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DECORATIVE PUNCHMARKS ON NON-FERROUS ARTEFACTS FROM BARRINGTON EDIX HILL ANGLO-SAXON CEMETERY 1989-91, CAMBRIDGESHIRE, IN THEIR REGIONAL CONTEXT

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Summary

Punchmarks on 45 objects from recent excavations at this sixth- to seventh-century inhumation cemetery were recorded using silicon rubber peels and examined using scanning electron microscopy, especially topographic backscattered electron imaging. This analytical technique was shown to be labour-intensive but capable of giving useful insights into punch manufacture and use. A classification of punches is proposed, based on manufacturing techniques. Marks from at least 16 non-circular punches were discovered and catalogued. Circular or oval marks were more difficult to categorise but as many as four different circular or oval punches were used to make marks on objects within one grave. Circular punches were mostly used to raise repousse bosses on sheet metal artefacts. Matches were seen between marks on objects from the same grave (for example pairs of brooches) but could not be proved between artefacts from different graves. Standards of punch application were variable. Punchmarks on museum collections of material from nearby, contemporary sites at Barrington and at Haslington were also examined. The double semi-circular punchmarks on this material were studied in detail and shown to be very varied in shape and size. No convincing punchmark matches could be made between artefacts, except those in pairs, demonstrating a large number of such tools were in use in this area.

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Decorative punchmarks on non-ferrous artefacts from Barrington Edix Hill Anglo-Saxon Cemetery 1989-91, Cambridgeshire, in their regional context

Catherine Mortimer and Martin Stoney

EXCAVATIONS by the Archaeology Section of Cambridgeshire County Council at Barrington Edix Hill Anglo-Saxon cemetery revealed more than 100 inhumation burials, accompanied by a typical range of sixth- to seventh-century Anglo-Saxon grave goods. An assessment of the potential for technological analysis was carried out (Mortimer 1993) and it was proposed that the non-ferrous artefacts would be suitable for a pilot study on punchmark analysis. Subsequently, material from two early Anglo-Saxon sites in Ipswich, Boss Hall and Buttermarket, was also identified as having potential for this sort of study (Mortimer 1994).

Punchmark studies give information about the tools which were used to mark artefacts with decorative schemes. This information is not available elsewhere, because few early Anglo-Saxon tools are extant; those which are extant (*eg* Hinton and White 1992) were made of ferrous alloys and they are now deeply corroded so that the area of main interest (the tip) is poorly preserved. Careful characterisation of the marks indicates the range of forms that the metalworkers could produce and hence what sorts of skills would be necessary to make the punches.

Furthermore, it was suggested that characterisation of punchmarks has the potential to give information about workshops and about dating. If it can be shown that two artefacts were decorated by marks from the same punch, this would suggest that the artefacts were made by the same person, or in the same workshop (*cf* Larsen 1987). As well as information about production, such data has chronological implications, because typological studies are currently the only method of dating early Anglo-Saxon metalwork – scientific methods are not precise enough to give detail within the sixth and seventh centuries AD. Even the relative dating information gained by associating two artefacts with a single maker or workshop would be of assistance to archaeologists.

Hence punchmark studies allow us to investigate the skills of early metalworkers and perhaps to gain chronological information in a period which is currently poorly dated.

This report details the information about punch manufacture recovered from the study on the Barrington Edix Hill material and comments on the characterisation of punchmarks. The recent Barrington finds are compared with the 19th century material excavated from this and neighbouring sites. The work on the Ipswich artefacts has begun (Draper unpublished) and will be included in the forthcoming excavation reports (Scull forthcoming). Besides the information gained about the range of tools available to the community in the Barrington area, these studies will also allow us to comment on the practicalities of punchmark studies and of the methodology used in this particular laboratory.

Methodology

The methodology used for this type of work is described in detail elsewhere (Mortimer and Stoney forthcoming a) so only an outline is provided here. Direct study of marks on the surface of artefacts is often unsatisfactory for various reasons, so silicone rubber peels were taken from the surface of the artefacts and studied by electron microscopy.

Sample selection. It was intended that this project should look at all the punchmarked artefacts at the site, in order to make it an effective pilot study. However, artefacts which were not cleaned or which had heavy corrosion products were generally avoided. Where such artefacts were recorded, the first peel taken was discarded because it included copper-alloy corrosion products; effectively, the act of taking the peel was equivalent to cleaning the surface in this area.

Surface preservation is an important parameter in this sort of study. Some artefacts were pitted due to corrosion products having been removed during conservation. The use of a conservation grade lacquer (Incralac) to coat and hence to preserve the artefacts may also have caused some loss of detail. In future projects, it is recommended that recording should take place after cleaning but before lacquering. Alternatively, lacquer should be removed from the surfaces to be recorded and replaced later. Many artefacts from nineteenth-century excavations at Barrington (both at Edix Hill and at other sites nearby) were available for comparison as they are curated at the Cambridge University Museum of Archaeology and Anthropology (CUMAA), the Ashmolean Museum, Oxford and the British Museum. Artefacts from museum displays should be cleaned with deionised water and allowed to dry before peels are taken, as they are normally covered in considerable amounts of dust, which causes bubbles to form in the paste. Finally, even apparently clean artefacts did not always produce flawless peels, and tiny bubbles are often found in the upper parts of peels (corresponding to the deeper parts of the marks). The presence of bubbles may distort the outline of the mark, as well as failing to reveal surface detail in the area of the bubble.

Recording the images. The silicone-based condensation-cured dental impression rubber Xantopren-L blue was used. At least 10 marks were recorded from each artefact wherever possible. The resulting peels were cleaned in soapy water, rinsed with distilled water, dried and mounted on 25mm aluminium stubs, then numbered and sputter-coated in gold.

The peels can be viewed in a variety of different ways but it is essential for this sort of study that viewing and recording are carried out in a standardised fashion (for full details see Mortimer and Stoney forthcoming a). However, due to methodological development during the project, exact standardisation was not achieved. A Leica Stereoscan 440i scanning electron microscope (SEM) was used, recording both secondary electron (SE) and backscattered electron (BSE) images. Backscattered electron images are best known for their ability to show elemental contrast, *ie* compositional mode. However, backscattered electron detectors can also be used to show topographic detail in samples (Meeks 1988). This mode of imaging appears to 'light' the sample surface from one angle. For this project, the detector was normally set so as to 'light' the marks from the top left. The SE detector was also used to image marks, as this data can be complementary to the BSE images. The SE detector is used to view the peels when they are tilted (in order to investigate their

profiles, see below, page 11).

Images were recorded digitally on optical discs and in hardcopy printouts, initially in Polaroid format and then in 35mm format, 35mm being the preferred format because of its cheapness and flexibility. For each artefact, one image of each type of mark found is presented here (Plates 1-38).

Measurements of the mark diameter or other dimensions were taken from the screen using the measurement functions of the Stereoscan. Some difficulties were noted in achieving totally systematic recording of dimensions (see pages 11-12).

Artefacts are referred to by their context number and their small finds number, *eg* 44a Δ22. Correlations between context number and grave numbers were not known at the time of study.

It should be remembered that the silicone rubber peels are negative impressions of the surface, so that features on the right- and left-hand sides of the marks themselves are reversed. However, features on the peels and the original tool tip will be in the same orientation. The discussions below will always refer to the situation on the peels, unless stated otherwise.

Analysis. General punchmark types (macro-identifications) were achieved by visual inspection of the marks on the artefacts. Work by this method is naturally hampered by problems of uneven corrosion products and glare from lacquering – problems which SEM imaging is intended to overcome – and the descriptions gained were of the most general type (*eg* 'semi-circular', 'double semi-circular').

Further details (micro-identifications) were gained by examination of the peels in the SEM and by inspecting the photographs taken from the SEM. The information from the SEM is much more precise and includes the records of dimensions in millimetres (mm) or microns (μ) and angles, as well as detailed descriptions *eg* 'double semi-circular, curves joined at either end'. The dimensions selected for detailed recording are indicated in Catalogue 1, Figure 12 and on some of the plates. Some artefacts had only a few punchmarks on them, which means that only a small number of photos and measurements could be taken, making the characterisation of the mark less precise. In two cases (the X-shaped and 'three-dots-in-a-frame' marks), no complete examples of the mark were recorded, so that external dimensions could not be recorded accurately. Estimates are given in these cases.

The punchmarks observed were then classified according to the typology below. Further research was carried out in some cases, especially amongst the circular/oval punchmarks, since these often benefitted from an examination of their profiles.

Classification and manufacture of punches

In order to describe the marks accurately and to discuss the way in which the relevant tools might have been made, it was necessary to have a classification of punchmarks. Such a classification means that general comments can be made easily and that each mark or tool does not have to be referred to individually. Punchmarks on Anglo-Saxon artefacts have been the subject of some earlier studies, but none of these address the questions about manufacture posed in this work.

Leigh examined the punchmarks on more than 100 great square-headed brooches of Kent and drew up tables of marks (Leigh 1980; Figs 69-73). He divided the marks up into broad categories on the basis of their overall shapes; circular and circular-derived (*eg* ring-and-dot), triangular, triangular with additions, more complex forms and those forms used for notching. Leigh later (1990) commented on the nature of the tools used but did not speculate on how they were made, or on how the techniques used may

have placed limitations on the styles produced. In his work, Leigh has also made useful comments on the difficulties of punchmark studies. For example, he published photographs of punchmarks which were very similar when viewed through an optical microscope, but which proved difficult to illustrate convincingly (Leigh 1990, Plate 1). He characterised the marks in terms of their dimensions and noted that, amongst the square-headed brooches of Kent, only seven tools were used to make the punched designs which later had niello inlaid into them, indicating that the brooches were the products of a very small number of workshops (possibly only one).

It is not known how generally applicable these conclusions are, because Leigh's punchmark studies concentrated on one relatively high-status artefact type, with findspots in a single county. For example, at Barrington and at many other Anglo-Saxon cemeteries, there are many sheet metal artefacts which were decorated using punches in repoussé style (struck from the back of the artefact, raising a bump or boss at the front). The marks used in repoussé work are less complex than some of those used on the square-headed brooches and might therefore be expected to be more easily- and widely-made.

The chronological and spatial distribution of particular types of punched designs were considered by Ager (1985). In this interesting study, he provided a list of types of designs found on late Roman and early Germanic artefacts (*op cit*, Fig 15), but did not order or group the designs, or the individual marks. Ager was often commenting on overall designs not individual marks; complex designs may be made up of simple marks, used in combinations or on their own, see *eg* the buckle from Grave 117, Mucking (Mortimer 1995). Tool manufacture was not considered.

The current study aims to investigate the shape of each punch tool and not just the indentations made by it because a tool can be hit at several different angles, thus producing a variety of indentations. Punches can also be used repetitively, sometimes producing designs by overlapping marks.

It is thought that the materials used and the method of manufacture of punches is very important and that, if possible, these factors should play a part in the classification of punch types, using insights gained through the study of punchmarks. For this reason, it was decided that information gained in studies of other punched and stamped material such as pottery (*eg* Myres 1977; Richards 1987) were not directly relevant. It is hoped that other types of punchmarked artefacts will be considered in more detail at a later stage of this research. Some aspects of research into punchmarks on other metal artefacts may be relevant (*eg* Larsen 1987). The discussion here is mainly concerned with the material at Barrington, but it is likely to be relevant for other early Anglo-Saxon artefacts.

Materials The Tattershall Thorpe tool set (Hinton and White 1992) and parallel finds abroad (*eg* Ardwisson and Berg 1983) suggest that punches would have been made from ferrous alloys. Writing in the 12th century, Theophilus gave various names for the types of tool to be considered here, all implying that they were made of iron; *ferrum aequale*, *ferrus ad ductile opus*, *ferrus punctorius* (Book III, Chapter 7). During the Anglo-Saxon period, ferrous alloys could not be cast, so punches would have been forged and filed into shape; other details could have been added to the tip using other punches.

It is likely that punches would have been made with two types of ferrous alloy, a steel tip being preferred for its hardness in the area with the design and a low-carbon iron alloy being used elsewhere, because of its greater resiliance to blows (see *eg* Fig 1). Designs similar to the 'sandwich' principle used to make some types of Anglo-Saxon or Anglo-Scandinavian knife (*eg* McDonnell and Ottaway 1992; 480-486) were used on four ninth- to eleventh-century punches from

York which were shown to be composed of either a steel core with a ferritic/phosphoric iron sheath, or three or four strips of iron of different types welded together (Ottaway 1992; 519-520).

Steels (iron alloys containing 0.2-0.8% carbon) have the advantage that they can be softened by heating (annealing), making it easier to carry out the work required on the design, and then hardened (by quenching) and tempered (by heating to a lower temperature), which makes the tool more durable (less brittle). Phosphorous-containing iron alloys can also be work-hardened.

Some Roman and late Saxon/Anglo-Scandinavian punches have been examined metallurgically. The tips of Roman punches (where preserved) have hardnesses between 224 and 385HV although one particularly poor example was only HV 150 (Tylecote and Gilmour 1986, 86). Cross-sections through these and the Coppergate artefacts (McDonnell and Ottaway 1992, 519-521) in several cases demonstrated that the punches were mis-used or mis-sharpened so that the hardest metal type was no longer present at the cutting edge.

The hardness required of a punch obviously depends on the hardness of the copper alloys on which they were used. As in ferrous alloys, the hardness of a copper alloy depends not only on the composition, but also on the degree of annealing and work hardening. So although compositional analysis of copper alloys from the site is being carried out as another element of the post-excavation process, the best assessment of hardness can be found by testing the artefacts themselves. For this reason, some of the copper alloys from the site were hardness tested.

Thirteen samples had been cut from sheet metal artefacts in order to determine their chemical compositions. They had been mounted in clear epoxy resin and polished, so they were suitable for hardness testing using a Vickers hardness tester.

Only three of the samples proved suitable for hardness testing (44b Δ89, 428 Δ40, and 428 Δ8); the others were too small or too corroded. Of these only one (428 Δ40) had recorded punchmarks on it but the others were from similar types of artefact.

These artefacts were analysed using energy-dispersive X-ray analysis (EDX) in the SEM. They proved to be made of three different types of copper alloy, one a brass (44b Δ89), one a bronze (428 Δ40) and one an alloy with significant tin and zinc levels (428 Δ8). Each of the alloys are leaded, with the lead globules clearly elongated in the section, indicating that the sheet metal had been worked.

Object	Hardness (HV)
44b Δ89	151, 172, 158, 156, 160
428 Δ40	140, 145, 158
428 Δ8	191, 205

Table 3 Hardness testing on copper alloy sheet artefacts from Barrington Edix Hill

A range of hardnesses were measured on these samples (Table 3).

It was not possible to measure the hardness of cast metal artefacts from the site in the same way because none of these had been sampled and mounted in a suitable manner. Some preliminary experiments were carried out to see whether hardness tests could be carried out on whole cast artefacts, by testing small areas from which the corrosion had been cleared away. It proved difficult to get a flat polished surface suitable for hardness testing (various grades of grinding papers and a scalpel were tried) and to hold the artefact firmly in position during testing. However, cast copper alloy artefacts are often more heavily leaded than sheet metal artefacts and are less likely to be hardened by working, so one might expect the cast alloys to be softer than the sheet alloys. If the cast copper alloys at Edix Hill are comparable to the alloys seen in other

small cast artefacts of the period (*eg* Mortimer 1991), one would expect hardnesses below 100HV in many cases, in the unworked state.

The thickness of the metal to be decorated and the nature of any backing placed behind the metal artefact when marking might also be significant in determining the hardness required of the punch.

Some copper alloys (*eg* low-lead or high-tin bronzes) could possibly have been used to make punches to decorate Anglo-Saxon artefacts. Copper alloys have the advantage that they can be cast, although making moulds with the sort of fine detail required would be difficult. No copper alloy punches have yet been found.

It is much less likely that metalworking punches were made from organic materials, such as those used for pottery stamps (wood, bone, antler *etc.*). The force with which the tools had to be struck in order to make an impression on the artefact would be too great for most organic materials and it would be impossible to cut the fine detail required.

Methods of punch manufacture. Some of the punch forms described below are known from many Anglo-Saxon artefacts but were not found at Barrington Edix Hill 1989-1991.

It was suggested above that the tips of punches were shaped purely by the use of hammers, files and punches. If this is correct, then it seems likely that all punches would share a similar original form, which was achieved by inserting a steel tip into an iron bar, or wrapping a ferritic iron alloy around a steel core leaving a small part of the steel protruding (Fig 1). The tool could have been further hardened by carburisation (diffusion of carbon into the iron) after manufacture. The tool may have been fashioned with a square-sectioned shank to make accurate positioning on the artefact easier. As will be shown later, the tip of the punches were either flat or slightly domed, whether deliberately or due to wear. It is quite likely such subtleties were not normally noticeable to the naked eye, as most of the marks were between 1mm and 3mm across.

It would be comparatively easy to adapt this basic shape to make solid geometrical forms such as circular, oval, square, rectangular and triangular shapes (Fig 2, top row), using a file. Files are reasonably well-documented in post-Roman (and earlier) contexts, including a range of different sizes of file at Coppergate, York (Ottaway 1992, 521-3) and at Tattershall Thorpe (Hinton and White 1992).

Solid shapes with more elaborate outlines could still be made using a file, as long as all the edges could be reached and formed by filing, *eg* angular Z or S shapes, paired triangles or paired parallelograms, X shapes and V shapes (Fig 2, second row).

The manufacture of ring and ring-and-dot designs is perhaps less obvious. It seems likely that the end of the punch was shaped into a roughly circular shape and, after the tip had been thoroughly annealed to soften it, the central dot (in the case of ring punches) or ring (in the case of ring-and-dot punches) was sunk using a punch. The circumference could then be filed down to make it symmetrical, or to thin down the outer ring shape. This procedure is described by Theophilus (Book III, Chapter 18). The punch would need rehardening after this, by reheating and quenching.

The same basic principle could presumably be used to make a triangle with an internal 'dot' (*eg* 1000, Δ48) and more complicated designs, for example, the 'three-dots-in-a-frame' seen on 44a Δ22.

It is more complicated to determine the method of manufacture for the punches used to make semi-circular and double semi-circular punchmarks (Fig 2, fifth line), but it is likely that these were also made using a combination of punching and filing. This can be deduced by looking at evidence for the manufacture of the double semi-circular punch that was used to make the marks on the tweezers 45 Δ1 (Plate 30). The SEM

studies strongly suggest that, in this case, a punch with a wide, roughly semi-circular tip was first made, perhaps by making a ring punch and filing it down on one side. The internal semi-circle was then sunk into the tip, using a semi-circular punch. The shape produced by the punch at each of these steps is illustrated in Figure 3. Similarly, single semi-circular punches could have been made by making a ring punch and trimming down one side. However, some semi-circular or double semi-circular punchmarks could have been made by hitting a ring or double ring punch at an angle, although no certain examples of this were found at Edix Hill (see discussion of results, pages 10-11).

The next step in terms of complexity, are the solid shapes which have been given straight-edged internal divisions. These could have been formed by making the basic outline using a file, as described above, and then adding the straight lines by further filing or by engraving using the point of a tool. Divided triangles, double Vs and divided Ys (Fig 2, sixth line) are some of the forms which could have been made in this way. Where the internal lines go across the full width of the mark, these could have been filed, *eg* divided triangles and divided Ys. In other cases the internal lines stop short, *eg* double Vs, and these were probably made by engraving. Annealing during or after the secondary filing or engraving may not have been necessary.

A well-made file with fine teeth would be required to make the details seen on such punches. The finest file found at Coppergate had 12 teeth per 10mm and had been used on for copper-alloy work. With care, this standard of file could have been used to cut channels in punches such as those seen in this project. A rather coarser file could have been used to shape the outside surfaces of the punch tip.

It would be interesting to establish the profile of the files themselves – square- and rectangular-section files are known from Coppergate (McDonnell and Ottaway 1992, 521-523). This can be attempted by looking at the samples when tilted, but it is difficult to reach firm conclusions on the basis of the current study, for several reasons. The cuts on the punches may have been made by drawing the file across the tip more than once, hence the relationship between the profile of the cut and the profile of the file may not be close. Also, many punchmarks are rather shallow (*ie* the punch only penetrated a short way or the artefact surface was worn afterwards), which means that the angle of cut can only be assessed over short lengths. Most significantly, only a few punchmark types bear evidence about two sides of a file. These are the divided triangles and divided Ys mentioned above. They are not common types and they were not found on material from the Barrington Edix Hill 1989-1991 excavations. However, the reference material has provided a few relevant examples and, although there was not sufficient time in the current project, it would be worth investigating the profiles of cuts in a few examples, to see what could be revealed about this aspect of early files.

Punches for ring and ring-and-dot designs are sometimes adapted using straight lines created with a file. This is not seen at Edix Hill, but see *eg* artefacts from Morning Thorpe, Grave 288 (Green *et al* 1987).

Classification scheme. The marks studied here have been arranged into five basic groups on the basis of the manufacture of the punches; a) solid geometric, b) solid, adapted from geometric, c) with punched additions, d) with filed/engraved internal grooves and e) with both punched and filed additions. Within each of these groups, there are many different possible designs (Fig 2).

This arrangement separates 'solid' circular/oval marks from 'hollow' ring or ring-and-dot marks, as well as separating solid half-circles from semi-circles and double semi-circles. On the other hand, semi-circular marks are grouped together with ring marks, on the basis of the hypothesis outlined above. This means that

a visual examination of punchmarks on the artefacts itself, which would not normally be adequate to determine whether a semi-circular punchmark had been made by using a ring punch at an angle or a semi-circular punch, could nonetheless assign the marks to the higher classification level, in this case, group d. Thus, this classification represents a move away from earlier, purely typological approaches but still provides a practical way of sub-dividing punchmarks which could be carried out in a typical post-excavation environment (*eg* by a conservator with access to a microscope). The application of this classification to the material from one site, Barrington Edix Hill, will test the usefulness and value of this technically-based classification.

Exploration of this subject is at a fairly early stage. Further research may demonstrate alternative ways of making the designs discussed here, although, as noted above, information will have to come from the artefacts which were decorated, not from the punches themselves. More research might also reveal additional types of punched design which might require different methods of manufacture, although a desktop survey of marks on artefacts from two published cemeteries (pages 17-21) did not reveal any examples.

The punchmark styles seen on metal artefacts are a subset of the pot stamps used at this time. Presumably the range seen on metal artefacts was limited by the metalworkers' technical ability to produce culturally-appropriate symbols at this scale and using these materials. Chronological or geographical patterning in metalworking knowledge can therefore be studied by looking at the use of different styles of punchmarks. A consideration of the size of the marks might also be interesting.

The methods of manufacture sound relatively simple and the skills required could be thought to be not very considerable, but the tiny scale of these tools and the relative complexity of some of the designs means that the metalsmiths must have had good eyesight and a lot of patience. It has been suggested that the best metalworkers for this sort of work would have been shortsighted. On the other hand, many of the punches used during the early Anglo-Saxon period had very simple designs and it might be possible for the metalworkers to rework the tip to some extent, by filing it or even by annealing and forging it again. Some Roman and Anglo-Scandinavian punches show evidence of intensive use or reworking (mentioned above, page 5) and Larsen (1987) has tracked the reuse (through trimming of damaged areas) of one particular punch on several panels of the Gundestrup cauldron.

Application of punches

Modern metalworkers usually use punches on a metal surface when it is supported on a firm but somewhat yielding material, with the precise consistency of the backing material being determined by its composition and temperature. The depth and the crispness of the impression made can be determined by having harder or softer backing materials – lead, soft wood, wax and pitch have been used – or by using mixtures, such as those containing pitch and various other materials (*eg* Maryon 1971; 114-118). Theophilus does not make direct reference to the use of pitch or similar materials, although his translators make it clear that they consider it must have been necessary (Hawthorne and Smith 1963, 92). As some punches were used to raise repoussé bumps on sheet metal, the artefacts must have been backed with something soft enough to give slightly.

Smiths' toolsets would include hammers of several weights (*eg* Theophilus Book III, Chapter 6; Hinton and White 1992; Ottaway 1992, 514-515). Relatively small, light hammers would be required for decorative punched work on non-ferrous metals,

especially on sheet metals. Some sort of vice or grip would have to be devised to keep the artefact from jumping about during working. A solid bench or heavy wooden block would give a steady base for the work.

Theophilus (Book II, Chapter 74) refers to the repeated hammering and annealing cycles needed to produce repoussé work. Although annealing could have been carried out to useful effect on most of the types of copper alloys used to make Anglo-Saxon sheet metal, it may not have been necessary for the sort of repoussé work carried out on the Edix Hill artefacts since this seems to have been carried out by simple single blows of the punch to create single 'bosses', rather than repeated blows to build up large raised areas such as those referred to by Theophilus. Furthermore, as some punched decoration which was clearly never intended to be repoussé work (*eg* on bow brooches) shows through to the back of the artefacts, it seems that ample force was applied when punchmarking all of the artefacts making repoussé work relatively simple. Some other artefacts at the site do have large raised areas which were probably achieved by pressing sheet metal over a die *eg* the sheet metal appliques on wrist clasps 526 Δ23 and Δ24 and the gilded applique sheet on the fronts of the applied saucer brooches from context 530. The sheet metal used for this type of work is much thinner than that used to make wrist clasps.

Results

The punchmarks on all suitable non-ferrous artefacts from Edix Hill were recorded, photographed (Plates 1-38) and classified, following the methodology and classification above. Due to developments in methodology during the period of the study, not all the marks are illustrated in the same way - for instance in some cases, BSE images only are recorded and in other cases, split screen images including both BSE and SE images. A more systematic procedure will be used in future studies.

The results of this study are tabulated in Catalogue 1. The observations made below about the number of artefacts refer to individual artefacts, *eg* to each item in a pair or of a set of wrist clasps. Repoussé and non-repoussé marks are considered together because it is the design of the tool, not the way it was used, which is being studied at this point.

Types of mark: The 45 non-ferrous metal artefacts studied are decorated with only 12 different types of punchmarks (Fig 4), which belong to three of the groups discussed above (groups a, b and c). Some artefacts have more than one type or size of mark *eg* four types on wrist clasp 44a Δ22(hook). Hence, altogether there are 53 different mark 'macro-identification' entries in the catalogue and theoretically as many as 53 different punches could have been used on the 45 objects.

The majority of the marks are solid forms (group a), mostly of simple circular/oval designs and of various sizes, ranging from 0.8 mm to 3.0mm in diameter (or largest dimension, for oval marks). One artefact has triangular marks, with perhaps a slightly pyramidal profile (16b Δ1). 32 artefacts are marked with group a marks, of which four artefacts very clearly have two different sizes of circular/oval mark used together and four have a combination of circular/oval repoussé marks and other marks applied to the front of the artefact.

Group b marks are least common. Five artefacts have Z, X, paired triangles and paired lines punchmarks. Thirteen artefacts have group c marks; semi-circles, three-dots-in-a-frame, circle in triangle, ring-and-dot, double semi-circle and ring marks. Two further artefacts (44b Δ47(loop) and 156 Δ5) have punchmarks on them which may be either circular/oval or ring-shaped but which were not fully recorded in this project. There are no examples of group d or e

marks.

Number of tools represented at the site: Visual examination was usually adequate to determine the general type of toolmark concerned. Eight types of punchmark (solid triangle, circle in triangle, double-ring-and-dot, ring-and-dot, paired triangles, three-dots-in-a-frame, X, paired lines) each occur on single artefacts at the site. Measurements and photographic records would probably serve to distinguish these particular marks from other examples of these types, where necessary *eg* if these marks were to be compared with marks from artefacts found in earlier excavations in the vicinity (see pages 18-23).

It was more difficult to determine the number of tools used to make the types of marks found on more than one artefact, and especially difficult to determine the number of tools used to make circular or oval marks.

Non-circular/oval marks. Three artefacts were decorated using **double semi-circular marks**. The dimensions in each case are rather similar, ranging from 1.74mm to 2.00mm across the base. However, the marks on the tweezers (45 Δ1) are clearly different from those on the other two artefacts (small-long brooches from context 156), since the outer semi-circle is joined to the inner semi-circle (actually a solid half circle) at each end (Plates 30, 31 and 32). On the tweezers, the straight line at the base of the design is quite prominent. This is partly because the punch was hit approximately perpendicularly to the surface, whereas a punch was hit at an angle to form the marks on the brooches from context 156, with the top of curve penetrating more deeply than the ends; this was noted when the peels were tilted. Nonetheless the ends of the curves appear quite abrupt on some of the marks on the brooches from 156 rather than tailing off (see especially Plate 32), so it is clear that the punch which made the marks on 45 Δ1 could not have made the marks on 156 Δ3 and Δ5, even if it had been hit at an angle to the surface.

It might be expected that the pair of small-long brooches from context 156 would have been decorated using the same tool. It is unfortunately difficult to prove this conclusively since there are only a few well-recorded marks from each artefact and the punch did not bite deeply into the surface, but comparison of the general shapes of the marks would seem quite convincing.

Even the briefest of examinations is sufficient to convince one that the two artefacts with **Z marks** were decorated with two completely different punches (Plates 16 and 29). The marks on 20b Δ33 are very crisp but those on 44b Δ2 are poorly-preserved and it is difficult to determine the form accurately.

Three artefacts were decorated with **semi-circular marks**. The marks on 4 Δ17 (hook) and 4 Δ11 (loop) have an unusual shape visible by naked eye as well as at high magnification (*eg* Plate 6). It is easy to deduce that both artefacts were probably decorated with the same punch and therefore that the wrist clasps in Δ11 and Δ17 were mismatched in the grave. It is also easy to distinguish these marks from the semi-circular marks on two small-long brooches, 20b Δ32 and 547 Δ5 (Plates 15 and 36). The latter two sets of marks are broadly similar to each other, at least in size and general design but the marks on 20b Δ32 have a rather angular outside edge, compared with those on 547 Δ5.

The **ring marks** on the brooches from 322b (Δ17 and Δ62) are extremely similar visually (Plates 33 and 34) and in their dimensions; it seems likely that these brooches were decorated with the same tool.

The detailed examination that the SEM technique permits means that the shape of the tool itself can be considered, as well as the shape of the punchmarks made. For example, it has been suggested that ring punches could have been used at an angle to make semi-circular marks, deliberately or otherwise (Fig 5a). The particular shapes of the semi-circular marks discussed above

means that neither of them could have been made using the ring punch used on brooch from in context 322b. None of the ring-and-dot marks on 20b Δ35 were well enough preserved to determine whether the outer ring of this mark could be matched up with the shape of the semi-circular marks discussed here (*cf* Fig 5b). Double semi-circular punchmarks could have been made by oblique blows from a double ring punch or double-ring-and-dot (Fig 5c and 5d), but the diameter of the only double-ring-and-dot mark at the site (on 547 Δ4) is too big to have been used for this purpose; there are no double ring marks at the site. Marks made by a ring-and-dot punch used obliquely might be seen as being double semi-circular in initial visual examination (*cf* Fig 5e), but it is unlikely that this mis-identification would continue after examination using a microscope.

The largest dimensions of the non-circular/oval marks (including those which occured only once at Edix Hill) range from 0.84mm to *c.* 5mm. Group b marks range in size from 1.17 to *c.* 2.7mm and group c punchmarks from 1.26 to *c.* 5mm. Most of the group c marks are between 1.5 and 2mm across, with only the ring-and-dot and the double-ring-and-dot marks being larger than 3mm.

Thus a visual examination of the marks at higher magnifications and the analysis of their size serves to determine that at least a further seven tools of four punch types were used. In two of these cases, a punch was used on more than one artefact from a grave. It is likely that semi-circular and double semi-circular marks were made with punches deliberately created for this purpose, not by using ring or double ring punches struck at an angle to the surface.

Circular and oval marks. It is much more difficult to determine the number of tools used to make the circular and oval marks. There are several reasons for this but, in a pilot project such as this, it seemed worthwhile to attempt a thorough study.

Sizes range from 0.78-3.02mm, with a large proportion of the measured marks being between 1.0 and 1.5mm (Fig 8 and Table 2), that is, on the whole, rather smaller than the non-circular/oval marks. Preliminary sorting showed that the overall size (diameter or largest dimension) serves to distinguish some of these marks from one another (Table 2). Certainly the tools used to make the large circular marks found on 44a Δ22 (hook) (diameter 3.02 mm) could not have been used to make the oval/hexagonal marks found on 16b Δ12 (maximum diameter 1.05 mm). Some of the circular/oval marks also seem to have internal features within their outlines *eg* the raised area within the large circular mark on 44a Δ22 (hook) or unusual profiles *eg* the truncated pyramidal forms of 16b Δ12 (loop and hook) as can be seen in Plates 20, 11 and 12. Such features are generally very slight but the more outstanding examples could be sought again amongst marks on other artefacts, and used, along with dimensional information, to suggest 'matches' between artefacts - the simple nature of these marks does suggest that it would always be difficult to prove a match.

Tilting the samples gave more information about the profile of the tool tip, although it was difficult to collect the data in a systematic fashion. Analysis of the tilted samples showed that many of the circular/oval punches were slightly flat at the tip (*eg* Plate 38). This is possibly as a result of wear during use but may have been a deliberate design feature as a pointed tool would tend to pierce, not just stretch the metal surface.

The dimensional data from the circular/oval marks were also difficult to grasp; for instance, the recorded ranges of diameters overlap for 13 out of 20 artefacts, in the range 0.93-1.47mm (Fig 8). Whilst it is clearly unlikely that the five marks measured on the loop part of the wrist clasp from 16b Δ12 (ranging from 0.93mm to 1.05mm) were made with the same tool as made the three marks on the hook from 359b

Δ2 (ranging from 1.38 to 1.47mm), there are no obvious 'cut-off points' in the diameter ranges recorded. The variation in the diameters recorded on a single artefact often reflects the difficulty in measuring the diameters of circular/oval marks reproducibly, but it is likely that some variation was also introduced during manufacture, as well as wear and corrosion during the subsequent use and burial of the artefact. Realistically, it might be appropriate to suggest 'error bars' due to measurement of ±0.1mm.

Because of sampling biasses, it is debatable whether the circular/oval marks listed are representative of the whole size range of circular/oval punches used on artefacts at this site, let alone those on early Anglo-Saxon material as a whole. It may be that tools with very small tips were difficult to make – about 1mm might be about the smallest which could be conveniently made. It would also be difficult to use tools with very small tips in punchmarking work, as they would tend to pierce the metal. Conversely, relatively few large circular/oval marks (more than 2mm) are recorded, partly because they tend to be used sparingly on the artefacts, often as a small part of an overall design, but also because increasing the diameter of the punch would make it necessary to hit the punch harder to still achieve a legible impression. However, it is also difficult to record marks made by small punches, since problems with bubbles forming in the peel material are more frequent on these small marks. In the future, improvements in taking peels could include using a more fluid impression material.

Because of the difficulty in digesting and assessing the circular/oval punchmark data on all artefacts from the site, it is sensible to consider briefly the information relating to artefacts from single contexts and pairs of artefacts.

Large oval marks were used to decorate wrist clasps from context 4 (Δ11 (loop) and Δ17(hook)) and these could have been with the same tool as they are similar sizes (2.09 and 2.19mm) and they are all flat at the tip, with a distinctive pointed oval shape (Plates 4 and 5). This confirms the impression, given by a visual examination of the clasps from this grave and by information about the semi-circular marks (page 10), that 4 Δ17(hook) and 4 Δ11(loop) were made as a matching pair, but were mismatched in the grave. However, punchmarks on wrist clasp 4Δ11 (hook) are too poorly preserved (se Plate 3) to make a comment on whether they are similar to those on the typologically-matching wrist clasp Δ10 (loop). Small oval marks on another two pieces from this grave, Δ10(hook) and Δ17(loop), have different appearances (see Plates 1 and 7), both to each other and to the other marks on wrist caaps from this grave. Thus the wrist clasps in context 4 must have been produced using at least four different circular/oval punches.

Shape as well as size is important in distinguishing between marks. For instance, it is initially difficult to know what to make of the correlation in size between the sole recorded example of circular/oval marks being used on the front of an artefact, 16b Δ12 (both parts of a wrist clasp) and those to make repoussé marks on the other wrist clasp in this grave, Δ11. Although the two sets of wrist clasps are of the same type (Hines Form B7), they are certainly not a pair – Δ11 is larger than Δ12, the sheet metal is thinner and its punchmarks are more erratically laid out. However, a closer examination shows that the punch which made the marks on 16b Δ11 was rounded on top, whereas the punch which made the marks on 16b Δ12 was a sort of truncated oval pyramid (Plates 9-12) and hence the wrist clasps could not have been decorated with the same tool.

It would be possible to carry out this type of analysis on artefacts from each grave in turn, but it would be difficult to determine subsequently whether there are any good matches between graves. In any case, before going too deeply into this sort of analysis, it is wise to consider the nature of these punches and of their use, and the way that

these factors affect the punchmark data which can be retrieved.

Circular/oval punches have relatively little potential to possess diagnostic features and they were relatively easy to make and use. In particular, it would have been simple to reshape them, as there was no internal detail to be damaged or lost by careless filing. Reshaping could have drastically changed the profile of the tip and, as with extensive use, reshaping might well have changed the size, for instance, by flattening out the end of the punch.

Circular/oval punches were often used in repoussé decoration, so that, even if hit at an angle, a punch of any shape might be used to raise a satisfactory bump on the side to be viewed. Hence the metalworker would not have to be as consistent in maintaining a particular shape of tip or angle of strike. As there is a high degree of layout irregularity in application for all punchmarks, it seems that exact reproduction was not important or beyond the competence of the metalworkers of the period, however within this collection no 'inappropriate' punches (*ie* non-group a) were used in repoussé work.

Punches used in repoussé designs caused surface depressions of varying depths. This is significant because if, as seems possible, the tools used were tapered towards the tip, then the diameter (at the surface) of the impressions produced would depend on the depth of penetration (Fig 6), and would thus relate to the force with which the punch was struck, as well as the hardness of the surface and its backing material. Because of this, and since repoussé work mainly depends on distorting through the whole thickness rather displacing metal on the top surface (Fig 7), it is important to note that the diameters measured in this study are the diameters of the impressions made, not necessarily those of the tip of the tool. Ideally the diameter of the tip of the tool should be measured, by tilting the specimen 90° and measuring the 'corners' of the impression. This is a time-consuming procedure and was not carried out in all cases.

The variation in surface relief between samples (*eg* samples from artefacts with curved surfaces or peels which curled away from the stub) means that it was not possible to record all the marks in a totally systematic manner. This is especially problematic where circular/oval marks were laid out in a row on thin sheet metal and distortion caused by punching means that the punchmarks lie along a deep valley (seen as a prominent ridge as recorded in the peels). In this case, it is difficult to measure their dimensions reproducibly. It is also difficult to describe marks accurately when the tool had been applied at an angle to the surface, because often the entire design could not be seen.

As circular marks do not have an obvious 'sense', such as the 'feet' of a V-shaped or semi-circular punchmark, it is not easy to line up the marks in a systematic way (*ie* in the same orientation) for examination in the SEM. Where marks are approximately circular, it was difficult to measure the same dimension in each case, since the tool may have been rotated between blows. Attempts at characterisation were also not helped by the small number and poor quality of peels recorded from some of the artefacts.

In conclusion, it is difficult and probably unwise to attempt to match circular/oval marks which are so simple and prone to alteration and variation during use. Any analysis of the circular/oval punchmarks will produce an inaccurate estimate of the number of tools used to make the decoration on objects from a single site or workshop – probably resulting in an overestimate. From the evidence at this site and on comparable material, we can at least say that metalworkers would probably maintain at least one large and one small 'plain' (*ie* circular/oval) punch, which were sometimes used in combination on a single artefact.

Patterns in use: The distribution of punchmark types with respect to artefact types, the designs in which the marks were

laid out, other uses for punches and the types and origins of non-systematic mark placement will be considered next.

Different types of punchmark tend to be found on different types of object. Circular/oval marks are mostly found on the back of thin artefacts, being used to form repoussé decoration. Certain types of artefacts, such as Hines' (1993) type B wrist clasps, are frequently thin enough (less than 1mm thick) to permit this sort of decoration to be carried out. These are all sheet metal artefacts. Other artefacts are too thick to be decorated using repoussé techniques (although it has been noted above that the marks occasionally show through to the back of the artefact). This is the case for cast artefacts, such as bow brooches. It should be noted that a pair of wrist clasps from context 16b (Δ12) which might, from their morphology, be expected to be decorated with repoussé bosses instead have small circular/oval punchmarks on the front surfaces. The reason for this may be the slightly thicker sheet metal used for this pair of clasps.

It has been noted that, for repoussé decoration, only the general outline of the punch tip was important at the time of production, although our modern day facilities allow us to view the designs at high magnification. Any additional details which were present at the tip of the punch were not significant. For instance, rounded bumps could have equally well been raised by using a circular punch with internal detail (*eg* a ring) as by solid circular punches – although no examples of these appear in this dataset. Similarly, the precise outline would not be important, as the detail of the design would not translate to the other side. Domed punches with would however be preferable in repoussé work to flat-topped punches with sharp edges.

Amongst the wrist clasps, it was clear during sampling which was the front and which was the back of the artefact, and hence on which side the decoration was applied, and from which side it was intended that the marks should be viewed. This is because of the orientation of the 'hook' part of the wrist clasp and the gentle curvature often seen on the plates; a knowledge of the typology of this artefact type is also useful in the case of incomplete artefacts. For some other artefacts, it was unclear whether marks were intended to be seen from the back or the front. This is especially the case where punchmarking has caused slight indentations of the 'reverse' side – which could reflect poorly-executed repoussé – and where artefacts are incomplete (*eg* the copper alloy strips from context 428). Recovering this information is not important for the purposes of characterising and comparing the marks (and hence the punches), but the style of punchmark application is of interest in other contexts.

On many of the wrist clasps, several dozen repoussé bosses are used together to form simple geometric, nominally-symmetrical designs, such as straight rows (*eg* 4 Δ10 (loop), 4 Δ17 (hook), 4 Δ11, 44a Δ27), zig-zags (4 Δ10 (hook) and 4 Δ17 (loop)), diagonals (44a Δ13 and Δ21) and framing lines (16b Δ11 and probably 44b Δ60). Rows of repoussé bosses are sometimes mixed with non-circular/oval punches applied to the front, as on 4 Δ11, 4 Δ17, 44a Δ27 and 1000 Δ48. Of the non-punchmarked but otherwise comparable examples, one wrist clasp has a scratched decoration scheme (401 Δ1) and a pair of wrist clasps from context 626a are without any sort of decoration.

The frequency of punchmarking and other decorative techniques on the wrist clasps are similar to other artefacts of this type known from other contexts. Most of the wrist clasps in this study are of Hines' (1993, 39-43) type B7; Hines observed (*op cit*, 40) that more than half of his type B7 wrist clasps are decorated with repoussé bosses alone, while the numbers that are either plain or decorated with both repoussé and non-repoussé marks are considerably smaller.

On the other classes of punchmarked

artefact, punchmarks are normally used to decorate outside edges, *eg* on either side of the headplate of small-long brooches or to embellish divisions within the artefact, *eg* the lines which denote the division between the footplate and the lappets on a small-long brooch. Punchmarks used in this way often have a 'sense', rather than being symmetrical around two axes, and they are usually used in a particular orientation, for example, the 'feet' of V and semi-circular punchmarks usually point outwards, towards the edge of the artefact or towards the line or ridge that was being embellished. The Edix Hill 1989-1991 material is comparable to other Anglo-Saxon material in this respect.

Punches could also have been used to pierce the holes on the edge of wrist clasps used for attaching the clasps to the garment, although turning with an awl might produce a neater hole, because the unwanted metal would be scraped away. The diameters of these holes are comparable to or slightly larger than the diameters of some of the larger circular repoussé marks, so one punch could have been used for both purposes. If punches were used for piercing, they are likely to have been conical shaped and hence the diameter of the holes made would vary with the depth which the punch penetrated. Exact measurement of the diameter of the pierced holes was not carried out in this survey.

It was noticeable that piercing was not carried out in a uniform manner. Some of the wrist clasps were pierced from the reverse (4 Δ10, 4 Δ11, 4 Δ17 (loop only), 44a Δ13 and 44b Δ60) leaving curls of metal on the top surface and some from the front (4 Δ17 (hook only), 44a Δ21 and Δ24), leaving protruding metal on the back. In some cases, the metal displaced by piercing was tidied up, or was worn away during use, so it is not possible to tell from which side they were pierced. In context 4, it is interesting that one of the punchmark-linked and typologically-matching wrist clasps (Δ17 (hook)) was pierced from the front and the other (Δ11 (loop)) from the reverse, indicating that individual metalworkers may not have worked in a consistent manner.

It is often difficult to determine whether the attachment holes were pierced before or after the punchmarking had been completed, because of the erratic execution of punchmarked designs (see below), but at least in some cases, the punchmarking is so close to the pierced hole, it seems likely that the piercing was carried out after the punchmarking (*eg* 44a Δ21).

Punches used for decoration often pierced the metal, to various extents, suggesting the metalworkers found it difficult to judge the strength with which to hit the punch. Damage due to wear, corrosion and conservation of the artefact, together with the effects of local work-hardening (and therefore embrittlement) caused by punching may have increased the number of occasions on which we observe this happening and hence we may underestimate the skill of the metalworkers.

If our assumptions are correct and the products of a particular workshop or metalworker may be reflected by a particular punch being used, then it also likely that the way in which these punches were used – the layout, degree of skill *etc.* – may also inform us about the metalworker(s).

It is difficult to quantify or appraise objectively the placement of punchmarks on artefacts, and it is probably sensible not to 'judge' arrangements, for instance as being 'well-executed' or 'high-quality'. However, clearly accuracy and evenness of punchmark placement do seem to vary among Anglo-Saxon artefacts and some comments can be made on the Edix Hill material in particular.

Amongst the wrist clasps, the layout of punchmarks is only approximately symmetrical. For instance the 'straight rows' of punchmarks waver considerably in many cases (see especially the bosses and semi-circular punchmarks on 4 Δ11 (loop)) and one of the Vs which make up the zigzag of repoussé bosses on 4 Δ10 was much wider than the others, wide enough to allow (or require?) an additional line of three repoussé

bosses inside it, to fill in the area. In both these cases, the evidence suggests that the metalworker may not have drawn a guideline on the artefact or was unable to follow the line. None of the wrist clasps seemed to have any scratched lines which could have acted as guidelines, although these have been seen occasionally on other artefacts of this period. Poor surface preservation may have hindered observation of such lines but it seems that these artefacts were not even marked up in a temporary way. In the case of thin sheet metal artefacts, substantial amounts of repoussé work may have given an undulating surface (see page 12), making it difficult to place marks accurately on the front of the artefact. However, even when there was a convenient edge to work from, and a relatively smooth surface, punchmark placement was not uniform, as is shown by the variation in placement on cast artefacts such as bow brooches.

In general, it seems to have been the intention to produce marks which were clearly seperated from each other, but occasionally marks overlap (*eg* 4 Δ17 (Plate 7)). No examples of punchmark 'interleaving' to form guiloche patterns were found at Edix Hill, although examples are known from nearby (see *eg* an example from Haslingfield Plate 50).

The angle of incidence for the punch also seems to have varied considerably, as can be seen most clearly amongst the non-repoussé punchmark designs, where in some cases the whole design is seen and in other cases only one side of it. This must mean that it was difficult to keep the tool predictably upright – or that it was not important to the metalworker to do so.

Using a punch at an angle, no matter how slight, leads to the production of punchmarks which are 'weighted' in one direction. For instance, on one row of the semi-circular punchmarks used on wrist clasp 4 Δ11 (loop), one 'leg' of the curve penetrated more deeply than the other (the left leg when the peel is orientated so the 'feet' point down, and therefore the right leg of the marks on the object itself and the left leg on the punch). After completing one row of marks on the artefact, the metalworker seems to have worked back in the opposite direction along the next row (whilst keeping the 'feet' of the punch in the same direction), because the emphasis is on the other leg of the design (Fig 9). The artefact was probably turned round in order to complete the other rows of marks as they show the same unequal 'weighting' but the feet of the mark face in the opposite direction; alternatively, these marks may have been done first, as shown in Figure 9. On this artefact, the lines of marks are wavy, which may be due partly to the existence of repoussé bosses running down the middle of the artefact and partly to the problem of lining up the punchmark where there was no edge or guideline to follow.

Normally a right-handed jeweller would tend to hold the hammer in the right hand and the punch in the left and, in this position, it seems probable that the punch would naturally slope slightly to the right and hence the right-hand side of the resultant punchmarks would be deeper than the left. This means that in the negative situation (as in the peels used here), the left-hand side would be deeper. On the samples from a small-long brooch from Haslingfield (Ashmolean 1909.234a; see comparative material, below), this is the case when the 'legs' of the semi-circular marks are pointing towards the observer; in fact there seems to be a considerable weighting to these marks, not only towards the left but also towards the top of the mark (Plate 54).

Given the assumption above about 'handedness', and viewing the brooch with its foot downwards, evidence from this particular artefact allows us to go a little further. On this artefact, the metalworker placed two marks wrongly (upside down) on the right hand side of the foot of the brooch before correcting the orientation for the rest of the row, which seems to suggest that, when punching, the metalworker worked from the right to the left (Fig 10). This

would have been the best way to ensure reasonably accurate placement of the punch with respect to the previous marks (because the hand holding the punch would not obscure the previous marks), and because the legs of the punch design would have been facing the metalworker, the alignment of the ends of the punch with respect to the edge of the artefact could be controlled more easily.

Of course, it cannot be known for certain from the punchmark evidence whether the metalworker was left- or right-handed. One assumes that right-handedness would be the norm, as it is today, but if the metalworker was left-handed the reverse conclusions would be valid. Too much stress should not be laid on discussions based on the evidence of one artefact, and one which clearly was not one of the best examples of punchmarking in the region (albeit without the 'errors' this artefact would be of no more assistance in these discussions than any other). It might be possible to determine on a larger group of artefacts whether most marks with a 'sense' (*ie* those not symmetrical around two axes, such as Vs) were weighted to the left or the right side. Assuming that the punches were used in the 'feet-facing' position, it would therefore be possible to work out from this the 'handedness' of the metalworkers.

For the non-repoussé punchmark designs, the orientation of the punch design is also important. As was noted above, the orientation of V and semi-circular marks is generally with the 'feet' of the design outwards and, where the punch was used at the edges of artefacts, the feet of the punched design were usually within 1-2mm of the edge. This suggests that the punch could be lined up with the edge of the object. However in some examples, it is clear that this was not done with any great precision, as the punchmark orientation changes noticeably between each impression. Among artefacts with curved edges, this is partly in order to follow the edge, but even so the feet of punchmarks are often not square to the edge. These slight differences are not as obvious as the use of the 'wrong' orientation altogether (*eg* the two 'upside down' punchmarks on the foot of the brooch from Haslingfield discussed above), so they might be considered part of the variation which would be normally found, especially if the punchmarking was done at some speed.

The depth of impressions is very difficult to quantify and any results gained would be strongly dependant to the angle of incidence. Many of the punchmarks are now quite shallow, probably due to a combination of originally light punching (see *eg* group b and c punchmarks such as Plates 22 and 24) and surface abrasion/wear. Details of the depth of impressions are not recorded here, although a more exhaustive study might find useful patterning in such a dataset.

Comparative data

Study of the Edix Hill 1989-1991 material indicated that there were a number of simple punchmark types used quite frequently but (apart from pairs of artefacts) the punchmark data was not sufficient to suggest that one punch was used on more than one artefact. This study was based on a relatively small number of objects, from one site. In order to investigate whether this finding is likely to be representative, a larger collection can be examined. This also allows evaluation of whether the range of marks found is typical of Anglo-Saxon material overall, and whether the suggested method of grouping punchmarks by the methods of punch manufacture is robust enough to deal with larger groups of material.

A suitable collection for this purpose is material from several neighbouring sites of similar date, so the Barrington Edix Hill 1989-1991 material was compared with early Anglo-Saxon grave goods from earlier excavations at Barrington A (*ie* the sites known as Edix Hill, Malton and Orwell), at

Barrington B (Hooper's Field) and at nearby Haslingfield, which are curated at Cambridge University Museum of Archaeology and Anthropology (CUMAA), at the Ashmolean Museum, Oxford and at the British Museum, London. The punchmarks on the material held at Oxford and Cambridge were examined by John Hines and Xantopren peels taken from many of them. The types of mark found on these artefacts were determined initially through a brief visual examination and through optical microscopy (Catalogue 2). The British Museum material was not examined, due to time restrictions.

The range of marks seen on the comparative material is quite similar to that seen on the Edix Hill 1989-1991 material and the additional types of mark can be easily fitted into the general typology of marks outlined above. The additional types seen on the museum material are single V (type b), double V, segmented Y and divided triangle/grid (all type d) and these are illustrated in Figure 11. A pair of disc brooches from Barrington (Ashmolean 1909.291a and b) were decorated with punchmarks comprising two- (or possibly three-) dots-inside-a-frame, which is a rather similar form to the three-dots-inside-a-frame punchmarks seen on a wrist clasp from context 44a (Δ22), so this should probably not be counted as an extra punchmark type. The three-dots-and-a-curve-in-a-frame seen on one of the silver bracelets from Barrington (CUMAA Z21330, no. III) are probably also of this type, but the available peels are not clear.

It seems possible that wrist clasps may be under-represented in the museum collections examined here, judging by the balance of artefact types found at Edix Hill 1989-1991. This could be for several reasons. Material retained from previous excavations, especially 19th-century ones, may not represent the whole range of material originally present at the site, as there was a collecting bias towards artefacts with higher prestige value, such as brooches, and against those which were poorly-preserved or difficult to reconstruct, for example, small fragments from bucket or box bindings. Not all punchmarked wrist clasps were recorded for the purposes of this study, because they are frequently marked with circular/oval repoussé marks alone and objects with these types of mark were not prioritized for recording in this part of the study because of the difficulties in characterising them. However, the full catalogue of the Ashmolean collections (MacGregor and Bolick 1993) indicates that relatively few wrist clasps were found (or kept) from earlier excavations at Barrington and Haslingfield.

It is of course possible that the Edix Hill 1989-1991 cemetery had an unusually high proportion of wrist clasps with punchmarks and particularly with repoussé punchmarks. A more general survey of punchmarks on artefacts from other early Anglo-Saxon cemeteries serves to resolve some of these questions.

Examination of published drawings of material from two Anglo-Saxon inhumation cemeteries in Norfolk (Morning Thorpe (Green *et al* 1987, Vol II) and Spong Hill (Hills *et al* 1984)) suggests that the types of mark found at Barrington and Haslingfield represent a large proportion of the types of punchmark seen regularly on early Anglo-Saxon non-ferrous jewellery (Tables 3 and 4). Some additional types of mark, usually more complicated types (*eg* segmented rings in a square-headed brooch from Morning Thorpe G288), are found occasionally but all the types of mark at these sites can be assigned to groups a to e.

The types of mark found at Morning Thorpe and Spong Hill are similar to those at Barrington and Haslingfield, but the frequencies of the mark types are different and require some discussion. In Tables 3 and 4, each artefact (or pair/set of artefacts) with at least one clear example of a punchmark type is counted as one. The most noticeable differences are the very high frequency of ring marks at both Morning Thorpe and Spong Hill, when compared with

the Edix Hill 1989-1991 material. It should be noted that it is often very difficult to differentiate between solid dot punchmarks (group a) and ring punchmarks (group c) when working from the objects themselves, without magnification, because of shadowing and reflection from shiny surfaces. But it is interesting that group c marks as a whole are rather common at Morning Thorpe and in the museum collections from Barrington and Haslingfield. Circular/oval marks are used more frequently in non-repoussé work at Morning Thorpe (accounting for one third of the group a marks) than at Edix Hill 1898-1991; solid triangular marks are also used on many objects at Morning Thorpe.

This brief survey of material from two modern excavations suggests that the Edix Hill 1989-1991 material has an unusually high frequency of repoussé marked sheet-metal artefacts and a correspondingly small proportion of objects with marks from groups b to e. The retrieval/retention problems of the museum collections means that it is more difficult to compare the overall frequencies of punchmark type/group usage in these collections with the 1989-1991 material. A more extensive survey of punchmarked material from a large number of modern excavations would be useful. Using the results of such a survey would place the punchmark types found at Edix Hill 1989-1991 into their context, with respect to the type of artefacts concerned and the relative 'status' of the burials (and of the site as whole).

The majority of the comparative collection studied here are copper alloy artefacts. The silver bracelets from Barrington A (CUM Z21330 and Z21322, and Ashmolean 1909.260) are unusual finds. They will not be discussed in detail here but their marks have been recorded here for the purposes of comparing them to those on the Boss Hall silver bracelets (Mortimer forthcoming). Such artefacts may represent the products of higher status metalworkers as well as being the possessions of a richer jewellery owner. It is also useful to have an opportunity to study the state of preservation of marks found on silver jewellery at another site. The marks on the Boss Hall bracelets are very well-preserved and it was noticeable that some silver artefacts from museum collections, such as the Barrington A bracelets, seem to have good surface preservation. Detailed work on this type of material might be more rewarding than some of the copper alloy finds.

Detailed study of the double semi-circular punchmarks. Lack of time meant that not all of the peels from the comparative material could be examined in detail, so one punchmark type, the double semi-circle, was selected for further study. This type of mark is relatively common, but has a sufficiently complicated design to allow characterisation, through description and measurement, and hence further attempts at punchmark matching. It was hoped that research into further examples of this type of mark would also clarify the method of manufacture of the punches, which had not been conclusively determined from the studies of the Edix Hill 1989-1991 material.

Peels from the 19 artefacts (including two pairs) with double semi-circular marks were mounted, viewed and recorded in the same way as the peels from the Edix Hill 1989-1991 material, with one technical amendment. The topographic setting of the backscattered detector was found to be much more effective when working at a relatively short working distance (18mm) previously the punchmarks had been recorded at a working distance of 24mm. The increased contrast was specially useful for some of the samples which had very low relief. In order to ensure that the comparative work carried out (below) was compatible, two sets of double semi-circular marks from the Edix Hill material (from 45 Δ1 and 156 Δ3) were re-recorded at this setting (the original settings were used for the images in Plates 30 and 31). For each object, a detailed description of the mark was recorded, together with the width across

the 'feet' of the mark (Table 5). Plates 39-61 illustrate the double semi-circular marks from the comparative material.

Two examples originally recorded as being double semi-circular marks were shown to be triple semi-circles (on a pair of small-long brooches from Barrington A; Ashmolean 1909.270c and 1909.303) and one example was shown to be a double semi-circular with a central dot (on a small-long brooch from Haslingfield, Ashmolean 1909.241). These marks were recorded in detail during this research because, as was noted above, using a punch of this design at an angle can produce double semi-circular punchmarks.

Many of the punchmarks recorded represent only a part of the design, with sometimes only the top or one side of the mark being discernible. It is unlikely that partial marks could be characterised sufficiently to allow matching with complete marks but it was thought worthwhile to determine at least whether, judging from the evidence available, it is possible that the partial marks were from punches which were in the same dimensional range as the punches which made the full marks. Hence full width estimates were made for all partial marks (data expressed on Table 5 as, for example, '*c.* 1.3mm').

Results. Few of the double semi-circular punchmarks recorded here were on objects with well-preserved surfaces, so recording and characterising the marks accurately was difficult and sometimes impossible. Nonetheless, it is noticeable that the double semi-circular punchmark type includes a good deal of variation. Some of the marks are actually more like double arches, as the 'legs' of the mark straighten and extend out past the halfway point (*eg* CUM 34.825b, Plate 45). Others are more like double horse-shoe shapes, because the legs begin to curve inwards again (*eg* Ashmolean 1909.225b, Plate 51)

Amongst the artefacts with good surface preservation are some very interesting examples, including the small-long brooch from Haslingfield discussed above (Ashmolean 1909.234a) which shows an example of a double hit (Plate 61; the initial blow was presumably too far away from the edge of the artefact) and of two marks with completely the wrong orientation (feet inwards, as discussed on page 16). The mark has a number of distinctive features within it which would allow it to be compared with marks from other artefacts, for the purposes of matching. On some of the marks on this artefact, a rather gentle curve from the top of the mark to the level of the brooch can be seen, especially when the mark is tilted and this gives the broad 'halo' around the top half of the mark. This might represent the shape of the punch slightly further up the shaft, which was revealed because the punch was hit hard and at an angle.

Similarly the broadened (perhaps broken) lower curve on the Barrington B girdle hanger (CUM 34.849a) or the distinctive joined double horse-shoe punchmark design found on a small-long brooch from Haslingfield (Ashmolean 1909.225b) would also be good features to seek on other artefacts (Plates 48, 49 and 50). However none of these features were found in marks on any of the other objects with semi-circular punchmarks.

Attempts to match marks were based on information about their sizes and shapes. Most of the double semi-circular marks are between 1.2 and 1.5mm across the feet. The punchmarks on the pair of small-long brooches from Haslingfield (Ashmolean 1909.240a and b) seem very similar in outline (the surface preservation is too poor to allow much comment on the interior layout of the marks, see Plates 56 and 57), and their widths are also comparable (1.19-1.27 and 1.13-1.31mm respectively). However, other marks with similar dimensions have different outlines *eg* those on the girdle hanger from Barrington B (CUM 34.849a) mentioned above and the legs of those on a cruciform brooch from

Haslingfield (Ashmolean 1909.237) are splayed out (Plate 55). Similarly, although there are no totally satisfactory impressions of the marks on a cruciform brooch from Barrington (Ashmolean 1909.297; Plate 41), it is clear that the upper curve of the mark is broader than that on a similar sized mark found on a small-long brooch from Haslingfield (Ashmolean 1909.227a; Plate 53).

The two sets of double semi-circular marks with widths of just over 2.5mm appear to be broadly similar but the examples from a disc brooch from Haslingfield (Ashmolean 1909.248; Plate 60) are so poorly-preserved that it is not possible to tell whether there are details within them that allow a certain match to be made with the marks from a small-long brooch from Barrington B (CUM 34.825b; Plate 45). There are some hints that the upper curve of the marks on the example from Haslingfield are rather thinner than those on the Barrington brooch, but this may be partly due to the rather slight penetration (or severe wear) on the latter example.

When comparing these double semi-circular marks with those from the recent Edix Hill excavations, none of the museum artefacts had marks convincingly like those on the tweezers from context 45 (Plate 30). The marks from the brooches from context 156 (Plates 31 and 32) are more similar to some of those seen in the comparative material, of which those on the small-long brooches from Haslingfield (Ashmolean 1909.226a and 1909.227a) are the most likely match (Plate 52 and 53) but unfortunately the marks on the Haslingfield artefacts are all partial ones.

The shapes observed within this group of marks could have been made with punches produced in the way suggested for group c punches (page 6).

Discussion. This brief study demonstrates that at least another eight types of punchmark were present on broadly-contemporary artefacts in the neighbourhood of Edix Hill. The more detailed study of the double semi-circular punchmarks revealed no convincing matches. Some of the observed lack of matching may be due to variation in use (*eg* the relative thickness of the upper and lower curves may be changed due to hitting the punch at an angle) and to poor surface condition. Some allowance should also be made for alteration caused by cleaning the punch between uses and by damage to the artefact during use. However, this work does seem to suggest that, with the exception of pairs of artefacts, each artefact with a double semi-circular punchmark was decorated with a separate punch. This in turn implies that a large number of decorative punches of this design were available to the metalworkers who supplied artefacts to a relatively small population - albeit over a number of decades, if not centuries. The level of metalworking knowledge required to make punches has been discussed above. It may be inferred from the large number of tools used that the local metalworkers made the tools themselves or that a good supply of ready-made tools was available.

Conclusions

This study concentrated on the material excavated from eleven inhumation graves out of the 151 burials found during the Edix Hill 1989-1991 excavations. The material at this site could be considered an 'average' assembly for an inhumation cemetery of this period, but a brief examination of museum collections and published sites has suggested that further research could usefully be carried out to compare the situation at Edix Hill with Anglo-Saxon non-ferrous metalwork as a whole. Nonetheless some

preliminary conclusions can be made about the application of this methodology to early Anglo-Saxon grave goods and about the punchmarking on them.

The results obtained reflect the research techniques used as well as the material studied. Generally the methodology employed was adequate for the requirements of this work, but as this study was the first of its kind to be carried out, there were inevitably many technical problems to be overcome (see Appendix), some which have not yet been resolved. Amongst the major considerations, further improvements could be made by selecting alternative impression materials. Sample selection is also critical, since punchmarks on samples with poor surface preservation should not be studied.

The archaeological inferences which can be made from the results of this study are in four main areas;

1) the materials and skills required to make punches,
2) the skills required to use punches,
3) the number of punches used and
4) evidence about possible workshop groupings, given by matching of marks seen on different artefacts.

Punches were made from iron and its alloys by hammering, filing, engraving and punching. A knowledge of forging techniques such as tempering and quenching would have been necessary. Most of the punches used at Edix Hill are not technically-complex forms, but the frequent use of group c punches on contemporary material and the very small size of the punches indicates skillful metalworkers.

Punches were applied by hand probably without the benefit of layout lines or of any sort of jig to keep the punch upright. The metalworkers may have worked at some speed, leading to some irregularity of impression.

Where punches needed maintenance by the metalworker during use, it seems likely that the simpler punch designs were quite readily repaired or cleaned, using filing, which could have lead to a single punch producing several different marks during its lifetime. More complicated forms of punch design would have required complete refurbishment, including annealing, if the repairs were anything except very minor. Some punches continued in use although they were damaged, possibly because suitable facilities or skilled workers were not available.

There is therefore an apparent dichotomy between the finicky, controlled-temperature, sub-millimetre working skills needed to produce some of the punches, especially group c punches, and the rather more approximate, room-temperature skills of applying the punches on the artefacts themselves. From this it could be deduced that the punches may have been made by different individuals to the ones who used them, although metalworkers of the historical period made their own tools. Alternatively, perhaps the punches were not used at the locations in which they were made, but in less well-equipped workshops. Research into activity patterns in contemporary metalworking sites, such as those abroad (*eg* Helgö, Sweden (Lamm 1980)), might reveal useful information, since there are no excavated examples of early Anglo-Saxon metal workshops. The punches needed to carry out repoussé work might be the exception to this idea, since their manufacture or maintenance did not require high-temperature, detailed work.

The large number of punches used may seem rather surprising. Given the lack of punchmark links between artefacts shown in the study of double semi-circular marks, and leaving aside the group a marks, it seems possible that nearly all the occurences of group b to group e marks at Barrington and Haslingfield represent different punches, that is, up to 100 different punches were used. However, it was noted above that the study was quite likely to have produced an overestimate of the number of punches available to the metalworkers of this particular community, because of the poor state of surface preservation of many

artefacts and the high degree of variation in application. Also, the burials at Barrington and Haslingfield span at least two centuries, and the metalwork is likely to be the products of several generations of metalworkers or to come from several different sources.

It was suggested above that punchmark matching together with styles of punchmarking layout might be evidence for the existence of the output of individuals or of workshops. Some interesting features were observed in this study. In most cases, the placement of the marks are only approximate (in terms of orientation and angle of mark) and some artefacts demonstrate what seem to be errors in application. However, the group of material is small, and it is difficult to put these observations in context. With a larger scale project, it might be possible to pick out layout schemes which are more common in some sites or types of objects than others, perhaps in combination with preferred punch types, and thus suggest workshop groupings, in addition to any punchmark matching which may be discovered.

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Appendix: Practical and technical considerations

The methodology was developed with this type of project in mind, but some of aspects of the techniques used are not as satisfactory as had been hoped. The silicone rubber used, Xantopren-L, although portable and easy to use, tended to provide peels with bubbles, possibly because of an interaction with conservation materials. This meant that peels had to be taken from some of the artefacts more than once, necessitating additional site visits. Methods using silicone rubber under vacuum or materials which are much more liquid when mixed might give fewer of these problems, but they would be more elaborate and time-consuming and would require the objects to be taken to the laboratory.

Despite the ability to take peels 'on site', it would probably have been much easier to have the artefacts at the laboratory during research, as well as the peels, particularly as aspects of the punchmark layout were found to be informative.

The methods of mounting and coating samples were found to be adequate although labour-intensive. After some trial and error, systematic viewing and recording procedures were established. Comparison or 'matching' work was carried out by eye and by the use of measurements, both of which are subjective techniques but seem to be adequate. Further research may require more sophisticated image analysis, although systematically producing images on very different samples would be a major problem.

A great deal of information was retrieved by use of the stage tilt facility but this was a time-consuming process, involving considerable dexterity and mental gymnastics. Greater efficiency might be achieved through the use of a eucentric SEM stage (one which can pivot around a point in three-dimensional space).

The application of the methodology to this particular group of material was hindered for several reasons. Because it was the first large scale study of this type at the laboratory, study methods were developed at the same time as attempts were made to record meaningful data. Many of the artefacts were also in a rather poor state of preservation, due to wear and corrosion; conservation methods may also have obscured some details. From this research, it can be seen that the quality of artefact preservation determines whether punchmark analysis can be usefully carried out and that, in many cases, both recently-excavated and older museum material is unsuitable for this sort of work. On this basis, it might be suggested that copper alloy artefacts are not the ideal material for this type of research, but in a number of cases, very clear punchmarks were visible, with features which could be satisfactorily recorded and characterised using the methodology of this project. Hence some copper alloys may be suitable for this sort of work. However, in future work, if the surface looks visually to be a poor state, then recording and analysis by this method will not offer any useful information, no matter how hard the researcher tries. Some silver artefacts seem to have very well-preserved surfaces; these and gold artefacts are likely to be highly suitable for punchmark analysis.

Each sample took at least two hours to prepare and record (probably nearer three hours where the samples were tilted). Some savings may be made by preparing large batches of samples, but the imaging and recording of samples requires extensive SEM time and, as this involves VDU work, such work should not be done in long sessions.

The study also took a long time because a relatively-inexperienced student (MS) was involved in the early stages. An experienced SEM operator, or better still, an SEM operator who had already carried out such a project would be able to work more quickly. About 50% of the time spent by the student on this project could be more accurately termed training and education. As it was the first project of this type to be carried out,

some of the difficulties encountered could not have been predicted. Subsequently, some duplication of effort was caused by the work being taken over by a second researcher (CM).

Some aspects of the methodology employed here are discussed in a forthcoming conference proceedings (Mortimer and Stoney forthcoming b).

Amongst other things, method development time was spent on the printed output of the images. This text and the plates were produced using WordPerfect 6.0a. To produce the plates, clipped versions of the TIF format images produced by the SEM were converted to WPG format and input into WordPerfect files. The files for the pages of plates are recorded on optical disc 'Punchmarks' (barrplat\pages \page1.wpd *etc*), from which additional copies can be made.

Catalogue 1: Punchmarks on Barrington, Edix Hill 1989-1991 material, listed by context number, artefact number (SF) and individual artefact

Notes

1) The term 'largest dimension' makes sense on circular, ring marks *etc.* but on other shapes other dimensions are used. Refer to Fig 12 for details.
2) Mark details are given in bold if the punch is used from the back (repoussé). NB some wrist clasps have marks made from both sides.
3) na = not analysed (*eg* peel not taken or peel was not investigated).

Artefact			Marks					
Cont.	SF	Artefact type (and part, where relevant)	Macro-ID	group	Micro-ID	Profile	Greatest dimension: range of values (no. of examples) in mm	Plate
4	10	wrist clasp (hook)	**circular**	**a**	**oval 'waisted'**	**applied at angle, flat at tip**	**1.07-1.34 (3)**	1 & 38
		wrist clasp (loop)	**circular**	**a**		**applied at angle, flat at tip**	**1.60-1.70 (5)**	2
4	11	wrist clasp (hook)	**circular**	**a**			**c. 2**	3
		wrist clasp (loop)	**circular**	**a**	**oval**	**applied at angle, flat at tip**	**2.09**	4
			semi-circular	c	comma			
4	17	wrist clasp (hook)	**circular**	**a**	**oval**	**poor sample, but flat at tip**	**2.19**	5
			semi-circular	c	comma		1.65-1.68 (3)	6
		wrist clasp (loop)	**circular**	**a**	**oval angular**	**no info gained**	**1.05**	7
16b	1	annular brooch	triangular	a	pyramidal		0.84-0.99 (3)	8
16b	11	wrist clasp (loop)	**circular**	**a**		**rounded, slightly flat tip**	**1.10-1.20 (4)**	9
		wrist clasp (hook)	**circular**	**a**	**rather angular**	**rounded, slightly flat tip**	**0.93-1.25 (9)**	10

Artefact				Marks					
Cont.	SF		Artefact type (and part, where relevant)	Macro-ID	group	Micro-ID	Profile	Greatest dimension: range of values (no. of examples) in mm	Plate
16b	12		wrist clasp (loop)	circular	a	oval/hexagonal	angles down, flat at tip	0.93-1.05 (5)	11
			wrist clasp (hook)	circular	a	oval		*c.* 1	12
20b	16	pair	spangle on ring (Ag?)	**circular**	**a**		**poor sample, ?rounded**	**0.98**	13
20b	22		spangle on ring (Ag?)	**circular**	**a**		**rounded with flatter tip**	**1.13-1.14 (3)**	14
20b	32		small-long brooch	semi-circular	c	mis-shape		1.26-1.32 (4)	15
20b	33		cruciform brooch	Z	b			1.17	16
20b	35		disc brooch	ring-and-dot	c	poor peel		*c.* 4.6	
44a	13	pair	wrist clasp (hook)	**circular**	**a**	**circular**		**1.19, 1.20**	17
44a	21		wrist clasp (loop)	**circular**	**a**			**1.33-1.45 (3)**	18
44a	22		wrist clasp (hook)	**circular**	**a**	**small, angular**	**slightly flattened on tip**	**0.98-1.03 (5)**	19
				circular	**a**	**large**	**flattened on tip**	**3.02**	20
				paired Δ	b			*c.* 2.7	21
				three dots in a frame	c			(no complete examples) *c.* 2.5	22
44a	22		wrist clasp (loop)	**circular**	**a**		**very flat on tip**	**1.17-1.22 (3)**	23
				X	b			(no complete examples) *c.* 2.5	24
44b	45		strip	paired lines	b	may be repoussé		*c.* 1.7	25

Artefact				Marks					
Cont.	SF	Artefact type (and part, where relevant)		Macro-ID	group	Micro-ID	Profile	Greatest dimension: range of values (no. of examples) in mm	Plate
44b	46	wrist clasp	pair	**circular**	**a**	**small, polyhedral**	**angled, then flat right at tip**	**1.15-1.30 (4)**	26
				circular	**a**	**large (broken)**		**c. 3**	
44b	47	wrist clasp (loop)		**circular**	**a**	**small, angular**	**applied at angle, flat at tip**	**1.81, 1.92**	27
				circular (or ring?)	**a/c**	**large**		**c. 2.5**	
44b	60	wrist clasp (hook)		**circular**	**a**	**no sample**			
44b	62	wrist clasp		**circular**	**a**	**bean-shaped**	**possibly rounded at tip**	**1.70, 1.74**	28
44b	87	wrist clasp (frag)		**circular**	**a**	**no sample**		**c. 1.5**	
44b	2	fitting		Z	b			2.17	29
45	1	tweezers		double semi-circular	c	curves joined at either end		1.74-1.99 (6)	30
156	2	buckle		ring?	c?	na			
156	3	small-long brooch		double semi-circular	c	applied at an angle		1.81, 1.82	31
156	5	small-long brooch		double semi-circular	c	applied at an angle		1.83, 2.00	32
322b	17	brooch		ring	c	oval		1.56?, 1.76	33

Artefact				Marks					
Cont.	SF	Artefact type (and part, where relevant)		Macro-ID	group	Micro-ID	Profile	Greatest dimension: range of values (no. of examples) in mm	Plate
322b	62	small-long brooch		ring	c	oval		1.70, 1.70	34
359b	2	wrist clasp (hook)		**circular**	**a**	**oval**	**flat on tip**	**1.38-1.47 (3)**	35
428	1	plate		**circular**	**a**	**poor sample**	**possibly rounded at tip**		
428	1.14	plate		**circular**	**a**	**poor sample**	**no info. gained**	**c. 1**	
428	1.1	plate with rivets		**circular**	**a**	**poor sample**	**no info. gained**	**0.78, 0.87**	
428	10	plate		**circular**	**a**	**no sample**			
428	11	plate		**circular**	**a**	**no sample**			
428	40	plate	girdle/bag complex	**circular**	**a**	**no sample**			
428	41	plate	girdle/bag complex	**circular**	**a**	**no sample**			
428	141	plate		**circular**	**a**	**no sample**		**c. 1.2mm**	
547	5	small-long brooch		semi-circular	c			*c.* 2.5	36
547	4	disc brooch		double ring-and-dot	c			(inner ring diameter) 2.89, 2.90 outer ring *c.* 5	37
1000	48	wrist clasp		circle in triangle	c	no sample			
				circular	**a**	**no sample**			

Catalogue 2: Punchmarks on material from 19th century excavations at Barrington and Haslingfield

Artefact					Mark	
Site	Museum	Accession no		Type	Macro-ID	Group
Barrington	Ashm	1909.279b		Small-long brooch	Dot	a
Barrington	Ashm	1909.278		Annular brooch (Ag)	Ring	c
Barrington	Ashm	1909.285a	pair	Small-long brooch	Ring?	c?
Barrington	Ashm	1909.285b		Small-long brooch	Ring?	c?
Barrington	Ashm	1909.300		Cruciform brooch	Semi-circular	c
Barrington	Ashm	1909.295b		Girdle hanger	Semi-circular ?	c?
Barrington	Ashm	1909.295c		Girdle hanger	Semi-circular ?	c?
Barrington	Ashm	1909.302		Small-long brooch	Semi-circular ?	c?
Barrington	Ashm	1909.290		Small-long brooch	Double semi-circular	c
Barrington	Ashm	1909.292		Cruciform brooch	Double semi-circular	c
Barrington	Ashm	1909.297		Cruciform brooch	Double semi-circular	c
Barrington	Ashm	1909.282		Small-long brooch	Triangle	a
Barrington	Ashm	1909.284i	pair	Small-long brooch	Triangle	a
Barrington	Ashm	1909.284ii		Small-long brooch	Triangle	a
Barrington	Ashm	1909.283		Small-long brooch	Double V?	d
Barrington	Ashm	1909.288		Small-long brooch	Double V	d
Barrington	Ashm	1909.289		Small-long brooch	Double V	d
Barrington	Ashm	1909.291a	pair	Disc brooch	2 or 3 dots-in-triangle	c
					ring	c
Barrington	Ashm	1909.291b		Disc brooch	2 or 3 dots-in-triangle	c
					ring	c
Barrington	Ashm	1909.286		Small-long brooch (pair)	Double R and D	c
Barrington	Ashm	1909.287a/b		Disc brooch (pair)	Ring and dot	c
Barrington	Ashm	1909.296		Cruciform brooch	Semi-circular	c
Barrington	Ashm	1909.299		Cruciform brooch	Semi-circular	c
Barrington	Ashm	1927.76		Annular brooch	Paired triangles	b
Barrington	CUM	Z21263		Bucket handle	Ring	c
Barrington	CUM	Z21264		Bucket hoop	V?	b?
					semi-circular?	c?
Barrington A	Ashm	1909.264a		Clasp	Segmented Y	d
Barrington A	Ashm	1909.264b		Clasp	Segmented Y	d
					tiny dots	a
Barrington A	Ashm	1909.268a		Small-long brooch	Ring	c
Barrington A	Ashm	1909.270c	pair?	Small-long brooch	Double semi-circular	c
Barrington A	Ashm	1909.303		Small-long brooch	Double semi-circular	c
Barrington A	Ashm	1909.260		Ag bracelet	Segmented Y	d
Barrington A	Ashm	1909.260a		Ring (Ag)	Dots	a
Barrington A	Ashm	1909.264i/ii		Wrist clasp	Dots	a
					Ring	c
Barrington A	Ashm	1909.267b		Ring	Ring	c
Barrington A	Ashm	1909.270		Small-long brooch	?unclear	?

Artefact				Mark	
Site	Museum	Accession no	Type	Macro-ID	Group
Barrington A	Ashm	1909.276i	Wrist clasp	Repoussé dots	a
Barrington A	Ashm	1909.276ii/iii	Wrist clasp	Repoussé dots	a
Barrington A	Ashm	1909.279a/b	Small-long brooch (pair)	Dot	a
Barrington A	Ashm	1909.282	Small-long brooch	Triangle	a
Barrington A	CUM	Z21328	Cruciform brooch	Dot	a
Barrington A	CUM	1923.1577	Small-long brooch (complete)	Dot?	a?
Barrington A	CUM	1923.1577	Small-long brooch (broken)	Dot?	a?
Barrington A	CUM	Z42255	Swastika brooch	Dot?	a?
Barrington A	CUM	Z16135 (G5)	Annular brooch	Ring	c
Barrington A	CUM	Z21325	Small-long brooch	Dot?	a?
Barrington A	CUM	Z21328	Cruciform brooch	Dot/ring?	a/c
Barrington A	CUM	D1961.8A	Buckle	Semi-circular	c
Barrington A	CUM	1883.515	Small-long brooch	Semi-circular	c
Barrington A	CUM	Z16082 (G6?)	Bucket binding	Semi-circular	c
Barrington A	CUM	Z16127 (pair)	Small-long brooch (A or B)	Semi-circular	c
Barrington A	CUM	Z16127 (pair)	Small-long brooch (A or B)	Semi-circular	c
Barrington A	CUM	Z16134	Small-long brooch (broken)	Semi-circular	c
Barrington A	CUM	Z21320	Applied disc brooch	Joined dots	b
Barrington A	CUM	Z21326	Cruciform brooch	Semi-circular	c
Barrington A	CUM	Z21315 (G11)	Great square-headed brooch	Unclear	?
Barrington A	CUM	Z21330 (set)	Bracelet (Ag) no. II	Divided triangle	d
Barrington A	CUM	Z21330 (set)	Bracelet (Ag) no. I	Segmented Y	d
Barrington A	CUM	Z21330 (set)	Bracelet (Ag) no. III	Segmented Y	d
				Divided triangle	d
Barrington A	CUM	Z21322	Bracelet (Ag) frag	Grid	d
Barrington A	CUM	Z16133	Small-long brooch	Large ring and dot	c
Barrington A	CUM	Z16131	Small-long brooch	Dot	a
Barrington B	CUM	Z21304	Applied SB (pair)	Dot? or ring?	a/c
Barrington B	CUM	Z16154	Small-long brooch	Paired dots	b
Barrington B	CUM	Grave 82	Small-long brooch	Semi-circular	c
Barrington B	CUM	Grave 85	Small-long brooch	Semi-circular	c
Barrington B	CUM	Z16147	Small-long brooch	Semi-circular	c
Barrington B	CUM	Z16150	Small-long brooch	Semi-circular	c
Barrington B	CUM	34.823	Small-long brooch	Semi-circular	c
Barrington B	CUM	34.827b	Small-long brooch	Semi-circular	c
Barrington B	CUM	34.835	Bucket mount strip	Semi-circular	c
Barrington B	CUM	34.848a	Small-long brooch	Semi-circular	c
Barrington B	CUM	Z16145	Wrist clasps	Ring	c
Barrington B	CUM	Z16151	Small-long brooch	Ring	c
Barrington B	CUM	Z16162	Small-long brooch	Ring (broken)	c
Barrington B	CUM	34.820	Small-long brooch	Ring	c

Artefact					Mark	
Site	Museum	Accession no.		Type	Macro-ID	Group
Barrington B	CUM	34.821a		Small-long brooch	Ring	c
Barrington B	CUM	34.820		Small-long brooch	Double semi-circular	c
Barrington B	CUM	34.830		Small-long brooch	Ring?	c
Barrington B	CUM	34.851a		Wrist clasp	Ring?	c
Barrington B	CUM	34.852		Buckle plate	Ring	c
Barrington B	CUM	34.825b		Small-long brooch	Double semi-circular	c
Barrington B	CUM	34.826b		Small-long brooch	Double semi-circular	c
Barrington B	CUM	34.831		Small-long brooch	Semi-circular?	c
Barrington B	CUM	34.849a		Girdle hanger	Double semi-circular	c
Barrington B	CUM	Z16155		Annular brooch	Dot or ring?	a/c
Barrington B	CUM	Z21303		Small shb	Dot or ring?	a/c
Barrington B	CUM	34.822a		Small shb	Dot or ring?	a/c
Barrington B	CUM	Z16136		Small-long brooch	Paired triangles	b
Barrington B	CUM	Z16162		Wrist clasp	Paired triangles	b
Barrington B	CUM	Z21310		Wrist clasp	Paired triangles	b
Barrington B	CUM	34.837		Neck ring	Paired triangles	b
Barrington B	CUM	34.822b		Small-long brooch	Double V	d
Barrington B	CUM	Z21318		Great shb	Divided triangle	d
Barrington B	CUM	34.839a		Silver finger ring	Paired triangles	b
Haslingfield	Ashm	1909.241		Small-long brooch	Large ring and dot	c
					double semi-circular	c
Haslingfield	Ashm	1909.231a	pair	Disc brooch	Semi-circular?	c?
Haslingfield	Ashm	1909.231b	pair	Disc brooch	Not examined	
Haslingfield	Ashm	1909.243d		Wrist clasp	Semi-circular?	c?
Haslingfield	Ashm	1909.227		Small-long brooch	Double ring	c
Haslingfield	Ashm	1909.225a	pair	Small-long brooch	Not examined	
Haslingfield	Ashm	1909.225b	pair	Small-long brooch	Semi-circular?	c?
					dot?	a?
Haslingfield	Ashm	1909.226a	pair	Small-long brooch	Double semi-circular	c
Haslingfield	Ashm	1909.226b	pair	Small-long brooch	Not examined	
Haslingfield	Ashm	1909.227a		Small-long brooch	Double semi-circular	c
Haslingfield	Ashm	1909.234a	pair	Small-long brooch	Double semi-circular	c
					Ring-and-dot	
					Dots	
Haslingfield	Ashm	1909.234b	pair	Small-long brooch	Not examined	
Haslingfield	Ashm	1909.237		Cruciform brooch	Double semi-circular	c
Haslingfield	Ashm	1909.240a	pair	Small-long brooch	Double semi-circular	c
Haslingfield	Ashm	1909.240b	pair	Small-long brooch	Double semi-circular	c
Haslingfield	Ashm	1909.248a		Disc pendant	Double semi-circular	c
Haslingfield	Ashm	1909.248		Disc brooch	Double semi-circular	c
					paired dots	b
Haslingfield	Ashm	1909.220		Swastika brooch	V?	b?
Haslingfield	Ashm	1909.219a		Annular brooch	?ring marks	?c
Haslingfield	Ashm	1909.221		Square-headed brooch	"Biconical"	?
Haslingfield	Ashm	1909.228		Small-long brooch	Dots	a

Artefact					Mark	
Site	Museum	Accession no		Type	Macro-ID	Group
Haslingfield	Ashm	1909.233i	pair	S-brooch	Ring	c
Haslingfield	Ashm	1909.233ii		S-brooch	Ring	c
Haslingfield	Ashm	1909.236		Cruciform brooch	Semi-circular	c
Haslingfield	Ashm	1909.238i	pair	Cruciform brooch	Dot	a
Haslingfield	Ashm	1909.238ii		Cruciform brooch	Dot	a
Haslingfield	Ashm	1909.242a	pair	Openwork disc brooch	Ring-and-dot	c
Haslingfield	Ashm	1909.242b		Openwork disc brooch	Ring-and-dot	c
Haslingfield	Ashm	1909.243a		Wrist clasp	Repoussé dots	a
Haslingfield	Ashm	1909.243b		Wrist clasp	Repoussé dots	a
Haslingfield	Ashm	1909.243g		Wrist clasp	Repoussé dots	a
Haslingfield	Ashm	1909.304		Bucket mounts	Repoussé dots	a
					"Triangle with small triangles inside"	c?
					Dot	a
					"Biconical"	?

Notes:

Barrington A is also known as Malton.
Ashm = Ashmolean Museum, Oxford; CUM = Cambridge University Museum of Archaeology and Anthropology. br = brooch. shb = square-headed brooch. SB = saucer brooch. Ag = silver
Some artefacts were not examined by John Hines or myself, but were noted from the descriptions and photographs in the published catalogue of the Ashmolean's holdings (MacGregor and Bolick 1993). There is no equivalent catalogue published for the Anglo-Saxon material at the CUMAA or the British Museum. "Biconical" and "triangle with small triangles inside" are the descriptions given in MacGregor and Bolick 1993 but it is not entirely clear what these terms mean.

Table 2: Circular or oval punchmarks, ordered by size

Cont	SF	Artefact	Micro-ID	Profile	Dimension in mm (no of samples if more than two)	Plate
428	1.1	plate with rivets	poor sample	no info. gained	0.78, 0.87	
16b	12	wrist clasp (loop)	oval/hexagonal	angles down, flat at tip	0.93-1.05 (5)	11
16b	11	wrist clasp (hook)	rather angular	rounded, slightly flat tip	0.93-1.25 (9)	10
44a	22	wrist clasp (hook)	small, angular	slightly flattened on tip	0.98-1.03 (5)	19
20b	16	spangle on ring	poor sample	?rounded	0.98	13
16b	12	wrist clasp (hook)	oval		c. 1	12
428	1.14	plate	poor sample	no info. gained	c. 1	
4	17	wrist clasp (loop)	oval angular	no info gained	1.05	7
4	10	wrist clasp (hook)	oval 'waisted'	applied at angle, flat at tip	1.07-1.34 (3)	1 & 38
16b	11	wrist clasp (loop)		rounded, slightly flat tip	1.10-1.20 (4)	9
20b	22	spangle on ring		rounded with flatter tip	1.13-1.14 (3)	14
44b	46	wrist clasp	small, polyhedral	angled, then flat right at tip	1.15-1.30 (4)	26
44a	22	wrist clasp (loop)		very flat on tip	1.17-1.22 (3)	23
44a	13	wrist clasp (hook)	circular		1.19, 1.20	17
428	141	plate	no sample		c. 1.2mm	
44a	21	wrist clasp (loop)			1.33-1.45 (3)	18
359b	2	wrist clasp (hook)	oval	flat on tip	1.38-1.47 (3)	35
44b	87	wrist clasp (frag)	no sample		c. 1.5	
4	10	wrist clasp (loop)		applied at angle, flat at tip	1.60-1.70 (5)	2
44b	62	wrist clasp	bean-shaped	possibly rounded at tip	1.70, 1.74	28
44b	47	wrist clasp (loop)	small, angular	applied at angle, flat at tip	1.81, 1.92	27
4	11	wrist clasp (hook)			c. 2	3
4	11	wrist clasp (loop)	oval	applied at angle, flat at tip	2.09	4
4	17	wrist clasp (hook)	oval	poor sample, but flat at tip	2.19	5
44b	46	wristclasp	large (broken)		c. 3	
44a	22	wrist clasp (hook)	large	flattened on tip	3.02	20

The following artefacts had circular or oval punchmarks but were not well enough preserved or recorded to be measured:

44b	60	wrist clasp (hook)
428	1	plate
428	10	plate
428	11	plate
428	40	plate
428	41	plate
1000	48	wrist clasp

Table 3: Punchmarks at Barrington, Haslingfield, Morning Thorpe and Spong Hill

		Current site	Museum collections				Published sites	
		Barrington Edix Hill	Barrington	Barrington A	Barrington B	Haslingfield	Morning Thorpe	Spong Hill
group a	circular/oval repoussé	13		2		7	16	3
	circular/oval (non repoussé)	1	1	9		4	13	2
	solid triangular	1	2	1			10	
group b	V		4			1	7	1
	S						2	2
	Z	2						
	Y						3	
	Paired triangles/dots	1	1	1	6	1		
	Paired lines	1						
	X	1					2	
group c	semi-circular	3	7	6	9	4	21	3
	double semi-circular	3		1	4	8	23	6
	ring	1	4	4	8	2	47	16
	ring and dot		1			3	2	1
	double ring					1	1	
	double ring and dot	1	1					
	double semi-circular and dot						1	
	triangle with central dot	1					2	
	triangle with three dots inside	1	1				1	
group d	double V		3				4	3
	double lines						1	
	segmented Y			3	1		1	2
	grid in triangle			2	1		4	1
e	others (group e)						4	
	Totals	**31**	**25**	**29**	**29**	**31**	**165**	**40**

Table 4: Punchmark groups at Barrington, Haslingfield, Morning Thorpe and Spong Hill

Site	Groups				
	a	b	c	d	e
Barrington Edix Hill 1989-91	15	5	11		
Barrington	3	5	14	3	
Barrington A	12	1	11	5	
Barrington B		6	21	2	
Haslingfield	11	2	16		
Morning Thorpe	39	14	98	10	4
Spong Hill	5	3	26	6	
Totals	86	35	197	26	4

The table shows the number of examples of each punchmark group. Pairs or sets of artefacts with the same mark type are counted as one. Where two types of punchmark from the same group are found on one artefact (*eg* a semi-circular and a double-V mark on the same brooch), these are counted separately. It is difficult to differentiate between solid dots (group a) or rings (group c) when using line drawings (because of drawing conventions) and when working from the objects themselves without magnification (because of shadowing and reflection from shiny surfaces).

Table 5: Double semi-circular marks on material from earlier excavations at Barrington and at Haslingfield

Artefact				Mark			
Site	Mus.	Acc. no.	Type	Micro-ID	Width in mm (no of samples)	Comments	Plate
Barrington	Ashm	1909.290	Small-long	Double	1.5	quite neat upper curve; more angular lower	39
Barrington	Ashm	1909.292	Cruciform	Double	1.44	flat, gentle curves; upper one blobby	40
Barrington	Ashm	1909.297	Cruciform	Double	*c.* 1.3	upper curve thicker; poor sample	41
Barrington A	Ashm	1909.270c	Small-long (possible pair)	Triple	2.55	quite angled curves; poor sample	42
Barrington A	Ashm	1909.303		Triple	na	quite angled	43
Barrington B	CUM	34.820	Small-long	Double	1.91, 1.91	upper curve thicker than lower; poor sample	44
Barrington B	CUM	34.825b	Small-long	Double	2.57-2.73 (4)	neat horse-shoe shapes; joined lower right legs	45
Barrington B	CUM	34.826b	Small-long	Double	1.45	quite neat; lower curve thicker	46 &47
Barrington B	CUM	34.849a	Girdle hanger	Double	1.25 (3)	lower curve not symmetrical to upper curve, and with broken element	48 &49
Haslingfield	Ashm	1909.241	Small-long	Double semi-circles and dot	2.78	the 'dot' is a half circle; semi-circles interlock, therefore difficult to measure	50
Haslingfield	Ashm	1909.225b	Small-long	Double	1.02, 1.04	joined horse-shoe shapes; poor samples	51
Haslingfield	Ashm	1909.226a	Small-long	Double	*c.* 1.8	hit at angle, therefore only one side of mark is clear	52
Haslingfield	Ashm	1909.227a	Small-long	Double	*c.* 1.3	thick lower curve; upper curve very gentle; shallow and overlapping marks	53
Haslingfield	Ashm	1909.234a	Small-long	Double	1.32-1.47 (3)	long legs, joined at lower right hand side; some distinctive details, some neat examples, incl.. mis-hitting	54 &61
Haslingfield	Ashm	1909.237	Cruciform	Double	1.35, 1.31	possibly joined at bottom of legs; poor sample	55
Haslingfield	Ashm	1909.240a	Small-long (pair)	Double	1.19, 1.27	shallow impressions; very poor samples	56
Haslingfield	Ashm	1909.240b		Double	1.13, 1.31	neat, quite symmetrical; semi-circles but poor samples, therefore outline only	57
Haslingfield	Ashm	1909.248a	Disc pendant	Double	1.41-1.52 (3)	mostly hit at an angle, but looks like quite neat semi-circles; suggestion of bulges	58 &59
Haslingfield	Ashm	1909.248	Disc brooch	Double	2.56	hit at an angle?; legs straighten out; poor sample	60

CUM = Cambridge University Museum of Archaeology and Anthropology
Ashm = Ashmolean Museum, Oxford

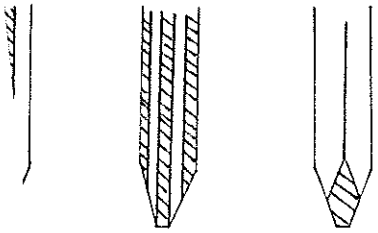


Figure 1: Suggested construction types for punches. Shaded areas are steel, plain areas are other ferrous alloys. Based on knife types of Tylecote and Gilmour 1986.

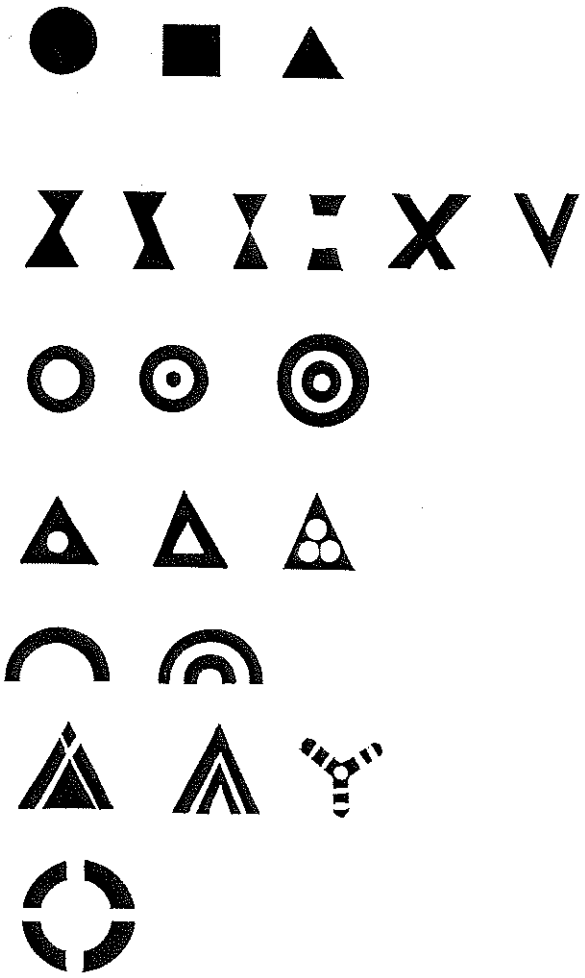


Figure 2: Typological scheme for punchmarks, schematic diagram. First line = group a forms, second line = group b forms, third to fifth lines = group c forms, sixth line = group d forms and seventh line = group e form.

Figure 3: Suggested method for making double semi-circular marks with joined ends (*cf* 45 Δ1), showing the shape of the tip at each of three stages of manufacture.

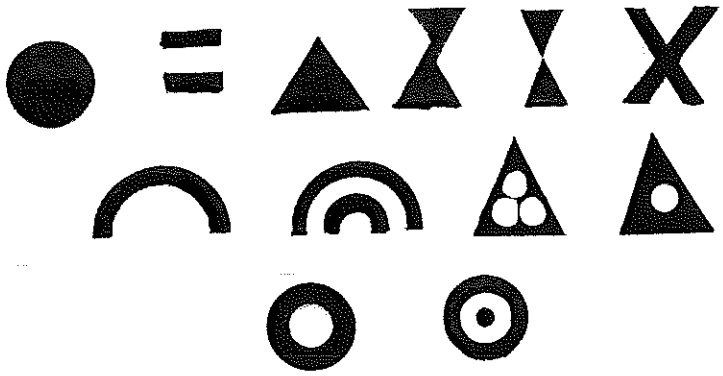


Figure 4: Punchmark types used on Barrington Edix Hill 1989-1991 material.

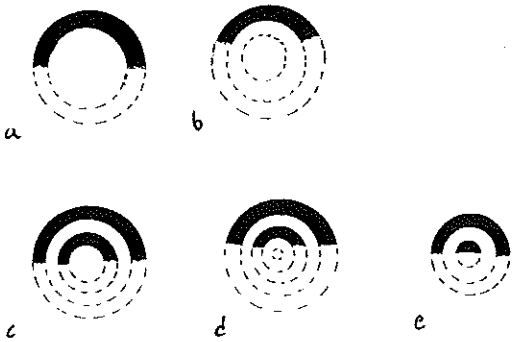


Figure 5: Use of ring, ring-and-dot, double ring and double ring-and-dot punches at an angle to create semi-circular and double semi-circular punchmarks. Dashed lines represent areas of punch not used to make the impression.

Figure 8: Diameter of circular/oval punchmarks on artefacts from Barrington Edix Hill 1989-1991

Context	SF	Diameter (mm)				
		1	1.5	2	2.5	3
428	1					
16b	12 (loop)					
16b	11 (hook)					
20b	16					
44a	22 (hook)					
4	17 (loop)					
4	10 (hook)					
16b	11 (loop)					
20b	22					
44b	46					
44a	22 (loop)					
44a	13 (hook)					
44a	21 (loop)					
359b	2 (hook)					
4	10 (loop)					
44b	62					
44b	47 (loop)					
4	11 (loop)					
4	17 (hook)					
44a	22 (hook)					

Figure 6: Impression diameters of punchmarks, when using a punch with a truncated cone-shaped tips at two depths (left), and with a cylindrical tip (right).

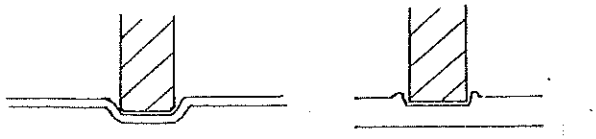
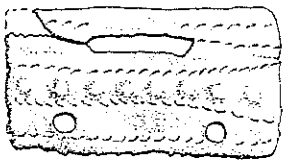


Figure 7: Distortion of metal surface caused by repoussé (left) and non-repoussé (right) punching.



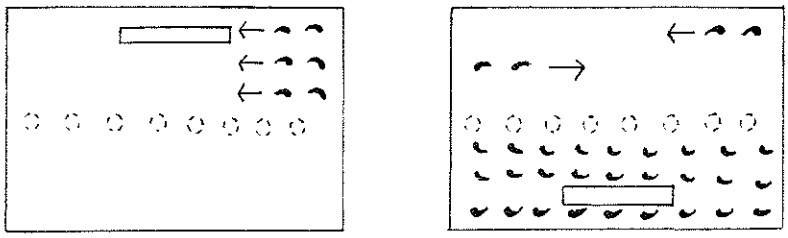


Figure 9: Wrist clasp 4 Δ11(loop) and suggested order of punchmarking. The repoussé marks were probably placed first and the holes would have been pierced last of all.

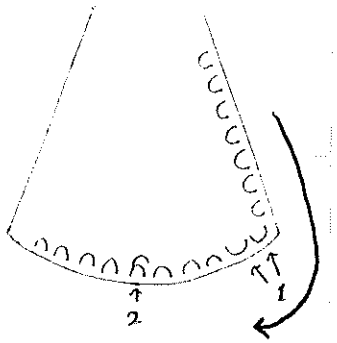


Figure 10: Small-long brooch from Haslingfield (Ashmolean 1909.234a). Diagram of punchmark layout on foot of brooch, showing (1) two punchmarks with wrong orientation and (2) double hit punchmark. Arrow indicates suggested direction of working.

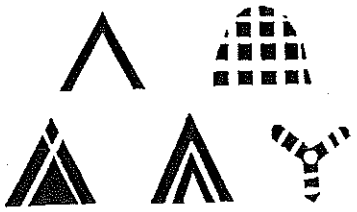


Figure 11: Punchmark types found on artefacts at Barrington and Haslingfield, excavated previous to 1989 (excluding those types found at Barrington Edix Hill 1989-1991 (see Figure 4)).

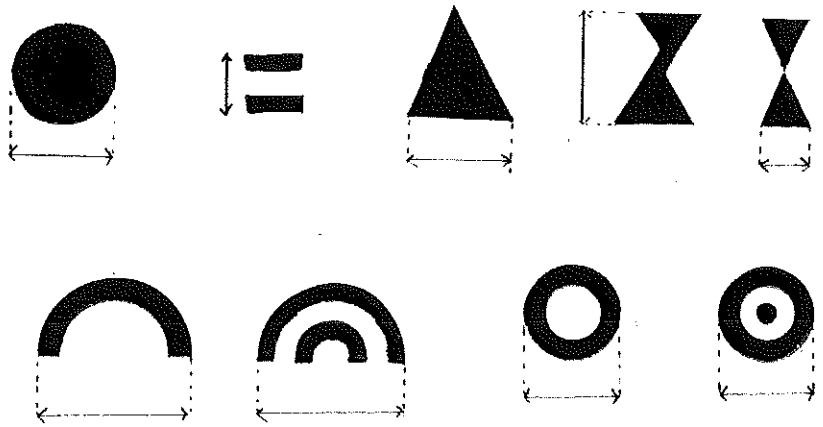


Figure 12: Dimensions measured on punchmarks on artefacts from Barrington and Haslingfield; there were no well-preserved examples of the forms not illustrated here.

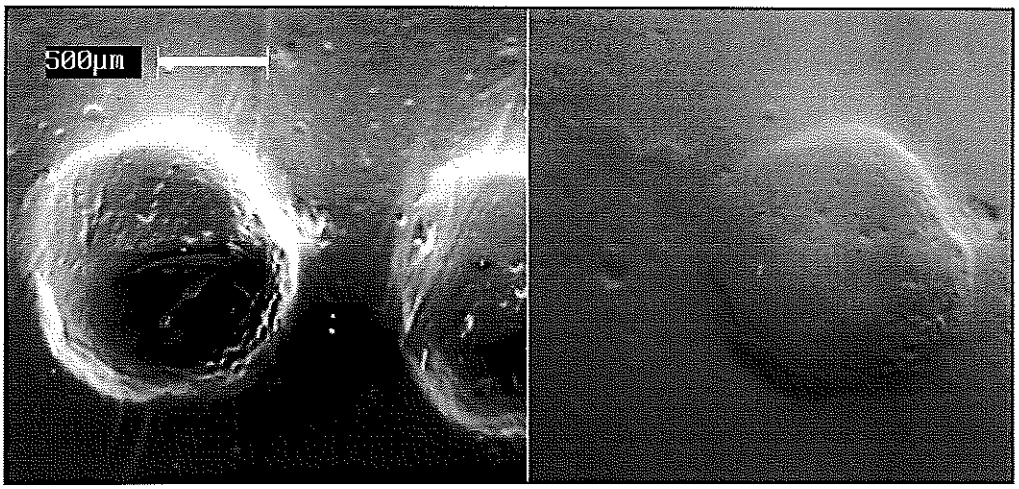


Plate 1: Repoussé circular punchmarks on wrist clasp 4 Δ10 (hook). SE (left) and BSE (right) images. Stub 49.

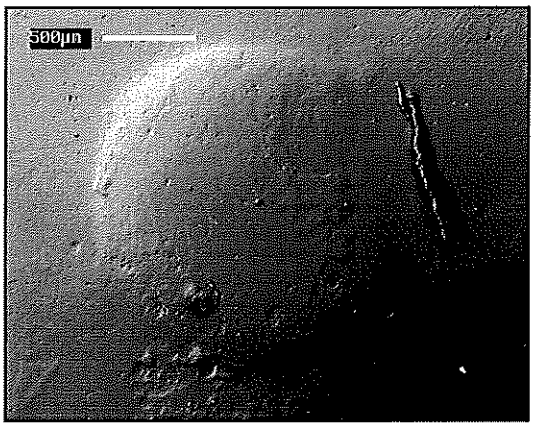


Plate 2: Repoussé circular punchmark on wrist clasp 4 Δ10 (loop). BSE image. Stub 50.

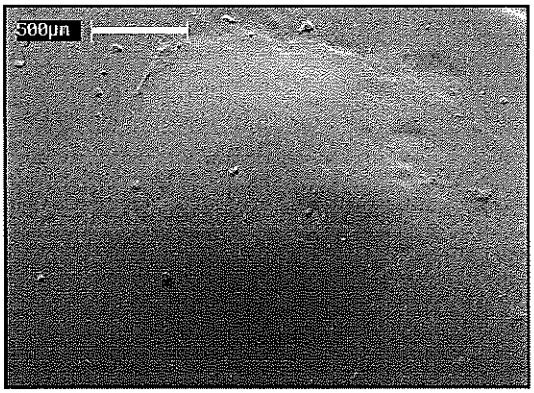


Plate 3: Repoussé circular punchmark on wrist clasp 4 Δ11 (hook). Shallow impression. BSE image. Stub 51.

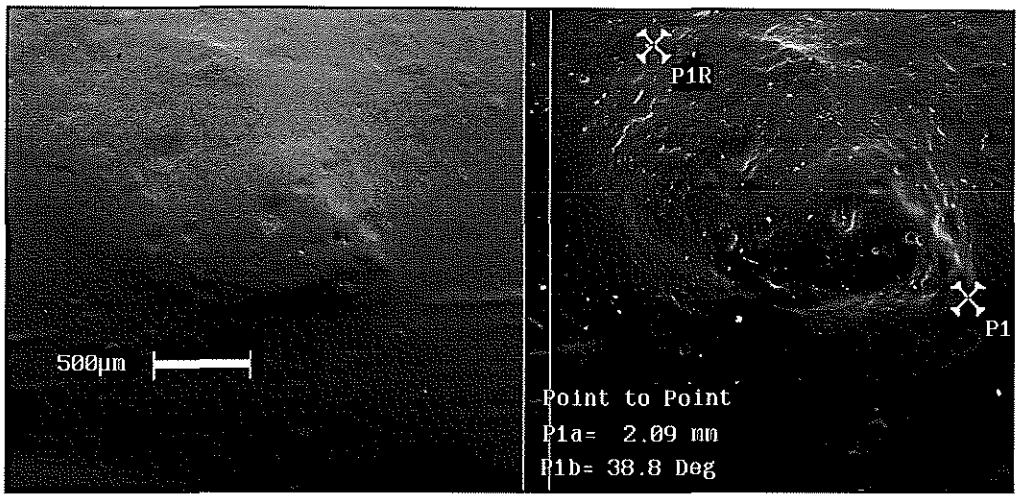


Plate 4: Repoussé circular/oval punchmark on wrist clasp 4 Δ11 (loop). BSE (left) and SE (right) images, showing dimension measured. Stub 52.

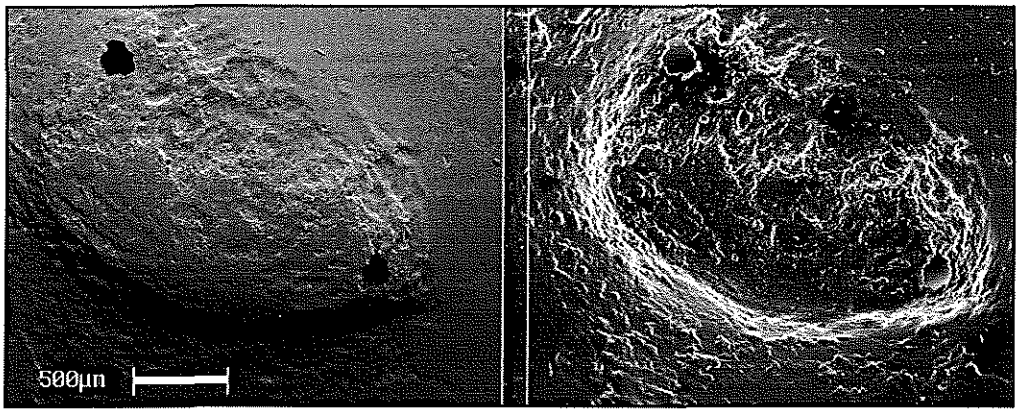


Plate 5: Repoussé circular/oval punchmark on wrist clasp 4 Δ17 (hook). BSE (left) and SE (right) images. Stub 53.

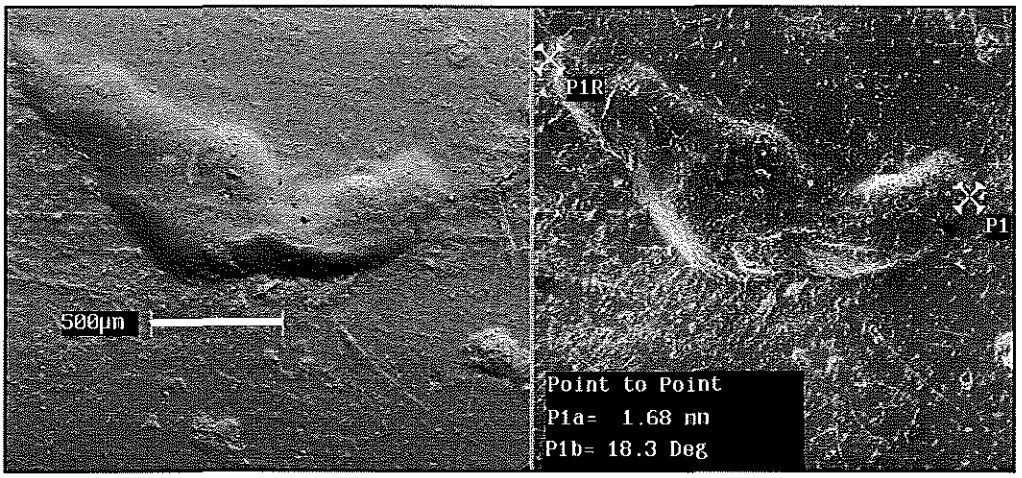


Plate 6: Semi-circular punchmark on wrist clasp 4 Δ17 (hook). BSE (left) and SE (right) images, showing dimension measured. Stub 54.

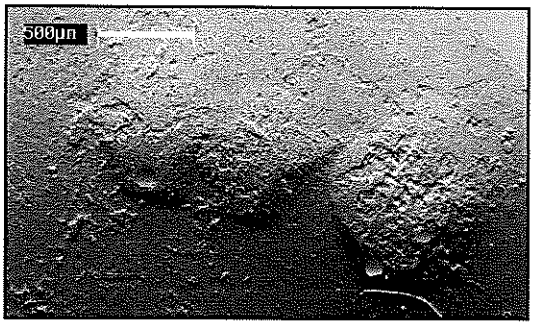


Plate 7: Three overlapping repoussé circular punchmarks on wrist clasp 4 Δ17 (loop). BSE image. Stub 55.

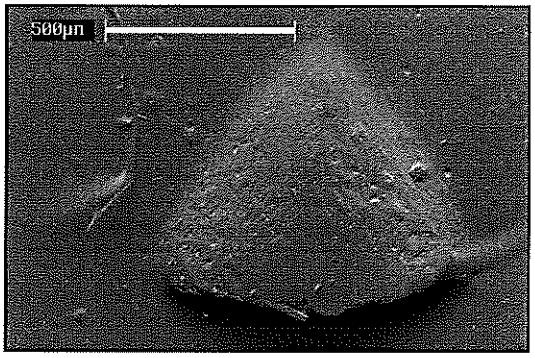


Plate 8: Triangular/pyramidal punchmark on annular brooch 16b Δ1. BSE image. Stub 79.

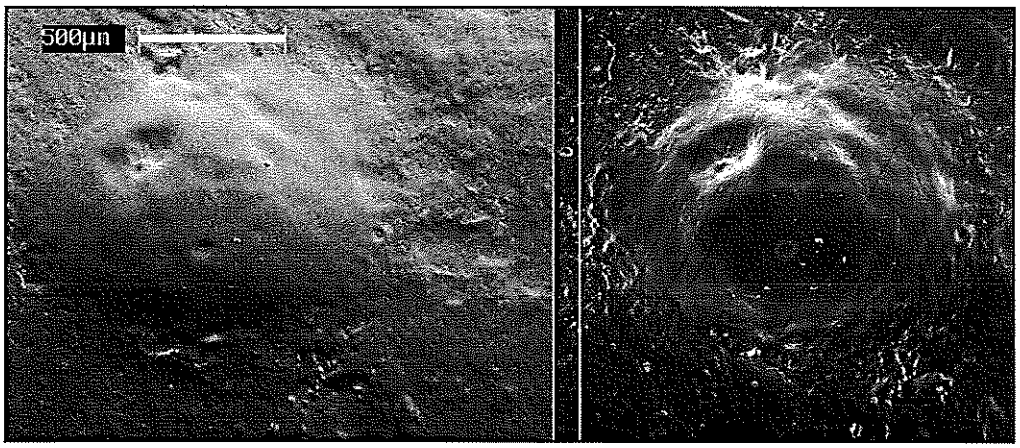


Plate 9: Repoussé circular punchmark on wrist clasp 16b Δ11 (loop). BSE (left) and SE (right) images. Stub 56.

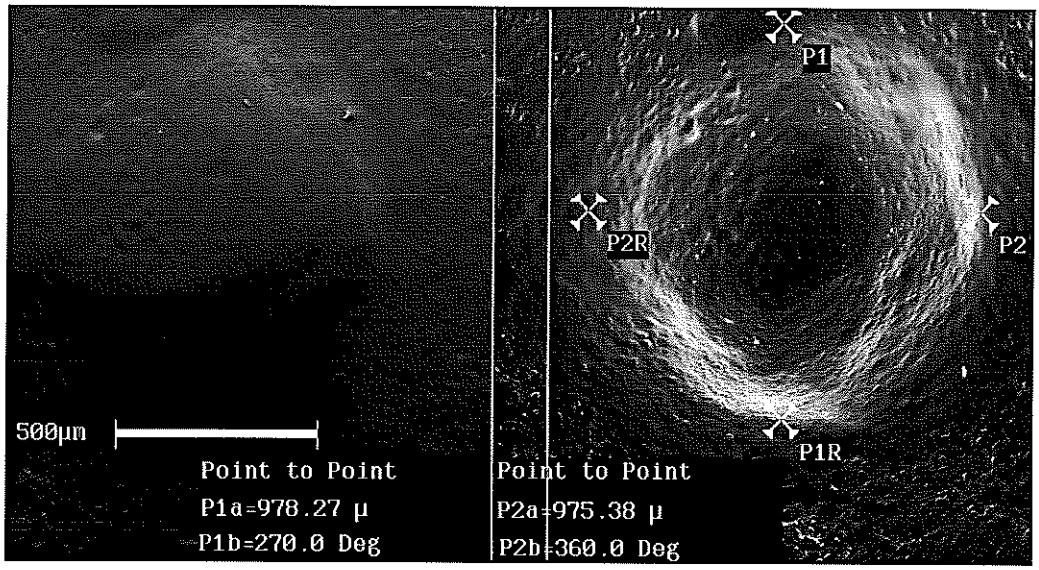


Plate 10: Repoussé circular punchmark on wrist clasp 16b Δ11 (hook). BSE (left) and SE (right) images, showing dimensions measured. Stub 57

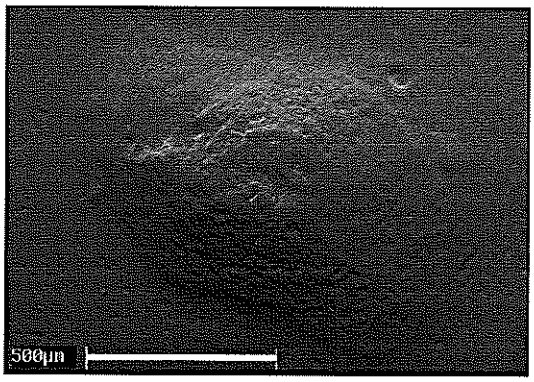


Plate 11: Circular/oval punchmark on wrist clasp 16b Δ12 (loop). BSE image. Stub 62.

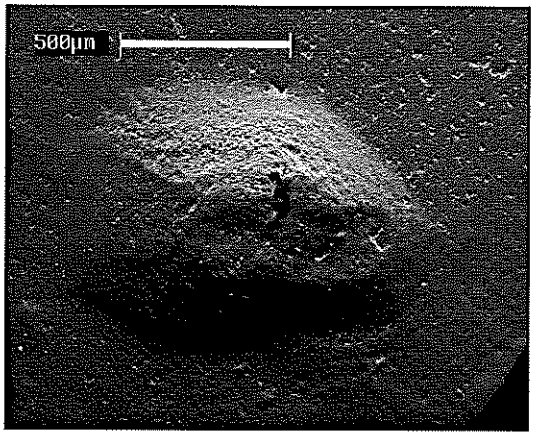


Plate 12: Circular/oval punchmark on wrist clasp 16b Δ12 (hook). BSE image. Stub 63.

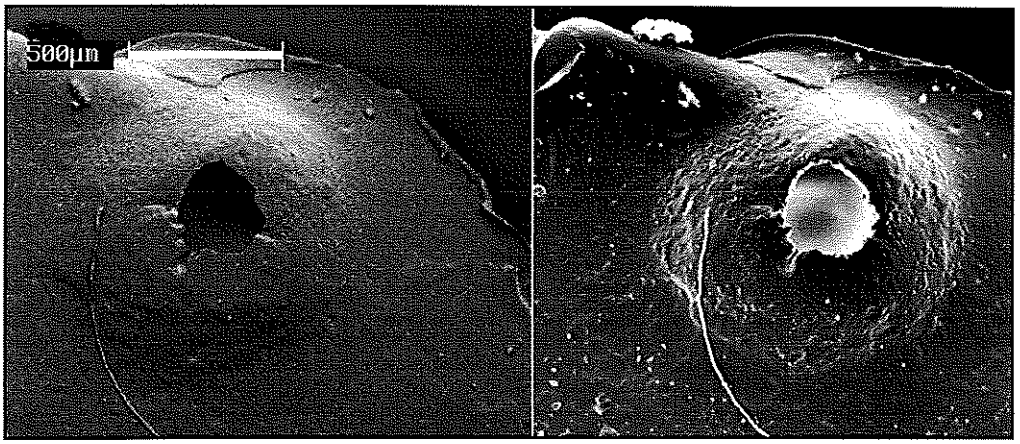


Plate 13: Repoussé circular punchmark on spangle on ring 20b Δ16. BSE (left) and SE (right) images. Bubble in centre of mark. Stub 78.

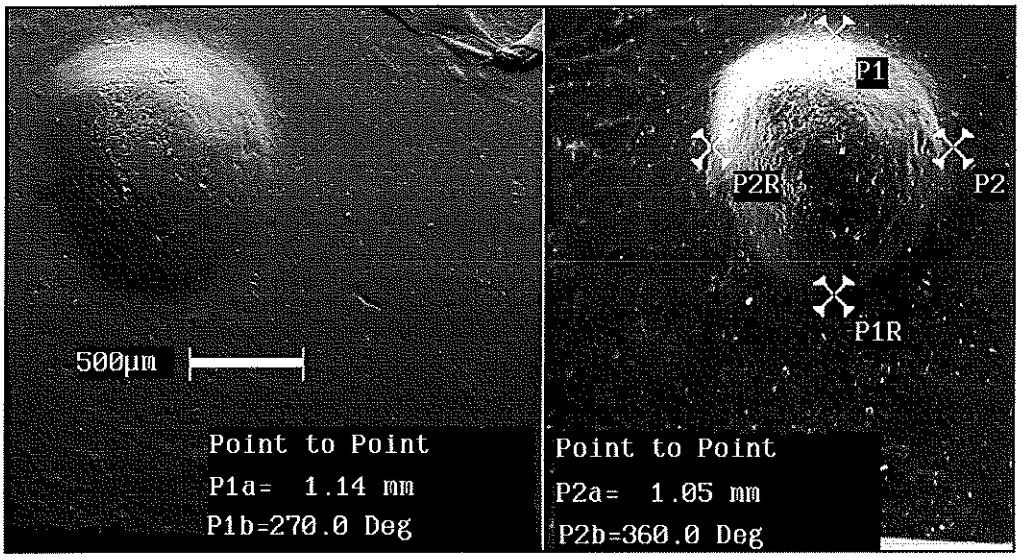


Plate 14: Repoussé circular punchmark on spangle on ring 20b Δ22. BSE (left) and SE (right) images, showing dimensions measured. Stub 82.

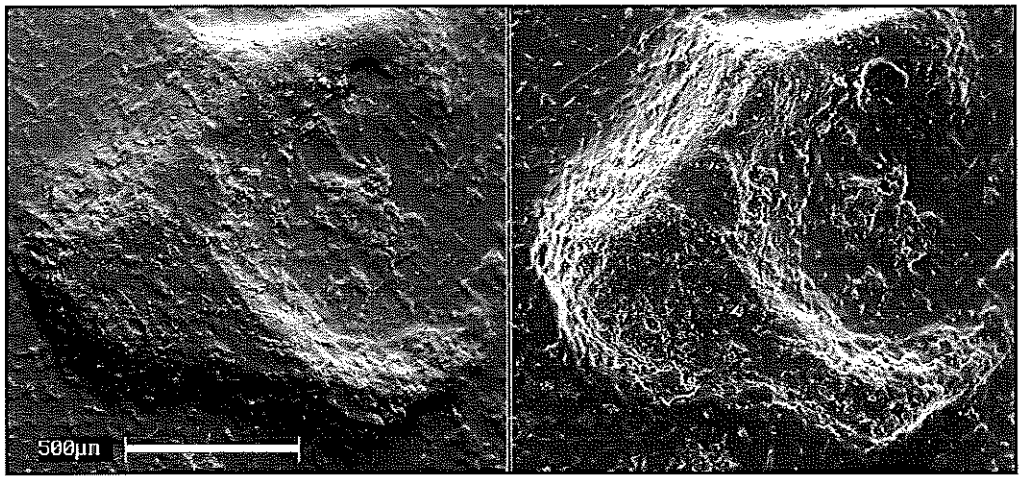


Plate 15: Semi-circular punchmark on small-long brooch 20b Δ32. BSE (left) and SE (right) images. Stub 64.

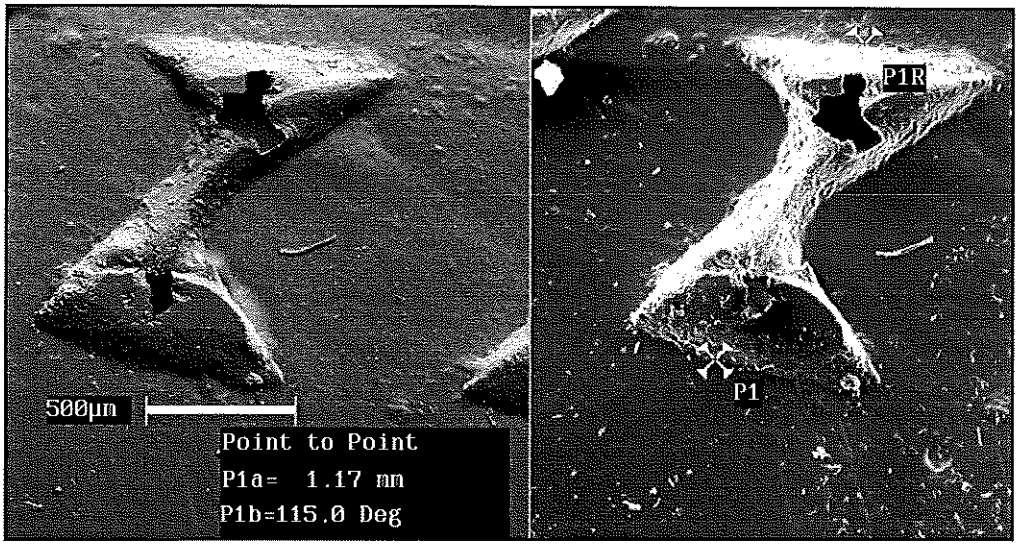


Plate 16: Z-shaped punchmark on cruciform brooch 20b Δ33. BSE (left) and SE (right) images, showing dimension measured. Stub 83.

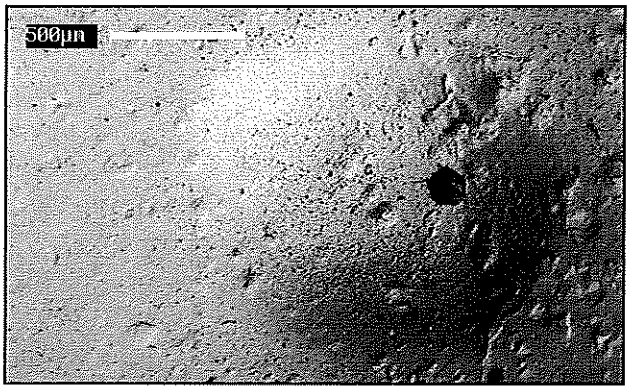


Plate 17: Repoussé circular punchmark on wrist clasp 44a Δ13 (hook). BSE image. Small bubble. Stub 58.

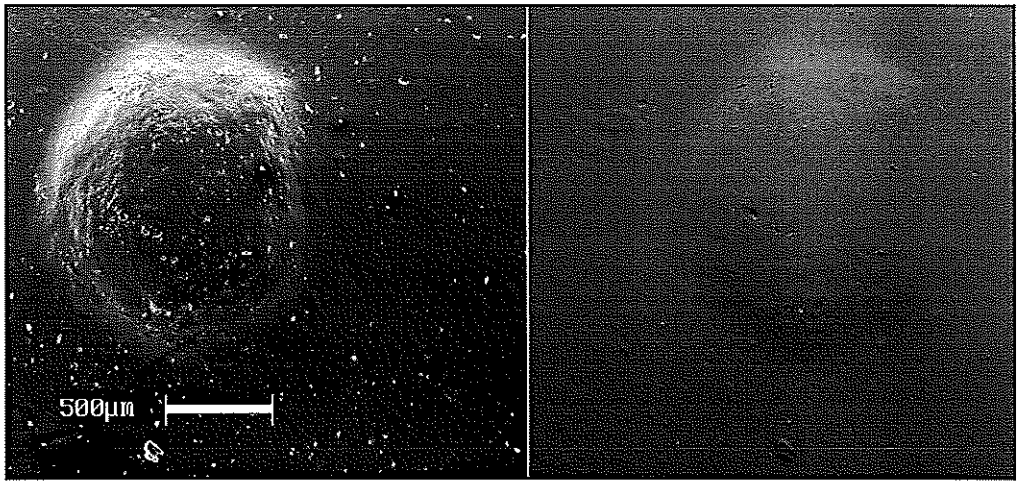


Plate 18: Repoussé circular punchmark on wrist clasp 44a Δ21 (loop). SE (left) and BSE (right) images. Stub 47.

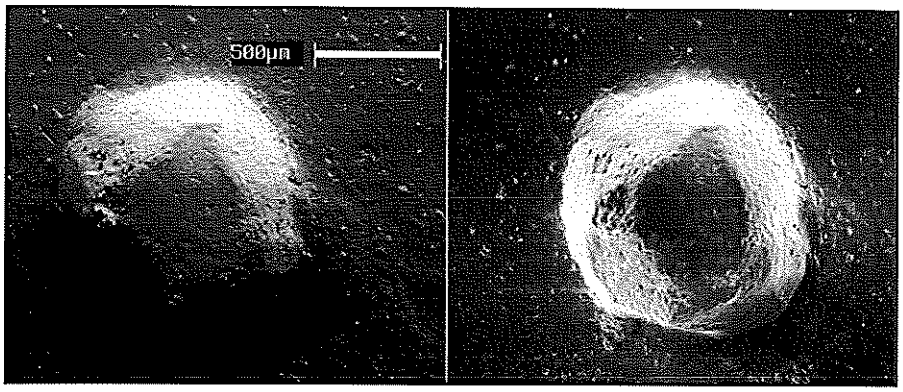


Plate 19: Small repoussé punchmark on wrist clasp 44a Δ22 (hook). BSE (left) and SE (right) images. Stub 66

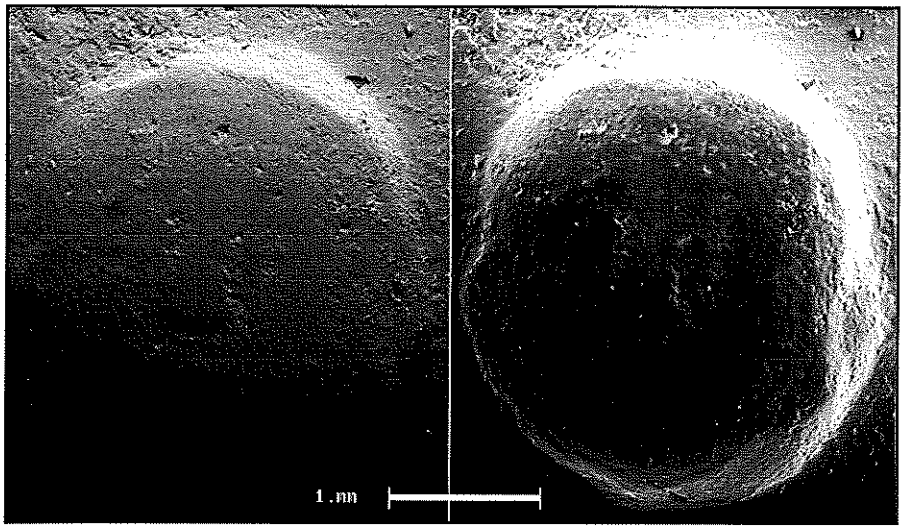


Plate 20: Large repoussé punchmark on wrist clasp 44a Δ22 (hook). BSE (left) and SE (right) images. Stub 66.

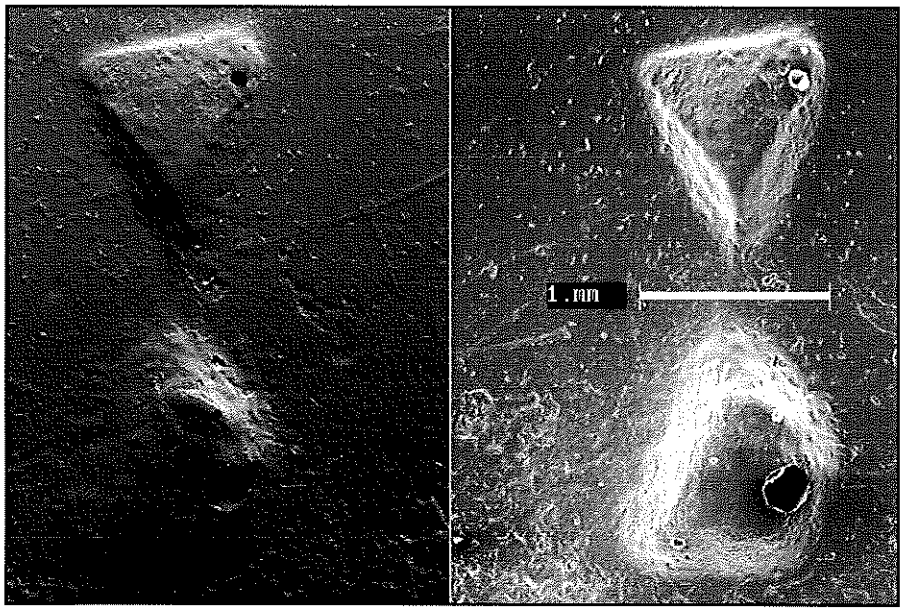


Plate 21: Paired triangular punchmark on wrist clasp 44a Δ22 (hook). BSE (left) and SE (right) images. Stub 67.

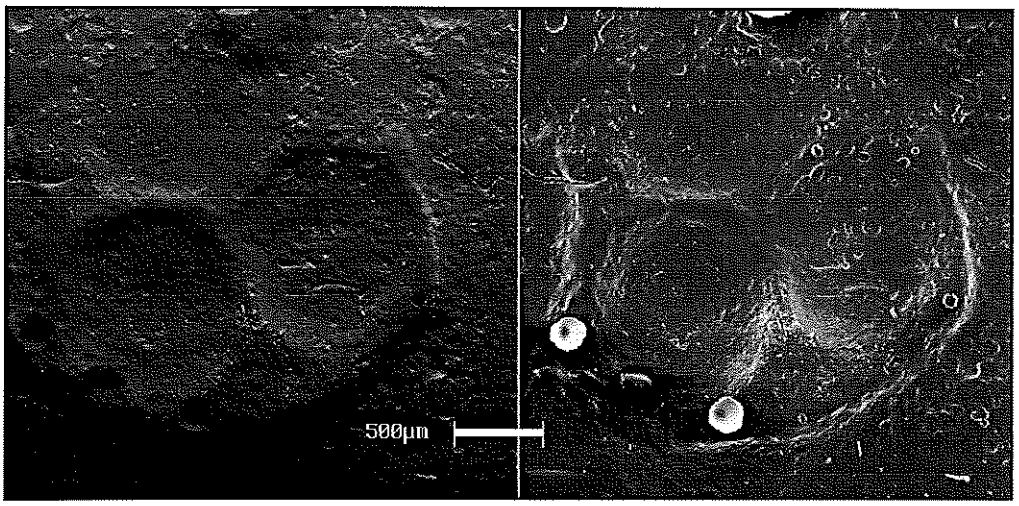


Plate 22: Three-circles-in-a-frame punchmark on wrist clasp 44a Δ22 (hook). Partial mark, so top circle not clear. BSE (left) and SE (right) images. Stub 67.

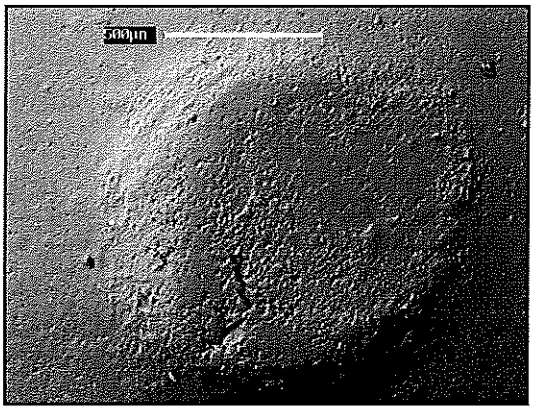


Plate 23: Large repoussé punchmark on wrist clasp 44a Δ22 (loop). BSE image. Stub 68.

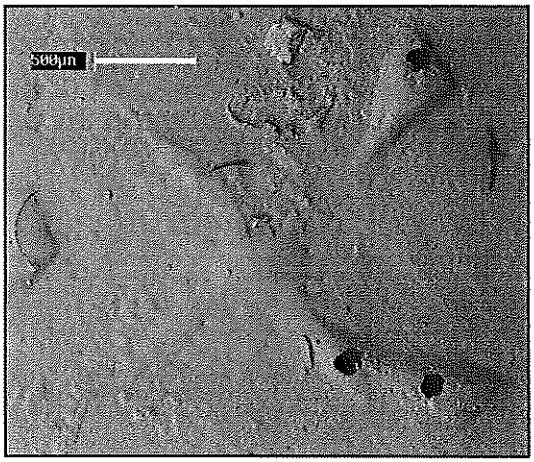


Plate 24: X-shaped punchmark on wrist clasp 44a Δ22 (loop). Some bubbles. BSE image. Stub 69.

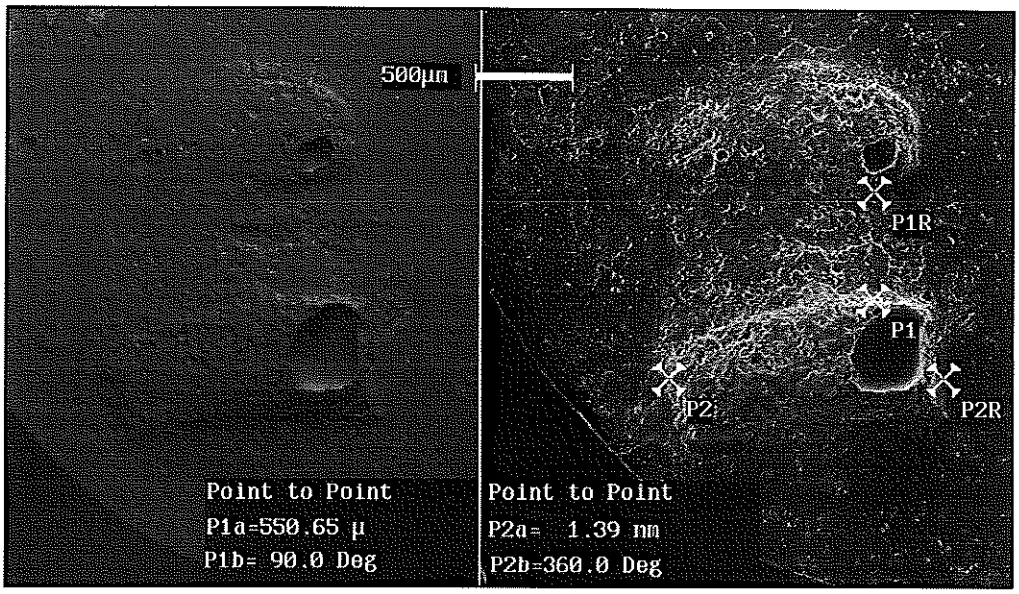


Plate 25: Punchmark in the form of paired lines, possibly repoussé, on strip 44b Δ45. BSE (left) and SE (right) images. Bubbles in peel. Stub 73.

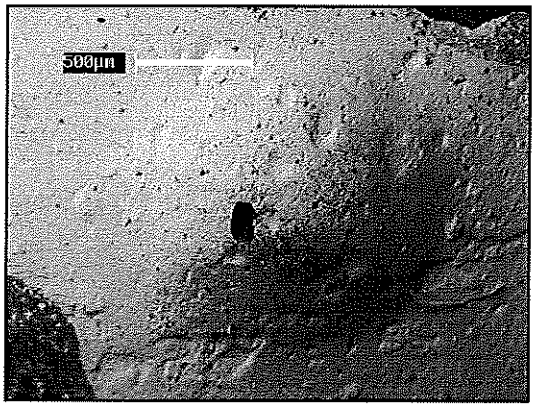


Plate 26: Small repoussé circular mark on wrist clasp 44b Δ46. BSE image. Bubble in peel. Stub 60.

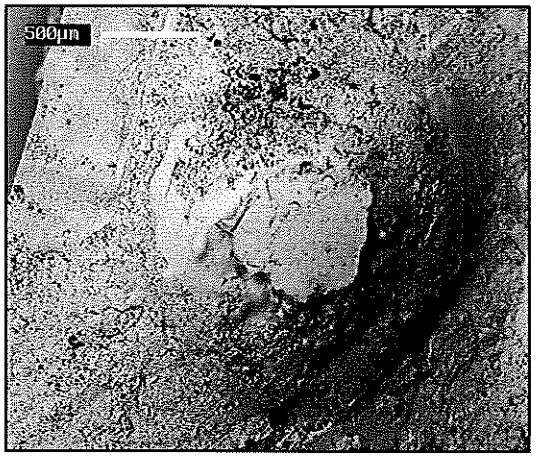


Plate 27: Small repoussé circular punchmark on wrist clasp 44b Δ47(loop). BSE image. Very poor peel. Stub 59.

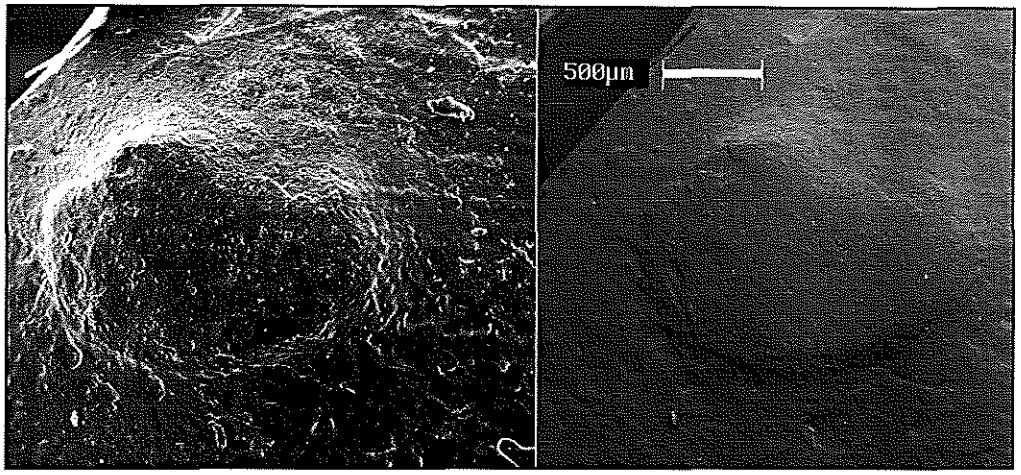


Plate 28: Repoussé circular punchmark on wrist clasp 44b Δ62. SE (left) and BSE (right) images. Stub 48.

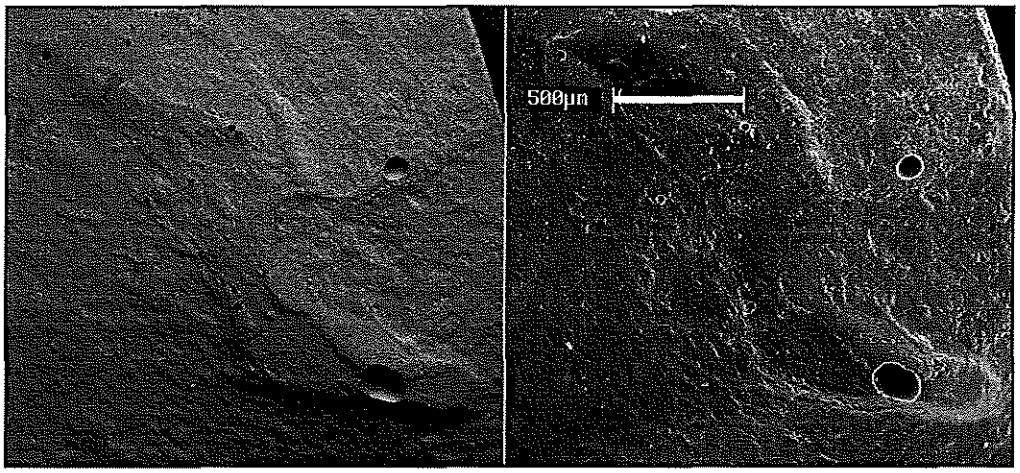


Plate 29: Z-shaped punchmark on fitting 44b Δ2. BSE (left) and SE (right) images. Bubbles. Stub 74.

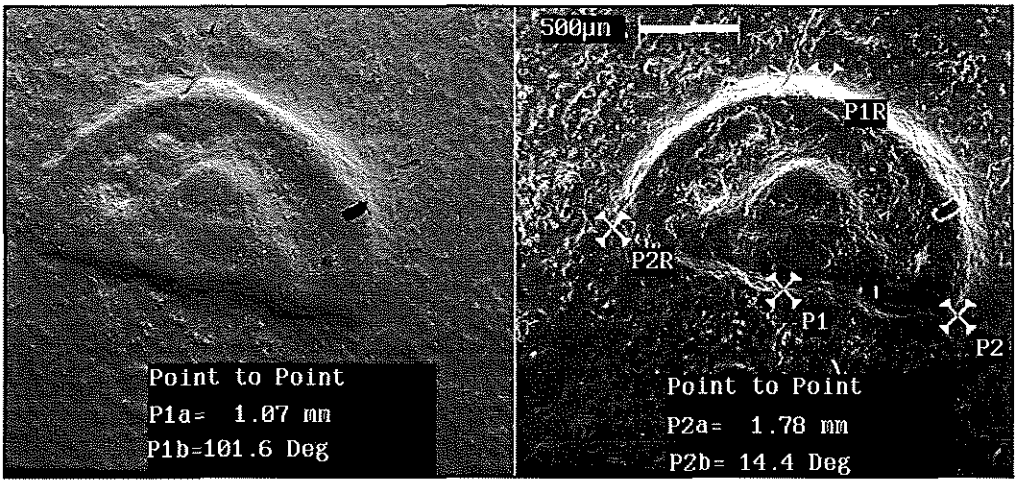


Plate 30: Double semi-circular (with joined ends) punchmark on small-long brooch 156 Δ3. BSE (left) and SE (right) images, showing dimensions measured. Stub 77.

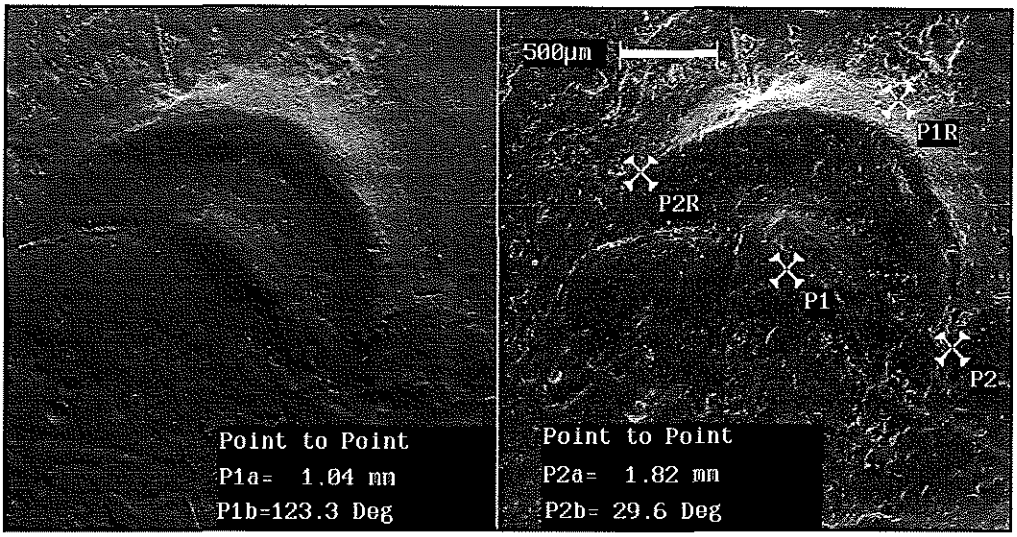


Plate 31: Double semi-circular punchmark on small-long brooch 156 Δ3. BSE (left) and SE (right) images, showing dimensions measured. Stub 76.

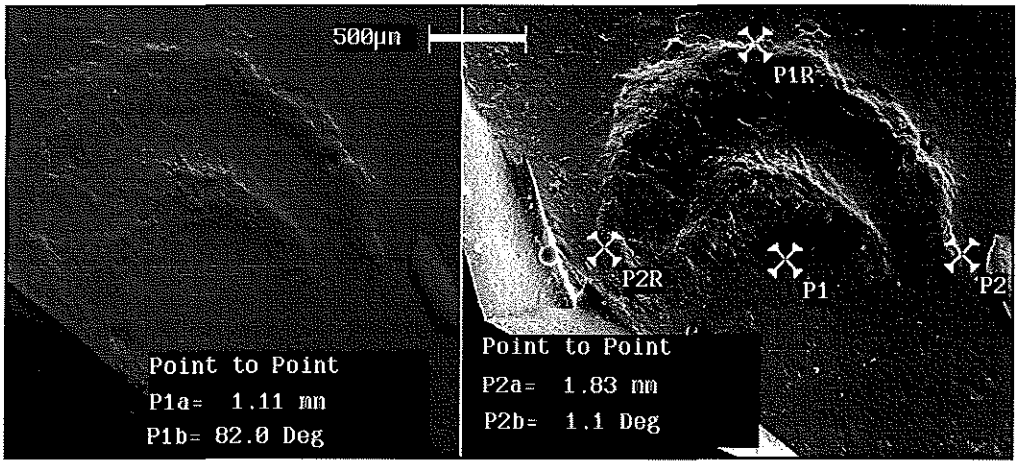


Plate 32: Double semi-circular punchmark on small-long brooch 156 Δ5. BSE (left) and SE (right) images, showing dimensions measured. Stub 75.

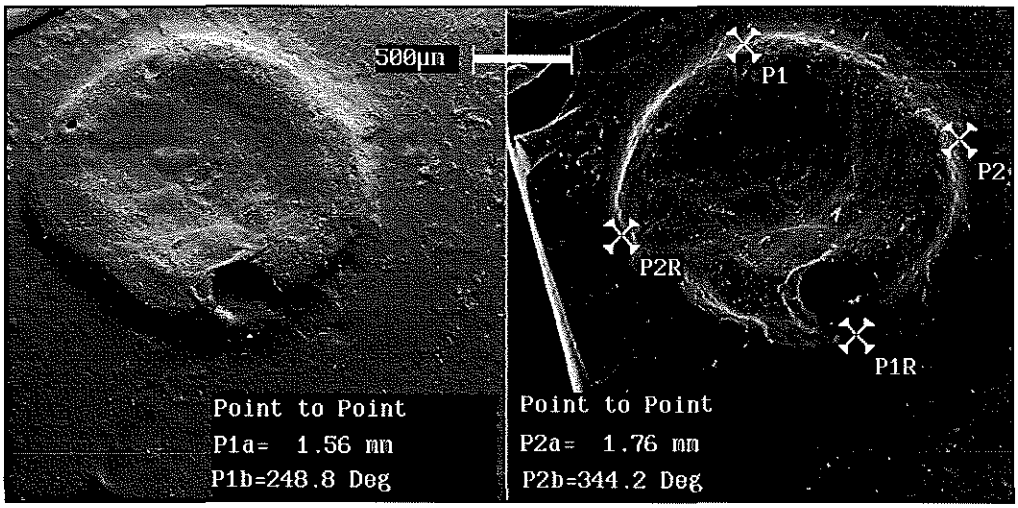


Plate 33: Ring-shaped punchmark on small-long brooch 322b Δ62. BSE (left) and SE (right) images, showing dimensions measured. Some bubbles. Stub 84.

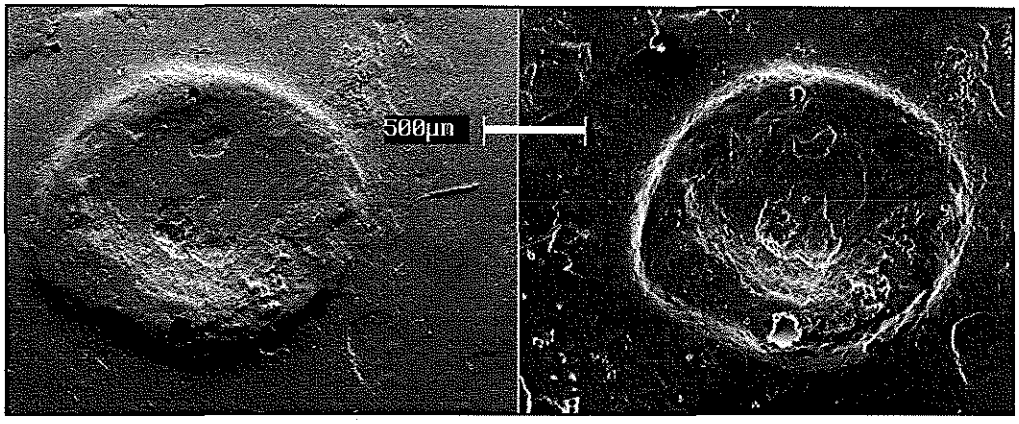


Plate 34: Ring punchmark on small-long brooch 322b Δ62. BSE (left) and SE (right) images. Bubble on lower curve. Stub 85.

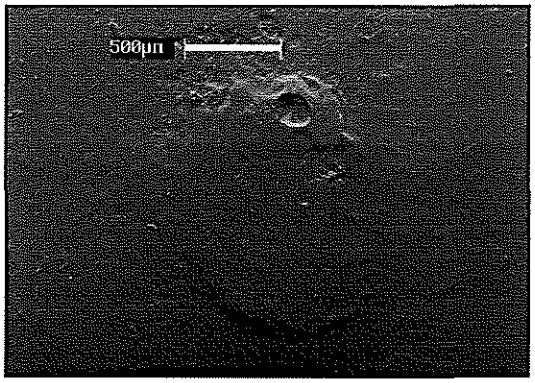


Plate 35: Repoussé circular punchmark on wrist clasp 359b Δ2 (hook). Very slight impression. BSE image. Stub 61.

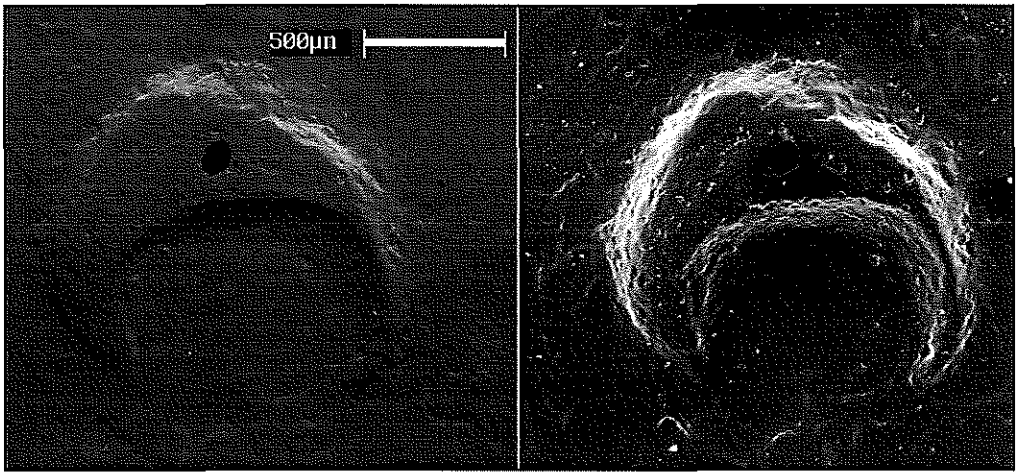


Plate 36: Semi-circular punchmark on small-long brooch 547 Δ5. BSE (left) and SE (right) images. Stub 80.

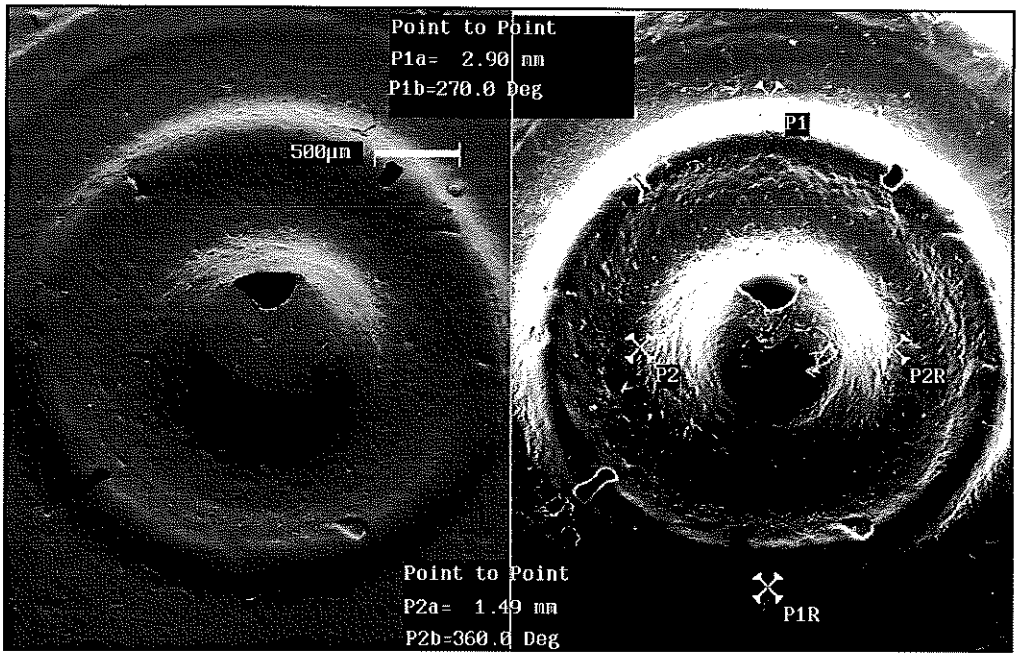


Plate 37: Inside ring of double-ring-and-dot punchmark on disc brooch 547 Δ4. BSE (left) and SE (right) images, showing dimensions recorded. Stub 81.

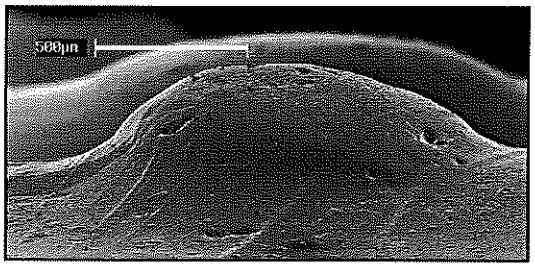


Plate 38: Tilted view of repoussé circular punchmark on wrist clasp 4 Δ10(hook). SE image, slightly flattened face towards camera. Stub 49.

Plate 39: Double semi-circular punchmark on small-long from Barrington (Ashmolean 1909.290). BSE image. Frequent bubbles. Stub 142.

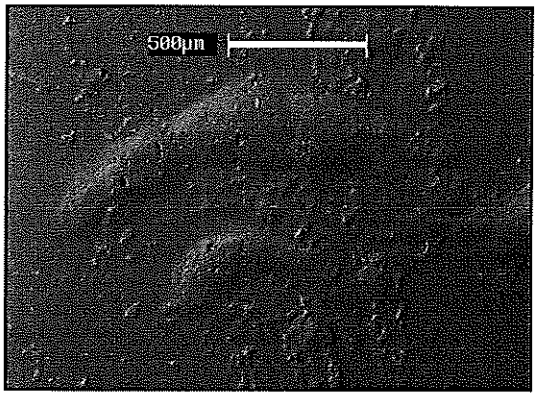


Plate 40: Double semi-circular punchmark on cruciform brooch from Barrington (Ashmolean 1909.292). BSE image. Stub 143.

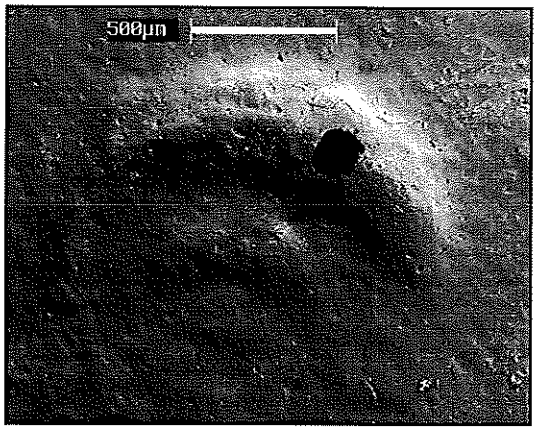


Plate 41: Double semi-circular punchmark on cruciform brooch from Barrington (Ashmolean 1909.297). BSE image. Stub 217.

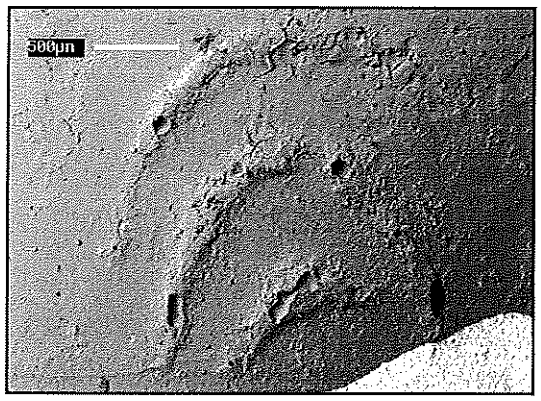


Plate 42: Triple semi-circular punchmark on small-long brooch from Barrington A (Ashmolean 1909.270c). In some areas on brooch the mark resembles double semi-circular punchmark to naked eye. See plate 43 for mark on possible brooch pair to this brooch. BSE image. Stub 131.

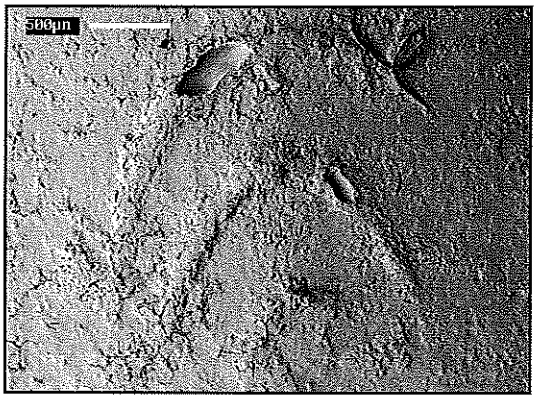


Plate 43: Triple semi-circular punchmark on small-long brooch from Barrington A (Ashmolean 1909.303). See Plate 42 for mark on possible brooch pair to this brooch. BSE image. Stub 132.

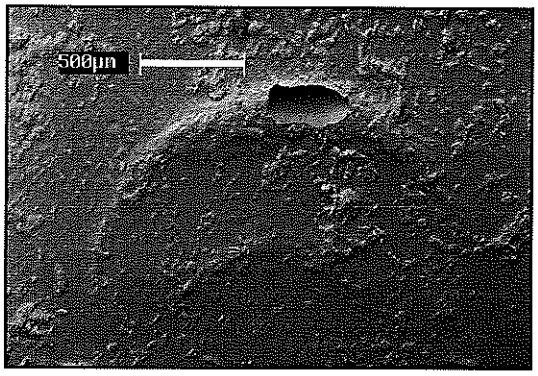


Plate 44: Double semi-circular punchmark on small-long brooch from Barrington B (CUMAA 34.820). BSE image. Stub 183.

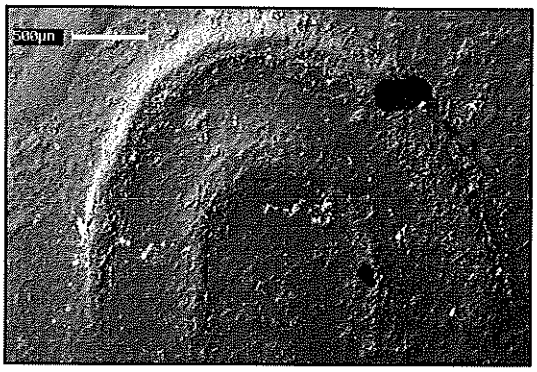


Plate 45: Semi-circular punchmark on small-long brooch from Barrington B (CUMAA 34.825b). BSE image. Stub 187.

Plate 46: Two double semi-circular punchmarks on small-long brooch from Barrington B (CUMAA 34.826b). For right side 'leg' of mark see Plate 47. BSE image. Stub 188.

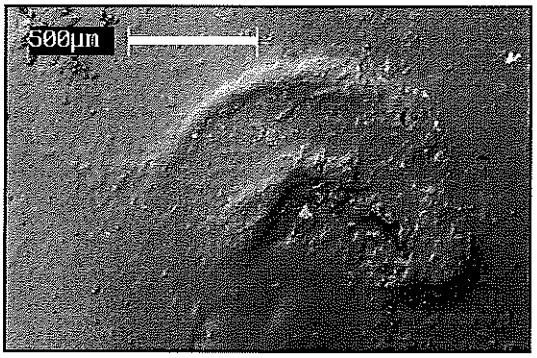


Plate 47: Double semi-circular punchmark on small-long brooch from Barrington B (CUMAA 34.826b). Showing right side of impression (see plate 46 for left side). BSE image. Stub 188.

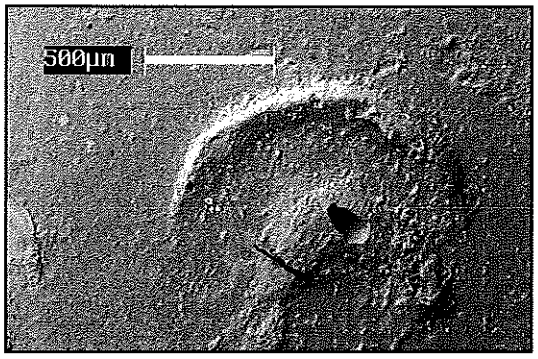


Plate 48: Double semi-circular punchmark on girdle hanger from Barrington B (CUMAA 34.849a). See plate 49 for another mark. BSE image. Stub 190.

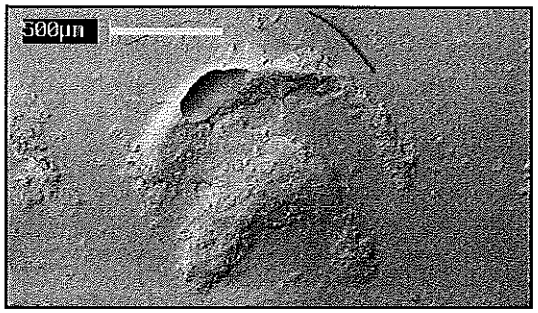


Plate 49: Double semi-circular punchmark on girdle hanger from Barrington B (CUMAA 34.849a). See plate 48 for another mark. BSE image. Stub 190.

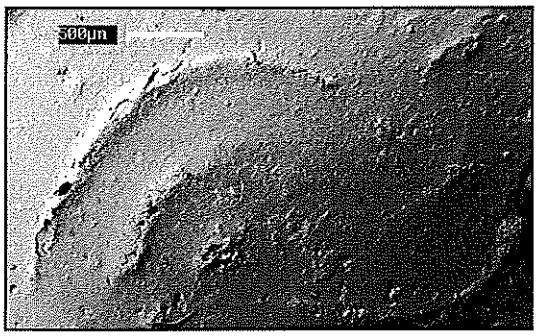


Plate 50: Double semi-circle and dot punchmark (left side of mark only visible), used in 'guilloche' design on small-long brooch from Haslingfield (Ashmolean 1909.241). Central semi-circular dot shows more clearly in some other examples on the brooch. BSE image. Stub 152.

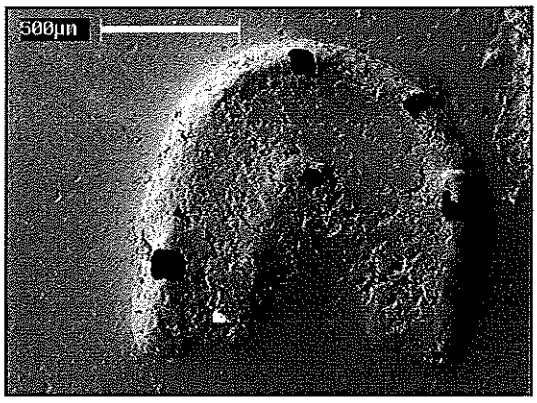


Plate 51: Double semi-circular punchmark on small-long brooch from Haslingfield (Ashmolean 1909.225b). BSE image. Stub 216.

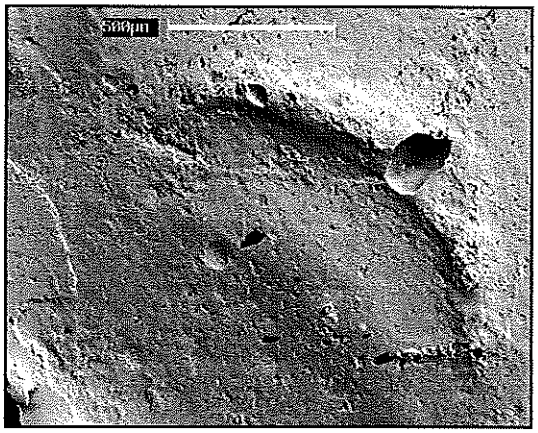


Plate 52: Double semi-circular punchmark on small-long brooch from Haslingfield (Ashmolean Museum 1909.226a). See also plate 53 (marks on pair to this brooch). Left-hand side and inner semi-circle not visible. BSE image. Stub 152.

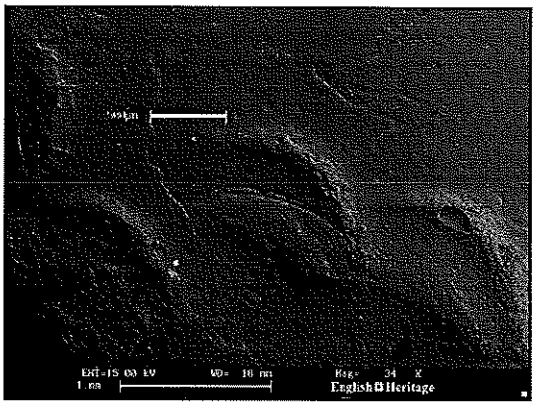


Plate 53: Three overlapping double semi-circular punchmarks on small-long brooch from Haslingfield (Ashmolean 1909.227a). See also plate 52. BSE image. Stub 215.

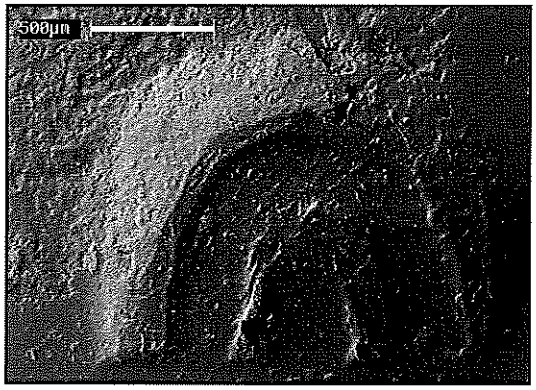


Plate 54: Double semi-circular punchmarks on small-long brooch from Haslingfield (Ashmolean 1909.234a). See also plate 61. BSE image. Stub 218.

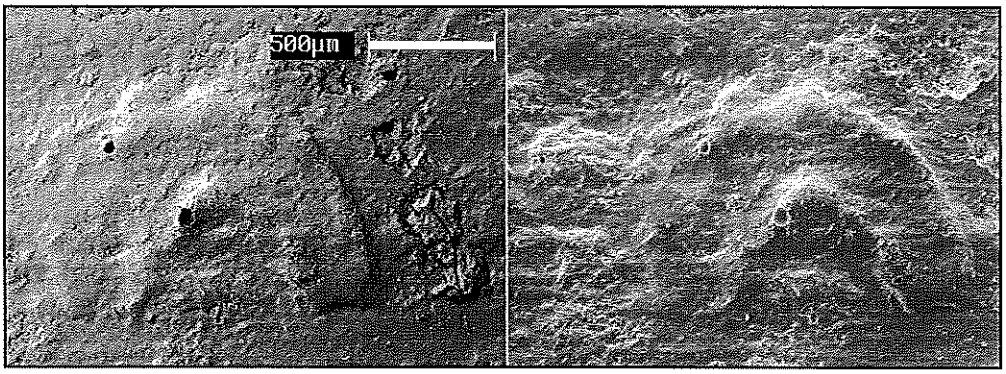


Plate 55: Double semi-circular punchmark on cruciform brooch from Haslingfield (Ashmolean 1909.237). BSE (left) and SE (right) images. BSE image shows corrosion products trapped within peel. Stub 214.

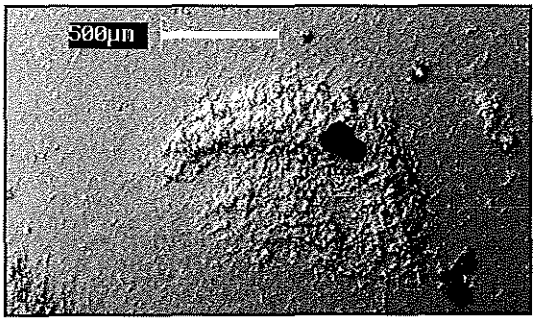


Plate 56: Double semi-circular punchmark on small-long brooch from Haslingfield (Ashmolean 1909.240a). See plate 57 for mark on pair to this brooch. Very poor preservation. BSE image. Stub 221.

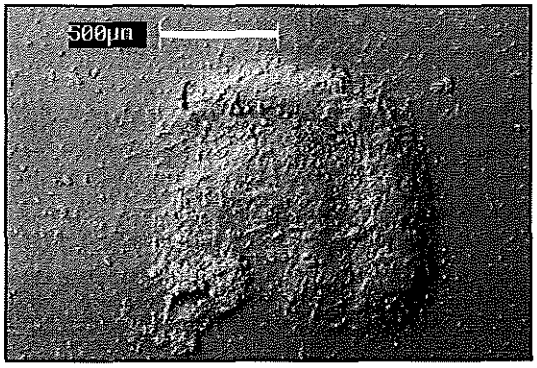


Plate 57: Double semi-circular punchmark on small-long brooch from Haslingfield (Ashmolean 1909.240b). See plate 56 for mark on pair to this brooch. BSE image. Stub 164.

Plate 58: Double semi-circular punchmark on disc pendant from Haslingfield (Ashmolean 1909.248a). Poor impression. See also plate 59. BSE image. Stub 165.

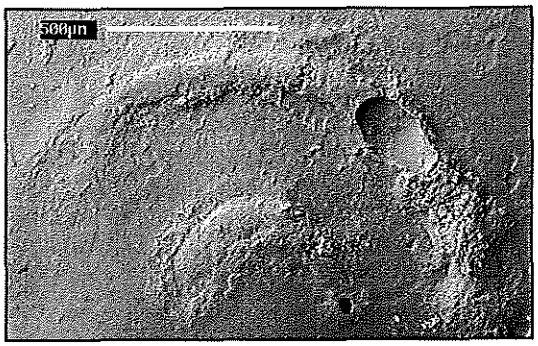


Plate 59: Double semi-circular punchmark on disc pendant from Haslingfield (Ashmolean 1909.248a). See also plate 58. BSE image. Stub 165.

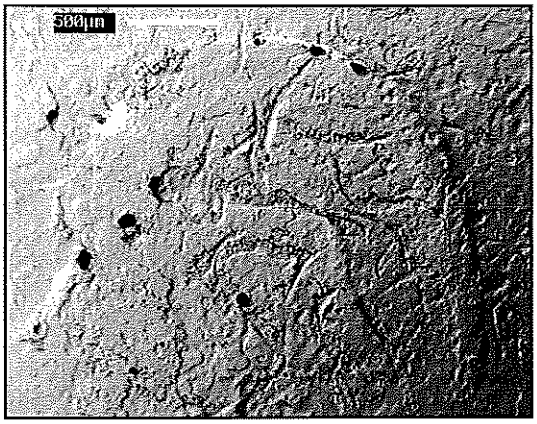


Plate 60: Double semi-circular punchmark on disc brooch from Haslingfield (Ashmolean 1909.248). Very poor surface preservation. BSE image. Stub 213.

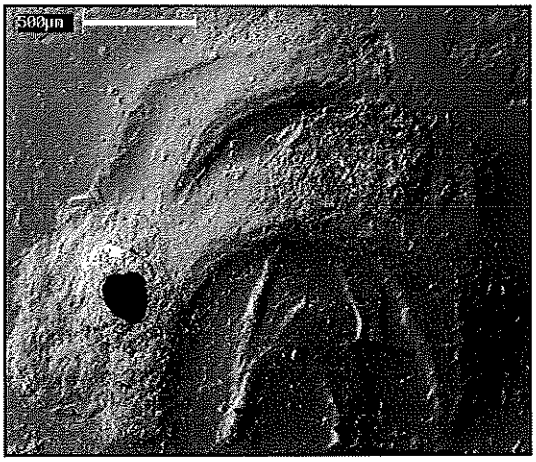


Plate 61: Double semi-circular punchmark mishit on small-long brooch from Haslingfield (Ashmolean 1909.234a). See also plate 54. BSE image. Stub 218.