leaded gunmetal
88		Tongue	Brass
89	Buckle	Body	Leaded gunmetal
90	Strap-end	Body	Base silver-copper, traces of gold
91	Belt mount (Inv. no. 36)	Body	Silver-copper, traces of gold and lead
91	Belt mount (Inv. no. 37)	Body	Silver-copper, traces of gold, lead and zinc
92	Belt mount (Inv. no. 34)	Body	Silver-copper, traces of gold, lead and zinc
92	Belt mount (Inv. no. 35)	Body	Silver-copper, traces of gold, lead and zinc
92		Pin	Copper
114	Buckle-plate	Body	Brass
115	Belt mount	Body	Leaded gunmetal
117	Earring	Body	Silver-copper alloy
118	Brooch	Body	Base silver-copper alloy, traces of lead and tin
118		Pin	Base silver-copper alloy, traces of lead and tin
131	Earring (Inv. no. 114)	Hoop	Silver-copper alloy, trace of lead
131		Sphere	Silver-copper alloy, trace of lead
131	Earring (Inv. no. 115)	Large sphere	Silver-copper alloy
132	Earring (Inv. no. 96)	Body surface	Mercury gilded (includes silver) on copper
132	Earring (Inv. no. 97)	Body surface	Mercury gilded (includes silver) on copper
132		Sample of interior	Silver and copper detected
133	Armlet (Inv. no. 117)	Body	Silver-copper alloy, traces of lead and gold
133	Armlet (Inv. no. 118)	Body	Silver-copper alloy trace of gold
135	Ring	Body	Silver-copper alloy, traces of gold
136	Mount	Front	Silver-copper alloy, trace of gold
136		Backing sheet	Copper with trace of tin
137	Mount (Inv. no. 146)	Body	Silver-copper alloy, traces of tin and lead
137	Mount (Inv. no. 147)	Body	Silver-copper alloy
137	Mount (Inv. no. 148)	Body	Silver-copper alloy, traces of gold

Plate 65 Detail of twisted square-sectioned gold wire, bordering garnet earring GR 1981,9-5,4 (**cat. no. 3**).

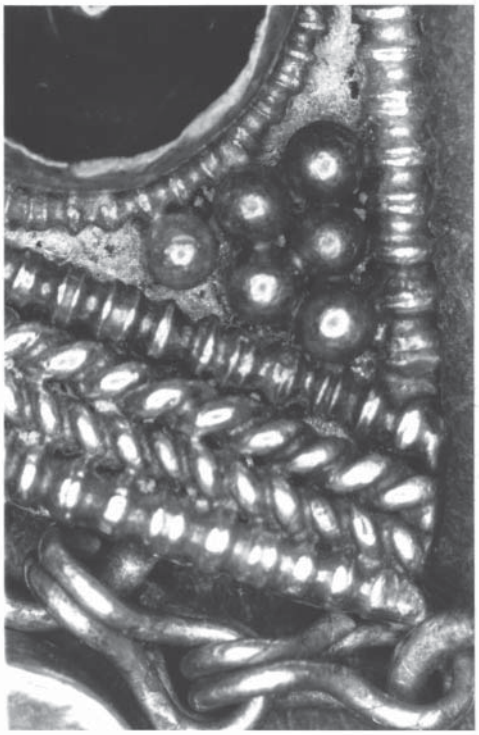


Plate 66 Detail of earring pendant P&E 1923,7-16,11 (**cat. no. 1**) showing several examples of filligree. The loop-on-loop chain has a spiral crease (**arrowed**) typical of wire made by twisting. The border is made up of beaded wire, granulation and a 'false-plait' all soldered to the base plate. The false-plait is formed from two pairs of wires, twisted like rope and laid side by side with opposite direction of twist.

Plate67 Garnet stud with beaded-wire border, P&E 1923,7-16,32 (**cat. no. 29D**).

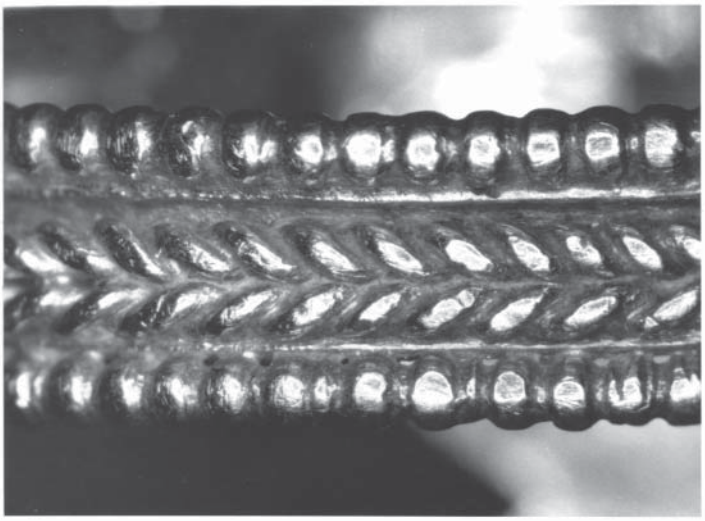


Plate 68 Detail of the hoop of ring P&E 1923,7-16,15 (**cat. no. 13**). It is decorated with a false-plait, bordered with beaded wire and shows evidence of wear.

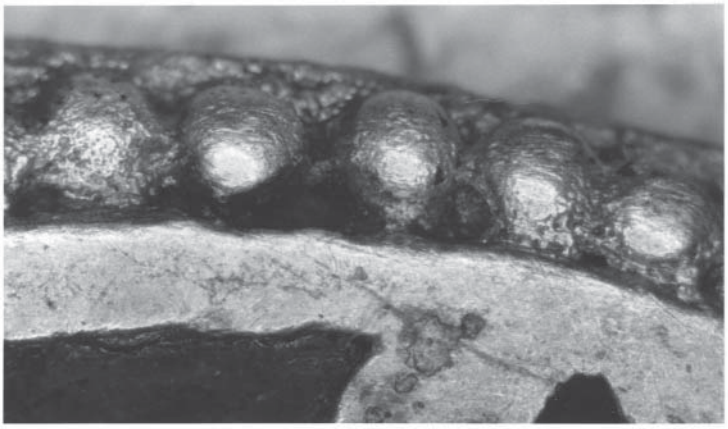


Plate 69 Detail of the border of gilt silver and garnet brooch, P&E 1923,7-16,73 (**cat. no. 15**). The border is made up of silver granules soldered to the base-plate before gilding.

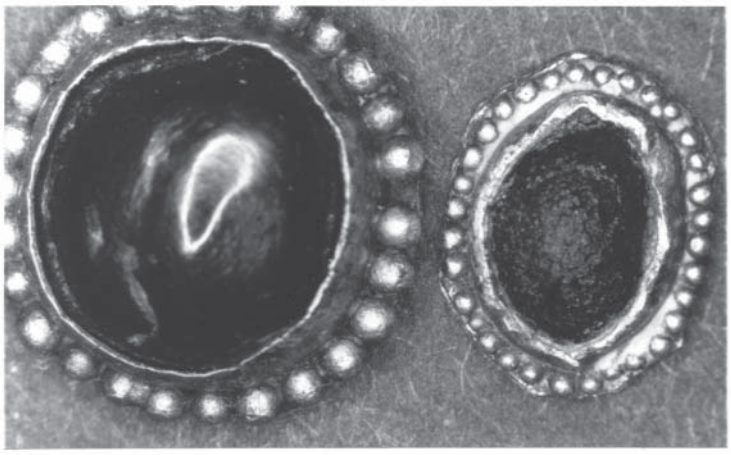


Plate 70 Cabochon garnet stud and a smaller stud of green glass P&E 1923,7-16,32 (**cat. no. 29 G–H**). Their borders are made up of individual granules soldered onto the base-plate.

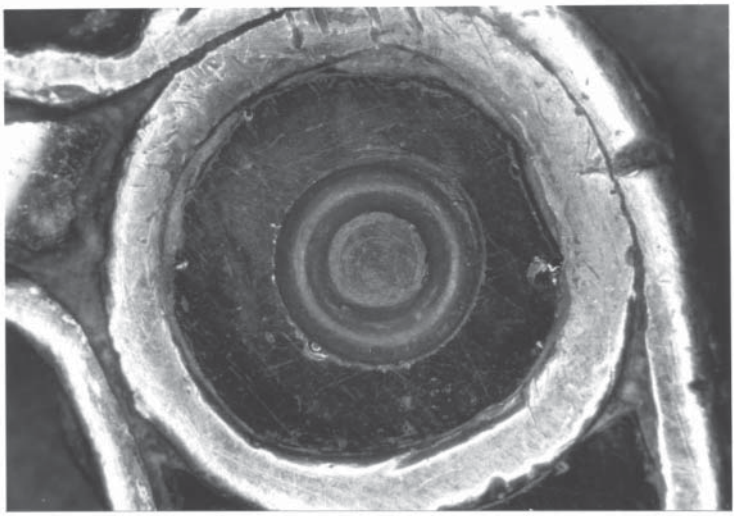
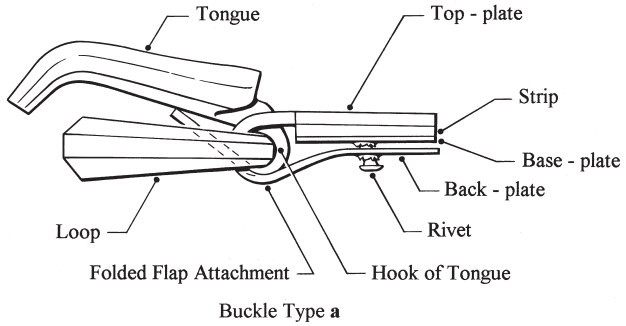


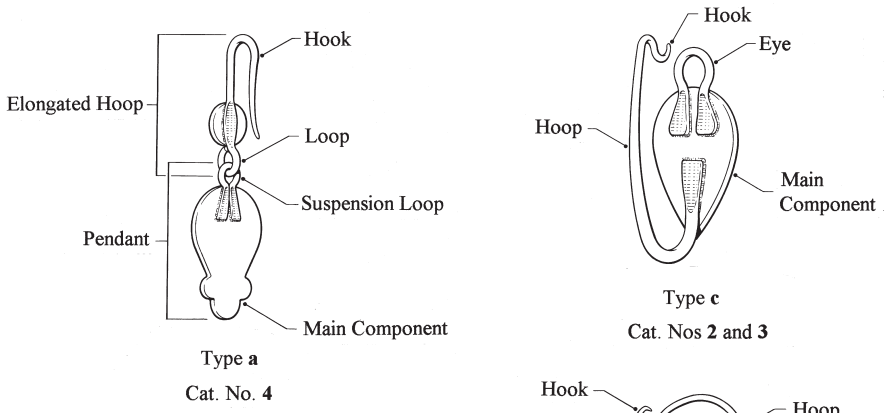
Plate 71 Detail of a garnet bird-head mount, P&E 1923,7-16,12 (**cat. no. 24A**). This circular garnet has been recut – note the straight edge on the right. The ring in the centre once held a gold inlay.

Glossary

Agate	A banded variety of microcrystalline quartz.
Amethyst	A purple variety of macrocrystalline quartz.
Beaded wire	Ornamental wire imitating rows of grains, produced by rolling a round section wire under either a single-edged, or a multiple-edged, tool, or by using a matching pair of swage blocks (organarium).
Brass	A golden-coloured alloy of copper with zinc.
Bronze	An alloy of copper with tin.
Buckle	Component parts see **Fig. 1 a, b, c**
Burnishing	Polishing a metal surface with a hard, smooth tool, usually of stone.
Cabochon	A stone with a convex surface and usually a flat base.
Carnelian	A variety of microcrystalline quartz ranging in colour from red to orange.
Chalcedony	A variety of microcrystalline quartz, usually of pale colour.
Chasing	A technique of metal decoration. A blunt tool known as a tracer or chasing tool is hammered into the metal while being moved across the surface in a smooth, continuous sequence. Chasing produces a groove by displacing the metal, not removing it (unlike engraving – see below).
Chip-carving	A style of decoration of sharply angled facets, also called 'kerbschnitt'. It is believed to have had its origin in the carving of softer materials such as wood and bone, and was done with metal chisels on bronze. The same name is also applied to cast metalwork for which the wax models were carved in this style.
Cloison	A strip of metal soldered to a base forming a cell and enclosing a stone (or enamel) of the same shape.
Cloisonné	A technique of stone setting (or enamelling) in which the stones are contained in cloisons. Most commonly used for flat pieces of stone.
Drawn wire	Method of wire production, that is pulling of a rod of metal through successively smaller holes in a draw-plate, thus making it longer and thinner. During the process the wire has to be annealed to restore its ductility.
Earring	Component parts see **Fig. 2 a-e**
Engraving	A technique of metal decoration. A sharp tool known as a graver is used to remove a sliver of metal and produce a groove. The graver is pushed into the metal by hand, not with a hammer (see chasing above).
Faience	A fired ceramic of ground quartz with an alkaline glaze, usually blue or green.
Filigree	Decoration with fine wire, normally of gold or silver, but also other metals.
Granulation	The decoration of a surface with tiny, spherical grains of metal.
Gunmetal	An alloy of copper with tin and zinc.
Hammered wire	Wire that is produced by hammering a strip or rod of metal into shape. Hammered wires are characterised by their slightly irregular cross-section.
Leaded bronze	An alloy of copper with tin and lead.
Leaded gunmetal	An alloy of copper with tin, zinc and lead.
Mercury gilding	Also known as fire-gilding. A method of plating gold onto silver- or copper-based objects by applying an amalgam of mercury and gold to a well-prepared surface, heating to drive off the free mercury, and then burnishing the plating.
Organarium	A tool for making beaded wire in which the wire is compressed between two dies or swage blocks.
Platinum group element (PGE) inclusions	Very small (only the largest are visible to the naked eye) white metallic inclusions in gold. These are usually alloys of osmium, iridium and ruthenium (rarely platinum). They are indicative of gold from an alluvial source, rather than mined gold.
Punching	Indenting an object, or impressing a shape or pattern on it by using a punch and a hammer.
Repoussé	Decorating sheet metal in relief from the back. In the process there is no loss of metal, as it is stretched locally and the surface remains continuous, though it may be cut through later. Often combined with chasing.
Swage blocks	A perforated or grooved block of metal which is used to shape rod or wire.
Twisted wire	Round-section wire was manufactured by tightly twisting strips or square sectioned rods of metal then rolling them between flat surfaces to produce a regular round-section wire. Wires made by this method are recognisable by the spiral crease left by the twisting (**arrowed in Pl. 66 above**).



Glossary Figure 1 Identification of buckle components



Glossary Figure 2 Identification of earring components