

SUPPLEMENTARY MATERIAL

To be read in conjunction with

EARLY MEDIEVAL GARNET-INLAID METALWORK: A COMPARATIVE ANALYSIS OF DISC BROOCHES FROM EARLY WESSEX

Hamerow *et al*

published in volume **101** of the *Antiquaries Journal*

Helena Hamerow: Institute of Archaeology, University of Oxford, 34–6 Beaumont Street, Oxford
OX1 2PG. Email: Helena.hamerow@arch.ox.ac.uk

Andrew Shortland: Cranfield Forensic Institute, Cranfield University, Defence Academy of the
United Kingdom, Shrivenham, Swindon SN6 8LA, UK. Email: a.shortland@cranfield.ac.uk

Esther Cameron, 36 Bertie Road, Cumnor, Oxford, OX2 9PS, UK. Email:
esthercameron.oxford@gmail.com

SM APPENDIX 1 OBSERVATIONS ON DESIGN, CONSTRUCTION AND CRAFTSMANSHIP

APPENDIX 1

OBSERVATIONS ON DESIGN, CONSTRUCTION AND
CRAFTSMANSHIP*Esther Cameron*

DESIGN

The front

The geometric symmetry of the cruciform designs, achieved with a compass and simple grid, is part of a tradition previously seen in disc brooches of the early seventh century as well as the jewelled crosses and manuscript illustrations of the late seventh century.¹ The designs of our three brooches are strikingly similar, and yet each is subtly different. Each has five bosses, one at the centre plus four subsidiaries, and five concentric circles forming the skeleton of the cloisonné design. Engraved arcs on the base-plate of the Hanney brooch show how some of these circles were marked out.

Isbell, in her geometrical analysis of five composite brooches including the two from Milton, proposes that the designs are based on a set of ratios obtained through geometry rather than rulers or numerical calculations.² The ratios are denominators of 2, 3 or 5 from which the sizes of concentric circles and satellite medallions (around the rivets) could have been calculated. Her study shows that, despite their similarities, the ratios of the two Milton brooches are not identical as the brooch in the Ashmolean is based on multiples of 3 while that in the V&A has slightly different proportions based on multiples of 3 and 5.³

From our measurements of the concentric rings taken from CT images of the brooches' base-plates, it is apparent that the V&A's brooch has the largest outer ring with a radius of 37mm (excluding the outer collar) and the Hanney brooch has the smallest with a radius of 33mm. Yet, as the various dimensions in Table 1 show, the radii of the second and third concentric rings, at 12.5mm and 17mm respectively, and the radius of the circle on which the four rivets are positioned, at 25mm, are identical in all three brooches, suggesting a shared template, while the radii of the other rings vary according to the proportions of each brooch.

¹ Coatsworth and Pinder 2002, 164–6

	Milton V&A	Milton Ash.	Hanney
Radius 1 (inner cloison)	10	9	8
Radius 2	12.5	12.5	12.5
Radius 3	17	17	17
Radius 4	32	30	27.5
Radius 5 (perimeter cloison)	37	35	33
Width of honeycomb panels	4.5	4.5	5.0
Radius of satellite boss ring	5.5	8.5	8
Width of gold mount	13	13	11
Radius from central rivet to the 4 other rivets	25	25	25

TABLE 1 Dimensions of the three designs, measured in mm from CT scans

Double rows of pentagonal garnets forming the outer borders of all three brooches are also used on the Milton brooches to form radial lines, and in small triangular fields on the Hanney brooch to mark out the cruciform design. This ‘honeycomb’ arrangement of garnets is uncommon: other than these three Oxfordshire brooches it occurs on the ‘Kennard’ brooch from Faversham, Kent and on a pendant from Milton, near Sittingbourne, Kent, half of which has a double row of pentagonal garnets in gold cloisons.⁴ There is also a gold cross from Winster Moor, Derbyshire, decorated with filigree scrolls and a faceted cabochon garnet, each facet a pentagon exactly like those on the brooches.⁵

Four-sided garnets are also used on all three brooches. On the two from Milton these garnets are small, either of similar size to the pentagonal garnets or slightly larger, whereas those on the Hanney brooch are substantially bigger and include seven extra-large garnets. Single garnets probably adorned the tops of all the white bosses. Where they survive on the four subsidiary bosses of the Milton V&A, they are of similar size to the four-sided garnets used elsewhere on that brooch. On the Hanney brooch these individual garnets are small cabochons.

On all three brooches part of the design between the third and fourth concentric rings is occupied by gold mounts, separated from each other by radial rows of garnets. The Milton V&A brooch has four mounts each comprising a gold sheet decorated in Style II interlaces representing a pair of confronting ‘animals’ in beaded wires of two sizes, a larger wire bordered each side by a finer one. Additionally, the sheet is bordered by a single beaded wire. The gold sheets are mostly smooth, but there is some evidence of modelling between and around the interlace decoration. There is also a slight difference

² Isbell 2015

³ Isbell 2015, 46-7, 51

⁴ Coatsworth and Pinder 2002, Plate IVb

of tone in the wires of the interlace, the larger one being paler than the finer ones to either side of it, possibly indicating that part of the surface was enriched. Each of its white domes is embellished with a gold collar encircled at the top with a single beaded wire and at the base by a two-strand beaded wire cable, which on the satellite domes is also surmounted by a single beaded wire.

The Milton Ashmolean brooch had eight gold mounts of which six are preserved. These are similar to those described above, with Style II animal interlace in beaded wires of two sizes, and more beaded wire around the borders of the sheets. On these gold mounts the modelling and different colour tones are more pronounced. Unlike the other brooches, this also had four small rectangular gold mounts of which two survive, decorated in the same way as the larger mounts, except that the motif is a minute sub-rectangle. The central boss and one of its satellites are trimmed at the base with a gold collar and single beaded wire.

The Hanney brooch also had eight gold mounts of which four are preserved. Unlike the Miltons' well-executed animal ornament, these are decorated with simple S-shaped scrolls, some more accomplished than others. Two of the mounts seem to be a matching pair in the forms of the scrolls and use of beaded wire while the other two – thought to have been replacements – use plain wire and are different both from the pair and from each other. The central boss and satellite bosses are trimmed at the base with a gold collar and single beaded wire. The top of the central boss, perhaps the base for a second boss, is also trimmed with a gold collar and single beaded wire. The tops of the satellite bosses vary: two are trimmed with a collar and triple beaded wires, one is trimmed with a collar and two wires, and the fourth is lost. There are three crown arches or sections of 'reeded' strip on the central boss of the Hanney brooch. If they were ever present on the Milton brooches, they have not survived.

The pattern on the gold foils beneath the pentagonal and small four-sided garnets is the same on all three brooches; a standard grid with a line-count of 4 per mm. Only the Hanney brooch has, in addition, boxed grids with a line count of 3.2 per mm beneath some of its larger garnets.⁶

The eye-catching white domes or bosses which feature strongly in the design are of such regular shape that a bow-lathe might have been used to produce them. The materials used by Anglo-Saxon jewellers for making circular domed inlays is most commonly shell, but aggregates of minerals including magnesite and christoballite have also been identified, as well as bone or ivory.⁷ Close examination of the white bosses of both Milton brooches suggests they are bone (predominantly compact laminar bone with traces of cancellous bone). The white domes on the Hanney brooch are of a dense, finely laminated substance that appears to be shell.

⁵ Campbell 1991, fig 41

⁶ Avent and Leigh 1977, 2, table 1; East 1985, 137

⁷ Evison 1951; La Niece 1988

While the form and proportion of the bosses are consistent within each brooch, there is some variation in height between the groups, such that the Milton Ashmolean's are relatively squat plano-convex shapes, the Hanney's are slightly higher and the Milton V&A's are the highest with a hemispherical outline. Seventh-century gaming counters show a similar variety of form, with both squat and high-domed shapes being used contemporaneously.⁸ The diameters of the central domes are 19mm, 15mm and 15mm (Milton V&A, Milton Ashmolean, Hanney), the diameters of the subsidiary domes 9mm, 9mm, 8mm respectively.

The profile and outer collar

The profiles of the Oxfordshire brooches, examined by CT scans, are slightly different from each other and this is partly due to small variations in the forms of the base and back plates and the distances between them. The plates of the Milton V&A are slightly convex resulting in a lentoid shape, the distance between the plates varying from 6mm at the centre to 3mm at the edge (Fig. 10a).

The plates of the Milton Ashmolean are not an identical pair as the lower one is flat and the upper one is convex, the distance between the plates varying from 9mm at the centre to 6mm at the edge (Fig. 10b). This domed effect causes the rivets to be slightly splayed.

The plates of the Hanney brooch are completely flat, 4mm apart, but in this case extra height is achieved by adding another tier of garnet cloisonné, a device which on present evidence may be unique to this brooch (see 'construction' below) (Fig. 10c). Brooch thickness as defined by the length of the rivets indicates that the profiles of the two Milton brooches show a closer resemblance to each other than to the Hanney brooch.

Copper-alloy composite disc-brooches are held together by a circumferential collar, a copper-alloy strip with a 'reeded' or corrugated profile achieved most probably by draw-swaging.⁹ When fitted around a brooch, the collar's upper and lower edges are angled to engage with the metal plates and clamp them together. Pinder differentiates between those made of thicker metal which have an even finish on the inside (Type 4) and those of thinner metal which are corrugated inside as well as outside (Type 5).¹⁰ The collars of the Milton brooches are of gilded copper-based metal with eight corrugations and a height of 10–11mm. From the outside they look identical although Pinder identifies one as Type 4 (Ashmolean) and the other as Type 5 (V&A).¹¹ The Hanney brooch was found without a collar; there is, however,

⁸ MacGregor 1985, 133–4

⁹ Pinder 2001

¹⁰ Pinder 1995, 12, fig 4

¹¹ Pinder 1995, 19–22

little doubt that it had one originally as traces of corrosion around the outer edge of the lower plate indicate where it had been attached.

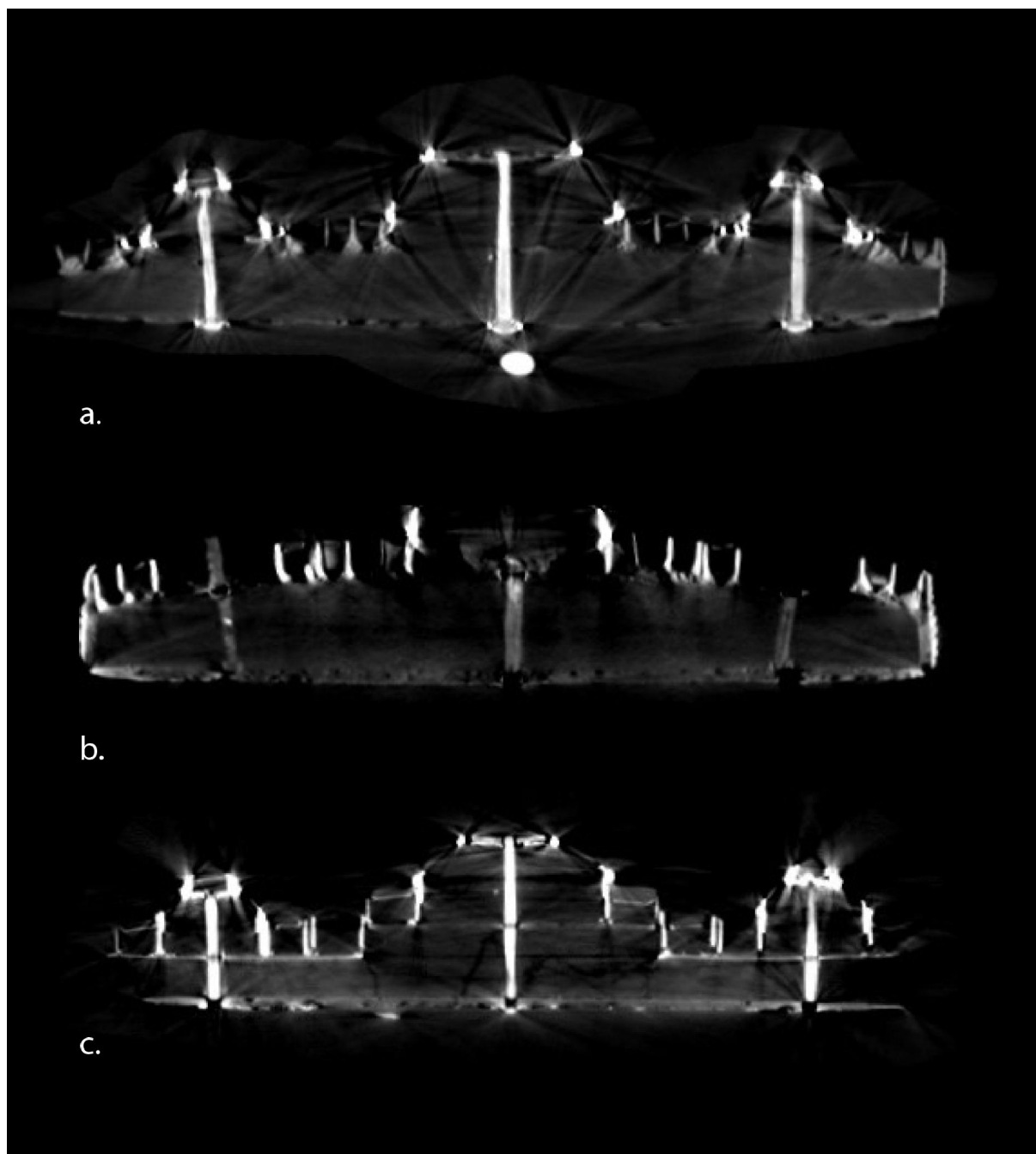


Fig. 10 Sections through the three brooches showing slightly different forms of base and back plates: (a) Milton V&A, (b) Milton Ashmolean, (c) Hanney (CT scans by S. Beckett)

The back

The backs of the brooches are copper-alloy discs with a layer of silver sheet covering the outside. Onto this are fixed the brooch-fastenings, footings of five main rivets, the lower edge of the outer collar and a small safety-loop to which a chain would originally have been attached. The design of the

back is constrained by the positions of the five rivets with the other fixtures arranged around them: the safety-loop between two subsidiary rivets, and the hinge and catch fastenings between two more, to either side (Figs. 11A–C and 12a–c).

Safety loops on the Hanney and Milton V&A brooches are well-preserved, and although a pair of rivet stubs is all that remains on the Milton Ashmolean brooch, a drawing of it published in 1847 shows the loop complete with a single chain link.¹² In each case, the footings of the loops are riveted through the back plate. Pinder notes that safety loops are associated with the largest composite brooches but it is also true that the majority of loops occur on brooches with copper-alloy cloisons, shoe-type pin catches and cylindrical hinge-casings (see below), which are all features of the later brooches.¹³

Fastenings on the back of the Milton V&A comprise a circular casing for the hinge which is attached to the brooch by a riveted flange or collar at its base, a pin, and a catch plate which is also flanged and riveted to the brooch (Figs. 11A and 12a). The Milton Ashmolean brooch's fastenings have not survived but the unmistakable imprints of a similar hinge-casing and catch plate are preserved on the back of the brooch (Figs. 11B and 12b). These were also flanged and riveted, and a corrosion residue beneath the catch plate suggests it was soldered as well. There are no fastenings on the back of the Hanney brooch apart from an imprint of the catch plate in corroded solder, but a few detached fragments of the pin, circular hinge-casing and half of a silver flange, are enough to show that this fastening was the same type as the others, although in this case it had been attached to the brooch with solder rather than rivets (Figs. 11C and 12c). Judging by their imprints, the sizes of the three catch plates were scaled according to the dimensions of each brooch.

Avent identifies two main categories of fastenings on composite brooches.¹⁴ One is the traditional type using two hinge-plates and a spring while the other involves a circular hinge-casing of the sort just described which despite the curious design might have had the advantage of not becoming entangled in the clothing of the wearer. The fastening of the Milton brooch V&A is classed as Avent's Type 5 and evidence suggests that the fastenings of the two other Oxfordshire brooches were also like this.

The silver sheet on the back of the Hanney brooch is engraved with a simple interlace against a partially cross-hatched background. Although the sheet is fragmentary, a decorated border is suggested with further engraving around the fastenings. The 'Kennard' brooch is similarly decorated although in this case the subject is zoomorphic.¹⁵

¹² Anon 1847

¹³ Pinder 1995, 13

¹⁴ Avent 1975, 21, fig 27

¹⁵ Avent 1975, inv no. 181, pl 71–2

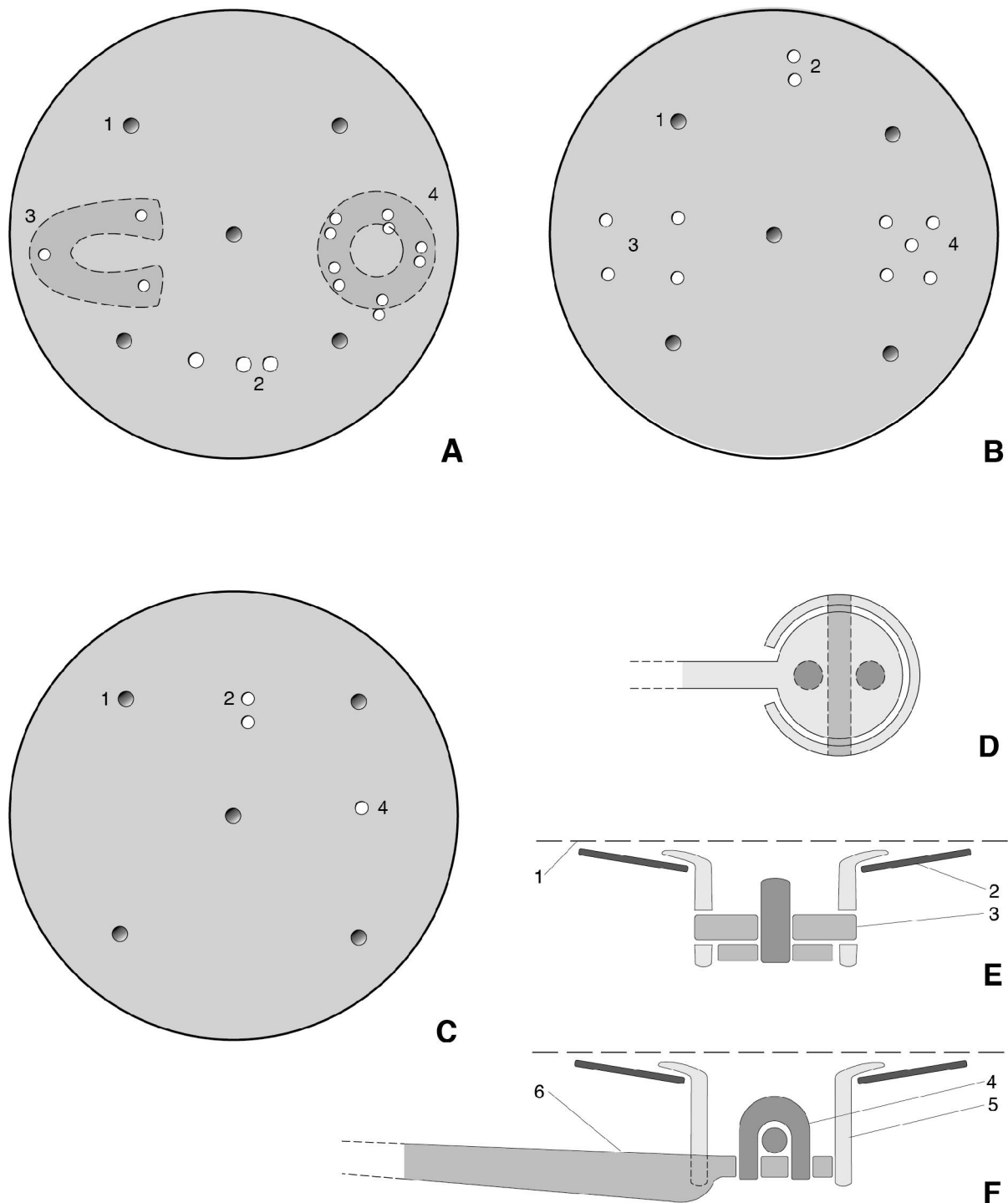


Fig. 11 Diagrams A–C, back-plates of the three brooches: (A) Milton V&A, (B) Milton Ashmolean, (C) Hanney, showing positions of: 1. five main rivets, 2. safety loop, 3. catch-plate, 4. pin-fixing. Diagrams D–F, Milton V&A pin-hinge: (D) in plan, (E) in section transverse to the pin, (F) in section along the axis of the pin, showing: 1. back of the brooch, 2. collar, riveted to back of brooch, 3. hinge, 4. loop, 5. cylinder casing, 6. pin

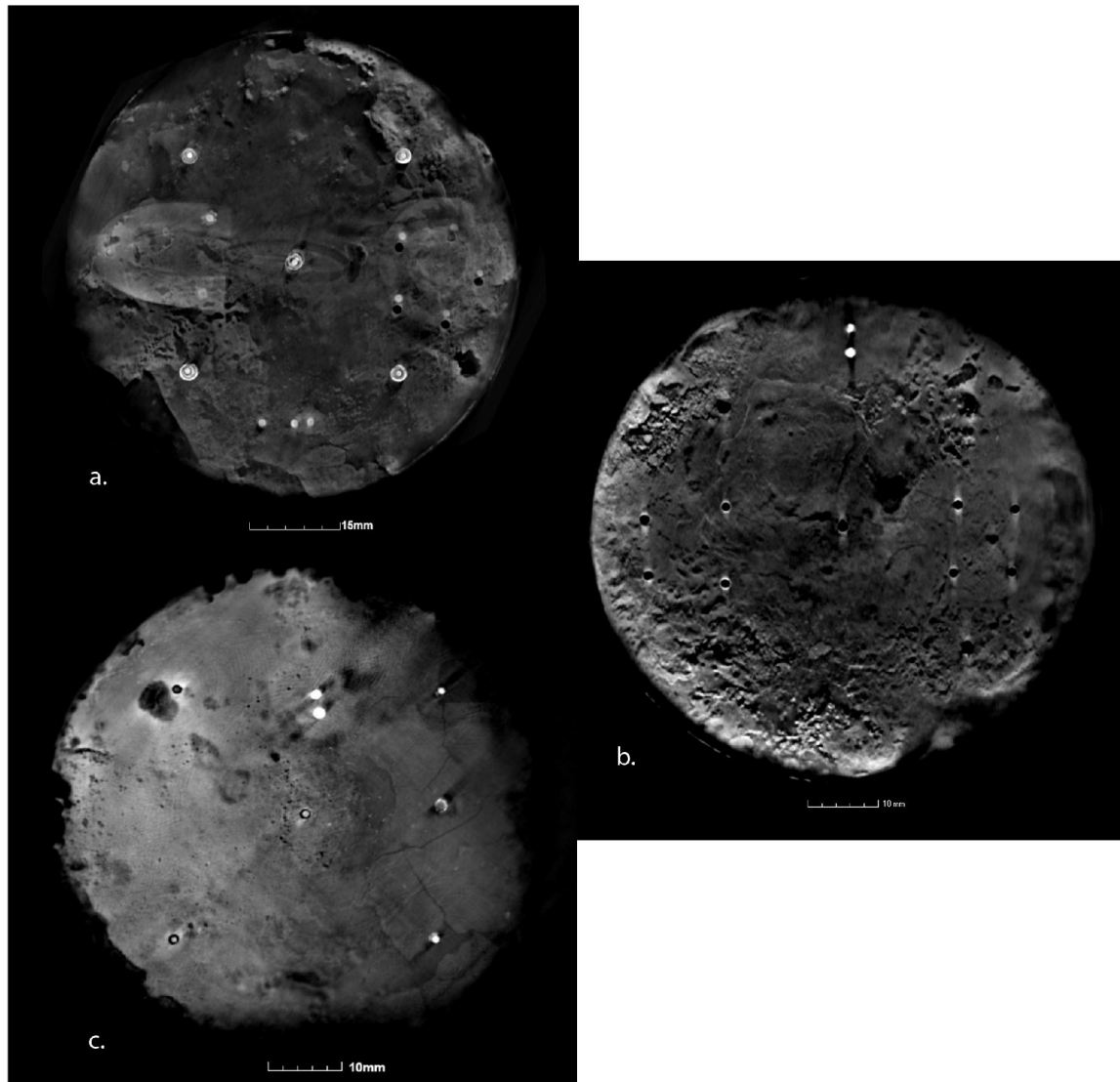


Fig. 12 Back plates of the three brooches: (a) Milton V&A, (b) Milton Ashmolean, (c) Hanney, showing a palimpsest of marks (CT scans by S. Beckett)

CONSTRUCTION AND CRAFTSMANSHIP

The plates

In all three brooches, the platform or stage supporting the cloisonné and filigree work consists of two metal discs, slightly less than 1mm in thickness, separated by a layer of hard white paste. These back and base plates – so called because one forms the base for the decoration, the other the back of the brooch – which are so obvious on the Hanney brooch are hardly visible on the Milton brooches as they are concealed from above by cloisonné, from the side by the outer collar and from below by a layer of silver sheet. The slight doming of the Milton brooches by virtue of their convex base-plates (see ‘Design’) provides further evidence of the brooches’ conformity. The construction of the Hanney brooch is significantly different, first by having a flat annular base-plate instead of a domed disc, and

second by having an additional small plate above this, supporting a raised tier of cloisonné (Figs 10c and 13c). The dimension of this small plate is the same as the annular hole in the base plate which suggests it may have been cut from it.

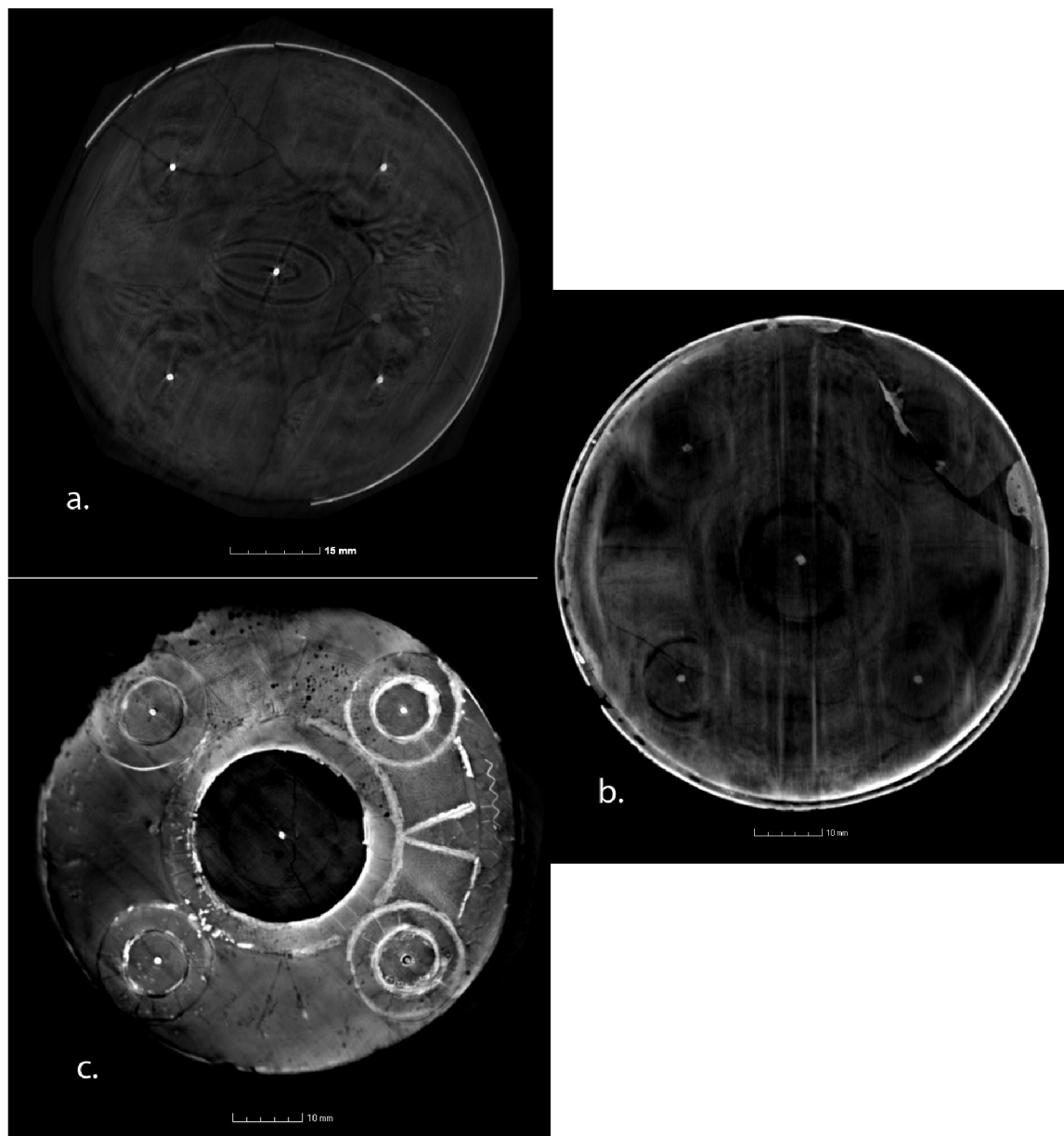


Fig. 13 Base plates of the three brooches: (a) Milton V&A, (b) Milton Ashmolean, (c) Hanney, showing the annular form of the Hanney plate and the discs of the other two (CT scans by S. Beckett)

The geometric design would have been drawn, perhaps onto wax or parchment, before being marked out on the base plate. Holes for the five main rivets would also have been prepared in both plates at this stage. The order of assembly of the back and base plates is generally unknown but it has been convincingly argued that the back plate would have been attached last, at the final stage of brooch

construction.¹⁶ However, in the case of the Milton V&A brooch, the collar of the pin-hinge casing has at least two sets of rivet holes, one of which appears to extend through the back plate into the base plate. This suggests the two plates were joined before the cloisonné work began as to do otherwise would risk damaging the decoration. Other examples of a base and back plate having been riveted together before the cloisonné was completed are a silver gilt buckle from Faversham and the gold buckle from Taplow.¹⁷

Rivets

Each brooch has five rivets which extend from the white bosses at the front, through the layers, to emerge at the back of the brooch. They are about 1mm in diameter. The rivets on the two Milton brooches are of similar length and composition (iron) whereas those on the Hanney brooch are different, being copper-alloy tubes.

Cloisonné

As far as it is possible to tell given their varying states of preservation, the cloisonné technique used on all three brooches is the same. Concentric rings in the designs, consisting of copper-alloy strips approximately 3mm in width and less than 0.5mm in thickness, are attached to the base plate with solder, traces of which are visible on the Milton Ashmolean and Hanney brooches and on the CT scan of the latter (Fig 13c). The other two types of cell-dividers, the concentric crimped strips and the short radial strips, are not soldered but bedded in white paste. The upper edges of these cell walls show no evidence of secondary working, such as filing or burring, although had it existed such detail might well have been lost due to advanced corrosion.

The cells are filled with white paste which must originally have had a putty-like consistency because impressions of gold foil, gold mounts and radial cell-dividers are preserved in the pastes on the Milton Ashmolean and Hanney brooches. Before conservation, the paste inside the Hanney cloisons (and also beneath its gold mounts and between the back and base plates) was greyish-white in colour and friable. In contrast to this, the pastes inside the cloisons and beneath the gold mounts of the Milton Ashmolean, and in empty pentagonal cells and between the plates of the Milton V&A brooch, have a darker, waxy consistency. Research has shown that the compositions of cloisonné pastes are not uniform although in Anglo-Saxon seventh century contexts the constituents tend to be calcite, quartz and wax in varying proportions.¹⁸

Each complete cell also contains a small piece of gold foil sandwiched between the paste and garnet inlay. In the pentagonal cells this work appears to have been done to the same standard on all three

¹⁶ Pinder 1995, 11

¹⁷ Coatsworth and Pinder 2002, 141

brooches: many of the foils are imperfect fits, slightly smaller or larger than required, some put in face downwards, or askew. The foils beneath the larger garnets of the Hanney brooch seem to be more accurately positioned, but this might be a function of size and ease of handling rather than craftsmanship.

The garnets may have been obtained ready-split into transparently thin sheets from which the individual stones were shaped by hand.¹⁹ On all three Oxfordshire brooches, the edges of the garnets are irregular, without evidence of wheel-cutting, which suggests a method of working associated with Scandinavian rather than Late Roman practice.²⁰ With regard to evenness and surface polish, which is of a good standard, the garnet work appears to be the same on all three brooches.

Gold mounts

Visual inspection of the decorative gold mounts suggests they were manufactured using standard techniques of the time: beaded wires were produced from round wires either by hammering or swaging; round wires were made by 'block-twisting' narrow strips of metal, possibly followed by rolling to smooth them.²¹ The method of fixing the wires to the gold plate probably involved the ancient technique of eutectic soldering which requires an organic paste such as wheat-flour to hold the wires in position, a solution of ground copper salts and alkali soap locally applied, and high heat.²² Surface residues were removed from the finished mounts by pickling, a process also used for surface enrichment, evidenced by silver and gold tones in the filigree. The finished mounts are bedded in white paste and seem to be held in place by adhesion.

On the two Milton brooches the standard of craftsmanship of the gold mounts is high. Both sets of mounts show the same levels of accuracy and consistency. In comparison, the design and technical expertise of the filigree mounts on the Hanney brooch are of a lower order. On its two more accomplished mounts (with S-scrolls in beaded wire) the gold plate is slightly undulating, some of the scrolls have sunk into it, some of the beading has fused and the surfaces are darkened. This may be due partly to heat damage, suggesting less control of the soldering process, and possibly a lack of finish. On its other two (replacement) mounts there is round wire rather than beaded, the designs are poor, and the surfaces are darkened. However, there is little evidence of heat damage.

¹⁸ Evison 1951; Avent 1975, 18, 20; East 1978; Arrhenius 1985, 82, 181, 200–4, table XI; La Niece 1988; Middleton, Shearman and Stapleton *et al* 1998, 32; Coatsworth and Pinder 2002, 136–41

¹⁹ Bimson 1985; Coatsworth and Pinder 2002, 147

²⁰ Arrhenius 1985, 18, 76

²¹ Whitfield 1990; 1998

²² Coatsworth and Pinder 2002, 98; Turner-Walker *et al* 1995, 398–9

White bosses

Empty settings for three subsidiary bosses which are missing from the Milton Ashmolean contain traces of white paste. This is likely to be the cement which held the bosses in position. CT scans of the three brooches suggest that all the bosses were fixed in this way.

Silver sheet

The copper alloy back plate of each brooch is covered on the outside with silver sheet approximately 0.2mm in thickness. Where it can be viewed from the side, the silver layer is separate from the back plate and must therefore have been attached to it either with a tin/lead solder (close plating) or a silver/copper one (eutectic bonding), both methods having been used in the Roman period.²³ Close plating is a relatively cheap and easy method requiring modest temperatures, up to 450°C, but the product is less durable as tin/lead solders are prone to decay. Eutectic bonding requires temperatures of approximately 780°C and results in a more durable product because silver/copper solders diffuse into the joining metals. The fact that the silver layer has in places become detached from the back plate suggests that the method used may have been close plating.

Pin hinge and cylindrical casing

As published information on the construction of Avent's Type 5 cylindrical casings is scarce, a diagram of the Milton V&A brooch's complete hinge and casing, based on CT scans, is included here (Fig. 11, *D–F*). It shows that the head of the pin is a flattened disc with a central riveted loop. The loop has a hinge running through it with its ends embedded in the wall of the cylindrical casing, one each side. At its base, the wall of the casing is turned outwards forming a small flange which is caught beneath the collar surrounding the casing, fixing it to the brooch.

BIBLIOGRAPHY

Anonymous, 1847. 'Archaeological intelligence', *Archaeological Journal* 4, 252–4

Arrhenius, B 1985. *Merovingian Garnet Jewellery: emergence and social implications*, Almqvist & Wiksell international, Stockholm

Avent, R 1975. *Anglo-Saxon garnet inlaid disc and composite brooches*, BAR Brit Ser 11, Oxford

Avent, R and Leigh, D 1977. 'A study of cross-hatched gold foils in Anglo-Saxon jewellery', *Medieval Archaeology* 21, 1–46

²³ La Niece 1990

- Bimson, M 1985. 'Dark Age garnet cutting', *Anglo-Saxon Studies in Archaeology and History* 4, 125–28
- Campbell, J (ed) 1991. *The Anglo-Saxons*, Penguin Books, London
- Coatsworth, E and Pinder, M 2002. *The art of the Anglo-Saxon goldsmith*, The Boydell Press, Woodbridge
- East, K 1978. 'Backing materials in the garnet inlays and behind bronze foils on the Sutton Hoo shield', in R Bruce-Mitford *The Sutton Hoo Ship Burial*, vol 2: arms, armour and regalia, Appendix B, 123–26, British Museum Publications, London
- East, K 1985. 'A study of the cross-hatched gold foils from Sutton Hoo'. *Anglo-Saxon Studies in Archaeology and History* 4, 129–41
- Evison, V 1951. 'The white material in Kentish disc brooches', *Antiquaries Journal* 31, 197–200
- Isbell, A 2015. 'Broaching the subject: the geometry of Anglo-Saxon composite brooches', MA thesis, University of Iowa, <<http://ir.uiowa.edu/etd/1641>> (24 Feb 2016)
- La Niece, S 1988. 'White inlays in Anglo-Saxon jewellery', in E Slater and J Tate (eds) *Science and Archaeology*, 235–46, BAR Brit Ser 196, Oxford
- La Niece, S 1990. 'Silver plating on copper, bronze and brass', *The Antiquaries Journal* 70, 102–114
- MacGregor, A 1985. *Bone, Antler, Ivory and Horn*, Croom Helm, London
- Middleton, A, Shearman, F and Stapleton C *et al* 1998. 'The Gilton brooch', *Jewellery Studies* 8, 27–35
- Pinder, M 1995. 'Anglo-Saxon garnet cloisonné composite disc brooches: some aspects of their construction', *Journal of the British Archaeological Association* 148, 6–28
- Pinder, M 2001. 'An aspect of seventh-century Anglo-Saxon goldsmithing', in M Redknap, N Edwards and S Youngs *et al* (eds) *Pattern and Purpose in Insular Art*, 133–39, Oxbow, Oxford
- Turner-Walker, G, Hamerow, H and Caple, C *et al* 1995. 'The gold Anglo-Saxon pendant: technical, analytical and stylistic attributes', in R Ivens, *Tattenhoe and Westbury: two DMVs in Milton Keynes*, 397–403 and fig 142, Buckinghamshire Arch Soc, Aylesbury
- Whitfield, N 1990. 'Round wire in the Early Middle Ages', *Jewellery Studies* 4, 13–27
- Whitfield, N 1998. 'The manufacture of ancient beaded wire: experiments and observations', *Jewellery Studies* 8, 57–86