Organic Remains in the Hoard from Balmaghie, Dumfries and Galloway, otherwise known as the Galloway Hoard

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Introduction

The organic remains associated with the Balmaghie (Galloway) hoard represent an exceptional, almost unique, survival. Although textiles and leather have been recovered from occupation sites of this period (e.g. Mould *et al* 2003; Pritchard 1984; 1988; 1992; Walton 1989; Wincott Heckett 2003) and from clothed burials (e.g. Gabra-Sanders 1998; 1999; Henry 2004; Speed and Walton Rogers 2004), relatively little has been preserved in association with hoards of metalwork in the British Isles (Walton Rogers in Graham-Campbell 1995). This is because organic materials only survive in a limited range of environmental conditions, most notably waterlogged soils and burials that include corroding metalwork (Walton Rogers 2012, 38-9). Precious metals, of their nature, corrode only slightly, and for the most part any wrappers in which hoards were buried will have decayed rapidly in the ground. In the case of the Balmaghie hoard, however, it is likely that the copper corrosion products emanating from the silver-alloy Carolingian vessel have provided a biocidal environment, which has inhibited the microorganisms that attack textile fibres and leather (Jakes and Sibley 1983, 37; Sibley and Jakes 1984, 23; Janaway 1985, 3).

The result has been the preservation of an extraordinary collection of silk, wool and linen textiles and braids, as well as ‘skin products’ (leather and/or parchment). Whilst the remains are fragmentary and brittle in the extreme, their structure has been fully preserved and has allowed a detailed reconstruction of the materials used to wrap and tie the objects in the hoard. They include high-status items, some of which will have been as valuable as the metalwork with which they are associated. Their places of origin and their value have the potential to provide a new perspective on Viking Age hoard deposition and its archaeological and historical context.

Fig.1. The two textile wrappers on the outer face of the Carolingian vessel.
The dark outer wrapper is the wool tabby repp and the pale inner wrapper is the spin-patterned linen tabby. © AOC Archaeology.

This report

Because of the fragility of the organic remains, it was deemed necessary to record them immediately. This was regarded as a preliminary intervention, and part of the preparation for the Treasure Trove process. Any analyses which could be left until a later stage were omitted from the programme. Within this report, therefore, recommendation will be made for further analytical work that will help with the date and provenance of the organic materials, and thereby the hoard. This work will be best done in parallel with the study of the inorganic artefacts from the hoard, so that research can be usefully focused and co-ordinated. *Text in blue italics, below, represents recommendations for this final stage.*

The primary goal of this first stage has been to identify the number of different fabric-types present and to characterise them. To achieve this, a catalogue has been compiled of structural details in 69 items, and their raw material has in each case been identified. For a detailed description of each item and the techniques of fibre identification, see the catalogue, below. The catalogue has been arranged according to the groups collected by the conservators at AOC Archaeology as (i) individual small-finds (SF numbers), (ii) fragments removed from the outside of the vessel before it was unpacked, together with loose fragments with a known location recovered during unpacking (D numbers), (iii) samples deliberately selected from a known location within the organic bundles during conservation (S numbers), and (iv) loose debris from unknown locations within the hoard (US numbers).

When the catalogue was re-arranged into fabric-types, it became clear that there had been originally a minimum of six different loom-woven textiles, three braids, two skin products and a layer of organic material likely to have come from the burial environment. These are discussed in groups, below. The identity of the different groups has been checked against the photographs and notes provided by the project conservators, Gretel Evans and Natalie Mitchell, and related as far as possible to their original position in the hoard.

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The outermost wrapper

The textile wrapped around the outer face of the Carolingian lidded metal vessel, D1-D5, D8-D9, has proved to be the only wool cloth in the hoard (Fig.1-2). A single fragment found with the leatherwork on the metal armbands, SF76(ii), is likely to represent the place where the wrapped vessel touched the armband group. Some further remains of poorly preserved wool textile associated with the wooden object SF 74.1B are probably part of the same wrapper. Samples from elsewhere in the collection are visually similar, but each has been determined as made of plant fibre (thus demonstrating the importance of identifying the raw material in every item).

The samples are all woven in tabby repp, a weave in which one system of threads, termed the dominant system, lies straight, while the other system bends round it. This weave often has an unbalanced thread-count, the lower count being in the dominant system. In this particular case, the dominant system has been made from S-spun yarn with 6 to 8 threads per cm, while the other system is Z-spun and more variable at 15-22 threads per cm. The presence of a simple selvedge in SF76(ii) demonstrates that the Z-spun system is the warp (the system under tension in the loom). This means that the loom must have been set up with a close warp and a tension slack enough for the warp yarn to be dominated by the weft.

Fig.2. Close-up of the outermost wrapper, a wool tabby repp. © AOC Archaeology.

The tabby repp weave gives a thick, hard-wearing fabric, suitable for heavy-weather outdoor garments and industrial and household cloths. Similar textiles have been recovered from the household-cum-workshop buildings in Anglo-Scandinavian York (Walton 1989, 319). The variable thread-count in the Balmaghie examples may indicate that this was an old cloth that had been stretched and pulled out of shape before it was used as a wrapper for the metalwork. No seams were recorded, the only surviving edge being the selvedge.

Transmitted-light microscopy of the fibres (see catalogue for method of analysis) has given further information on the character of this textile. Samples from warp and weft both proved to have the cuticular scale pattern (irregular waved mosaic with smooth near margins), that is typical of sheep's wool (Appleyard 1978, 26-7). Pigmentation was absent on most fibres but was moderate-to-dense on up to 10%. From a distance, therefore, this cloth will have appeared off-white, with a slightly greyish tone. Measurement of fibre diameters revealed that the warp and weft had been made from different fleeces. Within the Ryder system of fleece-type classification (Ryder 1969; Walton Rogers 1995), the Z-spun yarn was Medium and the S-spun system Hairy Medium. The Hairy Medium fleece is commonly encountered in textiles from a wide range of geographic and temporal sources in north-west Europe, but the Medium fleece is rare in Roman and Early Anglo-Saxon collections and only comes to the fore in Late Anglo-Saxon and Viking Age textiles. So far, it has been encountered in specialist products from Norway (Walton 1988, 149-52) and Hiberno-Norse Ireland (Walton Rogers in Pritchard in prep), and in more ordinary textiles from York and London (Walton 1989, 306-7). It is possible that, in combination with stable isotope analysis (von Holstein 2012), the broad geographic zone in which the wool originated can be identified.

Light stable isotope analysis of warp and weft yarns is recommended for the next stage of the study of the hoard.

The second outer wrapper

Inside the wool wrapper is a layer of a paler fabric, which also covers the lid (Fig.1 and Fig.3). Samples from the lid (S10) and the body of the vessel (S13)(Fig.3) have proved to be identical. A similar fragment in association with the leatherwork on the armbands, SF76(iii), may reflect the proximity of the vessel to the armband group. This is a spin-patterned linen tabby, a recognised textile type of the early medieval period and probably a product of specialist workshops. In these, yarns spun clockwise and anti-clockwise are alternated in warp and weft, to give a textured appearance to the simple tabby weave. The example from the hoard has a regular spin change every four threads in warp and weft, which is the most common pattern repeat found in comparable examples. The thread-count of 15 x 15 threads per cm (slightly higher in SF76(iii)) falls at the lowermost end of a scale that runs from approximately 15 to 28 threads per cm in examples from Early Anglo-Saxon England (Walton Rogers 2007, 76), although the more numerous material from Merovingian Germany includes finer and coarser variants (Bender Jørgensen 1992, 72-4).

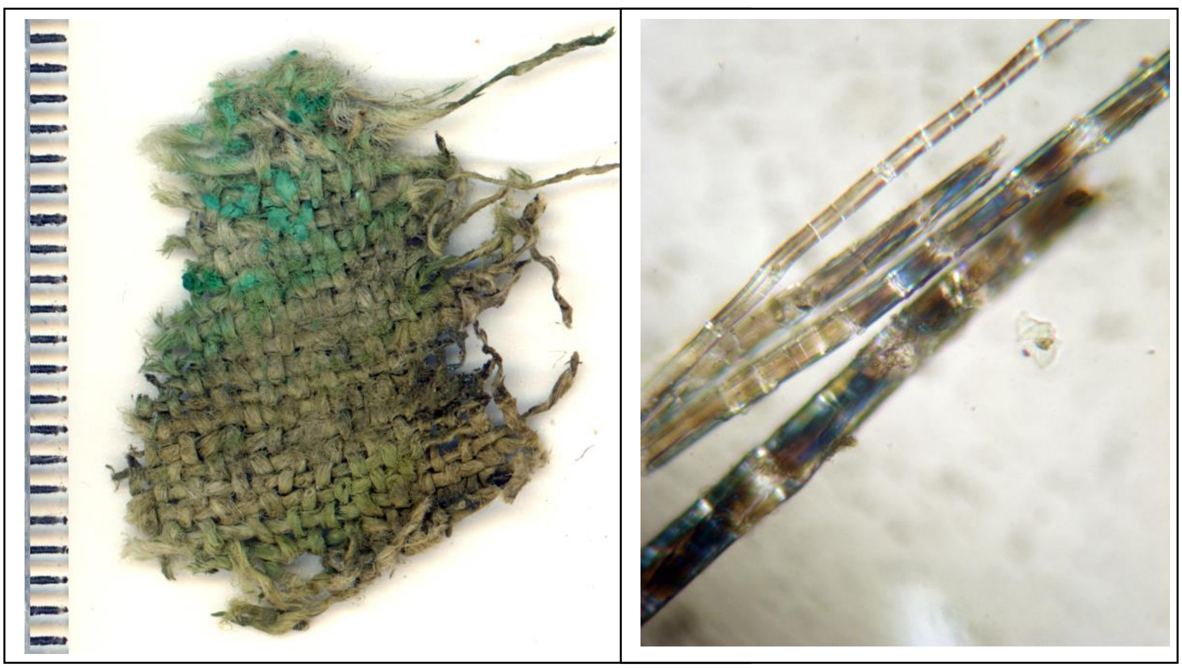

Fig.3. Spin-patterned linen tabby. Left, textile fragment S13 (scale in mm). Right, fibres extracted from textile S10, S-spun yarn, viewed with a transmitted-light polarising light microscope. This shows some fibres, still in fibre bundles; diameters of individual fibres, 9-10 microns. © ASLab.

Textiles made of flax (linens in the strictest sense of the word) in north-west Europe were traditionally woven with Z-spun yarn in warp and weft, but tabby-weaves with spin-patterning appeared in Anglo-Saxon England as a discrete type in the late 6th or 7th century (Walton Rogers 2007, 74-6). In her survey of textiles in north-west Europe, Lise Bender Jørgensen dubbed such fabrics the 'Gudmingegaard type' and noted that they had a distribution focused on the Alamannic cemeteries of southern Germany (Bender Jørgensen 1992, 141-2). They continued in use into the Carolingian period (*ibid*). The spin-patterning technique would not be difficult to reproduce elsewhere, but in the early centuries these textiles seem to cluster with other Alamannic weaves of more complex construction, which would be less easy to copy. It is therefore noteworthy that microscopy of the Balmaghie fibres showed that the flax was still in small fibre bundles, indicating that it had not been processed down to its finest filaments (Fig.3). This same feature has recently been recorded in some 6th-century spin-patterned linens from Lauchheim, on the edge of the Alamannic region in southern Germany (Walton Rogers in Peek in prep). Since, however, no full study of this fabric type has as yet been undertaken, it is not possible to confirm that spin-patterned linens were still a product of South German workshops in the 9th century.

Spin-patterned tabby-weave textiles appear in contexts that suggest that they were valuable. They include two tunics preserved at Chelles and believed to have belonged to 7th-century St Bathilde, wife of King Clovis II (Laporte 1984). One of these tunics was embroidered, and another example of an embroidered spin-patterned tabby was recorded in a burial in England, at Kingsworthy Hampshire (Walton Rogers 2007, 75, 101-2). Embroidery was frequently associated with status in the early medieval world (see below).

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Inside the vessel

Complex of silk samite with needlework, linen backing fabric and skin product

Three items were often found together in the different samples and appeared to represent a single complex object. One is the silk luxury fabric that is commonly called samite, though technically it is a weft-faced 1/2 compound twill. The second is an open net-like linen textile that lies in a flat layer on the back of the samite in at least five examples. The third is a skin product without its grain surface. In one instance, S12, these form a triple layer which has been folded over, with the skin product on the outside, the samite on the inside and the linen backing sandwiched between the two. A seam and remains of fine silk needlework on the samite add to the impression that this was originally a specially worked item such as a pouch, rather than just a wrapper.

The occurrence of these three items separately and together has been recorded in Table 1. Most came from the group identified by the conservators as the 'leather bundle', SF71.18, situated in the middle-upper region of the vessel and containing the gold filigree flask (Fig.4). Bearing in mind that the vessel was inverted for burial, the small fragments recovered from the loose debris (US numbers) are likely to have dropped down from this group. A layer of copper corrosion on the samite in S8 and smooth inorganic material on the same weave in D11 show where the front face of the silk has been in contact with a smooth metal surface.

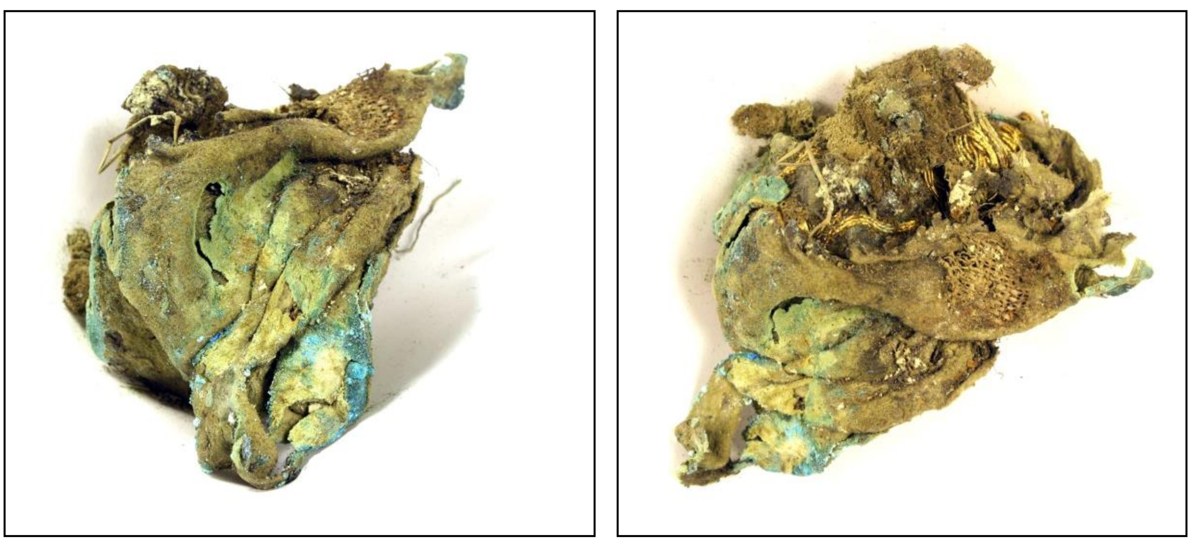


Fig.4. Two views of the 'leather bundle', SF71.18. Left, viewed from below; right, viewed from above.

Table 1. The samite, linen and skin product complex, as recorded in the different samples

	Samite	Linen tabby	Skin product	Needle-work	Notes
S1.	-	X	-	-	.
S2.(i)	-	X	-	-	Tubular braid, 3 mm diameter, in association.
S3.	X	-	-	X	Two pieces of samite joined with blanket stitch
S8.	X	X	-	X	probable sewing thread (plied silk) passes through samite
S12	X	X	X	-	Triple layer, folded inwards, samite innermost, skin product outermost.
D10	X	-	-	-	
D11	X	-	X	X	Detached Z-spun yarn in association. Smooth material on front of samite.
US2	-	?X	X	-	Cut edges forming corner on skin product.
US3	X	-	-	X	Remains of seam/fold covered by needlework
US4	-	-	-	X	Detached needlework resembling a guilloche plait.
US7	X	X	-	-	
US8	-	X	-	-	
US9	X	X	-	X	Needlework along a fold in fine blanket stitch...
US10	-	-	X	-	
US11	-	-	X	-	One probable cut edge on skin product.
US12	-	-	-	X	Detached braid-like needlework
US15	X	X	X	-	
US16	?	X	X	-	

Silk samite

Samite (weft-faced compound twill) is a sophisticated weave which will have been woven on a drawloom. It has two sets of warp (main and binding) and weft yarns of different colours, which are brought to the front by the patterning equipment as the design requires (Fig.5). Although samite could sometimes be produced in plain monochrome pieces, the weave was mostly used for bi-colour or multi-colour fabrics with large repeating motifs. Its diagnostic technical features include the thread-count (especially whether warp and weft are equal or unbalanced), the direction of the twill diagonal (defined as Z or S) and whether the main warp is single or double yarn, and twisted or non-twisted.

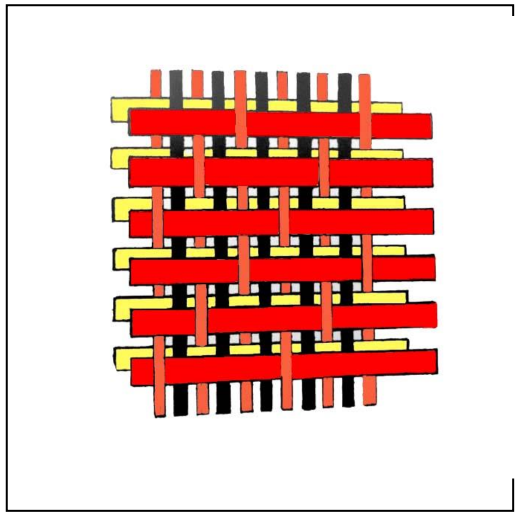


Fig.5. Structure of samite (1/2 weft-faced compound twill) with single main warp and twill diagonal running in the Z-direction. ASLab.

Fig.6. Fragment of silk samite. Left, front; right, reverse. Note how the Z-direction twill becomes S-direction on the reverse. Photos Natalie Mitchell. © AOC Archaeology.

The samite from the Balmaghie hoard (Fig.6) has approximately 20 main warp yarns and 20 binding warp yarns per cm; and 30-36 weft yarns per cm on the front face (an unbalanced thread-count). The twill diagonal runs in the Z-direction (NE-SW). All yarns have been reeled without twist and for that reason it is difficult to judge whether the occasional double thread in the main warp represents a paired warp or a single warp yarn that has split into two. After comparison with photographs of other samites of the period, the latter was deemed the more likely.

At this date, the drawloom, and samite production, existed in Byzantine and Islamic workshops of western Asia, North Africa and southern Spain, but had not reached as far as Italy. The single main warp is found as early as the 6th century, but is most commonly encountered in 8th- and 9th-century samites (Muthesius 1997, 65- 79). The Z-twill is less common than the S-twill, and, on a preliminary review of the relevant material, appears to be best represented in Islamic centres. It should be noted, however, that the Balmaghie example closely resembles a single example, No.14, from amongst the 15 samites from the 9th-century Oseberg ship burial in Norway. This also has a Z-diagonal, an unbalanced thread-count and a single no-twist main warp, but has been ascribed, not to the Islamic caliphate, but to eastern Central Asia (Vedeler 2014, 9, 18-19; Christensen and Nockert 2006, 277-337).

Attributing these technical groups to individual production centres is fraught with difficulty. Limited numbers of silks have been excavated in the regions in which they were made and much of the research has had to be based on those silks which have survived in European treasuries. They have generally been ascribed to individual production zones according to their design and technical features, with the help of occasional inscriptions in the borders. In the case of the Oseberg Z-diagonal silk, Vedeler (2014, 18) has followed Nockert (Christensen and Nockert 2006, 298) in relating it to the so-called Zandaniji silks and in rehearsing the arguments of Shepherd (1981; Shepherd and Henning 1959) for an origin in Sogdia in Central Asia (modern Uzbekistan and Tajikistan).

This attribution is largely based on a tentative identification of Sogdian script in the border of the 'Zandaniji' piece known as the 'shroud of St Mengold' at Huy, Belgium (Shepherd and Henning 1959). In 2008, however, the script on the Huy piece was re-examined by a specialist in Arabic paleography and firmly identified as Arabic (Sims-Williams and Khan 2008). The attribution of this whole group to Central Asia has thereby been called into question. Sims-Williams has placed them instead in the western Abbasid Caliphate (modern Egypt, Syria and Iraq), which would accord better with other kinds of Z-diagonal samite from European treasuries. *Since silks from the western caliphate and those from central Asia are likely to have arrived in the north by different routes and, quite probably different exchange mechanisms, this matter deserves a thorough re-assessment at the next stage.*

There are several mechanisms by which such silks could reach north-west Europe in the Viking Age. That there were trade routes from both the eastern Caliphate and Byzantium via Russian/Asian rivers to the Baltic, and thence to Scandinavia, is already well known and has been recently reviewed by Vedeler (2014, 55-66). The silks sold by Constantinople to northern merchants represented the less valuable range of goods and it was argued, from a variety of evidence, that the plain silks from Anglo-Scandinavian York could have arrived by the Baltic route (Walton 1989, 419). At the same time, silks made in Byzantium were being traded through Venice (Lopez 1945, 35-40; Muthesius 1993, 11) and the two chasubles that Bishop Theodred bought in Pavia in the 10th century may have been part of this trade (Whitelock 1930, 5). Indeed, the role of pilgrims with deep pockets returning to Britain with silks should not be overlooked. A further important mechanism in the exchange of the more prestigious figured silks lies in the diplomatic gifts from the Byzantine emperor to Christian princes, which, once in the north, could be passed on, as donations to shrines, individuals or institutions.

This requires further research at the next stage. The latest review of Viking Age silks (Vedeler 2014) provided an important summary of silks in Scandinavian graves and ably reviewed the eastern routes to Byzantium and Central Asia. However, in focusing on the eastern direction, it omitted all the silks (including samites and embroideries) from Britain. Since numerous pieces of metalwork from the British Isles, probably acquired in Viking expeditions, have been recorded in 9th-century graves in Norway (Wamers 1998), it is reasonable to suppose that silks could be acquired in the same way. A review of the British and Irish evidence in relation to the Scandinavian finds, with a particular focus on the Z-twill samites, will be undertaken by PWR at the next stage.

Silks of this kind were immensely valuable. Bede cites a case where two lengths of figured silk were enough to buy three hides of land (Alexander 1979, 202). Some have been found in burials of Anglo-Saxon saints such as St Cuthbert at Durham (Battiscombe 1956; Bonner *et al* 1989) but most, used for vestments and hangings, remained above-ground in church treasuries across Europe (e.g. Budny and Tweddle 1985; Muthesius 1997, 2008; Schmedding 1978; etc). As they became old and worn they were cut down and re-used for small items such as purses and relic covers (Clegg Hyer 2012). It seems likely that the Balmaghie samite represents this secondary use.

Silk needlework on samite

In S3, two pieces of samite have been joined, folded edge to folded edge, with a fine blanket stitch worked in silk thread (plied Z2S, 0.4 mm thick) (Fig.7a). There are 10-12 stitches per cm and the stitches are only 1.5 mm deep. The ply of the thread and the shallow nature of the stitch give the effect of a fine cord running along the seam. Further remains of the same stitching have been recorded in US9. The needlework has a reddish tinge, unlike the samite which is mostly green (though possibly a result of staining from the copper in the metalwork). *Dye analysis is recommended for the next stage*.

(a)


(b)

Fig.7. Silk needlework on samite: (a) blanket stitch on S3 SF71.18; (b) braid-effect needlework on US3; (c) detached piece of same. Photo 7(a) & 7(c) Natalie Mitchell, © AOC Archaeology. Photo 7(b) © The Anglo-Saxon Laboratory.

(c)

In US3 a double row of silk needlework resembling tablet-weaving lies across the front of the samite (Fig.7b). It is possible that this too covers a seam or fold, although the back of the samite is unclear due to damage. In US4 and US12 there are detached remains of the same needlework

(Fig.7c). They resemble two parallel braids, each less than 1 mm across, but broken threads on the back show where they were attached to the textile. The exact stitch could not be identified, due to the brittle nature of the remains. The sewing thread has a weak S-twist and is paler than the thread used for the blanket stitch. A single S-plied silk thread passing through the samite in S8 probably represents further remains of stitching.

Archaeologically, embroidery tends to occur most commonly in royal burial sites such as Mammen, Denmark, Oseberg, Norway, and Sutton Hoo, England, and in the burials of prominent ecclesiastics such as St Cuthbert. Historically, embroidery is known to have been practised by Anglo-Saxon women from important families and in Ireland there were professional embroiderers, who were paid well for their skills. The simpler forms, where ornamental stitching covers the line of a seam and emphasises the structure of the textile object are perhaps not necessarily so prestigious – an example in raised plait stitch has been recorded on a Viking-Age wool cuff in York (Walton Rogers on-line at http://www.iadb.co.uk/waterstones/showmatrix.php SF 85i) for example – but the Balmaghie examples are an extraordinarily fine representative of the technique.

<u>Open-weave linen</u>

The backing fabric is woven in simple tabby weave with Z-spun yarn in warp and weft (Fig.8). The yarn is very fine, 0.3-0.4 mm diameter and set at 12-16 threads per cm. It lies in a flat layer on the back of the samite in S8, S12, US7, US9 and US15. Textiles can sometimes be reduced to a skeleton of their former selves by the process of decay (see, for example, the edges of the textile illustrated in Fig.10), but in this instance the textile has retained the same net-like appearance throughout all samples. It is concluded, therefore, that this was its original structure. The fibre is a plant-stem fibre, probably flax, and in the samples examined, fully processed down to the finest filaments.

Relatively few linens of this type have been recorded previously, but this may be because in north-west Europe burial conditions are often hostile to the plant fibres. As previously described, the copper salts from the corroding alloy of the vessel probably protected the cellulosic fibres in this instance. Net-like wool textiles, sometimes called *Schleiergewebe* or 'veil weave', are already recognised as a specialist product of the early medieval period and there is no reason to suppose that they could not be produced in linen also.

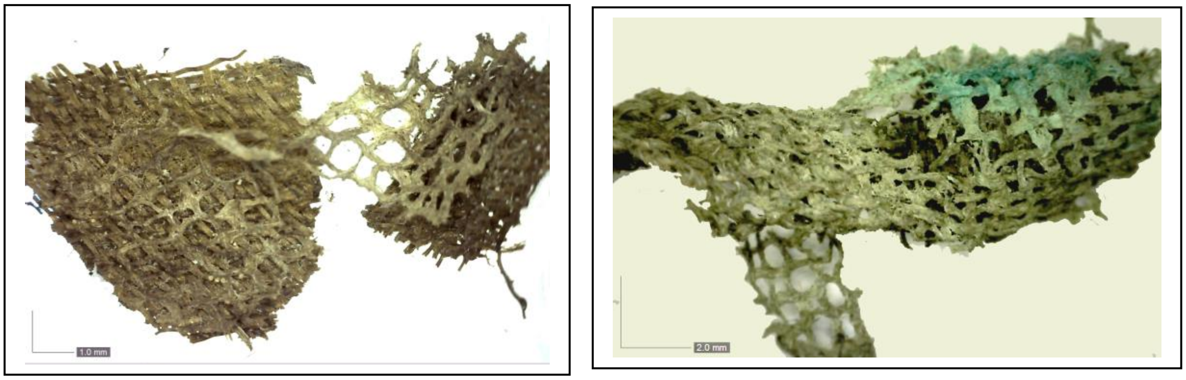


Fig.8. Net-like linen tabby, lining samite. Left US 15; right US 8. Photos Natalie Mitchell, AOC Archaeology, digitally enhanced at ASLab.

Skin product

A felt-like layer of fibrous material (Fig. 4 and Fig. 9), in its present state less than a millimetre thick, has been identified as the collagen layer of an animal skin.by microscopy. No grain surface has been preserved. This layer can become detached in archaeological leather, but the possibility that this is parchment or some other specially treated product should also be considered. In US2 there are two cut edges, 9 mm and 6 mm long, at right angles to each other, but otherwise there is little to indicate the original structure of the object. However, the tight fold visible in S12 suggests a relatively pliable material. *It is important to identify species (soft goatskin or deerskin versus heavier cattle hide) at the next stage. A combination of ZooMS and DNA is recommended. Once the information embargo has been lifted, this material will be shown to a parchment specialist at the University of York.*

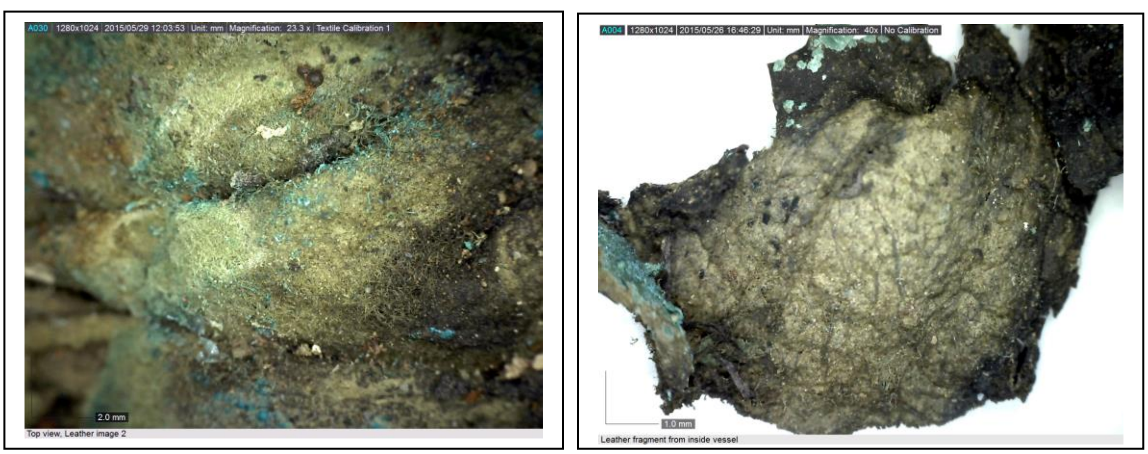


Fig.9. Skin product from inside the lidded vessel. Left, fragment US2; right, fragment US 10/1. Photos Natalie Mitchell, © AOC Archaeology.

Other linen tabby weaves

The two fragments labelled US1 were at first mistaken for pieces of the wool outer wrapper. They have the same tabby repp weave and similar counts of 7-8 x 14 threads per cm. However, the fibre proved to be a plant-stem fibre in both cases, and was confirmed as fully processed flax in US1(ii). On closer examination, the two fragments proved to differ from each other, with the spin Z x Z in textile US1(i) and S x Z+S in textile US1(ii). Further fragments, Samples S1 and S2, resemble US1(i), with the same weave, thread-count and Z x Z spin. The spin-patterned fragment also has, adhering to one face, remains of an open-weave Z x Z tabby, similar to that backing the samite (Fig.10).

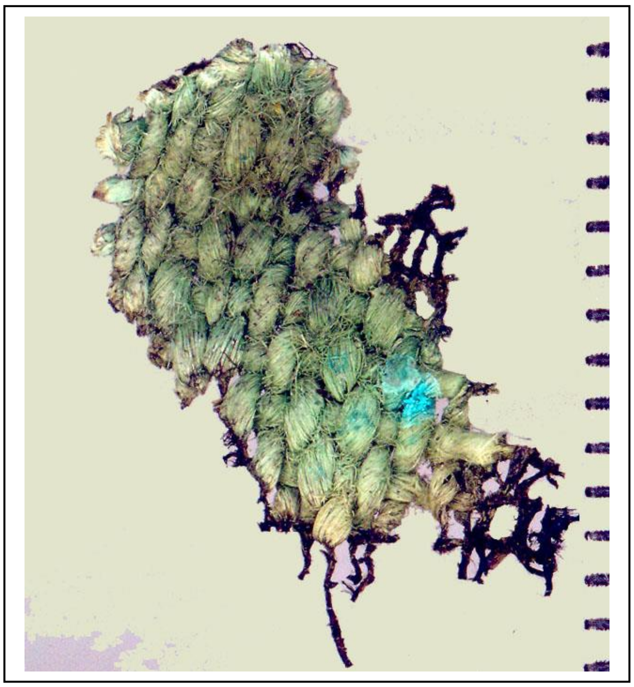


Fig.10. Spin-patterned linen tabby repp, US , fragment (ii). © The Anglo-Saxon Laboratory.

The mixed spin in US1(ii) is irregular, ZSSZSSZZZSSZZZZS (Fig.10). This can sometimes occur where a weaver does not have enough weft yarn for one cloth and has to work in another of a slightly different weight: a graded change from one to the other prevents a line of weakness opening up at the changeover. This would not, however, explain the S-spin in the other system. It has to be concluded that these four fragments either represent small pieces of a textile elaborately spin-patterned in warp and weft, with large blocks of Z x Z-spin, or that they come from two different fabrics, three fragments from a plain Z x Z fabric, S1, S2 and US1(i), and the fourth, US1(ii), from a spin-patterned cloth.

Textiles S4 and S5 are both relatively fine tabby-weave textiles with Z x S spin and similar thread-counts, 16-18/Z x 16/S in S4 and 20/Z x 14/S in S5 (not illustrated). The fibre could not be identified in S4, but it is probably flax in S5. S7 and S9 may be the same. Since S-spin is unusual in linens, it is possible that they too come from spin-patterned textiles, although they are too fine to have originated in any of the cloths described above.

Silk braids

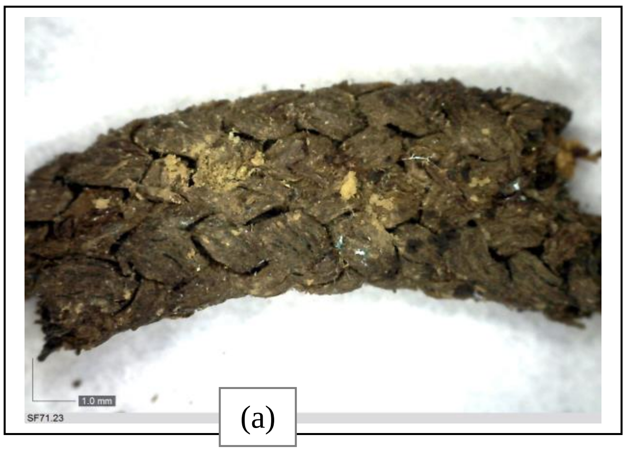
Braids are worked by interlacing threads without the introduction of a crossways weft. Three different braids have been identified. The first is a flat braid which has been rolled inwards from the sides and decorated along the join with gold-thread needlework. The other two are tubular braids of different diameters, worked on different numbers of warp threads. The braids come from the lower level of the Carolingian vessel where they can be seen in X-ray snaking back and forth amongst the artefacts (Fig.11). Since the vessel had been inverted in the ground, the fragments recovered from other levels of the vessel are likely to have fallen down from above.

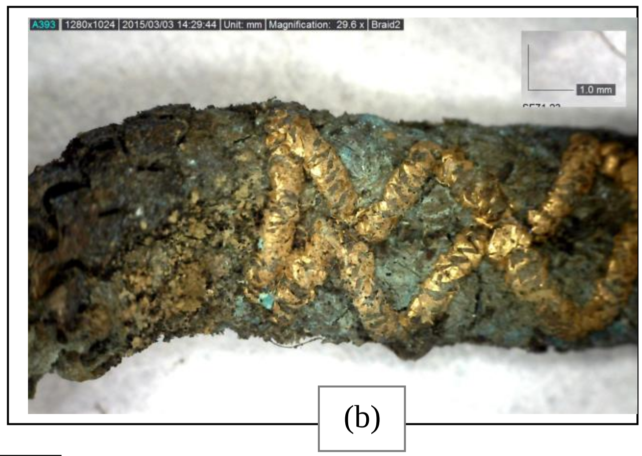
Fig.11. X-ray showing the braids in the textile bundle, SF 71.20. X-ray by Natalie Mitchell. © AOC Archaeology.

Both flat and tubular braids have been made by the 'fingerloop' technique (Crowfoot *et al* 1992, 138-40). For this, a bundle of yarns is folded in half and the cut ends tied together and anchored to a fixed point. The loops are then slipped on the fingers of both hands and the threads pulled taut. The braiding is worked by moving loops from one finger to the other, in a repetitive cycle, so that the threads interlace. Silk fingerloop braids are well-known from the late medieval period (Crowfoot *et al* 1992, 138-40), but these three represent interesting early additions to the record.

Silk rolled braid with gold-thread ornament

This is a single item, SF 71.23, in its finished state 5mm x 3 mm thick (Fig.12a-c and Fig.13). It has been made from a flat braid which, before rolling, was probably originally about 15 mm wide. It has been worked as a simple diagonal plait from at least nine yarns, the exact number unclear. The braid's full length cannot be determined. The fibre was identified as silk by a combination of transmitted-light microscopy and scanning-electron microscopy.





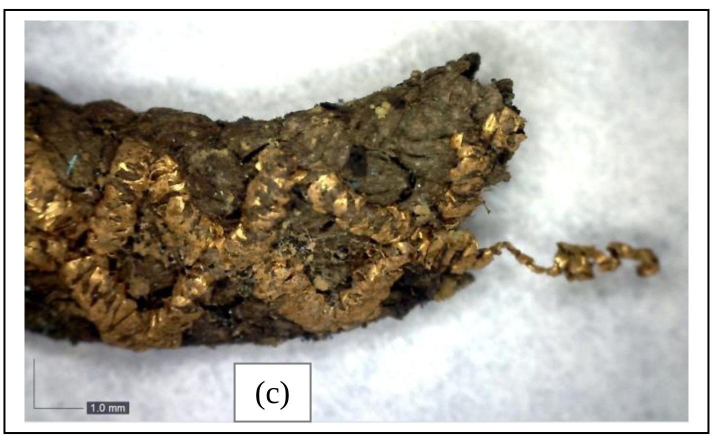


Fig.12. Rolled braid with gold-thread ornament. SF 71.23. (a) back; (b)-(c) front. (d) Scanning electron micrograph of fibres from the braid. Photos Natalie Mitchell, © AOC Archaeology.

The gold thread ornament appears to have been applied in discontinuous lengths along the braid. It forms a double row of zig-zags along the join and in one instance the end where one row of zig-zags crosses over and runs back down the other side has been preserved (Fig.12b). The thread does not dip down into the braid and must be held in place by couching threads, although these are not visible on the surface. The decorative thread itself has the appearance of a tightly coiled spiral, but the coils prove to be made from gold thread, itself a flat filament twisted S-wise around a silk core (for technical details, see catalogue). The surface has an evenly flattened appearance and there are fine crossways striations, which suggest a deliberate smoothing after the needlework had been completed. *XRF of the front and back of the gold filament will clarify whether it is pure gold, gold alloy or gilded silver: this should help with date and provenance*.

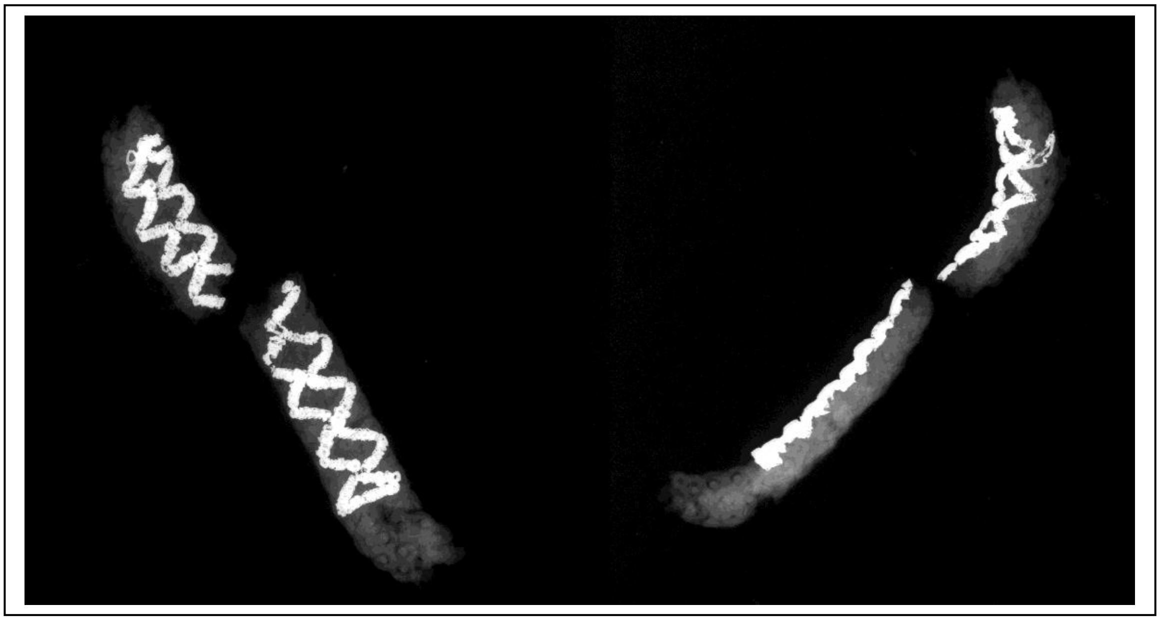


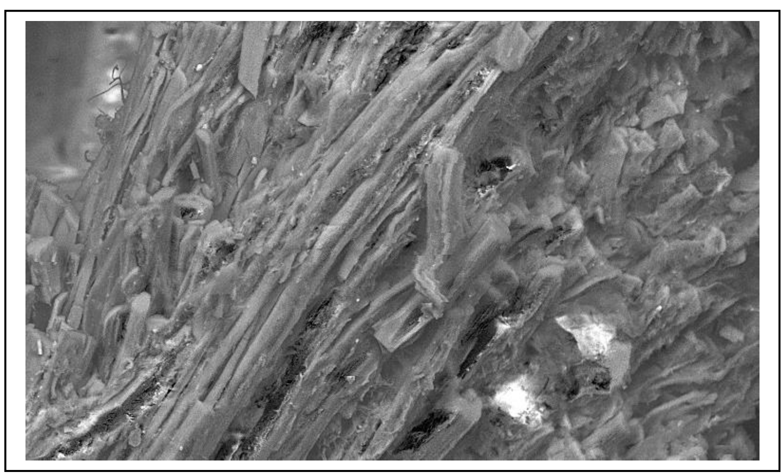
Fig.13. X-ray of gold-thread on rolled flat braid. Left, flat; right viewed from side.
X-ray by Gretel Evans, © AOC Archaeology.

Tubular braids

In US6, there are numerous fragments of a tubular braid, 1.5-2.0 mm in diameter (Fig.14). It is brittle and difficult to analyse, but was probably worked on four strands, each strand representing a pair of yarns used together. The fragments are relatively straight and when placed end-to-end they reach a length of 200 mm. They are clearly different from the tubular braid fragments in S2 (ii), S7(i), D12, D13 and US5, of which the best preserved is D13. These are thicker, 2.5-3.0 mm in diameter, and where the strands can be counted, there are six, each, again, represented by a pair of yarns. The fragments are all curving and in S7(i) form a semi-circular loop. The total preserved length of the sampled fragments is around 90 mm. Further fragments of tubular braid in D6, D7 and US13 are too poorly preserved to attribute to either of the above groups, although the fragment in D7, removed from next to the internal wall of the vessel, appears to represent a knotted end. Samples of the thicker braid from D13 and US5 showed all the features of degummed silk by transmitted-light microscopy and scanning electron microscopy (Fig.15), but, even with the aid of scanning electron microscopy, it was not possible to determine the identity of the fibre in the remaining fragments.

Fig.14. Tubular braids. Left, fragment D13; right, other fragments. Photos Natalie Mitchell, © AOC Archaeology.

Fig.15. Scanning electron micrograph of silk filaments in tubular fingerloop braid D13. SEM prepared by Vicky Garlick, Conservation Services, Durham University.



Skin product with armbands

Numerous fragments of a dark brown skin product, SF76(i), confidently identified as leather, were recovered from the metal armband group. The largest fragments are 70 x 33 mm, 55 x 30 mm and 53 x 11 mm. Some still have the impression of the metalwork on the inner surface and can be interpreted as a cover, wrapper or bag. Their recovery in association with small pieces of the outer wrappers on the Carolingian vessel (see above) suggest that the armbands in their leather container were placed immediately on top of the inverted metal vessel.

The leatherwork must have been relatively soft and pliable, to judge from the folds and creases. Remains of fine stitching along some surviving edges suggest that the object originally had closed seams joined by single-thread running stitch, with four-five stitch-holes (i.e.two or more stitches) per cm. Fibre tufts preserved in the stitch-holes mostly proved to be plant roots, although some more poorly preserved plant-fibre remains are likely to represent the original stitching.

Identification of species by a combination of ZooMS and aDNA analysis is recommended for this at the next stage.

Organic remains with wood

A thin layer of soft fibrous material lay across one face of the fragments of wood in SF 74.1/A, SF 74.2/A and SF 74.3/A, in the deposit above the Carolingian vessel. The same material appeared, detached, in S6, where it was associated with pendant SF 71.22; and in S11, which was taken from the armbands and wood complex. Under the microscope the fibrous material proved to be made up of fine hollow, colourless filaments with a smooth profile, which were consistently around 6 microns wide. They were mostly loose, but some lay in parallel groups and others radiated from a central core in a fan shape. These are not textile fibres, nor are they any recognisable fur or skin product. One possibility is that they represent feather down. Most feather filaments have prominent hooked nodes along their length, but in some species the nodes are so far apart as to be almost absent They were associated with frequent clusters of pollen/spores (Fig.16) (confirmed by Ciara Clarke). *Examination by a botanist is therefore recommended*.

Associated with this group, in SF74.1/B and SF74.2/B, are some off-white remains of poorly preserved textile, tentatively identified as tabby weave with Z x S spin, possibly part of the outer wrapper of the Carolingian metal vessel (see above).

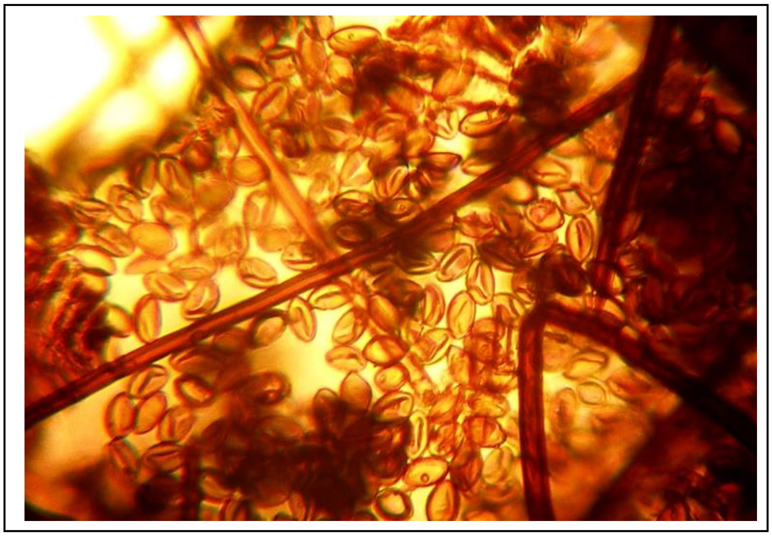


Fig.16. Spores, pollen and unidentified filaments from SF74.1A. Photo © ASLab.

Miscellaneous yarns

A small number of yarns, all of different types and collected together as US 14, could not be attributed to any of the above groups but are included in the catalogue.

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[Note added in 2022: this is forthcoming in 2023]

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Catalogue
Textiles and other organic remains with the Balmaghie (Galloway) hoard

Notes to catalogue
1. Material in quotation marks comes from the conservation team records, either the Excel table provided with the samples, or written on the bags and boxes.
2. Structural records were made with a binocular microscope at x10 magnification and a straking light.
3. Fibres, collagen, etc were identified with the aid of two microscopes. The first can be switched between incident light at x40-x160 magnification and transmitted light at x 40-x640 magnification. This also allows measurements through an eyepiece graticule at x40-x400 magnification. The second uses only transmitted light at x40-x400 magnification, but has a polarising facility and a rotating stage. All samples were viewed as whole mounts in tap-water. The drying-twist test (DTT) was applied to plant fibres where they were well enough preserved to allow it. In this, single fibres are wetted and their rotation, clockwise or anti-clockwise is observed as they dry under a hot lamp.

SF71.23 Braid with gold ornament

The braid
The braid itself is 5 mm wide by 3 mm thick; this fragment is 13 mm long and curved.
It has been constructed from a flat diagonal plait, which has the longitudinal edges rolled towards each other, to give a thick, seemingly tubular, braid. Gold thread has been stitched over the line where the edges meet, in a cross-stitch, 5 mm tall, stitches 3 mm long, 2.5 Xs per cm. X-radiography shows that the gold thread does not dip into the textile and must be couched on to the braid.

The diagonal plait
The flat diagonal plait was probably 15 mm wide before folding and appears to have a simple under-over construction. It is not possible to count the number of yarns in the braid, due to the rolling in of the edges and the brittle nature of the yarn, though at least nine yarns were observed. Each yarn is *c*.1.2 mm wide and weakly twisted in the S-direction.

Microscopy of plait fibres
A sample of the filaments of the plait mounted for microscopy (transmitted and polarising) proved to be 7-10 microns wide and transparent with no visible internal structure. Cross-sections were triangular. When the polariser was rotated, the predominant colour was blue, which did not change when the red plate was inserted.

The gold thread
The cross-stitch had been worked in gold thread that had been spun and then coiled into a thick yarn, 1.0 mm wide. It appeared to have been flattened or smoothed in situ.

The gross structure of the thread is a tightly coiled spiral. The spiral has an angle of twist of 70-75 from vertical and approximately 30 twists per cm (estimated from 2mm). No central yarn, around which it would have been coiled, could be detected. The spiral has been fashioned from yarn which is itself a spun-gold thread, approximately 0.3 mm thick. It has been made from a flat strip of gold wrapped in the S-direction around a core yarn. The gold strip is approximately 0.4 mm wide, with 15-20 twists per cm, at an angle of about 40 from vertical. The gold strip has noticeable striations running at different angles – probably the result of smoothing after use. The core yarn is poorly preserved, but enough filaments could be removed to establish that it is degummed silk, as above. The spin/ply of the core yarn could not be determined. *XRF of gold filament (front and back) required*.

SF74 'Worked wood from armband' = three pieces of wood with organic remains adhering to one face

SF74.1/A. A layer, approximately a millimetre thick, of a soft, brittle, felt-like material, covers an area 25 x 15 mm. Microscopy at x400 mag indicates that it is made up of extremely fine colourless hollow filaments, c. 6 microns wide. Some of these lie in parallel clusters, while others appear to radiate from a core. Frequent clusters of pollen grain and spores were present.

SF74.1/B. Separate from A, but on same face, a fragment, 5 x 5 mm of poorly preserved textile, possibly tabby weave ?S/0.4 x ?Z/finer. Microscopy at x 400 mag revealed fibres 17-34 microns wide. They were splitting longitudinally and resembled wool in the early stages of decay, after it has lost its surface cuticle.

The whole wood fragment is 75 x 25 x 15mm.

SF74.2 had further remains of felt-like material A, over area 5 x 4 mm, and a single S-spun thread, 4 mm long, similar in character to that in textile B. The wood fragment is 70 x 25 x 15 mm

SF74.3 had a small area of A, 3 x 3 mm on one face; no B was present. The wood fragment is 60 x 9 x 4 mm

SF76 from metalwork cluster incorporating armbands
(i) At least 13 fragments of leather, some with worked edges. No surface grain pattern preserved. Thickest fragments 3.0-4.0 mm thick; most now 1.2-1.5 mm thick. Fragments with significant features are as follows.
(a) 70 x 33 x ≥1 mm. One almost-straight worked edge, 70 mm long, turned in by 3 mm; puckered from stitching, four stitch-holes per cm (i.e. two stitches per cm). The remains represent only one half of the seam, but their arrangement, together with puckering of the leather, most resemble a seam closed by single thread running stitch. Fibre tufts survive in stitch-holes, although when mounted for microscopy they proved to be mostly plant roots, with some collagen fibres from the leather and some poor remains of possible plant-fibre.
(b) 53 x 11 x 1.2-1.5 mm. Moulded into curved shape as if originally covering an object such as an armband.
(c) 55 x 30 x 1mm. Creasing suggests a flexible leather.
(d) Four fragments, largest 22 x 12 x1.0-1.5 mm and 15 x 8 x 1.0-1.5 mm each with a straight worked edge. Stitching as on (a), but edge flat; 4-5 stitch holes per cm.
(ii) Fragment of textile, 7 x 5 mm, tabby repp with selvedge, wa/16-18/Z x we/8/S per cm. Fibre wool, identical with as D1-D5. Selvedge, simple in construction, has two clear weft returns.
(iii) Two fragments of textile, 7 x 7 mm and 7 x 5 mm, spin-patterned tabby, 16-20/S+Z x 20-24/Z+S per cm. Fibre flax/hemp, partially processed. Spin recorded in two fragments as ZZSSS x SSZZZZSSSSZ and SSSS x ZZZSSS: probably a 4Z/4S x 4Z/4S pattern repeat.

Decant D-numbers
D1 = T1.1 (outer layer)
Three fragments, 23 x 10 mm, 8 x 8 mm and 7 x 5 mm, tabby repp, dominant system 7-8/ S/0.4-0.5 x 20-22/Z/0.4 per cm. Microscopy at x 400 magnification revealed fibre to be wool, based on a scale pattern that was waved irregular mosaic with smooth margins. Approximately 10% fibres had moderate-dense pigmentation, the rest were non-pigmented.

D2 'Textile (T1.1 outer layer): from exterior vessel surfaces'
Short lengths of Z-spun and S-spun wool yarns, longest 10 mm. Wool fibre as in D1.

D3 'Textile (T1.1 outer layer): from exterior vessel surfaces'
Fragment, 20 x 15 mm of textile as D1, but with thread-count closer to 6/S x 18/Z per cm; fibre as D1, but not as well preserved.

D4 'Textile (T1.1 outer layer): from exterior vessel surfaces'
Fragment, 20 x 10 mm, of textile as D1, but with thread-count closer to 8/S x 15/Z per cm. Fibre not examined.

D5 'Textile (T1.1 outer layer): from exterior vessel surfaces'
Well preserved fragment, 30 x 25 mm (30 mm across Z-spun system), 1.5 mm thick, of same textile as in D1, with thread-count of 7/S/0.5 x 18/Z/0.7 per cm. Fleece types identified from fibre-diameter measurements (in microns) as follows.

Z-spun: range 11-61, mode 30, mean 31.5 standard deviation ±10.4; Pearson co-efficient of skew +0.13, symmetrical; 7% medullated; 9% moderate-dense pigmentation. Medium fleece type.

S-spun: range 10-77, mode 17, mean 26.5, standard deviation ±11.7; Pearson co-efficient of skew +0.40, skewed positive; 3% medullated; 2% pigmented in coarse hairs only. Hairy Medium fleece type.

D6 'removed between SF71.9 and underlying leather bundle' (in gelatine capsule)
Several fragments of gently curving tubular braid, 2.0-2.5 mm thick, longest fragment 14 mm (total approximately 30 mm). Between four and six strands in the plait; each strand is *c*.1.5 mm across and made up of a pair of non-twisted bundles.Heavily mineralised and decayed: fibres not identified by optical or scanning electron microscopy.

D7 'removed from beside vessel wall. Exact location is in annotated decant images' (in plastic tube container)
Fragment, 8 x 7 x 5 mm, of mineralised fibre product, probably a knotted tubular braid. Fibre not identified.

D8 'fallen to base of vessel from higher position. Exact location unknown'
Fragment of folded textile, 17 x 9 mm (17 x 18 mm before folding), woven in tabby repp. as D1: 6-7/S/0.7 x *c*20/Z/0.8 per cm. Fibre wool, as D1.

D9 [*location not recorded in Excel file*]
Curling fragments of textile, largest 18 x 8 mm, woven in tabby repp as D1: 7/S/0.7-0.8 x 18/Z/0.5 per cm. Wool as D1 but with inclusion of one fibre 53 microns diameter with a continuous medulla.

D10 ‘loose fragment from inside vessel, was not attached to an object’(labelled T7.1)
Three fragments, 8 x 7 mm, 7 x 7 mm and 8 x 4 mm, of same silk Z-twill samite as in S3.

D11 ‘loose fragment sitting on SF71.18, was not attached to object’ (labelled T7.1)
(i) Fragments, largest 11 x 6 mm, of same silk Z-twill samite as in S3.
(ii) Skin product in association with (i): examined at x200-x400 proved to be collagen. (iii) Fragments of a thin smooth material, on front of samite and detached, are of uncertain origin.
(iv) A single detached length of Z-spun yarn, 0.4 mm diameter, 10 mm long.

D12 ‘fallen during object lift SF71.18, no context recorded’ (in gelatine capsule)
A fragment of tubular braid, 2.5 mm thick, 7 mm long, worked from at least five strands, each strand made up of a pair of non-twist fibre bundles. Fibre not identified.

D13 ‘removed from base of vessel’ (labelled T5.1)
Tubular braid, 2.5 mm diameter, this fragment 18 mm long and curved. The braid is a simple 6-strand plait. The yarn is without twist, 1.0-1.2 mm thick. Microscopy of the fibres revealed degummed silk, identified from smooth filaments, 8-11 microns wide, with occasional bulges, transparent with no visible internal structure. When the polariser was rotated, the predominant colour was blue. Wedge-shaped cross-sections visible in SEM.

Sample S-numbers
S1. ‘Sample from leather bundle SF71.18 (loose on surface may not be directly associated)’
A fragment, 15 x 12 mm, of tabby weave, relatively open weave, 15/Z/0.4-0.7 x 8/Z/0.8 per cm. Microscopy of fibre indicates most are poorly preserved but best examples are 9-14 microns diameter, with fine central lumen, well-spaced cross-markings and an occasional ‘knee-joint’ node. This indicates fully processed flax or hemp, probably flax.

S2. ‘Sample from leather bundle SF71.18 (loose on surface may not be directly associated).’
(i) A poorly preserved triangular fragment, 10 x 10 mm, of same textile as in S1. It was not possible to count the threads, but the weave was certainly tabby and the yarn Z x Z. Microscopy revealed the same probable flax fibres.
(ii) Across one face runs a curving length of poorly preserved tubular braid, 3 mm diameter, 12 mm long. The braid is a diagonal plait and probably the same as the better preserved example, D13.

S3. ‘Sample from leather bundle SF71.18 (loose on surface may not be directly associated).’
A fragment, 14 x 8 mm, made up of two folded pieces of the same textile, held together by a fine needle-worked braid-like edging. The textile had a greenish blue tinge and the edging was reddish brown.
The textile is a weft-faced compound twill (samite) with ?single main warp and a wale that runs in the Z-direction. There are approximately 20 main warp yarns and 20 binding warp yarns per cm; there are 30-36 weft yarns per cm on the front face. It was impossible to judge the number of different weft in use. All yarns appeared to be reeled without twist. The main warp seems to be wo bundles of filament reeled together, rather than two individual warp yarns.

Two pieces of the same textile had been folded towards each other with a seam allowance of 3.5 mm on one and 6 mm on the other. In both cases the warp runs parallel to the fold. Along the joined folds ran what appeared to be a cord, but which on examination proved to be a stitched edging worked with plied yarn, Z2S/0.4 mm. It appeared to be a variant of blanket stitch, but was too brittle to investigate. There were 10-12 stitches per cm (based on a 5 mm length); the stitches were 1.5 mm deep and the 'cord' 0.5 mm thick.

Microscopy of fibres from samite proved them to be reeled silk, fully degummed: filaments are 9-12 microns wide, with a wedge-shaped cross-section.

S4. 'Sample from leather bundle SF71.18 (Loose on surface may not be directly associated).'
A folded fragment, overall dimensions approximately 15 x 15 x 7 mm, of poorly preserved and brittle textile woven in tabby, 16-18/Z x 16/S per cm. Attempts to identify the fibre by optical microscopy failed due to its poor preservation. SEM revealed presence of fungal mycelium..

S5. 'Sample from textile bundle SF71.20 (Removed from bundle, definitely associated).'
A flat fragment, 15 x 10 mm, of textile woven in tabby, 20/Z x 14/S threads per cm; varies between dense and open. There are at least six adjacent S-spun threads. Microscopy of the fibre showed relatively well preserved fibres, 11-15 microns diameter with a clear lumen and well-spaced cross-markings: probably fully processed flax.

S6. 'Sample from pendant SF71.22 (Removed from pendant, definitely associated).'
A fragment, 20 x 8 mm, made up of two layers, one of the same felt-like organic material seen in SF74.1-3/A and the second a net-like textile probably woven in tabby, 12/Z/0.2 x 16/Z/0.3 per cm. Microscopy of the fibre at x 400 mag showed it to be decayed: the mount was dominated by fine filaments of the felt-like material, arranged in clumps and fans.

S7. Sample from pendant SF71.22 (Removed from pendant, definitely associated).' Packet labelled 'T13 + T17'.
(i) Two curved fragments of tubular plait, 3 mm diameter, probably the same as D13. The fragments are 10 mm and 5 mm and together form a semi-circle, possibly the remains of a loop.
(ii) A fold of poorly preserved textile, 8 x 5 mm, possibly Z x S. Fibres definitely part-processed plant fibre: fibre bundles of at least six fibres with prominent nodes.
[T17 is supposed to be leather, but none visible to me]

S8. 'Sample from pendant SF71.22 (exact location unknown).' Packet labelled 'T15 + T16'
(i) Several fragments, largest 8 x 4 mm, of open-weave textile woven in tabby, 16/Z/0.2-0.3 x 12-14/Z/0.3 per cm. Fibre poorly preserved but definitely a plant-stem fibre with cross-markings.
(ii) Two fragments of well-preserved silk samite, as S3, 6 x 6 mm and 6 x 4 mm. One fragment has a loosely S-plied thread (probably silk) passing through it, possibly the remains of a stitch. Flat against the reverse face is more of S8(i): its net-like appearance seems to be original.
Traces of copper corrosion on the front face only.

S9. 'Sample from pendant SF71.22 (exact location unknown).' Packet labelled 'T13'
Two fragments, 14 x 5 mm and 7 x 6 mm, of a very decayed Z x ? textile of uncertain weave. Microscopy of fibres revealed that they were fine, 6-11 microns diameter, and the polariser revealed lumina and cross-markings: probably flax.

S10. 'Sample from vessel Lid SF71 (Removed from lid, definitely associated).'
Packet labelled 'T12'
A well-preserved fragment of textile, 35 x 15 mm, woven in spin-patterned tabby, 15/Z+S/0.3-0.7 x 15/Z+S/0.5-0.7 per cm; spin changes direction every four yarns in warp and weft. Identified as

flax from the following features. Microscopy of fibres showed both S and Z yarns to be the same: fine fibres with a clear lumen, well-spaced cross-markings and pointed cell-ends; fibres mostly around 9-10 microns diameter, but often still in original bundles of two-to-six fibres; drying-twist test consistently clockwise rotation.

S11. 'Sample from textiles associated with armbands/wood (exact location unknown).'
Several small fragments, largest 7 x 6 mm, of same material as seen in SF74.1/A [*?feathers ?flowers*].

S12. 'Sample from leather with underlying textile from leather bundle.' Packet labelled 'T2.2, T2.2, T2.3'
A curving fold of skin product with no grain surface present: identified as collagen by microscopy at x400 magnification. Inside the fold were fragments two folded textiles, largest fragment 13 x 4 mm: one was the silk samite (see S3), folded with the face inwards, and the other was the fine net-like textile (see S8(i)), which lay flat against the back of the samite. The sequence of layers is therefore samite, then net-like textile, then skin product, all folded inwards, with the skin product on the outside.

S13. Sample from outer wall of vessel.
Fragment, *c.* 18 x 15 mm, of same textile as on lid, S10.

U/S Numbers
U/S 1 (Labelled T1.1, but technically proved to be different)
Two fragments visually similar, but technically different.
(i) 20 x 10 mm, tabby repp, 7-8/Z/0.8 (dominant) x 14/Z/0.8 per cm. All yarns were consistently Z-spun, including a run of eleven adjacent threads in the dominant system. Microscopy at x400 magnification, with and without polariser, revealed fibres 12-22 microns wide; although poorly preserved, lumen and cross-markings, indicating a plant-stem fibre, were visible.
(ii) 12 x 8 mm, tabby repp, 8/S/0.4-0.9 (dominant) x 14/Z+S/0.7 per cm. Yarns in second system were spun as follows: ZSSZSSZZZSSZZZZS. Microscopy at x 400, with and without polariser, revealed fibres 12-20 microns wide, with prominent wide lumens and well-spaced cross-markings. Drying-twist test gave clear clockwise rotation on two fibres: low-grade flax, fully processed.

U/S 2 'Textile and leather fragments from SF71.9, T2.1'
(i) A fragment, 14 x 3 mm of fibrous material with silvery material on one face. Microscopy of material at x200-x400 magnification revealed the branching network typical of the collagen layer of leather.
(ii) A fragment, 9 x 6 mnm of the same material as (i), but with two adjacent cut edges forming a square corner.
(iii) Small fragments, largest 3 x 2 mm, of poorly preserved textile: c.15 threads per cm, but no further technical details could be recorded.

U/S 3 'T4.1' in gelatine capsule.
Fragment, 4 x 4 mm of same samite as in S3, with possible remains of a seam or fold covered by corded needlework resembling braiding or tablet-weaving. No fibres extracted because of small size and fragility. [digital image of moderate quality taken of front and back]

U/S 4 'T4.2' in gelatine capsule
Three fragments, 3 mm, 4 mm and 5 mm long, each 1 mm wide, of detached needlework: front resembles a guilloche plait or tablet weave (probably the former) but the back has broken yarn ends where it has broken away from the ground textile. Yarn weak S-twist and filaments smooth and fine. No fibres extracted because of small size and fragility.

U/S 5 'T5.1' in gelatine capsule
Three curving fragments, 15 mm, 10 mm and 7 mm long, of a tubular braid 2.5-3.0 mm diameter. Worked in six-strand technique, each strand in pairs, together 1.2 mm wide. Microscopy at x 400 magnification revealed smooth regular filaments 10-11 microns wide with no internal features: degummed silk.

U/S 6 'T5.2'
Numerous broken fragments of tubular braid, longest 12 mm, total length *c*.200 mm; 1.5-2.0 mm diameter; mostly straight, sometimes slightly curving. Worked in ?four-strand technique; yarn worked in pairs, together *c*.1.0-1.2 mm wide. Fibres too brittle for successful microscopy, but at x10 magnification have general appearance of silk.

U/S 7 'T6.1, T6.2'
A fold of samite enclosed in a fold of the fine open-weave as seen in S3, over-all 20 x 6 mm. The open-weave textile is better preserved than in S3: it is a tabby-weave, 14/Z/0.4 x 14/Z/0.4 per cm. Its fibres, at x400 magnification, with and without polariser, were 7-11 microns wide, each with a smooth profile, fine lumen, well-spaced cross-markings and, in two cases, pointed cell-ends: probably flax. The degree of processing was not clear (possibly fully processed).

U/S 8 'T6.1'
Several fragments of the same open-weave textile as in S3 and U/S 7, largest 14 x 5 mm and 10 x 7 mm: tabby, 14/Z/0.4 x 12/Z/0.5 per cm. Fibres too brittle for analysis.

U/S 9 'Textile with stitched edge. T 7.1. T7.1.1, T7.2'
(i) Two folds of samite stitched together, with an open-weave tabby on the back and a needle-worked corded edging along the fold, as in S3, 13 x 10 mm. One flap of the samite has been lifted up and folded back (unlike S3).
(ii) Further fragments of the same complex, but with corded edge better preserved and in places detached. It is clear from these remains that the corded edging is in fact a fine blanker stitch worked in plied (Z2S) ?silk yarn, 0.3-0.4 mm diameter.

U/S 10 'Textile and leather fragments from SF 71.11. T9'
(i) Fragment, 7 x 6 mm, of the same skin product as in S12 etc(this sample identified as collagen from the network of branching fibres).
(ii) Fragment of bright green, rigid, corrosion product with fibrous appearance, but not structure visible, 6 x 3 mm.

U/S 11 'T9'
Fragments of collagen layer, as in S12, etc (checked by microscopy), largest 25 x 15 mm, with one probably cut edge, 25 mm long.

U/S 12 ‘T10’
Three detached fragments, 15 mm, 8 mm and 7 mm long, of the braid-like needlework seen on samite in U/S 3 and U/S 4; 1 mm wide. Fibres viewed at x400 magnification were consistently 11 microns wide, with smooth profile and no internal structure: silk.

U/S 13 ‘T11’ [gelatine capsule]
A number of heavily mineralised threads, 1.0 mm wide, to judge from the kinks and bends, probably from one of the tubular braids. No fibre identification attempted.

U/S 14 ‘T12’ [gelatine capsule]
A collection of miscellaneous yarns of different types, all heavily mineralised.
They include (i) Z-spun yarns, 0.4 mm diameter, longest 7 mm; (ii) loops of fine, probably silk, yarn, *c*.0.3 mm wide; (iii) unidentified material, 0.5 mm wide, up to 4 mm long, possibly remains of stitched corded edge seen in S3.

U/S 15 ‘T15 + T16’
Fragments of samite, as S3, largest 9 x 6 mm, one with remains of open-weave tabby on back and one with remains of collagen layer of skin product in association.

U/S 16 ‘mixed fragments’
Miscellaneous fragments of textiles seen in other samples, mostly detached remains of the open-weave tabby seen in S3 and S12, largest fragment 12 x 3 mm.
The remainder are poorly preserved remains of yarns and skin product.

U/S 17 ‘mixed fragments’
Poorly preserved and brittle fragments of uncertain origin, but most likely to be remains of the samite-tabby-leather complex seen in S12, largest 12 x 5 mm, 10 x 8 mm and 15 x 7 mm.

Penelope Walton Rogers
The Anglo-Saxon Laboratory
18 January 2016

Part 2

Outline of scientific analyses and research questions for the next stage

A compilation of notes provided to

National Museums Scotland

in 2018 and 2019

for use in their grant application

Notes on the next stage

The preliminary study demonstrated the range of organic material present in the hoard and clarified the scientific analyses and historical-archaeological research that still remained to be done.

Scientific research

All the scientific research proposed for the next stage will help characterise the hoard's contents and has the potential to provide date and provenance for individual elements. The Anglo-Saxon Laboratory already has established contacts with the institutions where these analyses can be carried out and has in some instances been involved in the development of procedures. It is proposed that the work is managed from our laboratory using the samples already studied (now stored at NMS).

(i) Light stable isotope analysis (of carbon, nitrogen, hydrogen and possibly oxygen isotopes) can be carried out on the wool yarns of the outermost wrapper of the Carolingian vessel. Since there are two different fleeces present, warp and weft will be treated as separate samples. This form of analysis has proved capable of distinguishing wool from sheep reared in different broad geographic bands (von Holstein 2012). The bands are (a) Northern Scotland, Norway and the islands of the North Atlantic; (b) Ireland, most of Britain and Denmark; (c) the eastern Baltic; (d) the near Continent; (e) the southern Continent, but are being refined all the time. Broadly speaking, these isotopes reflect climatic conditions (sometimes modified by animal husbandry). The isotopes of strontium instead have a closer relationship with underlying geology. Their analysis has been successfully used on human teeth and more recently has been applied to sheep's wool. Ideally, both types of analysis should be done to provide a cross-reference to each other. These procedures are destructive but only of small samples.

(ii) Dye analysis is recommended for the next stage. This will be based on solvent extraction followed by High-Performance Liquid Chromatography (HPLC). It is unlikely (though not impossible) that the identity of the dyestuff will help with date or provenance, but whether the dye is a prestigious or cheap one will help clarify the status of the textile. It is also worth checking to see if the three silk braids, the outer wool wrapper and the skin product of the pouch have been dyed. This procedure is destructive and will require the sacrifice of one small sample of each item.

(iii) Different skins were used for different kinds of leather (and other skin products), depending on whether they were intended for something soft and pliable or tough and hard-wearing. Identification of the skin product of the 'leather bundle' will therefore be addressed by biomolecular means. ZooMS

(Mass Spectrometry) has become the preferred method of species identification, but if any questions arise from this, the skin products can be also investigated by one of the proteomics procedures or by DNA analysis. These tests are all destructive but can be carried out on the small fragments that are already detached.

(iv) There is gathering evidence that the Viking Age saw a transition from pure gold to gilded silver and gold alloys in textile threads. Energy Dispersive X-ray Fluorescence of the gold thread on the flat braid may help with date and provenance (of the thread, not the braid). This is technically non-destructive, although a sample will have to be removed for analysis. Front and back of the filament will be tested in order to check for surface gilding.

<u>Library and archive research</u>

The difficulties of identifying the source of the silk and its likely route into Britain have been described above. The significance of the spin-patterned tabbies has also been emphasised.

Research at the next stage will be as follows.

(i) A catalogue will be compiled of samites from shrines, treasuries and archaeological excavations in the British Isles, their structure, use and context. This will include unpublished material in the author’s own archive and typescripts inherited from the late Elisabeth Crowfoot.

Silk braids and comparable needlework will also be reviewed.

(ii) Comparanda will be sought in the numerous published catalogues of material held in Continental treasuries, focusing on the Z-twill samites and early examples of fingerloop braids.

(iii) Material being investigated by French textile specialists on French and Sino-French archaeological excavations along the Silk Road and currently making its way towards publication (projects to which the author is a minor contributor) will be considered.

(iv) Any developments in the distribution of spin-patterned tabbies since Bender Jørgensen’s 1992 survey will be reviewed through recent Belgian and Dutch publications.

(v) The use of textiles in reliquary pouches will be explored through publications describing textiles held in church treasuries of Europe.

Integrating the results

The results of the research described above need to be integrated with the study of the metal artefacts, so that the research can be correctly interpreted. I suggest a meeting of researchers engaged on the project to discuss our findings (happy to host this at ASLab, York). Organics and metalwork need to be considered in tandem if we are to understand the context and back-history of this hoard.

Defining goals

We should further define research questions. General issues to be reviewed should include the following.

1. Hoarding in times of stress: what do the wrappers tell us about the process of putting the hoard in the ground? Was it premeditated or done in a rush?
2. Are the hoard contents likely to be monastic/ecclesiastical? How do the organics relate to comparable materials from non-hoard sites?
3. Historic environment: Northumbria and Scotland in the Viking Age.
4. Review the function of wrappers and bags in this period.
5. Consider the geographic and socio-economic routes whereby the organic materials will have arrived in the hoard.

Extracts on Viking-Age matters from the bibliography of Penelope Walton Rogers
For the full bibliography, go to http://www.aslab.co.uk/bibliography/

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