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FERRY FRYSTON, SITE D, YORKSHIRE
FREEZE-LIFTING, CONSERVATION AND ANALYSIS OF GRAVE GOODS FROM AN EARLY BRONZE AGE BURIAL

ARCHAEOLOGICAL CONSERVATION REPORT

Jennifer Jones

ARCHAEOLOGICAL SCIENCE

ENGLISH HERITAGE

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SUMMARY

A soil block from an early Bronze Age inhumation was freeze lifted. The laboratory excavation recovered a variety of copper alloy artefacts, some with mineral preserved remains. The metalwork and a ceramic vessel from the grave were investigated and conserved, and EDXRF and SEM analysis work were undertaken on the metal and mineralised material.l

ACKNOWLEDGEMENTS

I would like to thank Sonia O'Connor of Bradford University for assistance with identification of the mineralised horn.

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Introduction

During work to upgrade the A1 motorway in Yorkshire, over 60 archaeological investigations were carried out by Oxford Archaeology North (OAN) and West Yorkshire Archaeology Services (WYAS). This report concerns the freeze lifting and conservation of metal artefacts from an early Bronze Age inhumation (2245), excavated by OAN at Site D, Ferry Fryston. The well-preserved male skeleton was crouched on his left side, and there was evidence that he may have been placed in a coffin or container. Grave goods including a stone wrist guard and an incomplete ceramic beaker were found lying at his feet. The burial has been radiocarbon dated to 3732+/- 27 BP.

Freeze lifting

During excavation of the grave, evidence of copper alloy artefacts was noticed among and below the bones of the hands and forearms. Because of time constraints on site and the position of the metalwork, it was decided to lift the hand bones plus artefacts for later investigation in the conservation laboratory.

Fig 1 : Inhumation in grave 2245 with detail showing the approximate area of the freeze lift, which included the hand bones and copper alloy artefacts, but excluded the long bones of the arm

Ground freezing using solid carbon dioxide pellets (at a temperature of -79ºC) was chosen for the lift. After removal of the radius and ulna, which were not to be included, the lift area was defined using flexible 150mm wide aluminium strips, pushed into the ground to contain the spread of pellets, and bent to accommodate the irregular shape. CO2 pellets were then spread inside the aluminium edging, with polythene bubble wrap used as insulation to slow down sublimation of the CO2. Freezing was monitored using probes inserted into the lift area before application of the pellets. The probes were periodically attached to a portable electronic thermometer.

When a temperature of 0°C was achieved after around 30 minutes the insulation and aluminium strips were removed. A spade inserted beside the frozen soil block was used to ease it from the ground. The horizon between the frozen and unfrozen ground below the block provides a natural cleavage plane. The block of frozen soil plus artefacts was wrapped and supported for transport from the site. A block frozen with CO2 pellets will stay below 0°C for several hours, but should be stored in a freezer unless it is to be worked on immediately.

The grave was cut into magnesian limestone - geology not previously encountered during freeze lifting. Though the lift was successful, it proved difficult to maintain cohesion between the artefacts and the lumpy, non-friable rock, even whilst frozen. Wetting the lift area before application of the pellets would probably improve consolidation of the soil block.

X-radiography

The block was X-radiographed while still frozen. Fig 2 shows three X-radiography plates which were exposed together. A dagger blade, two metal pins and other small dense metal objects can be seen. The hand bones are difficult to see as they are similar in density to the surrounding geology. The outline of the blade is also obscured as it lay over a piece of rock.

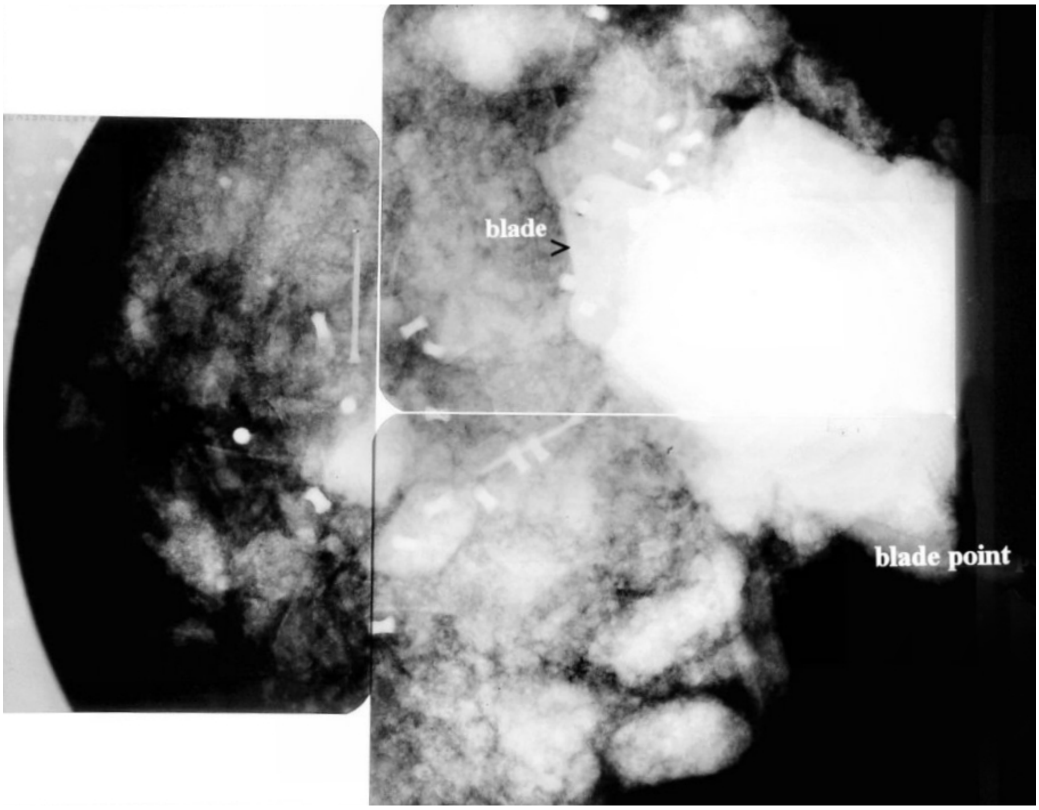


Fig 2 : X-radiograph (3 adjoining plates) showing the dagger blade, 2 pins and several other small dense metal objects

Laboratory excavation

Following X-radiography, the block was allowed to thaw while supported to avoid slumping, and an excavation was carried out in the conservation lab. The sides of the block were notionally marked A-D for orientation, and two markers were inserted into the soil. As the excavation progressed, the location of individual finger bones and artefacts was recorded on overlaid sheets of Melinex (a clear polyester film), positioned by reference to the markers.

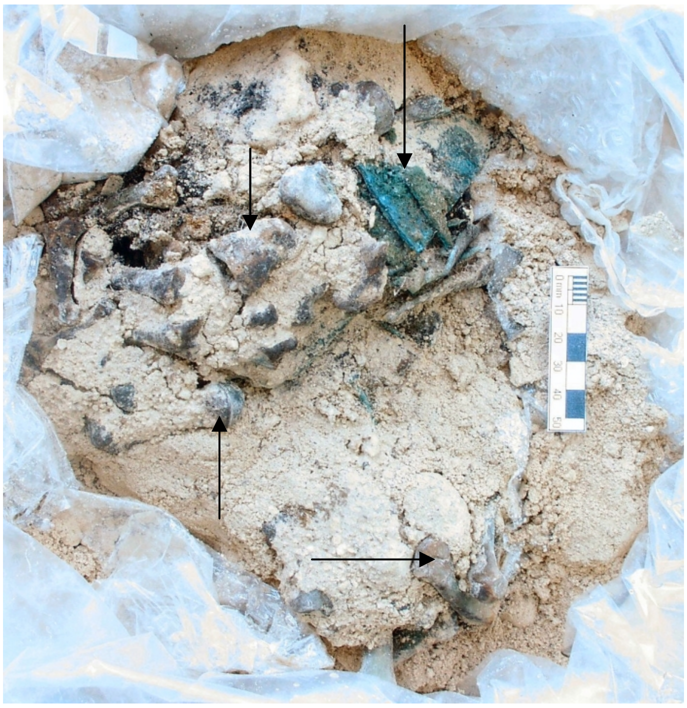


Fig 3 : The unexcavated block showing part of the CuA dagger and hand bones

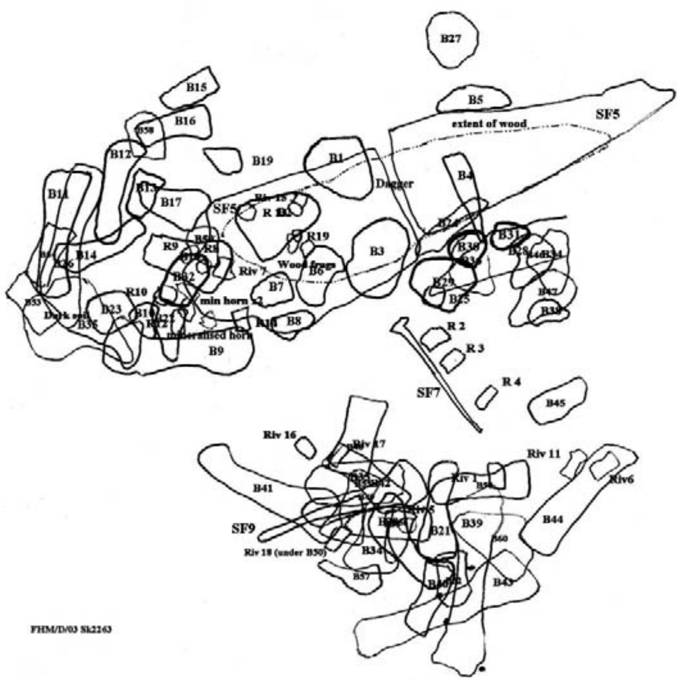


Fig 4 : Position of all objects and bones recovered from the soil block

Sixty pieces of bone from the block were plotted, numbered, bagged and passed on to OAN osteologists after air drying. Excavation of the block also recovered a copper alloy dagger blade (broken into 2 pieces), 2 copper alloy pins and 18 small solid copper alloy rivets. Distribution of the bones and artefacts is shown in Fig 4.

Metal artefact descriptions

Copper alloy Pins 7Δ and 9Δ

Two copper alloy pins or nails, 36 and 36.5mm long, with flat circular heads c5 and c7mm diameter, and tapering shanks c2.5mm diameter. X-radiography showed them to be complete. The shanks and undersides of the pin heads are covered with a mineralised material, up to 3mm thick (Figs 5 & 6). Joins between two pieces of the mineralised material can be seen on both shanks, characterised by a ridge and a change in the structural direction (shown arrowed on Fig 5). Visual and microscopic examination of the mineralised material identified it as horn.

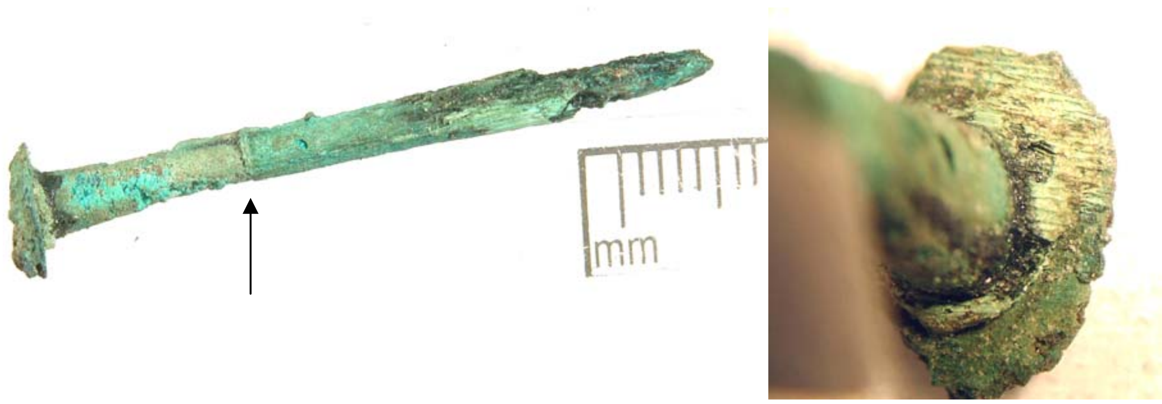


Fig 5 : Pin 7Δ, with X16 view of mineralised horn below the head

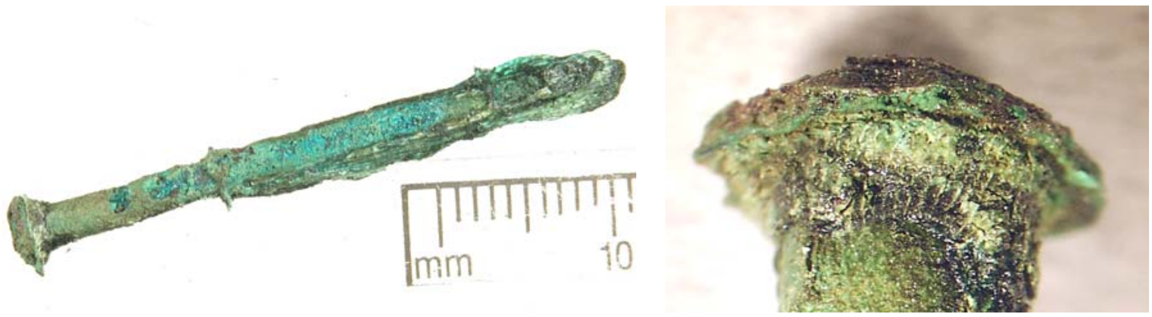


Fig 6 : Pin 9Δ, with X16 view of mineralised horn below the head

Copper alloy rivets 10Δ (Rivets 1-12 & 14-19)

A group of 18 apparently complete copper alloy rivets. They are solid and circular in section with expanded ends. Dimensions of all the rivets are similar (c6-8mm long, and 3-4mm diameter), though not identical.

The rivets were found scattered mainly through the centre of the lifted soil block, following a faintly linear pattern. Though they may have become displaced since burial, when excavated they were found lying in small pockets of amorphous dark soil and root material, suggesting that they had lain undisturbed for some time in the positions in which they were found.

All the rivets are covered with a discontinuous mineralised organic material, though some (especially 1 & 10) have thicker areas surviving around the ends, retaining some structure. The structural orientation of the material, where discernible, runs at right angles to the object's length, and appears to be the same on all rivets (Fig 7). Visual and microscopic analysis identified this mineralised material as horn. Two of the rivets can be seen after conservation in Fig 8.

Fig 7 : Rivet 10 showing orientation of the mineralised horn

Fig 8 : Copper alloy rivets 12 and 16

Copper alloy dagger 5Δ

The CuA dagger is almost complete, 158mm long, and was recovered in 2 pieces. Patination along the edges of the break shows this damage to be ancient. The width of the blade at the shoulder is 50mm, tapering to 20mm just above the point, which is lost. The metal is 1.5-2mm thick. The dagger blade was found lying directly over a large stone. The hilt of the dagger , now lost, was made from an organic material and was fixed to the blade by means of three copper alloy rivets, which were still *in situ.* The rivets, two of which can be seen in the side view X-radiograph below (Fig 9), appear to be of a similar size and shape to the group of rivets described above. A raised line of copper corrosion and mineralised material clearly delineates the shape of the edge of the hilt on both sides of the blade (Fig 10).

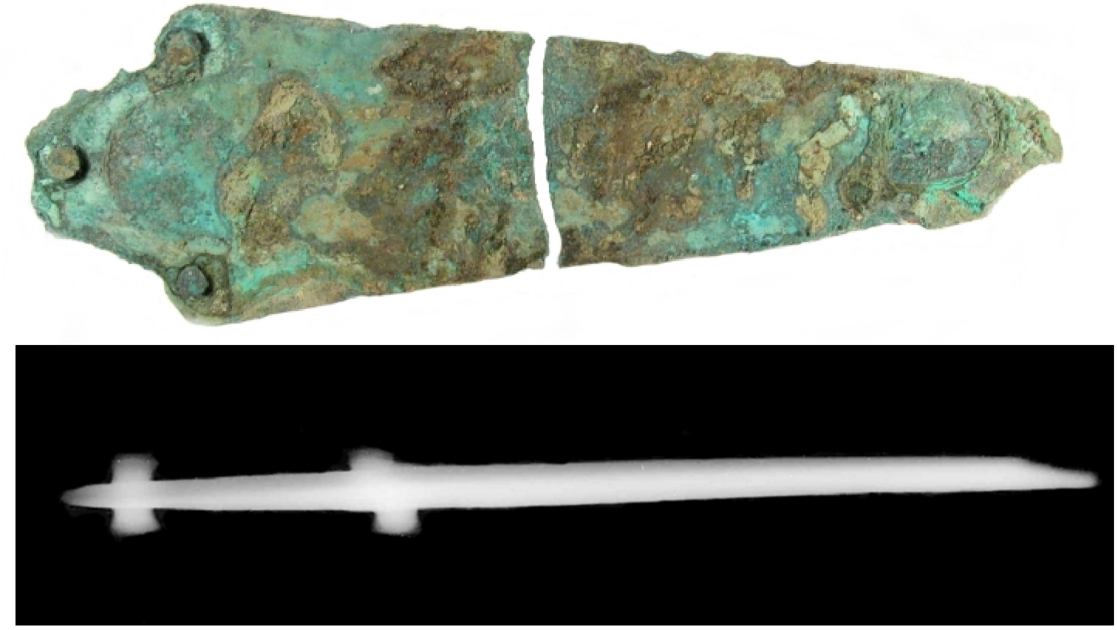


Fig 9 : Copper alloy dagger and side view X-radiograph, showing rivets

Fig 10 : Raised line of copper corrosion and mineralised material showing the shape of the edge of the hilt

The mineralised remains of the hilt are mainly thin and fragmentary, but some linear structure was visible under X16 magnification, lying parallel to the length of the blade. In places, the material survived to the full depth of the rivets. Visual and microscopic analysis identified this mineralised material as horn.

X16 microscopy of the top surface (as recovered) of the dagger revealed a discontinuous area of mineralised material, resembling hair or fur, running along one edge of the blade, and extending for c14mm onto the blade surface (Fig 11). This was visible without the aid of a microscope. Mineral-preserved individual hairs could also be seen under X16 magnification at the dagger point among the copper corrosion products. Samples of both were removed for SEM examination (see below). There were also areas of other mineralised material visible discontinuously on both sides of the blade. It was not possible to determine whether this represented plant or textile remains.

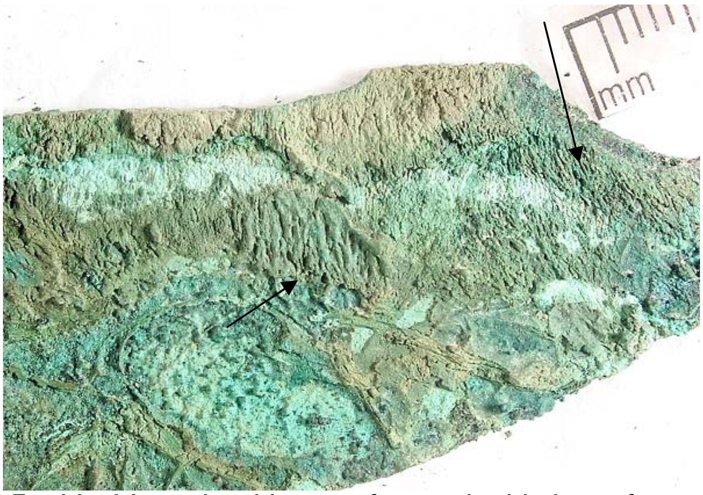


Fig 11 : Mineralised hair or fur on the blade surface

When the dagger was removed from the soil block, a discontinuous layer of very thin (<1.5mm), non-mineralised wood was revealed lying directly below it (Fig 12). No original edges of this wood remained, and its preservation is thought to be the result of the protective biocidal effects of its proximity to the copper alloy dagger. The wood may have formed part of a dagger sheath, or may be the remains of another wooden object. The extent of the wood is indicated by a dotted line in Fig 4 above. The fragmentary wood had disintegrated into small pieces, but was retained and treated,. Sections were cut from an untreated sample for species identification, but the wood proved to be too degraded. Wood fragments were also examined using SEM (see below).


Fig 12 : Non-mineralised wood found directly below the dagger

Where the ‘original’ corroded surface of the dagger could be examined below overlying corrosion products and mineralised organic material, it was observed to be very dark in colour, with an uneven surface. This surface is very fragile, and cracks and small blisters are visible in under X16 magnification.

Metal conservation

All artefacts were examined under X16 magnification to assess their stability and condition and to look for evidence of technology and mineralised organic material. Overlying soil and selected obscuring corrosion products were removed mechanically, using hand tools. Because of the extent of the mineralised material (both identified and unidentified), removal of overlying corrosion products was limited. Objects were consolidated using a 7.5% solution of Paraloid B72 (an ethyl methacrylate co-polymer) in acetone/toluene, applied by brushing. The material was not chemically stabilised. The objects were packed in suitably-sized, pierced polythene bags or polystyrene boxes, with polyethylene foam or acid-free tissue support. These were stored in airtight polythene boxes with active silica gel to maintain a relative humidity of <40%.

Analysis

EDXRF

Surface EDXRF analyses of the dagger, the pins and a selection of the rivets were done using a Links System 200 series machine. A method formulated to detect a range of elements present in copper alloys was used, and the results were normalised.

	Sb%	As%	Pb%	Ag%	Sn%	Cu%
5Δ dagger hilt	0.408	0.49		0.264	3.94	94.44
5Δ dagger point	0.315	0.491		0.238	3.374	95.078
7Δ pin	0.502				3.246	94.33
7Δ pin	0.264	0.453		0.261	1.963	96.337
9Δ pin	0.358	0.584	0.61		2.316	95.155
9Δ pin	0.368	0.531		0.307	2.283	95.778
10Δ rivet 1				0.356	0.576	97.77
10Δ rivet 7			0.712		0.754	97.623
10Δ rivet 10				0.273	0.194	97.904
10Δ rivet 14		0.422			0.382	98.355
10Δ rivet 18	0.246	0.464		0.307	1.444	96.734

Fig13 : EDXRF results

As the analyses were carried out on corrosion surfaces, detected element levels should be regarded as being semi-quantitative only. Surface analysis does not accurately reflect the quantitative composition of the original alloy, because of preferential deposition of some elements into the surface corrosion products (*Oddy & Bimson 1985*). EDXRF results are shown in Fig 13 above.

Copper and tin, the major components of the alloy, were present in all analyses. Antimony (Sb), found in all four pin analyses, is the only other element present with any consistency. Arsenic and silver were detected sporadically, and lead was found in two analyses only.

It is clear that the metal used for all the objects was bronze. However, because of the effects of preferential corrosion deposition, it is not wise to make further differentiations between alloys used for different classes of objects from the surface analyses alone. Analyses of samples taken from uncorroded metal would be required to allow such comparisons.

Scanning Electron Microscopy (SEM)

Samples of the mineralised hair or fur observed on the top surface of the dagger blade were submitted for SEM examination, and a resulting image can be seen in Fig 14. The image clearly shows the casts of individual hairs. However, examination at higher magnification revealed no identifying characteristics, as the inside surfaces of the hair casts proved to be deeply cracked.

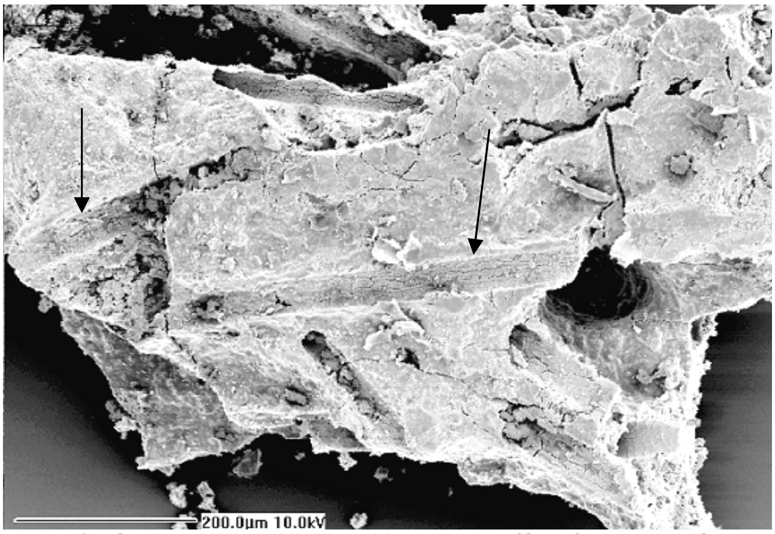


Fig 14 : Scanning electron microscope (SEM) image of mineralised hair or fur

No surviving non-mineralised hairs were discovered in the SEM sample, though it is possible that hairs may be preserved elsewhere within the mineralised material on the dagger blade. Neither the mineral-preserved hair taken from the point of the dagger nor the sample of non-mineralised wood from below the dagger showed any identifiable characteristics under SEM. The surface of the hair proved to be completely covered in copper corrosion products, obscuring any identifiable features, and the wood was too severely degraded for species identification.

Ceramic vessel

A ceramic vessel was also recovered from the foot of the burial in grave 2245. It was received broken into many fragments, but it was possible to determine a complete profile following conservation. The reconstructed vessel stands 222mm tall from base to rim, with a rounded carination and a straight neck. The rim is almost complete, slightly sub-circular and 164mm in diameter max. The base is flat and 82mm in diameter.

The fabric is grey-buff inside and fairly evenly coloured. The outside is variable grey-buff/buff/red-buff. The sherd interior is black. Fabric thickness is fairly uniform at around 7mm, except at the base, where it is 10mm. The vessel has well-executed, all-over decoration of lozenges, hatching and zig zag lines, possibly all executed with the same implement. No carbonised organic residues were detected adhering to the vessel.

Vessel conservation

Some vessel fragments had areas of loss on the inside or outside surfaces, suggesting impact damage. The fabric was quite well fired, and the surface, where intact, appeared stable as received. Fragment edges were prone to loss however, and some micro-cracking of the fabric was visible, especially on the inside surfaces.

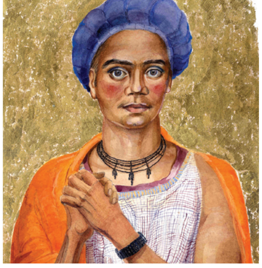
Sherds were carefully washed, supported on a net frame, and allowed to air dry. They were then immersed in a consolidant of 5% Paraloid B72 in acetone/toluene, and slowly dried in an atmosphere of acetone to discourage surface deposition of the polymer.

Sherds were assembled using Paraloid B72 adhesive. Reconstruction was done in two major sections – the base and body of the vessel together, and the rim and part of the wall separately (Fig 15). These could be joined to produce a complete profile, but extensive reconstruction would be necessary to achieve a safe join between the two sections. Consultation with the specialist and excavators suggested that the present level of reconstruction was sufficient to allow study of the vessel.

Fig 15 : The two major sections of the vessel as reconstructed

Acknowledgments
I would like to thank Sonia O'Connor of Bradford University for assistance with identification of the mineralised horn.

Bibliography
Oddy, W.A. and Bimson, M, 'Tinned Bronze in Antiquity', in *Lead and Tin : Studies in Conservation and Technology,* eds G. Miles & S. Pollard, UKIC Occasional Paper No 3, 1985



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