Conservation of Finds from the Cardiff Castle New Interpretation Centre Excavations, 2006 (GGAT P1338).

Chris Wilkins & Phil Parkes

1 Introduction

Excavations at Cardiff Castle were conducted in 2005-2006 in the footprint of the New Interpretation Centre. Cardiff Conservation Services, Cardiff University was contracted to conserve a selection of the materials recovered from the excavations. These materials consist of copper alloys, glass, iron, lead, semi-precious stone, shale, silver and wood. Conservation was conducted by Phil Parkes and Chris Wilkins in 2018-19.

2 Conservation Brief

- Clean objects to reveal technological information including construction and decoration.
- Desiccate waterlogged objects or objects stored in water.
- Stabilize objects for storage.
- Provide before and after record photographs and treatment records for all conserved objects.
- X-Ray all iron

3 Selection and Storage

Objects were categorised into five groups (A-E) rated by archaeological significance prior to entering the conservation laboratories. Groups A-C were determined to require some form of conservation treatment to clean, stabilize and reveal further information.

4 Examination, Documentation and Analysis

4.1 Photography

Before and after photographs were produced for all the conserved objects as part of the treatment documentation. Most objects were photographed with direct light. Coins were photographed with direct and raking light to highlight the surface details. Glass was photographed with direct light, transmitted light (i.e. light box beneath the object) and a combination of both. Transmitted light enables the observation of transparency of the glass. The intaglio was photographed using the same procedure as the glass with the addition of raking light to highlight the details of the carved surface.

4.2 Visual

The objects were examined in-hand and with optical stereo-microscopy using an external light source. The lights were configured to provide direct and/or raking light to reveal surface features and to assist in cleaning.

4.3 X-Radiography

A Faxitron X-ray machine was operated at varying voltages and exposure times (based on subject density), to reveal details about object structures and to indicate whether additional cleaning was warranted. Each X-ray plate was marked to show plate number, site (i.e. Cardiff Castle), special finds (SF) number, context (in absence of SF no.), kilovolts and exposure time. Analogue X-ray plates were digitalized to electronic bitmap (.bmp) files for computer viewing using a laser film digitalizer set to high resolution. The X-rays revealed details on structure, structural stability (e.g. cracks, fissures), decoration and a differentiation in material types (i.e. silver versus copper alloy coins).

4.4 Instrumental Analysis

Material types of some objects were identified using portable X-ray fluorescence (pXRF) qualitative analysis. The presence of inlays on some of the brooches was investigated using scanning electron microscopy (SEM) in conjunction with back scattered electron imagery (SEM-BSE) and energy dispersive X-ray analysis (SEM-EDX). BSE imagery provides a direct comparison of atomic mass with darker areas in the image representing lower atomic mass. EDX and pXRF will reveal most of the atomic elements found within a sample depending on the capabilities of the detector.

5 General Treatment Methodology

Dirt and surface obscuring corrosion was removed from copper alloy, lead and silver objects using scalpels, wooden skewers, needles, soft and glass bristle brushes, air-abrasion and IMS impregnated cotton wool swabs. Cleaning was conducted under the stereo-microscope for better control. Silver coins were chemically cleaned using localized application of ammonium thiosulphate (10% in water) in conjunction with mechanical cleaning to remove the silver bromide layer. Silver chloride was removed through mechanical cleaning to reveal the coin surface. Silver, lead and copper alloys were coated in 10% (v/v) Incralac in toluene as a barrier. Much of the iron had spalled in storage prior to entering the conservation labs. These objects were X-rayed but not treated nor coated. Used silica gel in the metal objects boxes were replaced with re-conditioned silica gel to lower the RH and reduce the probability of akaganeite formation and further spalling. The condition assessment, treatment and investigation of each conserved object were maintained in a database.

6 Condition and Results

6.1 Copper Alloys

The copper alloy objects entered the lab in various conditions. Many of the objects had a light to moderate coating of surface dirt easily removed through light brushing and swabbing with Industrial Methylated Spirits (IMS, 99% ethanol / 1% methanol).

Other objects were encrusted with thick corrosion deposits. Most of the copper alloys were somewhere in between. Intact pale green to dark green, and in some cases light buff to reddish-brown, patinated surfaces were visible beneath these corrosion deposits. Some of the surfaces were friable and required lighter force when cleaning. The core metal of the objects was sound with thickness as the main factor in its fragility. No active corrosion was identified among the copper alloy objects.

Some of the copper alloy coins (SF nos. 0077, 0126, 0142, 0165, 0325, 0447, 0615, 0855 and 1025) and a brooch (SF0068) have extensive black patination. Others coins have localized areas of black patination while most of the copper alloy objects (including coins) are lacking it. The colour is sometimes restricted to one side of a coin. It can appear as nearly covering the object (or the side of a coin) or as a mottled green/black colouring or marbling effect (black on green), thereby not completely covering the surface. Application of the Incralac coating to these objects intensified the black colour. It is unclear if this is copper sulphide corrosion products. Qualitative pXRF analysis of the coins is inconclusive. The Kα peak for sulphur is in a convoluted area of the XRF spectrum resulting in the sulphur peaks being masked in the presence of lead. Several coins randomly selected for controls (lack of black colouring) all had significant lead. Two coins (SF0615 and SF0142) exhibited black on one side and typical green corrosion on the other. Comparison of these spectra show slightly higher sulphur peaks for the black side of the objects but the difference is not considered significant.

6.2 Glass

The glass has deteriorated, was friable and required immediate consolidation. One glass object appeared to have minor surface dirt deposits. Removing these deposits from the glass was impossible without removing some of the glass as well and, as a result, these deposits have been consolidated on the glass. Some of the glass fragments have mottled transparency while others are opaque.

6.3 Iron

The iron is covered in a thick reddish brown corrosion crust. The condition of the iron varies. Some of the iron retains an intact corrosion crust, however, for many of the objects the corrosion material has spalled off prior to entering conservation. The replacement of the silica gel in the sealed Stewart boxes has produced a low RH microenvironment to reduce the possibility of continued corrosion but many of the objects are already irretrievably damaged.

6.4 Lead

The lead objects were mostly coated in a buff to light brown corrosion with a thin dirt layer on top. A dull light grey surface was exposed on some objects that were not completely covered by the thicker corrosion. These objects were relatively thick and structurally sound.

6.5 Semi-Precious Stone (Intaglio, possibly cornelian)

The intaglio was relatively clean with only a thin layer of dust on the surface. The surface has minor scratches only visible through a microscope. There is a minor loss near the bottom edge of the obverse. The intaglio is intact and structurally sound.

6.6 Shale

The shale was mostly clean with a thin layer of surface dirt. Thicker deposits of dirt were removed in the two holes of a bead (SF0106). Two of the bracelet fragments exhibited minor cracks at broken edges (SF 226 and SF159). One bracelet fragment (SF1038) came into the conservation lab immersed in water. The water was allowed to evaporate over the course of two supervised weeks during which there was no observed change to the object. The shale objects are structurally intact and sound but their light weight give a sense of fragility.

6.7 Silver

The silver objects were covered in a thick layer of silver bromide overlaying a thinner layer of silver chloride (horn silver) and required cleaning through mechanical and chemical (ammonium thiosulphate) means. Removal of the silver bromide and silver chloride layers from coins revealed details (i.e. portrait, relief and legend) if they existed prior to deposition (some coins appeared to have been rubbed smooth in antiquity). Coin SF0021 is of medieval origin. The silver bromide layer was thin and clearly showed the surface details and was, therefore, retained.

6.8 Wood

The wood was covered in thick layers of lime (calcium oxide/hydroxide) that helped to maintain significant moisture within the wood structure. X-Rays and cleaning were required to see the wood structures and technology. X-Rays revealed possible nails in three fragments (contexts 1076, 1096 and 1103). Lime was removed from most of the fragments through mechanical cleaning in a water bath. One fragment (context 1096) is nearly encased in a hard lime shell which supports the shape and structure of the wood object. This shell was retained for this reason. Another wood fragment (context 1103) was frozen then placed in the freeze-dryer to remove moisture immediately after treatment. As a result of this treatment, this wood showed minor dimensional change and was structurally weakened through the loss of water. It was decided that the remaining wood would be bulked prior to freeze-drying to maintain object dimensions and to strengthen the resulting dry wood. As of the time of writing of this report most of the wood is immersed in polyethylene glycol (PEG) 3550 for bulking prior to freeze-drying. Freeze-drying of the wood is expected to occur in September 2019.

7 Findings of Note

This section covers significant findings on specific objects. The significance is based on finding something that was not known to exist about the object prior to conservation, correcting an erroneous identification and/or confirming a pre-conservation assumption.

7.1 Analytical Results

SF 0414 is an Intaglio carved from a translucent orange material. The material was assumed to be cornelian based on the colour, translucency and its association with intaglios from other provenances. Cornelian is a chalcedony, a silica based mineral, coloured by iron inclusions. Qualitative pXRF analysis of the intaglio showed high peaks for silica and iron in the material. The carving in the intaglio was examined through stereo-microscopes and appears to be a water horse possibly signifying Neptune (Fig. 1). The intaglio was clean but required a light dusting.

Five brooches (SF0385, SF0532, SF0541, SF0738 and SF0944) of the assemblage possibly contained glass inlay. The brooches were cleaned and qualitatively analysed using SEM-BSE and EDS. SF 0385 is identified as a “T”-shaped brooch and associated soil concretion (Fig. 2). Cleaning of the brooch revealed 16 triangular glass inlay cells running down the leg. Eight of the inlays running down one edge of the brooch were analysed. There were four main areas of each inlay analysed; these include a dark smooth appearing surface, brighter overlying

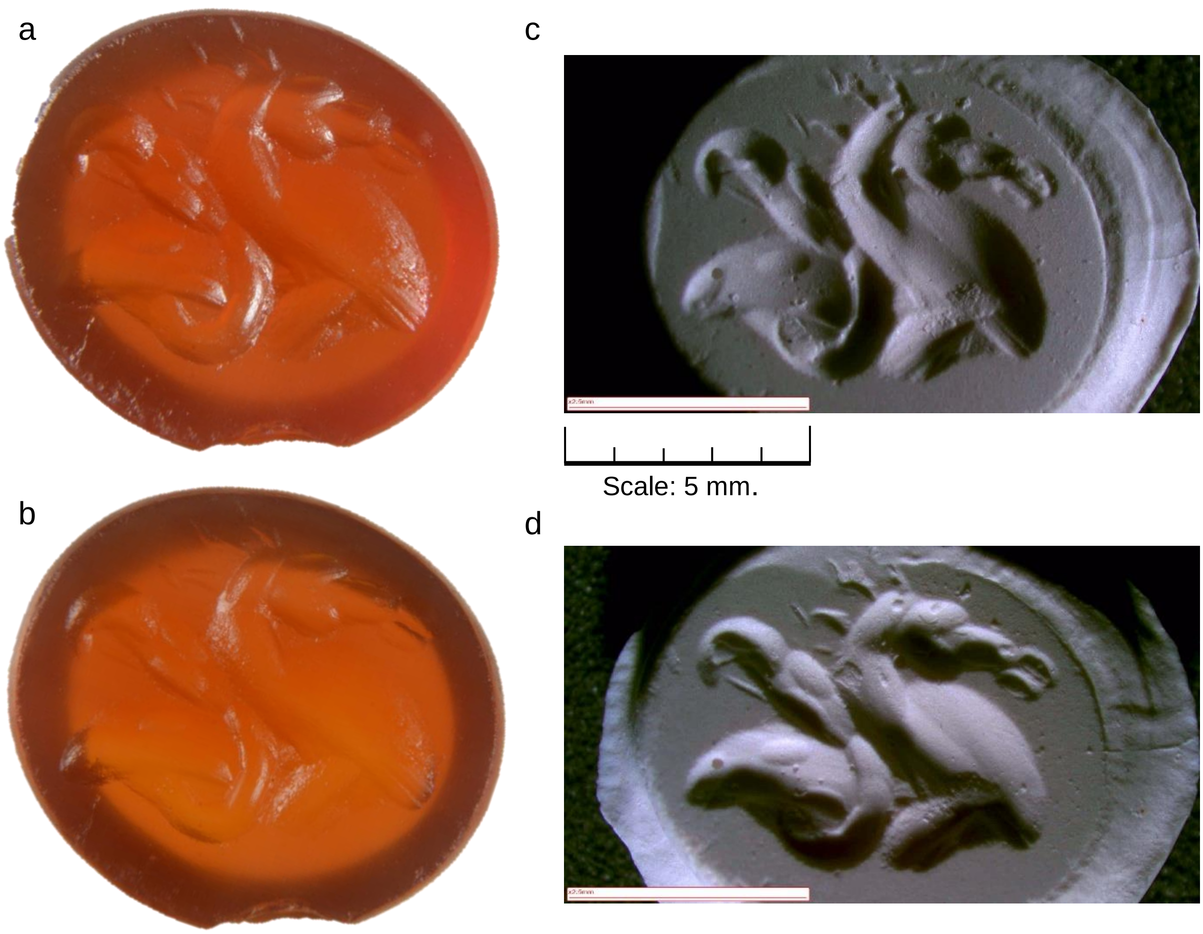

Figure 1: SF414 Intaglio with possible water horse carving. The upper left (a) micrograph is taken with reflective light coming from the left and right. The micrograph below that (b) is the intaglio taken with reflective and transmitted light. To the right are raking light micrographs of a SF414 mould with the light source on the right (c) or on the bottom (d) of the mould. The scales indicate 5 mm and are true for all four micrographs.

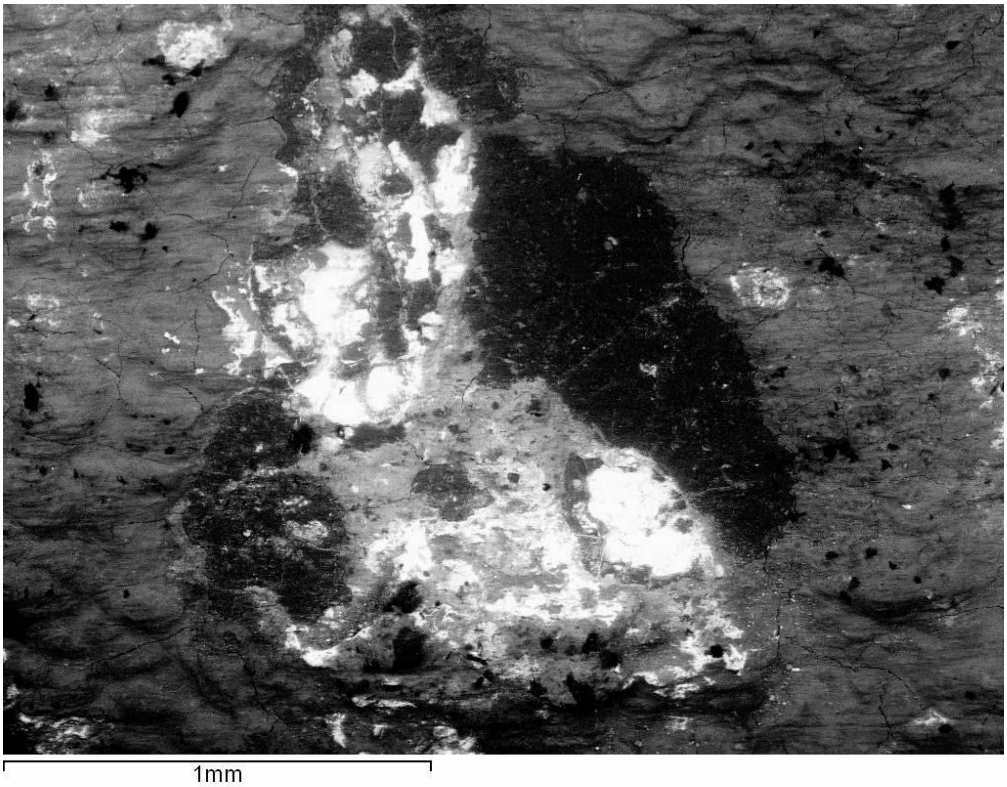

Figure 2: A "T"-shaped brooch and a cat pendent (above). Both objects are classified together as special find 0385. The brooch has triangular and circular (end) glass inlays. The cat pendent was possibly tinned. A high tin peak (higher than expected for bronze) was noted with qualitative pXRF analysis of the pendent. The BSE image (below) shows a single triangular glass inlay with possible copper alloy corrosion material overlying it. The darkest material represents the glass inlay. The brightest material represents lead or high lead copper alloy. The presence of lead may be due to the preferential corrosion of copper in a copper-lead alloy.

material, a much brighter overlying material on top of that and the surrounding copper alloy body.

Qualitative analysis of EDS should be based on presence/absence of elements but the elements detected do no change between any of these areas. The peak height, however, does. Qualitative analysis showed high silicon and low lead peaks for the darkened area. The brighter material overlaying the dark smooth area shows the same peaks but higher peaks for lead and copper. The brighter material overlaying these areas is similar except the lead peaks are higher than all others. The copper alloy body of the brooch shows the same elemental peaks with copper and lead peaks being the highest. A comparison of the EDS background continuum indicate that the dark area is the least dense (lower continuum) while the other areas are of greater but comparable density (higher continuum).

Based on this information, the dark smooth area is probably composed of glass due to the smooth appearance in the BSE image, the presence of silicon and the possible lower density and atomic weight (darkness) of the area compared to the other three. The brighter overlying areas could be overlying copper corrosion with the brightest showing a greater artificial concentration of lead due to the lower electrode potential of the copper component (more easily corroded).

The colour of the glass is difficult to determine based on the elements detected. The presence of copper in the proposed glass inlay could indicate that it was a blue or green colour. However, some of the elements detected (copper, lead, iron and tin) are also found as a group in red but this is usually in the presence of antimony (Freestone et al. 2003) which was not detected in this glass inlay. Colour determination is inconclusive.

All of the analyses show high levels of phosphorus. This is not accounted for in the construction of the brooches nor their glass inlays. It is understood within the concept of archaeological soil testing where the presence of phosphorus could represent skeletal remains, organic deposition in the form of urine or faeces (animal and/or human), organic food waste deposition and/or artificial fertilizer (McCawley and McKerrell 1972).

A concreted lump of soil was associated with the brooch. Micro-excavation of the soil concretion under a stereomicroscope revealed a cat pendant (see Fig. 2). Qualitative pXRF analysis of the cat pendant revealed a high tin peak possibly indicating the surface was tinned and/or the bulk alloy has a high tin content.

SF 0417 is identified as a bow brooch (Fig. 3). The brooch was covered in loose soil from the burial matrix. Cleaning revealed a patchy green patinated surface with extensive corrosion warting. The brooch has two circular glass inlays along the leg. SEM-EDS of the body shows moderate to high copper, lead, iron, tin, silicon, calcium and phosphorus (see above) peaks. The copper, lead and tin are most likely representative of the bulk body. The iron, silicon, calcium and phosphorus could represent material from the burial matrix that has been incorporated into the corrosion (warts) on the surface of the brooch.

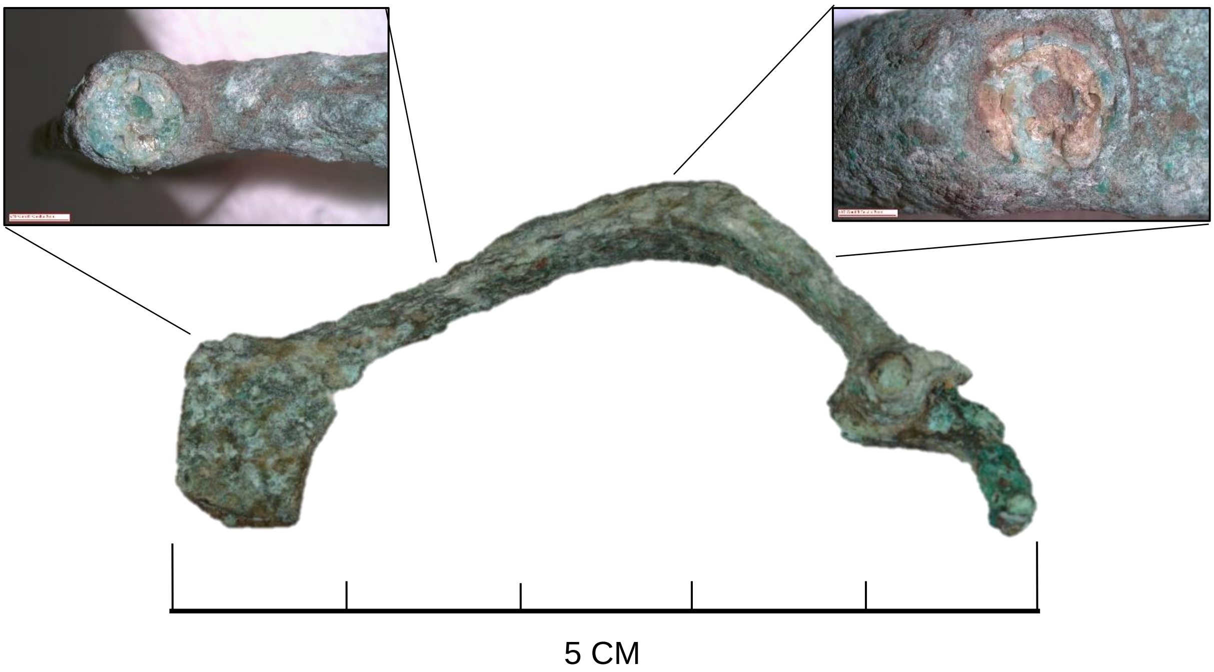

Figure 3: The profile of a bow brooch (SF0417) with two circular glass inlays. The scales for the inset photographs (shown in plan view) read 2 mm.

The circular glass inlay spectra are the same and show a high silicon peak with a moderate calcium peak and smaller peaks for copper, lead and iron. The silicon and calcium peaks probably represent the glass. The copper, lead and iron could represent the copper alloy corrosion overlaying the glass inlay. The copper could also represent the colourant (see discussion on colourants for SF385 above). No antimony was detected.

SF 0532 is identified as a “T”-shaped brooch (Fig. 4a). The brooch was covered in loose soil from the burial matrix and light green corrosion products. Cleaning revealed a series of four diamond shaped glass inlay cells running down the leg of the brooch. A fifth cell may be obscurred by dense corrosion and corrosion warts. A round black bead is partially embedded into the foot of the brooch.

The first diamond inlay cell (see Fig. 4b) from the lugs down the leg best represents the remnants of the glass in the brooch as the spectra of the other cells show much lower silicon peaks indicating that the glass has deteriorated. The BSE image for the first inlay shows two distict areas: a darker area with a lighter material overlying it. The EDS spectra for the darker area exhibits a high peak for silicon and a moderate to low peak for copper and calcium. Potassium is also present. The spectra for the overlying lighter areas show a lower silicon peak and higher peaks for calcium, copper and phosphorus (see above). Spectra of the body show high copper and phophorus peaks. Based on this information the darker areas represent the glass inlay. The lighter area overlying the glass is copper corrosion possibly intermixed with burial matrix soil that has not been removed during the cleaning process.

The BSE image of the brooch end shows a dark rounded bead partially embedded into the foot of the brooch (Fig. 4c). The EDS spectra of the glass bead shows a high silicon peak with a moderate calcium peak and low copper, potassium, manganese a

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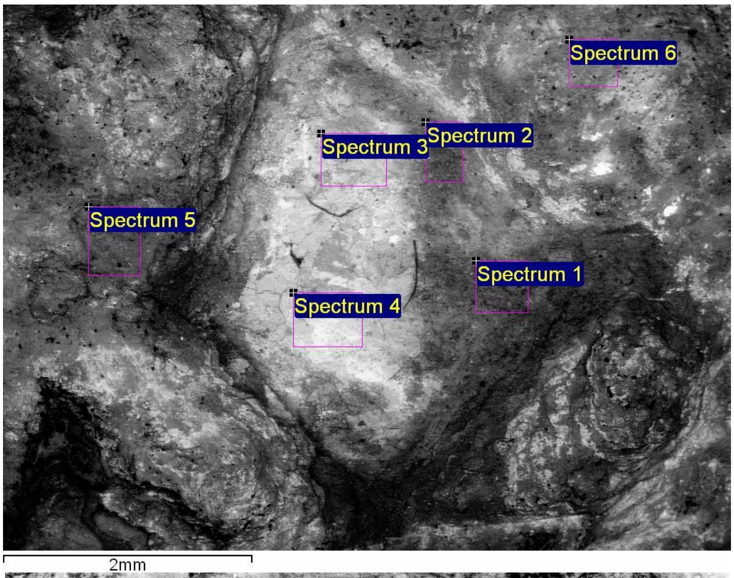

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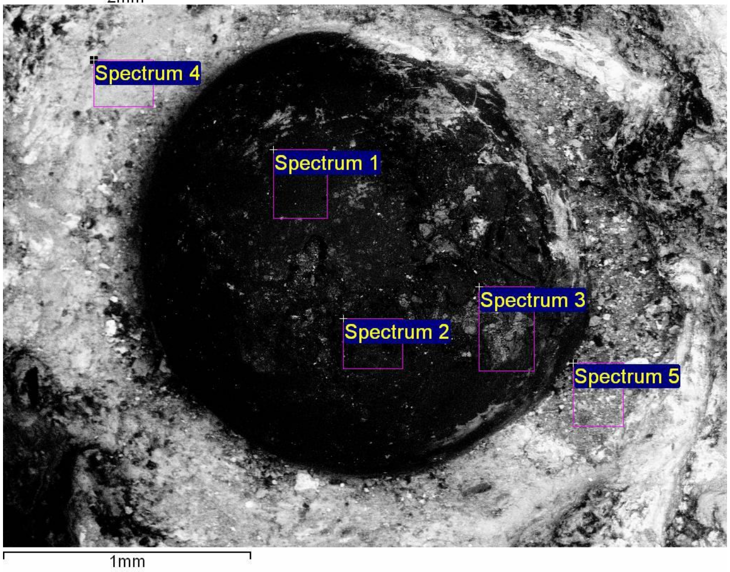

Figure 4: A "T"-shaped brooch (SF0532) (a) with diamond glass inlays (b) and a bead partially embedded into the brooch end (c). The darker areas in the BSE images correspond with lighter atomic weight and most likely represent glass.

Figure 5: Photograph of a "T"-shaped brooch (SF0541) taken in raking light to show the relief. Four panels near the top of the brooch are smooth and may have contained glass inlays in the past. The scale on the inset photograph reads 2 mm.

and iron peaks. Manganese and iron can be used as colourants for producing black glass and glazes.

SF 0541 is identified as a "T"-shaped brooch (Fig. 5). It was covered in loose soil from the burial matrix and light green corrosion. Removal of this material revealed four glass inlay panels on the upper leg of the brooch near the intersection with the lugs.

The EDS spectra show moderate to low peaks for silicon and moderate to high peaks for copper and lead. The spectra for the glass inlay are similar to the spectra of the body, both in elements detected and peak hieghts. Based on this information the analysis has detected intentional smooth flat panels on the copper alloy body or areas where the glass inlays have completely deteriorated.

SF 0738 is identified as a Wroxeter brooch (Fig. 6). The object was covered in loose soil from the burial matrix and light green corrosion. The surface was friable and the leg is bent. Removal of soil and corrosion required light mechanical cleaning and application of IMS with cotton swabs. The brooch has a glass inlay panel on the upper leg composed of 18 individual cells in three columns of 6 cells. The colours appear to be alternating between red and blue or green.

The EDS spectra of the bulk body and exposed body areas between enamel columns show high lead and tin peaks with moderate to low copper peaks. The spectra of the enamel cells show high silicon peaks, moderate calcium and iron peaks and low copper and lead peaks. The elements for each cell are the same but the peak heights differ. This differentation does no seem to correspond with the a

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Figure 6: A Wroxeter brooch (a, profile and plan views) with 18 enamelled cells of alternating red and possibly blue or green (b, scale reads 5 mm) and a BSE image (c, scale reads 1 mm) which distinctly shows crazing in one cell with dealkalization at the cracks where the ingress of moisture would occur.

difference in cell colour except that there is a larger peak hieght ratio of iron to copper in the cells expected to be red and larger copper peaks in general for cells expected to be blue/green.

7.2 Presence/Absence of Organic Materials

SF 0017 is a medieval scabbard chape (Fig. 7) with remnant leather in the interior. The object was covered in soil from the burial matrix. Removal of this material revealed a green patinated surface and the leather remnants in the interior although these were noticeable prior to cleaning.

Figure 7: Medieval scabbard chape (SF0017) with leather remnants in the interior.

SF 0209 has been identified as a possible copper alloy hinge composed of an upper and lower plate. The fragments were covered in soil from the burial matrix. Two additional fragments associated with the object are composed of bone and may have been enveloped by the copper alloy plates. Remnants of bone exist on the interior of the lower plate and copper salts have discoloured areas of the bone. The copper alloy plates were attached by a thin rivet or join. A possible moulded floral decoration was uncovered on the exterior of the larger plate that could represent a stamen and stem design.

SF 0564 is identified as a large Roman sheet rivet. The object was covered in loose soil and light green corrosion that was removed through mechanical cleaning. A dark grey to black material was noted in the folds. This material was retained in situ for future analysis.

SF 0978 is a copper alloy armature with three arms radiating off a large loop. The object was covered in a thick layer of soil from the burial matrix. There were three large clumps of concreted soil associated with the object. These concretions were noted pre-conservation to have possible textile remains/impressions. The concretions were meticulously excavated in the conservation laboratory but were only found to contain soil and impressions of natural vegetation (e.g. grass, roots). These same impressions were found with other objects covered in thicker soil deposits and, like with the others, no weave pattern was identified.

7.3 Coins

SF 0046 was identified as a possible vessel handle covered in concreted soil. Cleaning in the conservation laboratory revealed the object to be a heavily encrusted coin with a large pebble concreted to its surface. A small portion of the portrait was recognizable as a radiate crown. The remainder of the coin relief is either missing (reverse) or covered by dense copper corrosion products.

Figure 8: Special Find 2008 (a) obverse and (b) reverse. The silver coin was confirmed to be of republican mint.

SF 2008 is a coin previously identified as a third century AD copper alloy coin. The coin was covered in thick silver bromide overlaying a layer of silver chloride (horn silver) which was overlaying a silver tarnish on a silver coin. The obverse reveals a portrait in profile (Fig. 8). The reverse shows a temple with a faded legend beneath. Peter Guest (Pers. Comm.; Cardiff University) confirmed that the coin is republican.

7.4 Wood Pseudomorphs

Wood pseudomorphs, or material where the organic matter has been replaced by iron corrosion products, have been identified on three objects in the assemblage.

SF 0107 is a copper alloy dome with an iron stud. The object was covered in a layer of soil from the burial matrix. Removal of the deposits revealed a wood pseudomorphs within the dome and surrounding the iron stud.

SF 0523 is a copper alloy knob with an iron stud. The object was covered in a layer of soil from the burial matrix. Removal of the deposits revealed a wood pseudomorphs surrounding the iron stud.

SF 0910 consist of three fragments identified as a copper alloy box fittings. The box fittings were covered in loose soil from the burial matrix. Removal of the loose soil revealed wood pseudomorphs where the fittings would have been attached to wood.

7.5 Decorations

Several objects aside from the coins revealed decorations prior to or upon cleaning. Most of this decoration consists of banded and moulded lines, typically found on brooches, and cross-hatching as typically found on tweezers and toilet sets of this assemblage. Glass inlay was identified on 5 brooches as discussed in Section 7.1 of this report. Objects with decoration not so typical of the assemblage are as follows.

Figure 9: Medieval knife (SF0010) with iron blade and tang, copper alloy (brass) bolster, butt and rivet heads. The blade has a possible maker's mark in the form of a "T".

SF 0010 is identified as a medieval knife (Fig. 9). The knife was covered in calcium and soil deposits which were obscuring some details. Removal of this material revealed a "T" shaped mark, possibly a maker's mark, on one side of the blade. The blade and tang are composed of iron. The copper alloy (brass) bolster is gold in colour. The bolster was covered in dark grey to black thin layer that easily flaked off to reveal the gold colour beneath. The butt of the knife forms two outward facing lizard or frog-like animal heads. The surface of the butt is coated in a dark material similar to that which was covering the bolsters, but in this case the material was retained. Scratches in this surface reveal gold colour similar to the bolsters. SEM-EDS analysis indicated the material could be a copper sulphide corrosion layer. The rivet heads along the handle are also copper alloy (brass) and are gold in colour. The handle leafs were composed of wood represented now by pseudomorphs. The rivet nearest the butt has anchored a large section of wood pseudomorphs on both sides of the tang. There is also thin sections of wood pseudomorphs along the tang.

SF 0150 is identified as a medieval knob (Fig. 10). The object was covered in thick copper corrosion and soil from the burial matrix. Removal of the copper corrosion material, including some corrosion warts, revealed a gilded surface. The entire object appears to have been gilded in antiquity. PXRF confirmed the presence of gold (i.e. gilding).

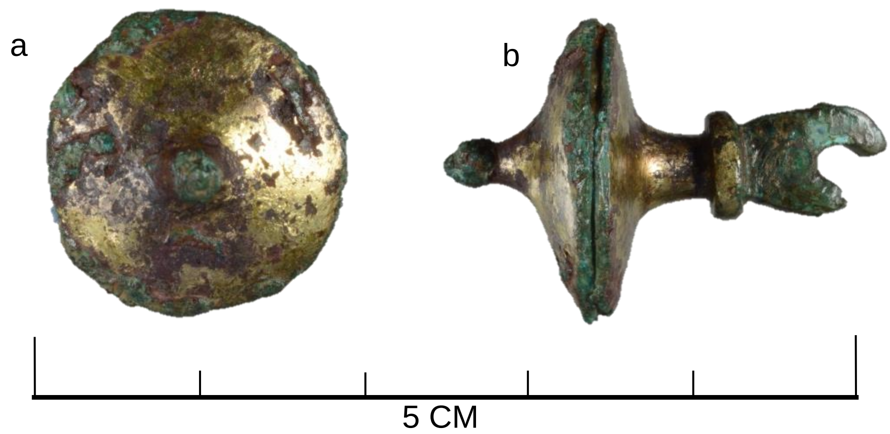

Figure 10: Plan (a) and profile (b) view of a medieval knob (SF0150) with a gilded surface.

SF 0607 was identified as an angled bar. It was covered in soil from the burial matrix and light green corrosion. Removal of this soil and corrosion revealed an anthropomorphized attachment in the form of a human arm (Fig. 11). The object's surface is covered in corrosion warts but there are small areas of brassy and dark green patination.

SF 0944 (Fig. 12) is identified as a Hod Hill brooch. The object was covered in soil from the burial matrix and the pin had separated from the body. Cleaning revealed extensive tinning on the spine of the brooch leg, the side of the leg and near the foot. Small decorative punctations are clustered on the front.

Figure 11: Attachment (SF0607) in the form of a human arm.

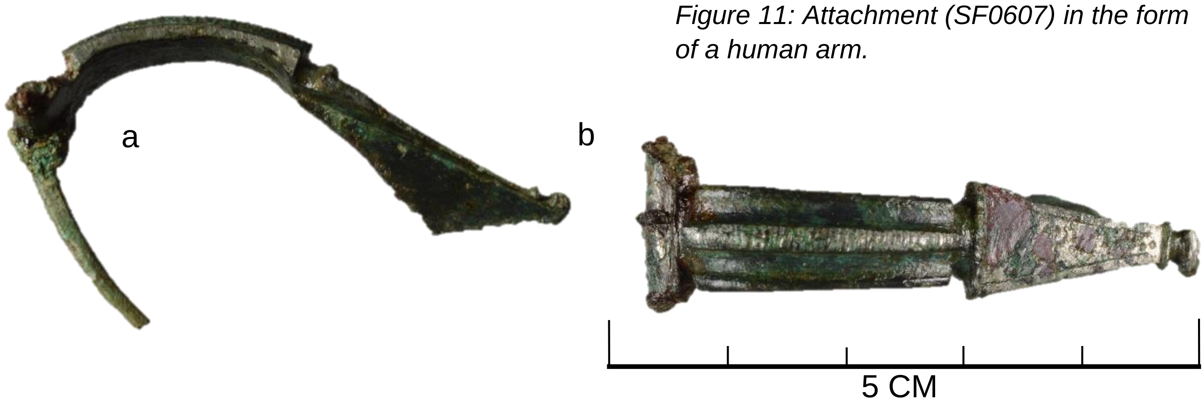

Figure 12: Profile (a) and plan (b) view of a Hod Hill brooch (SF0944) with tinning on the front and sides, and decorative punctations grouped into clusters on the front.

SF 1040 is identified as a domed stud. The object was covered in soil from the burial matrix and had fragmented into two pieces. Cleaning revealed two perpendicular dark lines which cross at the apex of the dome. The edges on the dome also exhibit a dark line running partially around the circumference. These lines were visible and brighter than the surrounding copper alloy matrix in the X-rays of the stud indicating greater density (Fig. 13). PXRF revealed the line to be composed of silver.

7.6 Miscellaneous

SF 0076 is identified as a military pendant (Fig. 14). The object is in moderate condition based on its fragility. It came into the lab in poor condition with fragile and loose fragments. The object was consolidated with 10% B-72 in acetone. Local application of NaOH, immersion in water, and immersion in a dewatering bath in IMS revealed tinned surfaces which were more difficult to see in a dried state.

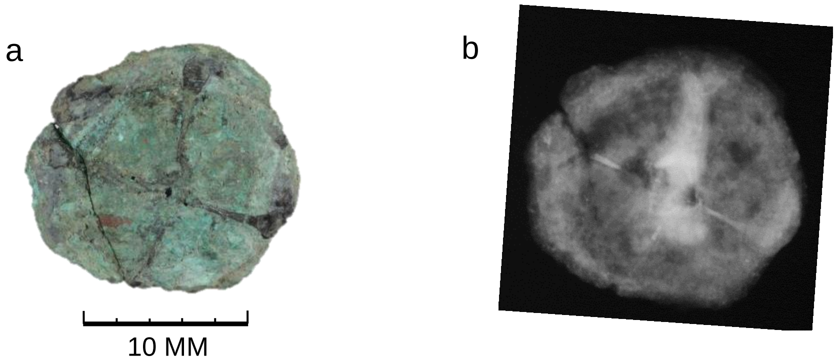

Figure 13: A photograph (a) and X-ray (b) of a domed stud with silver decoration in the form of two perpendicular lines crossing at the apex and partially around the circumference of the dome. The thin bright lines in the x-ray are silver. The X-ray was taken at 90 kV for 3 minutes.

SF 0149 and **SF 0216** are copper alloy maille links associated with iron rings. SF0149 is a series of interlinked copper alloy butted rings with small areas of iron concretion along one edge of the join links. Remnants of iron links are visible in the concretion. **SF 0216** is a grouping of copper alloy maille links associated with two large iron concretions. Air abrasion of the iron concretions revealed remnants of

Figure 14: Roman military pendent with tinning (a). The tinning is more evident when the object is immersed in water and IMS (b).

interlinked iron maille links. In discussion with a maille specialist (Nick Checksfield, pers. comm.) it was suggested that the type and size of maille here is unusual and that further analysis is recommended. In particular it was suggested that the solid rings be examined in order to try and determine whether they have been stamped / drifted from a sheet, or whether they have been forge welded. This would require mounting, polishing and etching a ring in order to examine the metallographic structure.

SF 0289 is a pin with a glass head. The object was covered in loose soil from the burial matrix and light green corrosion (Fig. 15a). Removal of this material revealed the head of the pin to be composed of glass (Fig. 15b and 15c).

SF 0560 is identified as a possible Lorica hinge strap fragment adhered to bone with corrosion. The objects were covered in soil from the burial matrix. Removal of this material revealed the strap to be covered in corrosion warts. Portions of the bone are stained green with copper salts. Examination under the microscope revealed “v”-shaped butchering marks on the bone (Fig. 16).

Figure 16: Roman pin with a glass head. The pin is shown uncleaned (a) and cleaned state (b and c). The cleaned pin is shown in reflective light (b) and transmitted light (c) which reveals the qualitative insertion depth of the copper alloy pin into the glass.

Figure 15: Butchering marks with a “v”-shaped profile found along the edge of a bone associated with SF0560. The scale for inset photograph reads 1 mm. The scale for the main photograph reads 5 mm.

8 Storage Recommendations

A total of 890 small finds and context designations representing 2000+ individual objects were examined and/or treated between November (2018) and May (2019). Certain environmental parameters are desirable to maintain these objects in their current condition. In summary all metal objects should be stored with silica gel that is regenerated as necessary (6 monthly intervals in the first instance).

8.1 Iron

Many of the iron objects have spalled or have completely corroded while in storage prior to entering conservation. The iron objects that are still intact will probably not be at risk of further corrosion if a target of ≤30% RH is maintained while in storage or on display. This should be possible with regular (6 monthly in the first instance) changing of the silica gel that is in the boxes. However, surveys of the iron collection should be implemented to insure that further corrosion is not occurring. Look for active corrosion in the form of visible surface corrosion and/or continued spalling, blistering and delaminating. If these are evident, a target of <11% RH is desirable (Rimmer et al. 2013) which will require more frequent changing and regeneration of the silica gel. Handle with gloves to prevent unintentional surface deposition from soiled hands.

8.2 Copper Alloy

An RH ≤ 42% in an acetic acid free environment is recommended for copper (Rimmer et al. 2013). These parameters should be good for the Cardiff Castle copper alloy assemblage as well. Active corrosion of the copper alloy objects did not appear to be a problem with the Cardiff Castle assemblage during pre-conservation storage. Conservation of these objects has exposed new surfaces to air (oxygen) and there is a chance that renewed corrosion will commence. Occasional collection surveys will identify the presence of active corrosion in the form of “bronze disease”, a bright green powdery surface deposit. If encountered, drop the RH below 42% and seek consultation with a conservator. Handle the material with gloves to prevent barrier coating breach and unintentional surface deposition from soiled hands.

8.3 Lead

An RH ≤ 40% is recommended for lead objects. More importantly, avoid organic acid pollutants, such as those found in wooded storage furniture, which will activate corrosion. Active corrosion takes the form of the rapid surface expansion of a soft white powder that disintegrates on contact (Rimmer et al. 2013). If encountered, drop the RH below 40%, which will slow the corrosion (Tétreault 2003), and consult a conservator immediately. Lead objects can be stored is sorbents which will scavenge the air of pollutants. Handle the material with gloves to prevent potential lead poisoning.

8.4 Silver

It is ideal to store silver in airtight containers in interior rooms away from windows. Air pollutants will cause the silver to tarnish. This, in itself, is not necessarily bad as it will form a protective layer on the silver but it will obscure surface details required for study. Continual cleaning of tarnished silver will further abrade the surface thereby reducing the surface details. Silver objects can be stored with sorbents which will scavenge the air of its pollutants. Handle this material with gloves to prevent deposition of chlorides on the surface.

8.5 Shale

Avoid abrupt handling of shale objects as they will break if enough force is excerpted. Avoid wet cleaning and certainly avoid immersion into water as uncontrolled drying of this material can lead to cracks, delamination and possibly fragmentation. It is best practice to handle this material with gloves to prevent deposition of salts on the surface. Salts, having penetrated the surface, can lead to cracks and delamination.

8.6 Glass

Avoid abrupt handling of glass objects as they will break if enough force is excerpted. The conserved glass of the Cardiff Castle assemblage should be stored dry and at 45-55% RH and cool temperatures should be avoided to prevent condensation (Cronyn 1991; Newton and Logan 2007). Consult a conservator if cracking and/or glass spalling is encountered.

8.7 Bone

Bone should be stored at 45-55% RH at a temperature not exceeding 25°C (Stone 1988). Buffer the stored bone from sudden changes in temperature and RH. Consult a conservator if any changes in the bone are noted.

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