Staffordshire Hoard
Research Report 3

Macro-organic Materials from the Staffordshire Hoard

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Information about this report

This report was produced in 2013 as part of Stage 1 of the project, i.e. before fragments were joined and catalogued. The concordance of the K numbers given in the report to the catalogue numbers as they appear in the final publication is as given below. The list also includes the names of the objects as used in the final publication.

The owners, Historic England and Barbican Research Associates are grateful to National Geographic for the funding which enabled the work to be carried out.

K number	Catalogue number	Name in publication
3	336	Hilt-plate in gold (part).
133	335	Hilt-plate in gold.
242	76	Pommel in cast silver, of cocked-hat form with double sword-rings, with cast interlace and niello inlay, and mounts with cloisonné and filigree decoration (part).
274	684	Silver 'arm' with one expanded semi-circular terminal.
282	264	Hilt-plate in gold of oval form with a pair of bosses.
283	243	Pair of hilt-plates in gold of oval form with garnet bosses.
290	75	Pommel in cast silver, of cocked-hat form with double sword-rings, with cast interlace, niello and glass decoration (part).
660	166	Hilt-collar, in gold, of high form with cloisonné decoration.
680	40	Pommel in gold, of cocked-hat form, with filigree and one side cloisonné decoration.
787	685	Socketed bracket in silver with wood remains (part).
1536	621	One of a pair of gold bosses with filigree collars.
1551	593	Helmet-band in cast silver-gilt, inset with a silver-gilt sheet band, showing a continuous procession of kneeling or running warriors (part).
1620	636	Gold boss with filigree collar.

The British Museum

DEPARTMENT OF CONSERVATION AND SCIENTIFIC RESEARCH

Macro-organic materials from the Staffordshire Hoard

Science Report PR07444-2

Caroline R. Cartwright

Abstract: Optical microscopy and variable pressure scanning electron microscopy were used to identify macro-organic remains from the Staffordshire Hoard. Wood and horn were identified associated with two joining silver/copper fragments, K274. The wood was identified as *Fraxinus excelsior*, ash. Horn was identified in association with a pair of gold sword hilt plates, K282 and K283, and horn was also present inside a gold pommel cap with garnet inlays, K352. *Acer campestre*, field maple wood, was identified from K283. In K274, K283 and K352 the horn showed signs of having been affected by heat. Horn, possibly the remains of a thin lining, was present inside a gold pommel cap with filigree decoration, K680. *Fraxinus excelsior*, ash wood, was identified from the inside of a silver/copper fitting, K290, and *Carpinus betulus*, hornbeam wood, from flanged box fitting, K787. Neither is suitable for radiocarbon dating, as ash and hornbeam are long-lived species. *Acer campestre*, field maple, and *Corylus avellana*, hazel, charcoal fragments were identified from silver fragments, K1551. *Betula pendula*, silver birch, charcoal fragments were found inside gold boss, K1620. The charcoal fragments may be modern and cannot unequivocally be associated with K1551 and K1620; modern macro-organics are fairly common from the Staffordshire Hoard.

The gold hilt collar, K660, had modern root material associated with some of its cloisons. Samples from K3 and K133 were also examined microscopically; K3 contained no original plant remains, only modern root hairs, and K133 did not contain identifiable traces of plant remains, horn, antler, ivory, shell or bone. No macro-organic materials could be identified associated with a silver filigree bead, K242. No macro-organic materials could be identified in two samples from a gold boss/rivet, K1536, other than a fragment of charcoal, which was identified as *Acer campestre*, field maple.

CSR Project no. PR07444
Date 20 March 2013
External Registration Numbers: K3, K133, K242, K274, K282, K283, K290, K660, K680, K787, K1551, K1536, K1620

Introduction

A) 2 joining silver/copper fragments, K274, were submitted for microscopic identification of any possible surviving traces of original plant remains, or traces of horn, antler, shell, ivory or bone.

B) A pair of gold sword hilt plates, K282 and K283, that were presumed to have horn associated with them, were submitted for microscopic examination.

C) A gold pommel cap with garnet inlays, K352, was submitted for microscopic identification of any possible surviving traces of original plant remains, or traces of horn, antler, shell, ivory or bone.

D) A gold pommel cap with filigree decoration, K680, was submitted for microscopic identification of any possible surviving traces of original plant remains, or traces of horn, antler, shell, ivory or bone.

E) A silver/copper fitting with wood inside, K290, was submitted for microscopic identification of the wood.

F) A silver and wood flanged box fitting, K787, was submitted for microscopic identification of the wood.

G) Silver fragments with charred organics, K1551 were submitted for microscopic examination and identification.

H) Gold boss, K1620, with charcoal fragments inside, was submitted for microscopic examination and identification.

I) The gold hilt collar, K660, was submitted for variable pressure scanning electron microscope examination of the surface macro-organic remains (area examined is arrowed).

J) Soil from K3 was submitted for microscopic identification of any possible surviving traces of original plant remains (excluding modern root hairs).

K) The internal contents of K133, including a fine greenish granular material, were submitted for microscopic identification of any possible surviving traces of original plant remains, or traces of horn, antler, shell, ivory or bone.

L) A mud sample from a silver filigree bead, K242, was submitted for microscopic identification of the black material associated with the mud.

M) 2 samples from a gold boss/rivet, K1536, were submitted for microscopic identification. #1: large clump of black material from inside; also contains green material; #2: smaller clump of black material from inside

Methods of analysis

A) 2 joining silver/copper fragments with associated organics, K274, were examined using a Hitachi S-3700N variable pressure scanning electron microscope (VP-SEM). Wood and horn were identified. Following standard procedures for wood and charcoal identification, three sections were examined: transverse (TS), radial longitudinal (RLS) and tangential longitudinal (TLS). Reference collection wood thin sections in TS, RLS and TLS were used for comparison and for identification to species. This method was used for all other wood and charcoal remains from the Staffordshire Hoard.

B) Gold sword hilt plates, K282 and K283, were initially examined using a Leica Aristomet biological optical microscope (OM) with reflected light in darkfield mode at magnifications ranging from x50 to x250, and then using VP-SEM.

C) Traces of horn and other organic materials associated with a gold pommel cap inlayed with garnets, K352, were examined using the VP-SEM.

D) Traces of horn and other organic materials associated with a gold pommel cap with filigree decoration, K680, were examined using the VP-SEM.

E) A silver/copper fitting with wood inside, K290, was submitted for OM and VP-SEM examination.

F) The fragments of wood from a silver and wood flanged box fitting, K787, were examined using the OM and VP-SEM.

G) Silver fragments with charred organics, K1551 were examined using the OM and VP-SEM.

H) Gold boss, K1620, with charcoal fragments inside: each charcoal fragment was fractured into TS, RLS and TLS for VP-SEM examination.

I) The macro-organics caught up in and over the edges of the cloisons of the gold hilt collar, K660, were examined using the VP-SEM.

J) Soil from K3 was submitted for OM identification of any possible surviving traces of original plant remains (excluding modern root hairs).

K) The internal contents of K133, including a fine greenish granular material, were submitted for OM identification of any possible surviving traces of original plant remains, or traces of horn, antler, shell, ivory or bone.

L) The black material associated with a silver filigree bead, K242, was examined using the OM.

M) Two samples from a gold boss/rivet, K1536, were examined using the VP-SEM. The charcoal fragment was examined in TS, RLS and TLS for identification to species.

Results

A) Examination of the organic materials associated with 2 joining silver/copper fragments, K274, using VP-SEM revealed the presence of horn and wood. As can be seen in Figure 1, the horn is directly adjacent to the metal and the wood is adjacent to the horn.

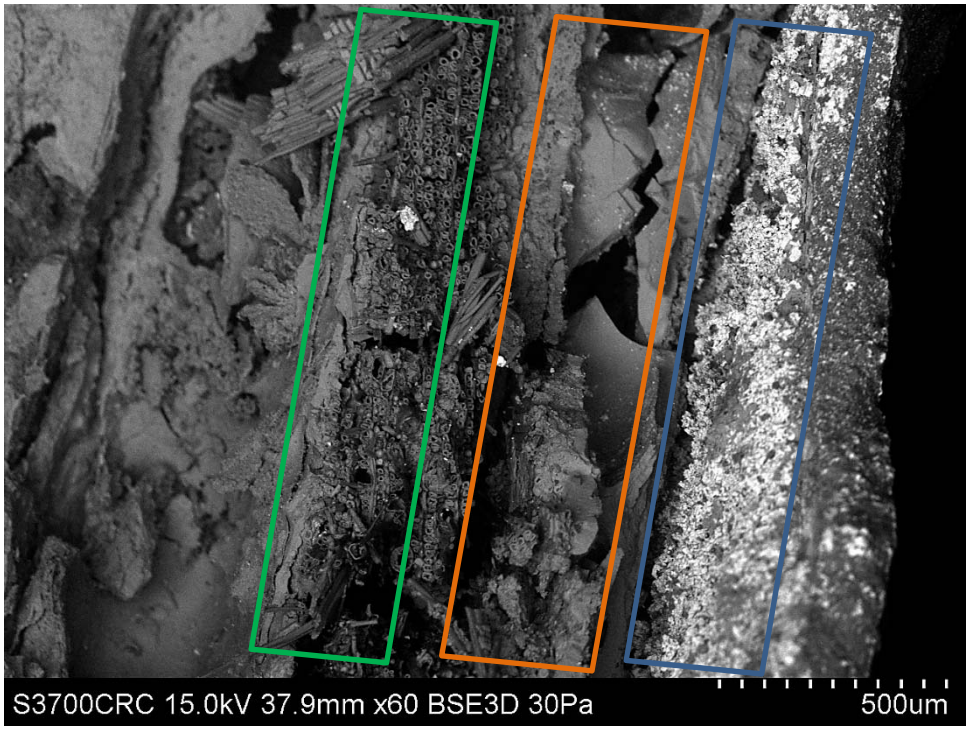

Figure 1: K274 viewed in the VP-SEM showing (right to left): external edge of metal (roughly indicated by the blue box); horn (roughly indicated by the orange box); wood (roughly indicated by the green box).

The structure of the horn shows fracturing, delamination (see Figure 2) and deformation. These may, in part, be signs of having been affected by heat (see comparable example from 352 in Figure 3). It is not possible to identify the animal species from which the horn derived.

The wood was identified (see Appendix 1, below) as *Fraxinus excelsior*, European ash – a good, all-purpose timber, much used for hafts, and many weapon/tool components.

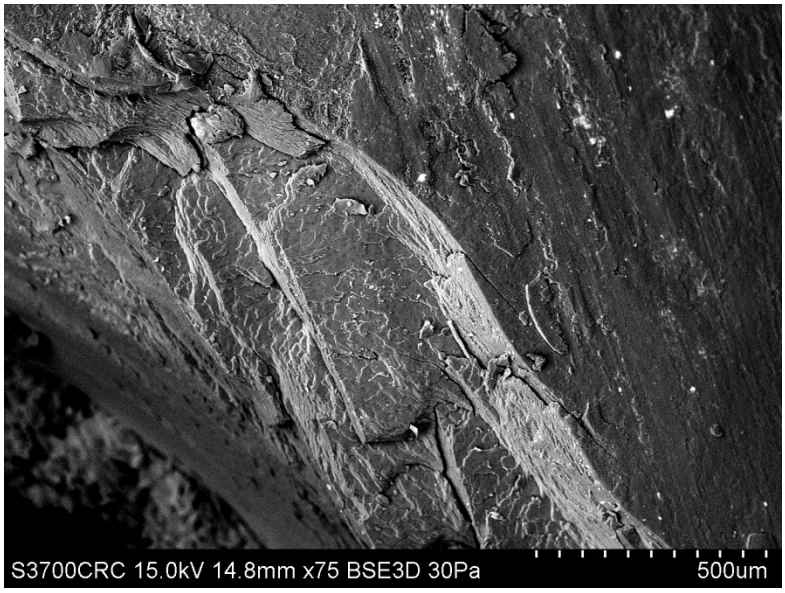

Figure 2: K274 viewed in the VP-SEM showing delaminating horn

B) Horn was identified in association with gold sword hilt plates, K282 and K283, using optical microscopy. Examination of the organic materials associated with K283, using VP-SEM, revealed the condition of the horn in more detail. The structure of the horn shows fracturing, delamination and deformation. Blackening, in addition to structural deformation, shows it has been affected by heat (see comparable example from K352 in Figure 3). It is not possible to identify the animal species from which the horn derived; this applies to all horn associated with the Staffordshire Hoard objects examined. Wood was noted to be present on K283 and was identified (see Appendix 1, below) as *Acer campestre*, field maple – a timber valued for its fine grain, and much used for turned objects.

C) Examination of the organic materials associated with a gold pommel cap with garnet inlays, K352, using VP-SEM revealed the presence of horn fragments, ashy particles, and compressed (modern) plant remains. Blackening, in addition to structural deformation, shows that the horn fragments have been affected by heat (see Figure 3). Examination of the remaining black material that does not fall into any of these categories suggested that the material was some form of amorphous organic material, but identification could not be taken any further using these methods.

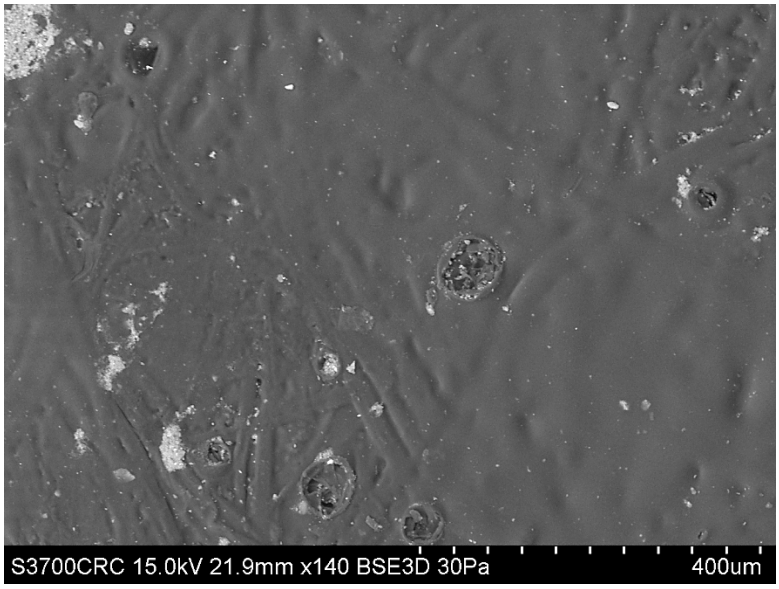

Figure 3: K352 viewed in the VP-SEM showing heat-affected horn

D) Examination of the organic materials associated with a gold pommel cap with filigree decoration, K680, using VP-SEM revealed the presence of horn fragments (possibly a very thin lining). Imprints of modern plant roots and root casts were present in the mud infill.

E) The wood inside the silver/copper fitting, K290, was fairly degraded, but the OM and VP-SEM examination provided sufficient anatomical details for it to be identified (see Appendix 1, below) as *Fraxinus excelsior*, ash. As *Fraxinus excelsior* is a very long-lived species and can live up to 400 years (with coppiced trees living even longer) this wood is not suitable for radiocarbon dating. Ash wood is strong, durable and flexible and has long been popular for the manufacture of tool handles.

F) Initially the wood fragments and slivers from K787 were thought to be modern and, with the naked eye, they still look as though they might be – with little apparent deterioration or loss of cellular integrity. However, the silver fitting with which these fragments are believed to be associated is unlikely to be modern because of the metal composition (see spreadsheet PR07444-8) and therefore these fragments of wood were examined using the OM and VP-SEM. TS, RLS and TLS (see above) were available for examination as the wood was already fragmented when received. An identification of *Carpinus betulus*, hornbeam, was determined (see Appendix 1, below). Figure 4 shows an area of the TS viewed in the VP-SEM. Despite the external appearance of the wood fragments seeming to be in very good condition, Figure 4 indicates some cellular distortion that is usually caused by rapid drying of wet/very damp wood. Unfortunately this is not an indicator of whether the wood is original or modern; the same cellular distortion will be seen as a result of rapid drying, irrespective of age.

   As *Carpinus betulus* is a long-lived species and can live up to 150 years (with coppiced trees living longer than that), this wood is not suitable for radiocarbon dating of the Hoard, but could be suitable for dating to test whether the wood is modern. Hornbeam wood is strong, heavy and extremely durable, making it highly desirable for many types of objects such as tool handles, bowls, dishes, mallets and blocks. *Carpinus betulus* was originally native to South and East England but rapidly

spread through planting and cultivation to many other parts of the British Isles.

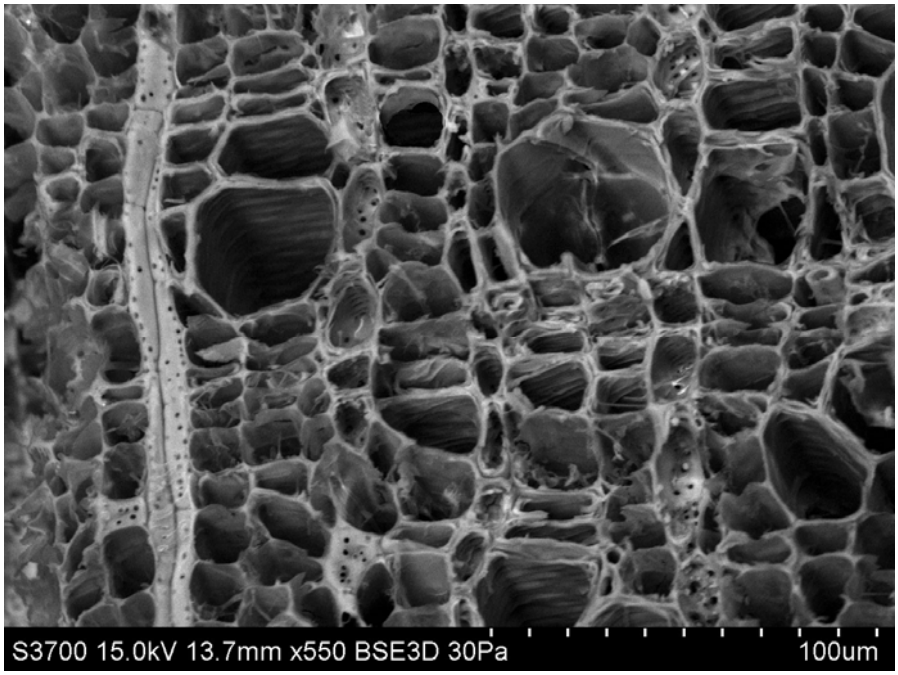

Figure 4: VP-SEM image of the TS of *Carpinus betulus* from K787

G) Silver fragments with charred organics, K1551, contained six charcoal fragments that could be identified to species level; three were *Acer campestre*, field maple, and three were *Corylus avellana*, hazel (see Appendix 1, below). These fragments cannot be unequivocally associated with the objects; they may be modern.

H) VP-SEM examination of the charcoal fragments inside the gold boss, K1620, resulted in the identification (see Appendix 1, below) of silver birch, *Betula pendula* (Figure 5). These fragments, too, cannot be unequivocally associated with the objects; they may be modern.

I) The gold hilt collar, K660, was examined using the VP-SEM, which revealed modern rootlets in some of the cloison voids and over the edges of several cloisons.

J) The contents of two gelatine capsules containing soil from K3 were examined using the OM but there were no surviving traces of original plant remains, only modern root hairs.

K) The internal contents of K133, including a fine greenish granular material, were examined using the OM but there were no surviving traces of original plant remains, or traces of horn, antler, shell, ivory or bone.

L) Examination of the black material associated with the mud from K242 using the OM suggested that the material was some form of amorphous organic material rather than the remains of some form of macro organic material such as wood, but identification could not be taken any further using these methods.

M) Examination of the 2 samples from a gold boss/rivet, K1536 using VP-SEM suggests that the materials are some form of amorphous organic material, but no further identification was possible using this method. A charcoal fragment was identified within the samples

and was identified (see Appendix 1, below) as *Acer campestre*, field maple – a timber valued for its fine grain, and much used for turned objects

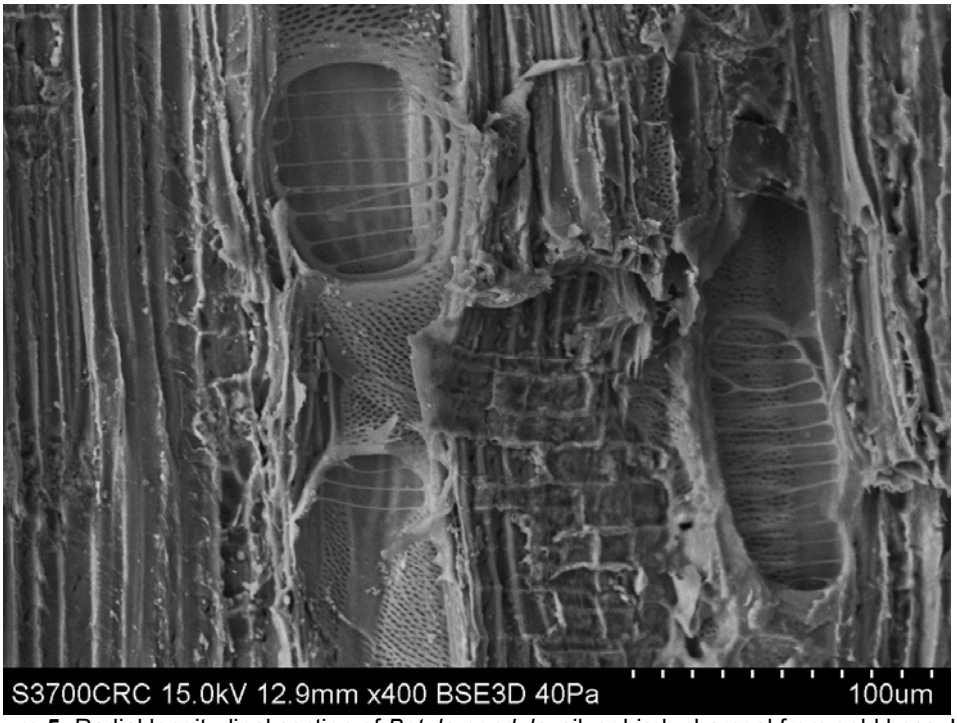

Figure 5: Radial longitudinal section of *Betula pendula*, silver birch charcoal from gold boss, K1620 showing the diagnostic scalariform perforation plates in the vessels.

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20 March 2013

Appendix 1

The identification of *Fraxinus excelsior*, European ash (Oleaceae family), was made on the following anatomical features: distinct growth ring boundaries; ring-porous; simple perforation plates; polygonal alternate intervessel pits; vessel-ray pits with distinct borders, similar to intervessel pits in size and shape throughout the ray cell; non-septate fibres; fibres thin- to thick-walled; fibres with simple to minutely-bordered pits; vasicentric, aliform and confluent axial parenchyma; some axial parenchyma in marginal bands; rays 1 to 3 cells wide; larger rays commonly 4 to 10 cells wide; homocellular rays (all with procumbent cells).

The identification of *Carpinus betulus*, hornbeam (Betulaceae family), was made on the following anatomical features: distinct growth ring boundaries; diffuse-porous; vessels in radial multiples of 4 or more common; angular outline of solitary vessels; simple perforation plates; polygonal alternate intervessel pits; vessel-ray pits with distinct borders, similar to

intervessel pits in size and shape throughout the ray cell; delicate helical thickenings in vessels; non-septate fibres; fibres thin- to thick-walled; fibres with simple to minutely-bordered pits; diffuse axial parenchyma; axial parenchyma in marginal bands; rays 1 to 3 cells wide; some aggregate rays present; some rays homocellular with only procumbent cells; some rays with body ray cells procumbent with one row of upright and / or square marginal cells; some prismatic crystals present in enlarged ray cells.

The identification of *Acer campestre* (Sapindaceae family), was made on the following anatomical features: distinct growth ring boundaries; diffuse-porous; simple perforation plates; polygonal alternate intervessel pits; vessel-ray pits with distinct borders, similar to intervessel pits in size and shape throughout the ray cell; helical thickenings in vessels; non-septate fibres; fibres thin- to thick-walled; scanty paratracheal axial parenchyma; axial parenchyma in marginal bands; rays 1 to 3 cells wide; larger rays commonly 4 to 10 cells wide; homocellular rays (all with procumbent cells); prismatic crystals present in chambered axial parenchyma cells.

The identification of *Corylus avellana*, hazel (Betulaceae family), was made on the following anatomical features: distinct growth ring boundaries; diffuse-porous; vessels in radial multiples of 4 or more common, scalariform perforation plates with less than 10 bars; polygonal alternate intervessel pits; vessel-ray pits with distinct borders, similar to intervessel pits in size and shape throughout the ray cell; helical thickenings in vessels; vascular tracheids present; fibres with simple to minutely-bordered pits; non-septate fibres; fibres thin- to thick-walled; diffuse axial parenchyma; rays 1 to 3 cells wide; aggregate rays present; heterocellular rays (procumbent cells with upright/square marginal cells).

The identification of silver birch, *Betula pendula*, silver birch (Betulaceae family), was made on the basis of the following anatomical features: distinct growth ring boundaries; diffuse-porous; scalariform perforation plates with10 to 20 bars; minute alternate intervessel pits; vessel-ray pits with distinct borders, similar to intervessel pits in size and shape throughout the ray cell; fibres with simple to minutely-bordered pits; non-septate fibres; fibres thin- to thick-walled; diffuse and diffuse-in-aggregates axial parenchyma; rays 1 to 3 cells wide; larger rays 4 to 10 cells wide; homocellular rays (all procumbent cells).

Staffordshire Hoard Research Reports

Staffordshire Hoard Research Reports were produced by the project

Contextualising Metal-Detected Discoveries: Staffordshire Anglo-Saxon Hoard

Historic England Project 5892

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