Petrological and Chemical Analysis of Anglo-Saxon and Medieval Pottery

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One hundred and fifty-nine samples of Anglo-Saxon and medieval pottery from St Peter's church and comparanda were examined in thin-section. The samples were chosen either to characterize a locally-produced ware which had not been described in print before, or to test a proposed identification, by comparing samples from Barton with those from other sites, or to investigate the source of a vessel which because of its form or fabric has been suggested to be exotic. Because there was a clear ceramic break between the early to middle Saxon pottery and the late Saxon and later wares, they are described here under those two major headings.

Polished thin-sections were produced, suitable for reflected light microscopy and SEM analysis, should this prove necessary. The sections were then stained, using Dickson's method. This stains ferroan calcite blue, non-ferroan calcite pink and leaves dolomite unstained. Subsamples were taken and crushed to a fine powder which was then submitted to Royal Holloway College, London, for Inductively Coupled Plasma Spectroscopy (ICPS)[20].

[19] The report was submitted in 2004 and it is clear that the final part of the discussion on the chemical analysis of the Late Saxon and Medieval pottery was only an outline draft. Dr Vince died in 2009 and no final version of that section has been found amongst his papers. As a consequence that part of the report has not been included here, though it does form part of the archive. The complete set of ICPS data from Barton forms part of Dr vince's archive which is to be deposited with the Archaeological Data Service.. Thanks are due to Jane Young for checking this report in 2010.

[20] Acknowledgements: the samples were prepared by Peter Hill; the thin-sections containing igneous rock fragments were examined by Dr R. Ixer, Dept. of Earth Sciences, University of Birmingham; the thin-sections were also produced in the same department, and the ICPS samples were analyzed at the Dept. of Geology, Royal Holloway College, London.

Petrological Description

Early to Middle Anglo-Saxon Wares

Acid Igneous rock-tempered wares ('Charnwood Ware', CHARN)

Four samples from vessels containing fragments of biotite granite were sectioned (V513, V524, V525 and V568). In one of these (V524) the range of inclusions was typical of 'Charnwood ware' (Williams and Vince 1997): coarse, angular fragments of biotite granite and coarse sandstone (with grains up to 1.0 mm across and some slightly stained kaolinite cement) in an anisotropic clay matrix containing sparse angular quartz. In another (V513), the rock fragments might come from a high grade metamorphic rock containing plagioclase feldspar, muscovite, altered biotite, stretched and mosaic quartz and microcline feldspar. In the other two (V525 and V568), the samples contained angular fragments of a biotite granite. The first of these samples contained arfedsonite, which is characteristic of the Oslo Graben and not found in the Charnian inlier together with altered biotite, rod perthite, potassium feldspar and plagioclase feldspar. In addition, moderate quantities of quartz sandstone with sparry ferroan calcite cement were present in V525. The larger grains were well-rounded and the smaller grains subangular. The clay matrix contained abundant glauconite pellets up to 0.2 mm across in a highly birefringent matrix. These features suggest that the pot was produced from raw materials derived from the Cretaceous deposits of north-east Lincolnshire with erratic granitic inclusions.

Sample V568 contains acid igneous rock fragments which are more like the Mountsorrel granodiorite: zoned feldspar crystals, mostly plagioclase, string perthite, very altered biotite, amphibole crystals and quartz. However, the sample also included a single fragment of bone and two or three non-ferroan micrite (chalk?) both of which are common inclusions in vessels made in north-east Lincolnshire.

The first two samples are indistinguishable from other examples of 'Charnwood ware', including samples found in southern Lincolnshire and the upper Trent valley for which a source in north-east Leicestershire makes archaeological sense. The discovery of such wares at Barton has previously been treated with caution (see Hines 1999 reviewing work by Leahy[21]) on the grounds that the proposed source is an unacceptably long way from Barton. Nevertheless, the distribution pattern of this ware south of the Humber suggests that it is more common in the Trent valley than in the Fens or Wolds, which would agree with the model of distribution by boat using the river and coast Young and Vince 2009). V525, however, is clearly a local product and V568 probably one. The ferroan calcite-cemented sandstone is Spilsby Sandstone and the glauconite-rich clay is a lower Cretaceous clay such as the Gault clay. The biotite granite, therefore, was probably of erratic origin, although it might alternatively have been obtained as gravel from Leicestershire. The presence of hornblende, however, argues against this option.

Sandstone-tempered wares (SST)

One of the commonest temper types used in early to middle Anglo-Saxon pottery in the east Midlands and Yorkshire is sandstone. North of the Humber, the sandstone fragments are probably derived from Lower Carboniferous strata, such as the Millstone Grit. These are coarse-textured porous rocks with overgrown quartz grains. Even when disaggregated, the quartz grains from these rocks are often recognizable by their crystal faces. Sandstones are also found in the Anglo-Saxon pottery of Leicestershire, either in the same fabrics as the igneous rocks or separately. These lack the overgrowth of the Yorkshire (and Peak district) wares, have no cement but are not porous, consisting of interlocking grains. However, by eye these wares are very similar, even when using a binocular microscope.

One hundred and sixty-five sherds were identified as having predominantly sandstone inclusions by eye. Six of these were selected for thin-section. However, these were chosen mainly because they contained inclusions which could not be positively identified using the binocular microscope and it is therefore not clear how relevant these samples are to the identity of the remainder, which showed variations in texture (from 'fine' – *i.e.* less than 0.3 mm – through 'medium' to 'coarse' texture – *i.e.* more than 1.0 mm across) and variations in the quantity of organic inclusions ('chaff').

The six samples showed some variation in their composition but in some cases contained the same distinctive inclusions. The incidence of these inclusions is best shown in tabular form (Table 69).

The inclusion types found were:

A Fine-grained sandstone with either no cement or some cryptocrystalline silica cement. Grains up to 0.3 mm across and fragments up to 1.5 mm across. One sample (V523) contained angular fragments of a coarse-grained sandstone with light-coloured clay minerals as cement.

B Medium-grained sandstone with a sparry ferroan calcite matrix. The larger grains (1.0 mm and over) are well-rounded monocrystalline quartz and the smaller grains were subangular. The grains contain cracks and veins filled with brown amorphous material (presumably iron) but this neither coated the grains nor was any present in the matrix. The quartz grains ranged up to 1.5 mm across and the fragments up to 2.0 mm. Fragments of angular matrix, often bearing the concave impressions of quartz grains were also present, indicating that they had undergone little or no mechanical weathering.

C Opaque 'iron ore' with few inclusions. These grains ranged up to 1.5 mm across and were subangular.

D Angular fragments of acid igneous rock, including feldspar, quartz and biotite. These fragments ranged up to 2.0 mm across and had very angular outlines. There is no indication from any of these fragments for mechanical erosion or sorting and the fragments have therefore either been crushed by

[21] Dr Leahy has kindly provided a reference to a more recent publication where the problem is discussed – Leahy 2007, 83-4.

human agency or come from a glacial till. No definite basic igneous rock fragments were seen, although some of the smaller fragments containing solely feldspar might have been from a basic rock. In addition, a few possible fragments of volcanic glass were seen.

E Micrite (fine-grained limestone). The texture of this rock is slightly coarser than most samples of chalk seen by the author, where individual crystals are difficult to see. The rock is composed of non-ferroan calcite crystals up to 0.1 mm across and smaller dolomite. It is possible that the calcite is a secondary growth of an original dolomitic limestone. The micrite fragments were rounded and in some cases had a rim of brown staining showing that they were detrital grains. The likelihood is that these inclusions are indeed chalk, but perhaps a distinctive facies.

F Bivalve shell fragments up to 1.0 mm long. These were only seen in one sample (V520). The shells were both of nacreous texture (*i.e.* oyster-like) and almost flat shells with one thick sparry calcite layer and one thinner one with smaller crystals. The latter may well be *inoceramus* a common bivalve in Cretaceous strata.

G Oolitic (or pelletal) limestone. Large (up to 1.0 mm) oval pellets of micrite (some with non-ferroan sparry calcite cores) in a sparry ferroan calcite matrix.

H Fish bone fragments. Small fragments of light brown phosphatic fish bone up to 0.3 mm long and 0.1 mm wide.

I Glauconite. Altered (oxidized) pellets of glauconite, showing zoning and radial cracking. Up to 0.3 mm across.

J Clay pellets. One sample (V518) contained distinct angular clay pellets which may be relict clay or (less likely) grog. Sample V519 contained iron-rich concentrations with a concentric structure. These might be formed by iron panning along the voids created by plant roots in recent times or might be features of the parent clay. V523 contained clay relicts.

The clay matrix was in each case anisotropic. In most samples the matrix birefringence was masked by carbon and the matrix contained sparse fragments of angular quartz (and rare muscovite laths) up to 0.1 mm long. One sample contained a mixture of clay textures (V520) with a lighter coloured, inclusionless clay being present as laminae in a darker, siltier matrix. Two samples (V522 and V523) contained no quartz silt in the matrix, which was highly birefringent.

All six samples have a different composition and there is no real indication as to whether any subgrouping is justified. All samples contain rocks or minerals of probable Cretaceous origin which probably indicates a local origin, whilst the presence of erratics (d) in three of the samples may be significant, either indicating a glacial till element in the parent clay or the deliberate admixture of acid igneous rock. Pottery produced from the Basal Till which outcrops along the coast from Flamborough Head down to the Wash, contains fresh angular fragments of basic igneous rock but, to date, no examples of acid igneous rock have been found. In any case, these wares are not glauconitic clays and do not contain lower Cretaceous rocks (which outcrop on the north and west sides of the Lincolnshire Wolds not the east). The oolitic/pelletal limestone is of Jurassic age and probably derived from the Lincolnshire Limestone. Detrital fragments of this rock are found in the central clay vale and presumably also occur in Humber terrace sands east of the limestone outcrop. Thus, in theory at least, they could be present in sands in the Barton area.

Northern Maxey-type ware (MAX)

A single sample of Northern Maxey ware was sampled, to confirm the identification. Northern Maxey-type ware is tempered with abundant fragments of shelly limestone with non-ferroan calcite nacreous bivalve shell fragments in a ferroan calcite matrix and, as predicted, these fragments are present in the Barton sample. In addition, a scatter of rounded quartz grains was present, some with iron-stained veins. In one limestone fragment it was clear that the sparry calcite was a secondary cement, later than a clay-rich primary cement The source of the shelly limestone has not been positively identified but is likely to be within the upper Jurassic strata exposed on the dip slope of the Lincoln Edge ridge. Sub-fabrics have been identified on the basis of the texture of the shell sand (Fabrics A and B) and the presence of echinoid spines (Fabric E) but all share the same basic rock. Other sub-fabrics present at Barton are Fabric U (Unknown source: separated by treatment and/or form) and Fabric G.

Table 69: Presence of inclusions in the sandstone tempered wares

TSNO	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*
V518	Yes	Yes	Yes	-	-	-	-	-	-	Yes
V519	-	Yes	Yes	Yes	-	-	-	-	Yes	Yes
V520	Yes	Yes	-	-	Yes	Yes	-	Yes	Yes	-
V521	-	-	-	Yes	Yes	-	-	-	-	-
V522	Yes	-	Yes	-	-	-	Yes	-	-	-
V523	-	Yes	-	Yes	Yes	-	-	Yes	Yes	Yes

Erratic-tempered ware (ERRA)

Although 'erratic' fragments of basic igneous rock are present in a number of the early Anglo-Saxon samples they are usually in the minority. In three samples, however, they form the main inclusion type (V509, V510 and V514). In each case the groundmass consists of moderate subangular and angular quartz sand, up to 0.2 mm across, in a matrix of anisotropic clay minerals. The erratic inclusions are moderate in quantity and range up to 4.0 ,mm across. All are subangular. Thus they are more likely to be detrital grains than the result of crushing of rock by human agency. Two of the samples (V509 and V510) contain a mixture of alkali olivine basalt and ophitic dolerite, both unweathered. The rock fragments in V510 are remarkable in that within a relatively small thin-section there are at least seven different types of basic igneous rock:

a) A highly altered basic rock containing phenocrysts of fresher plagioclase feldspar.
b) A alkali olivine basalt.
c) A coarse-grained basalt or dolerite containing late stage myrmekite. This is visually similar to the Whin Sill.
d) An alkali olivine dolerite containing titaniferous augites.
e) Laths of plagioclase in an altered matrix.
f) A mass of pyroxene crystals.
g) Alkali feldspar and plagioclase feldspar phenocrysts in a groundmass of fine-grained quartz crystals. This is a felsite, and may be an acid lava or fine-grained hypabyssal rock.

The third sample (V514) contains a mixture of coarse-grained acid igneous rock (containing minor quartz and highly altered feldspar) and quartz-mica phyllite fragments.

The characteristics of these samples are very similar to those of the Iron Age Erratic-tempered Ware found on the Yorkshire Wolds and the Vale of Pickering and studied by Wardle (1992) and Freestone (1992). There, current views are that erratic pebbles were picked out of the local gravels and used as temper. This would require either calcining (plunging red-hot rocks into water) to shatter them or pounding and sieving. The amount of labour required to do this is realized by Warble and Freestone but in their views this is the only model to fit the observed facts, in particular the concentration of one or two rock types in each vessel. This is also a characteristic of the Barton samples but the angularity and grain size found in these samples suggests to this author that the rock fragments were broken by natural forces. Samples of boulder clay from Tetney were found to contain abundant basic igneous rock fragments and form a reasonable match for the Barton samples (Vince 1995).

The Barton samples might be from later prehistoric vessels or might indicate that the same tempering technique was used in the early Anglo-Saxon period. At West Heslerton, where erratic tempered wares are common in the later prehistoric period, only a few examples had features which suggest an Anglian date. This does not preclude the use of a similar technique south of the Humber however. Especially if, as proposed above, the ware is actually produced from boulder clay without subsequent tempering.

Chalk and fine sandstone tempered

Three samples have different petrological characteristics but can be grouped together through the presence of rounded chalk fragments and fine-grained sandstone. The first of these samples (V517) was classified in the hand as chaff-tempered, the second as a local product (ESAXLOC, V511) and the third, V512, simply as ESAX. The three samples are sufficiently dissimilar to suggest that they come from separate sources although all close to the chalk.

V517 contains mixed sand, with grains up to 2.0 mm across. These include moderate rounded fragments of fine-grained sandstone with a iron-rich cement; subangular flint or chert; rounded laminated clay pellets and sparse rounded chalk containing some sparry non-ferroan calcite crystals. All of these are likely to be of Cretaceous origin. In addition, sparse rounded acid igneous rock fragments, moderate rounded basic igneous rock fragments (including both basalt and altered lava) and sparse rounded gneiss fragments were present. All of these are of glacial derivation. Unlike those found in the Erratic tempered ware samples it is notable that they have varied petrologies and are rounded.

The groundmass consists of an anisotropic clay matrix and moderate angular quartz up to 0.2 mm across and sparse fragments of sparry ferroan calcite, some with curved edges. This is possibly the matrix from the Spilsby Sandstone. V512 contains a similar range of Cretaceous rocks and minerals but *without* the glacial erratic component: rounded fragments of fine-grained sandstone (with a birefringent ?clay cement matrix rather than the opaque matrix of V517); rounded chalk of two textures, the coarser of which has calcite crystals up to 0.2 mm across; rounded laminated clay pellets and rounded brown chert. The groundmass consists of anisotropic clay minerals and moderate to abundant angular quartz and sparse muscovite up to 0.1 mm long.

V511 contains abundant rounded quartz sand up to 0.5 mm across; sparse rounded chert; sparse rounded fine-grained sandstone (as in V512) with ferroan calcite fossils (unidentified, perhaps unpunctate brachiopod shell or algae); sparse rounded chalk (as in V512); sparse bivalve shell with rounded edges; sparse subangular echinoid shell fragments. In addition there was a single fragment of fresh hornblende, presumably a glacial erratic. The groundmass consists of highly birefringent anisotropic clay minerals and sparse angular quartz.

Clearly, more samples are required to determine the true characteristics of these chalk and sandstone-tempered wares but as it stands these three samples suggest that the wares contain highly distinctive inclusions which are potentially capable of narrowing down the potential source area of these wares.

Oolitic limestone-tempered wares (LIM)

Five samples of pottery containing fragments of oolitic limestone were thin-sectioned (V526, V527, V528, V567 and V569). All have similar petrological characteristics apart from V567 which contains at least one fragment of ferroan calcite-cemented sandstone and fragments of loose ferroan calcite probably from the same source.

The samples are tempered with a mixture of quartz sandstone and oolitic and pisolitic limestone fragments up to 2.0 mm across. The sandstone consists of overgrowth quartz grains up to 0.3 mm and some laths of muscovite up to 0.2 mm long. Similar sandstones are found in samples from various sites in Yorkshire and the Tees valley but are finer textured than the majority of sandstone fragments found there, which originated in the lower Carboniferous (*e.g.* the Millstone Grit). The oolitic/pisolitic limestone consists of ooliths up to 1.0 mm across and often only a small core and pisoliths consists of micrite with an oolitic coating. Dolomite veins and some replacement are found in both types. The cement is formed of both ferroan and non-ferroan calcite, often finer grained next to the ooliths and pisoliths. The ferroan calcite is less heavily stained than that found in the Spilsby sandstone, which is why the loose fragments in V567 are thought to be from that sandstone rather than the limestone. A single fragment of angular flint, 1.5 mm long, was present in V567.

The groundmass consists of highly birefringent clay with sparse angular quartz grains up to 0.1 mm across except in V567 where sparse muscovite laths up to 0.1 mm long occur. This sample also had a moderate quantity of small voids in the matrix.

It is difficult to know whether V567 is from a totally separate source or is a variant sub-fabric. The limestone is presumably Lincolnshire Limestone but it has distinctive traits, which might allow it to be more closely provenanced. The blown sand and terrace sands of the Trent valley have a distinctive character and include chert fragments not present in these samples. Therefore, the limestone is likely to have either been obtained from detrital deposits in the Humber estuary or the Ancholme valley/central clay vale. Thus, the presence of Spilsby Sandstone might be a significant clue to the origin of the ware, except that this sample is different from the remainder not only in having Spilsby Sandstone inclusions but also in the character of the groundmass and even the presence of flint.

Bone-tempered wares (ESBN)

Two samples of what were visually taken to be oolitic limestone-tempered ware turned out in thin-section to have bone as their major inclusion (V515 and V529). The two samples have different petrological characteristics.

V515 contains abundant fragments of bone up to 0.5 mm across. These vary in roundness, some are angular others sub-rounded, and in colour, from colourless to dark brown. The internal structure suggests that some are fish bone. In addition, moderate fragments of rounded and sub-rounded quartz up to 0.5 mm across are present. The groundmass consists of highly birefringent clay minerals with few inclusions.

V529 also contains abundant bone fragments, of similar nature to those in V515 but ranging up to 2.0 mm across. Some of these have pores, up to 0.5 mm long, which are not filled. In addition, fragments of a limestone containing pisoliths and ooliths and a sparry ferroan calcite cement are present. The pisoliths and ooliths range up to 1.5 mm across. Some of the pisoliths have a bioclastic core, recognizable in one case as a bryozoan. In others the core is composed of micrite. The groundmass consists of anisotropic clay minerals, sparse angular quartz grains up to 0.1 mm across and moderate rounded grains of altered glauconite.

The limestone in V529 is likely to have come from the Jurassic ridge whilst the glauconitic clay suggests that the clay itself came from the western edge of the Wolds. The bone is presumably derived from a phosphatic sand within the Cretaceous rocks of the Wolds. The similarity of the bone in V529 may indicate that this sample too originated close to the Wolds, although 'bone beds' occur within earlier strata, such as the Rhaetic of the lower Jurassic.

Spilsby Sandstone-tempered ware (ESSPIL)

A single sample was tempered with fragments of sandstone containing rounded and sub-rounded grains of quartz, up to 1.5 mm across, with a sparry ferroan calcite cement (V516). The section also contained several charred organic inclusions (so-called chaff-tempering) up to 2.0 mm long and *c.* 0.2 mm wide. The groundmass consists of anisotropic clay minerals, altered glauconite, sparse angular quartz, muscovite and angular fragments of ferroan calcite.

All the characteristics of this sample suggest a source along the western edge of the Lincolnshire Wolds where glauconitic, slightly micaceous clays outcrop and Spilsby Sandstone outcrops.

Ipswich-type ware (IPS), Fine quartz/flint sand

A single sample of Ipswich-type ware (V500) was analyzed because visually it looked similar but not identical to Ipswich ware from the production site of Ipswich, Suffolk. In thin-section, this sample contained abundant well-sorted subangular sand *c*. 0.2 mm across. The majority of the grains were quartz but flint formed a minor element (perhaps 10–20% of the grains). No larger, rounded quartz grains were seen. Moderate quantities of dark red altered glauconite with darker weathering rims were present together with sparse muscovite, chalcedonic quartz, feldspar and unidentified accessory minerals.

The characteristics of this sand (the quantity of flint and the size and sorting) are very different from those found in Lincolnshire, although the range of inclusions could theoretically all occur in the county. Flint-rich sands are more common in areas draining Tertiary and later strata, such as occur in the Thames basin. The quantity of fresh minerals of igneous origin could be due to a contribution of glacial material to the sand. These characteristics are typical of Ipswich ware.

Late Saxon and Later Wares

Beverley-type wares

Wares with a similar appearance to Beverley Orange ware (Watkins 1987) were found in some numbers at St Peter's. However, they appeared to be slightly different in detail from wasters from the Beverley kiln sites, and to test the possibility that the Barton sherds were indeed Beverley products samples from the known kiln groups in Beverley were examined (Table 70). They were compared with 17 sherds from St Peter's; one of these was visually similar to Scarborough ware (V553).

Beverley wares are subdivided into two chronological types and three main fabrics (Didsbury and Watkins 1992). Fabric A, used for Beverley Type 1 vessels (BEVO1), contains more obvious coarse sand temper and especially 'chalk'. It is also often not thoroughly oxidized. Fabric B, used for Beverley Type 2 vessels (BEVO2), is finer and oxidized throughout. A similar split could be made in the atypical Barton material, which has therefore been coded BEVO1T and BEVO2T.

Unfortunately, the Barton samples were leached so that none of the 'chalky' inclusions remained in the section and are represented by rounded voids. All the samples, both of BEVO1T and BEVO2T had similar groundmasses, except for one, V371, which had an inclusion less, highly birefringent clay matrix. The standard groundmass contains abundant ill-sorted quartz (and sparse rounded iron oxides), ranging from silt-sized to about 0.3 mm across. Sparse large flakes of muscovite, up to 0.3 mm long, are a distinctive feature, both in thin-section and in the hand. The clay matrix is usually anisotropic, but in one case (V369) was isotropic, implying a higher firing temperature (or difference in the chemical composition, such as a higher iron content, thus lowering the vitrification point of the clay).

In addition to this standard groundmass, subangular and rounded quartz grains are found, some of these are overgrown and derive from a sandstone. Sparse fragments of such a sandstone occur, together with sparse flint or chert and sparse angular basic igneous rock fragments, all up to 0.5 mm across. The most notable inclusions, however, are rounded clay pellets. These are often structured and contain concentrations of iron or manganese. These pellets can be over 1.0 mm across. No obvious difference between the visually-separated fabrics could be seen in thin-section and in fact the samples of Type 2 (BEVO2T) contain more clay pellets than Type 1 whilst one of the Type 1 samples, V370, was completely oxidized.

The Beverley kiln samples came from three separate interventions: coded be84, bgr85 and 'Grovehill Rd'. The be84 material consisted of Beverley Types 1 (six samples) and 2 (six samples) whilst the bgr85 samples consist solely of Type 1. The single 'Grovehill Rd' sherd is of Type 2.

Table 70: Description of the fabrics found at the Beverley kiln sites

TSNO	Site code	C NAME	Coarse inclusions (other than quartz)	Micrite	Matrix
V570	bgr85	BEVO1	Clay pellets (sparse)	M	Anis
V571	bgr85	BEVO1	Acid igneous and/or basic igneous rocks, Flint/chert and chert/lava	N	Anis
V572	bgr85	BEVO1	Acid igneous and/or basic igneous rocks, Flint/chert and chert/lava	N	Anis
V573	bgr85	BEVO1	Acid igneous and/or basic igneous rocks, Flint/chert and chert/lava	S	Anis
V574	bgr85	BEVO1	None (but small section)	N	Anis
V575	bgr85	BEVO1	Acid igneous and/or basic igneous rocks, Flint/chert and chert/lava	S	Anis
V579	Grovehill Road	BEVO2	Acid igneous and/or basic igneous rocks, chert	N	Anis
V581	be84	BEVO1	Clay pellets (cf Barton)	N	HBC
V582	be84	BEVO1	Acid igneous and/or basic igneous rocks, angular flint	S	HBC
V583	be84	BEVO1	Acid igneous and/or basic igneous rocks, sandstone, flint	N	HBC
V584	be84	BEVO1	Acid igneous and/or basic igneous rocks, chert, sandstone	S	HBC
V585	be84	BEVO1	Chert, sandstone, angular flint	N	ISOT
V586	be84	BEVO1	Clay pellets, chert, acid igneous and/or basic igneous rocks	N	HBC
V593	be84	BEVO2	Clay pellets	S burnt out	Anis
V594	be84	BEVO2	Acid igneous rock	S burnt out	Anis
V595	be84	BEVO2	Basic igneous rock, clay pellets	S burnt out	Anis
V596	be84	BEVO2	Clay pellets	N	HBC
V597	be84	BEVO2	Clay pellets	S burnt out	Anis
V598	be84	BEVO2	Acid igneous rock, clay pellets	S burnt out	HBC

Columbia plain ware (COLP)

Columbia Plain ware is a tin-glazed ware manufactured in Seville in the sixteenth and early seventeenth centuries (Hurst *et al*. 1986, 59–61). Since the ware is undecorated and has no large visible inclusions it is difficult to positively identify by eye. The two sampled sherds appear to come from hollow ware vessels, a class not recorded from northwest Europe previously and it was therefore felt worthwhile to try and confirm the visual identification.

Both sections show a very similar fabric. There is a groundmass of heat-altered calcareous clay and moderate angular quartz, biotite laths (mainly heat-altered) and laths of muscovite, all up to 0.2 mm long. In addition there are sparse fragments of metamorphic rock, acid igneous rock, chert, and an iron-cemented fine sandstone containing grains of dolomite and quartz. All of these inclusions range up to 0.5 mm across. Finally, both sections contained one or two fragments of non-ferroan micrite/clay mixture, which may be relicts of concretionary calcite from the parent clay.

These inclusions are consistent with an origin in the Guadalquivir valley and support the identification of the two samples as Seville products.

Early medieval handmade ware (EMHM)

A sample of Early Medieval Handmade ware (EMHM) was thin-sectioned (V501). It contained a quartzose sand with grains up to *c.* 1.0 mm across with sparse bivalve shell composed of non-ferroan calcite (including ornamented shells), rounded fragments of chalk, with calcispheres, fossil limestone including ferroan calcite echinoid shell with a groundmass of ?dolomite, and rounded chert all up to 1.0 mm across. The groundmass consists of highly birefringent clay minerals with sparse muscovite fragments up to 0.1 mm long.

The presence of chalk indicates an origin close to the chalk outcrop, which might in this case mean a local source.

(GLGS)

A sample of GLGS was thin-sectioned (V502). It contained coarse quartzose sand with grains up to 1.5 mm across (some with iron-stained veins) together with sparse rounded flint, Lower Greensand Chert, both up to 1.5 mm across and rounded iron ore up to 1.0 mm across. The groundmass consists of a heat-altered calcareous matrix with abundant angular quartz, sparse biotite, muscovite and glauconite up to 0.1 mm across.

These characteristics all point to a source in a region of Cretaceous rocks and therefore the sample could well have been locally made.

Late Saxon non-local (LSAXX)

A sample of a possible regionally imported vessel of late Saxon date was thin-sectioned (V566). The sample contained abundant rounded and subangular quartzose sand with grains up to 1.5 mm across. Several grains were polycrystalline and fragments of coarse sandstone were also present. The groundmass was a highly birefringent clay matrix with few visible inclusions.

The temper in this fabric is typical of the sandstone-derived sands of the Pennines and Peak district. They are typical, for example, of the fluvio-glacial sands York area but do not occur in Lincolnshire. Thus the thin-section confirms that this vessel is indeed a regional import, from somewhere to the west or northwest of Barton.

Medieval non-local (MEDX)

Two samples of fine-textured redwares were thin-sectioned (V456 and V457). V456 has a similar character to NLFS and may indeed be an example of this ware. V457 has few inclusions over 0.3 mm and has a groundmass of angular quartz, muscovite, glauconite and biotite up to 0.1 mm. The clay matrix may be heat-altered calcareous clay. The characteristics of this sample too can be paralleled in probable local wares from Barton. In these cases, therefore, the attribution of the sherds to a non-local source cannot be supported by thin-sectioning.

North Lincolnshire coarse sandy ware (NLCS)

Four samples of North Lincolnshire Coarse Sandy ware were thin-sectioned (V469, V470, V471 and V499). Two (V469 and V471) contain a rounded quartz sand, including probable Greensand quartz, rounded chert, rounded opaques and a single fragment of brown-stained bone, all up to 1.0 mm across. The groundmass consists of highly birefringent clay minerals with sparse muscovite and altered glauconite up to 0.1 mm across. Neither sample actually contained any chalk or similar limestone inclusions, which are a diagnostic visual characteristic of the ware.

The remaining two sections (V470 and V499) have a similar fabric, distinct from that of the first two. They contain a rounded quartzose sand with rounded chalk (including calcispheres), angular non-ferroan sparry calcite, rounded acid and basic igneous rock, iron-cemented sandstone and rounded chert, all up to 1.0 mm across. The groundmass consists of anisotropic clay minerals with moderate laths of muscovite, sparse angular quartz, altered glauconite and biotite up to 0.1 mm long. The sand temper in these two sections is similar to several others from Barton. The distribution of the sand from which it was obtained is as yet unknown, but a mixture of Cretaceous and glacial detritus would be appropriate to sands to the north and east of the Wolds.

North Lincolnshire Fine Shelled ware (NLFS)

Five samples of North Lincolnshire Fine Shelled ware (NLFS) were thin-sectioned (V494, V495, V496, V497 and V565). All contained abundant fragments of a shelly limestone up to 1.0 mm across. The shells were nacreous bivalves composed on non-ferroan calcite, some with an extra external layer of prismatic non-ferroan or slightly ferroan calcite. The matrix of the limestone was porous and contained several generations of cement. The earliest was a mixture of fine-grained slightly ferroan calcite and clay minerals(?), this was succeeded by sparry ferroan calcite and dolomitic micrite. The latter sometimes lined open voids. The ferroan calcite post-dated deformation of the limestone, leading to the splitting and splintering of some of the shells. Sparse fragments of phosphate up to 1.0 mm across were present, as were nodules of the same size composed of a phosphate groundmass and minute ?dolomite crystals. The groundmass consisted of fragmentary limestone of the types described above and abundant brown material which might be clay minerals or altered glauconite (although it is slightly birefringent whereas glauconite is isotropic).

This fabric clearly belongs to the same family as the shell-tempered wares of Lincoln and the surrounding area (such as Potter Hanworth). The unusual features are the several-generational cement and the phosphate nodules. Shelly facies apparently occur in the upper levels of the Oxford Clay and it might be that this NLFS fabric was produced somewhere to the east of the Ancholme rather than in the Lincoln area, although on petrological grounds that source is not excluded.

North Lincolnshire glazed coarse sandy ware (NLGCS)

Nine samples of North Lincolnshire glazed coarse sandy ware (NLGCS) were thin-sectioned (V472-6, V548-9, V551-2). Three sub-fabrics were recognized:

Fabric A is the most common (7 samples) and consists of a quartzose sand, including grains of Cretaceous origin, and fine-grained iron-cemented sandstone. Rare large fragments of acid igneous rock are also present. The groundmass consists of abundant muscovite, biotite and possible altered glauconite fragments up to 0.1 mm across in a matrix of anisotropic clay minerals. A single lens of iron/manganese panning cementing angular quartz grains up to 0.3 mm across was present in one section.

The sandstone in Fabric A is probably of lower Cretaceous origin, which would indicate a source either along the western edge of the Wolds or the north. The ware might therefore be local but is clearly distinguished from other 'local wares'.

Fabric B (V476) contains abundant quartzose sand, no examples of the fine sandstone which characterizes Fabric A and sparse fragments of non-ferroan Sparry calcite, up to 1.0 mm across. These may be shell fragments rather than calcite veins. The groundmass appeared to be a heat-altered calcareous clay with moderate angular quartz silt and opaque grains and sparse muscovite, all up to 0.1 mm long. The clay matrix of Fabric B is very similar in appearance to a number of other Barton samples for which a local origin is proposed and for this reason a local origin is proposed here too. The larger inclusions are not particularly distinctive.

Fabric C (V552) contains quartzose sand with sparse fine-grained, iron-cemented sandstone or siltstone. The latter rock is finer-textured than that in Fabric A. In addition, Fabric C contains numerous voids which by their appearance probably contained shell. The clay matrix is composed of highly birefringent clay minerals and few other inclusions. No source can be proposed for Fabric C on the basis of these inclusions.

North Lincolnshire Fine Sandy ware (NLFSW)

A sample of North Lincolnshire Fine Sandy ware (NLFSW) was thin-sectioned (V489). The sample contained abundant subangular quartz up to 0.5 mm across, sparse rounded basic igneous rock, sparse rounded chert up to 0.5 mm, sparse rounded opaque inclusions up to 0.3 mm across in a groundmass of abundant angular quartz and muscovite up to 0.1 mm and anisotropic clay minerals. These characteristics are consistent with a local North Lincolnshire source.

North Lincolnshire Late Saxon Grey ware (NLLSG)

Two distinct fabrics have been grouped together at Barton as North Lincolnshire Late Saxon Grey ware (NLLSG). Fabric 1 appears visually to be very similar to SNLS, which is made in kilns in Lincoln. Fabric 2 has a siltier matrix and contains numerous rounded black inclusions. In thin-section the three samples of Fabric 1 (V503, V504 and V505) contain a well-sorted quartzose sand with subangular, sub-rounded and rounded grains up to 0.4 mm across. Sparse fine sandstone fragments and chert also occur. The groundmass consists of highly birefringent clay minerals with finely divided iron-rich inclusions. One of the samples also contained large rounded laminated clay pellets, of similar colour and texture to the matrix. The characteristics of Fabric 1 are very similar to those of the Lincoln SNLS, and other Lincoln sand-tempered wares produced from Jurassic clay with windblown sand temper.

The three thin-sections of Fabric 2 (V506, V507 and V508) contain a quartzose sand of similar size and character to that in fabric 1 but with a higher proportion of rounded grains and some iron-stained veins (*i.e.* a greater contribution from Cretaceous deposits). In addition, each contains moderate quantities of rounded altered glauconite and opaque iron ore. There are some grains, which are barely translucent of similar size, and shape, which suggest that the opaque iron ore is also, altered glauconite. The groundmass of Fabric 2 consists of abundant quartz silt and moderate muscovite in an anisotropic clay matrix. Fabric 2 was clearly produced from a glauconitic clay of which a number occur in the Upper Jurassic and Cretaceous of Lincolnshire.

North Lincolnshire quartz and shell-tempered ware (NLQS)

Two samples of North Lincolnshire quartz and shell-tempered ware (NLQS) were thin-sectioned (V461 and V547). They both have similar characteristics in thin-section. They contain moderate rounded fragments of rounded chalk, fine-grained iron-cemented sandstone, phosphate nodules with quartz and muscovite inclusions, chert, sparry non-ferroan calcite and basic igneous rock, all up to 1.0 mm across. The clay matrix consists of highly birefringent clay minerals and moderate grains of ?altered glauconite up to 0.1 mm across. The chalk fragments include examples with a dolomitic matrix and non-ferroan calcite infilling of calcispheres.

These characteristics are similar to several other wares found at Barton for which an origin to immediately west or north of the Wolds is postulated.

Reduced Chalky ware

Three samples of Reduced Chalky ware were thin-sectioned (V576–8). Reduced Chalky ware was first defined at Beverley, where these three samples were found. They were sampled as part of this project for comparison with the various North Lincolnshire wares which contain chalk or similar fine-grained limestone.

All three samples have a dark core, which gives the ware its name. However, the thin-sections make it clear that this is a misnomer, since the core is actually oxidized but its colour masked by finely-divided carbon.

The samples contain a subangular to rounded quartzose sand with grains up to 0.5 mm, and rarely as large as 2.0 mm. All other inclusions are sparse but range up to 1.0 mm. They include chalk, chert, fossiliferous limestone, basic igneous rock, acid igneous rock, siltstone, dolomitized sparry non-ferroan calcite, opaque grains, bivalve shell and mudstone. The chalk includes fragments with ostracods and calcispheres. Some of these have a dolomitized micrite matrix with the microfossil tests and sometimes their fillings of non-ferroan calcite. The fossiliferous limestone includes a gastropod shell with sparry non-ferroan limestone filling whilst the shells themselves are composed of dolomite. Sparry ferroan calcite occurs as replacement. A mudstone fragment includes a lens of faecal iron pellets.

The groundmass is highly birefringent clay with moderate quantities of angular quartz and sparse muscovite.

The range of inclusions found in Reduced Chalky ware is indeed similar to that found in probable North Lincolnshire wares. In both, there is a contribution from fluvio-glacial sources and from the chalk. It is possible, however, that rocks and minerals from the lower Cretaceous deposits are not present in Reduced Chalky ware on account of its being produced to the east of the Wolds whereas the lower Cretaceous rocks north of the Humber outcrop to the west.

North Lincolnshire Glazed Quartz- and Chalk-tempered ware (NLGQC)

By eye, the characteristics of North Lincolnshire Glazed Quartz and Chalk tempered ware (NLGQC) are a mixture of quartz sand and rounded calcareous inclusions, assumed to be chalk. Seven samples were thin-sectioned in order to provide an accurate description of the ware (V462 to V468).

In thin-section all the samples contained rounded chalk (stained purple by Dickson's method), which includes some calcispheres but is general just fine-grained micrite, and rounded quartz grains, both up to 0.5 mm across. In addition, most of the samples contained rounded fragments of acid and/or basic igneous rock or their constituent minerals, rounded opaque iron ore, rounded chert and flint, rounded fragments of an iron-cemented fine-grained sandstone. Non-ferroan calcite bivalve shell, including ornamented examples, were present in four of the sections, a gastropod shell in one section, a fragment of sparry non-ferroan calcite in one section, a fragment of a quartz-mica schist in one section and a rounded fragment of phyllite in another section.

The groundmass consisted of isotropic clay, whose colour and appearance suggests that it is heat-altered calcareous clay. Three of the samples contained sparse rounded fragments of glauconite up to 0.2 mm across and all contained sparse to moderate flakes of muscovite, up to 0.2 mm long.

These inclusions could all be derived from a detrital sand. Given the fact that chalk and other calcareous matter forms a major element in the sand it is likely that the sand comes from close to the chalk outcrop. The presence of large flakes of muscovite, together with glauconite, might indicate some contribution from the Lower Cretaceous. It is possible that the fabric consists of a calcareous Lower Cretaceous clay with a sand derived from the Upper Cretaceous.

North Lincolnshire Quartz- and Chalk-tempered ware (NLQC)

North Lincolnshire Quartz and Chalk tempered ware is the unglazed version of NLGQC. Twenty-one samples were thin-sectioned (V477-490, V546, V550, V558, V560, V587–92). They include samples from sites in Hull and Beverley as well as from Barton.

In thin-section the NLQC samples fell into two clear groups, plus a third represented by a single sample, V489. The first group is subdivisible into two sub-fabrics on the basis of the clay matrix. In the first, the clay matrix is identical to that found in NLGQC, an isotropic clay appearing to have once been calcareous, giving rise to a distinctive colour and texture. The second sub-fabric has a highly birefringent clay matrix with few silt-sized inclusions. The sand fraction in both of these sub-fabrics is identical to NLGQC, with the exception that shell has not been noted in any of the sections. All contain erratic material, mainly basic igneous with some acid igneous and rare metamorphic rock fragments. The range of non-erratic material is identical to NLGQC and there is little doubt that the source of the temper used in the two wares is the same.

The second fabric contains quartzose sand and rounded 'chalk' fragments but without any erratic rock fragments. There are only three samples in this group (V481, V483 and V490) and it may simply be chance that the sections do not contain the erratic rock, which is never common. Other than quartz and 'chalk' the samples contain rounded iron-rich inclusions, rounded phosphate pellets, rounded flint/chert and rounded fragments of fine-grained iron-cemented sandstone. All three samples have a highly birefringent clay matrix.

Humberware, Fabric A

Two samples of Humberware, Fabric A, were thin-sectioned (V458 and V459). Fabric A is recognized by eye by its smooth fabric, quartzose sand and occasional calcareous (chalk?) inclusions. In thin-section the samples contained abundant rounded quartz, including grains probably from lower Cretaceous deposits ('greensand quartz') all up to 1.0 mm across. In addition, the following were noted: Sparse fragments of rounded iron-cemented fine sandstone, rounded mudstone, angular acid igneous rock, coarse-grained sandstone, chert, all up to 1.0 mm across, rounded non-ferroan chalk (heat altered) up to 0.5 mm across and muscovite laths up to 0.2 mm long. The groundmass consists of highly birefringent clay minerals and moderate quantities of angular phosphate, up to 0.2 mm across. Lenses of similar phosphate fragments, quartz, biotite and muscovite laths all up to 0.2mm across were present.

The phosphate inclusions in the groundmass of this fabric are very distinctive, but have not been previously noted in other fabrics and so give no real clue as to the source. The range of inclusions in the quartzose sand is similar to that found in other Barton samples, combining probable fluvioglacial detritus (the acid igneous rock and coarse sandstone) with material from the local Cretaceous deposits (the chalk, chert and fine sandstone). A local origin is therefore postulated.

Thetford-type ware? (THETT?)

A sample of possible Thetford-type ware was thin-sectioned (V564). It contained abundant quartzose sand with grains up to 1.0 mm across. Sparse rounded chert, angular basic and acid igneous rock and rounded opaques were also present. The groundmass consists of highly birefringent clay minerals and sparse angular quartz and muscovite laths up to 0.1 mm long. The present of the acid and basic igneous rock may suggest that this sample had a local origin, although there are also fluvio-glacial deposits throughout East Anglia. There is certainly no characteristic of this sample that could not be matched locally.

Anglo-Netherlandish tin-glazed ware (TGE)

A single sample of tin-glazed earthenware was sampled (V556). It contains moderate quantities of subangular to rounded quartz sand up to 1.0 mm across, sparse angular flint up to 1.0 mm, sparse fine-grained sandstone (grains up to 0.2 mm) up to 0.5 mm, black clay pellets with a concentric structure up to 1.5 mm across, and rounded brown clay pellets up to 1.0 mm across. The groundmass consists of sparse angular quartz, muscovite and/or biotite laths (*i.e.* lightly coloured, slightly pleochroic) up to 0.1 mm long, angular sparry non-ferroan calcite up to 0.2 mm across and a heat-altered calcareous matrix. The glaze is identical in character on the inside and outside of the vessel and contains concentrations of cloudy white glass and moderate angular quartz grains up to 0.2 mm across.

Although on balance a northwest European source is likely for this sample the character of the mica and the absence of glauconite in the groundmass makes this attribution uncertain on petrological evidence alone.

Torksey-type ware (TORKT)

Five samples of Torksey-type ware from Barton were thin-sectioned (V491–3, V562–3). Wares looking like the products of the Torksey pottery industry are common throughout the east midlands and north of the Humber. There is difficulty, however, in distinguishing genuine products of Torksey from wares sharing the same forms and manufacturing techniques. However, in thin-section the Torksey products consistently contain a subangular to rounded quartz sand with fine- and medium-grained sandstones and rounded chert fragments as minor elements. A re-examination by the author of the thin-sections of Torksey-type wares from York, looking at the character of the sand temper, has enabled the York Torksey-type wares to be divided into locally-produced Torksey-type wares and regional imports from Torksey.

The Barton samples all have this quartz/sandstone/chert sand temper, with grains up to 0.4 mm together with sparse rounded opaques up to 0.3 mm, laminated clay pellets up to 1.5 mm across, calcareous clay pellets (non-ferroan calcite) up to 1.5 mm across, and an echinoid spine (non-ferroan calcite). The groundmass consists of highly birefringent clay minerals with sparse quartz and muscovite.

These characteristics are consistent with the Barton samples being produced at Torksey. Furthermore, the total absence of either rocks and minerals of Cretaceous origin or fluvio-glacial erratics argues against a local north-east Lincolnshire source.

Unglazed Greensand Quartz-tempered ware (UNGS)

A sample of Unglazed Greensand Quartz-tempered ware (UNGS) was thin-sectioned (V561). It contained abundant quartzose sand, mainly quartz grains up to 1.5 mm across (some with the well-rounded appearance of quartz grains from the lower Cretaceous) with moderate fine-grained, iron-cemented sandstone and phosphate nodules, sparse rounded chalk up to 2.0 mm across, angular basic igneous rock temper, chalcedonic chert and reddish clay pellets, up to 1.5 mm across. The groundmass consists of highly birefringent clay minerals. These characteristics are consistent with a local, north-east Lincolnshire, source.

Chemical Analysis

Early to Middle Anglo-Saxon wares

The chemical data were analyzed using principal components analysis (PCA). For the early to mid Anglo-Saxon samples, the data were assigned to nine groups which are shown by different symbols in the accompanying plots:

Table 71: Early to middle Anglo-Saxon wares plotting symbols

Group		Symbol	No. of samples
CHALK+SST	Chalk and fine sandstone tempered	Circles in circles	3
CHARN	Acid Igneous rock-tempered wares ('Charnwood Ware')	Half-filled circles	2
ERRA	Erratic-tempered ware	Circles	5
ESBN	Bone-tempered wares	Squares	2
ESSPIL	Spilsby Sandstone-tempered ware	Square in square	1
IPS	Ipswich-type ware: fine quartz/flint sand	Triangle	1
LIM	Oolitic limestone-tempered wares	Diamonds	5
MAX	Northern Maxey-type ware	Half-filled square	1
SST	Sandstone-tempered wares	Circles in triangles	6

Plotting pairs of components reveals the relationships of these groups, IPS and MAX consistently form outliers. This is due to the high shell content in MAX, which gives rise to high CaO and Sr values, and to the high fine sand/silt content of IPS, which should give rise to high Rare Earth values. The two ESBN samples also plot together, as a result of their high P_2O_5 content, but surprisingly this element was not sufficient to separate these two samples greatly from the remainder. All the remaining samples formed a loose 'cloud' in the centre of the plots (Fig. 858). This is because, essentially, they contain similar inclusions and have a similar groundmass. Within this 'cloud' the LIM and SST samples plot close together whereas the ERRA samples have a wide spread. This again is understandable, in that this group includes both acid igneous and basic igneous rock-tempered examples. The two samples with basic igneous rock temper, V509 and V510, in fact fall outside the main 'cloud' because of their high PC1 values. The elements which contribute to PC1 are shown in Fig. 859.

Since it is clear that the analysis of the chemical data is mainly explicable in terms of the major inclusion types the analysis was re-run excluding CaO, P_2O_5 (present mainly in bone and post-burial enrichment by calcium phosphate), K_2O (which may be entering the samples in feldspars and muscovites) and Sr (usually present as a trace within $CaCo_3$). The results indicate that MAX is still an outlier, mainly as a result of high values for Na_2O, Cu and Zn (Fig. 860). The basic rock-tempered ERRA samples are also still separated whilst the two CHARN samples are also separated. The SST samples form a distinct cluster, excluding the shell-tempered V520 which plots alongside the LIM, CHALK+SST and ESSPIL samples. One of the two ESBN samples, V529, plots on the boundary of the SST and LIM samples and the other, V515, plots close to the two acid igneous rock-tempered ERRA sherds. These results show no differences between the minor and trace elements found in the samples with Cretaceous rocks and minerals and those found in the oolitic limestone-tempered sherds. This tends to support the view arrived at through petrological analysis that the limestone is a detrital sand tempering a clay derived from a Cretaceous source. In other words, LIM is probably 'locally' produced.

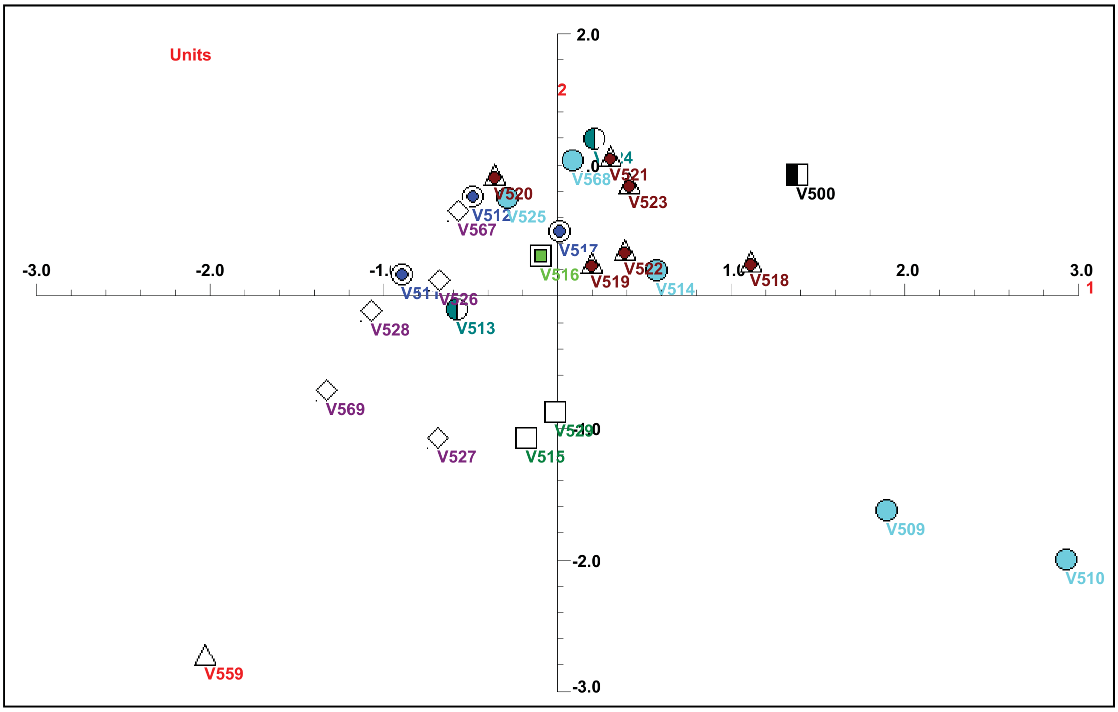

Fig. 858: Principle component analysis plot of early to mid Saxon wares

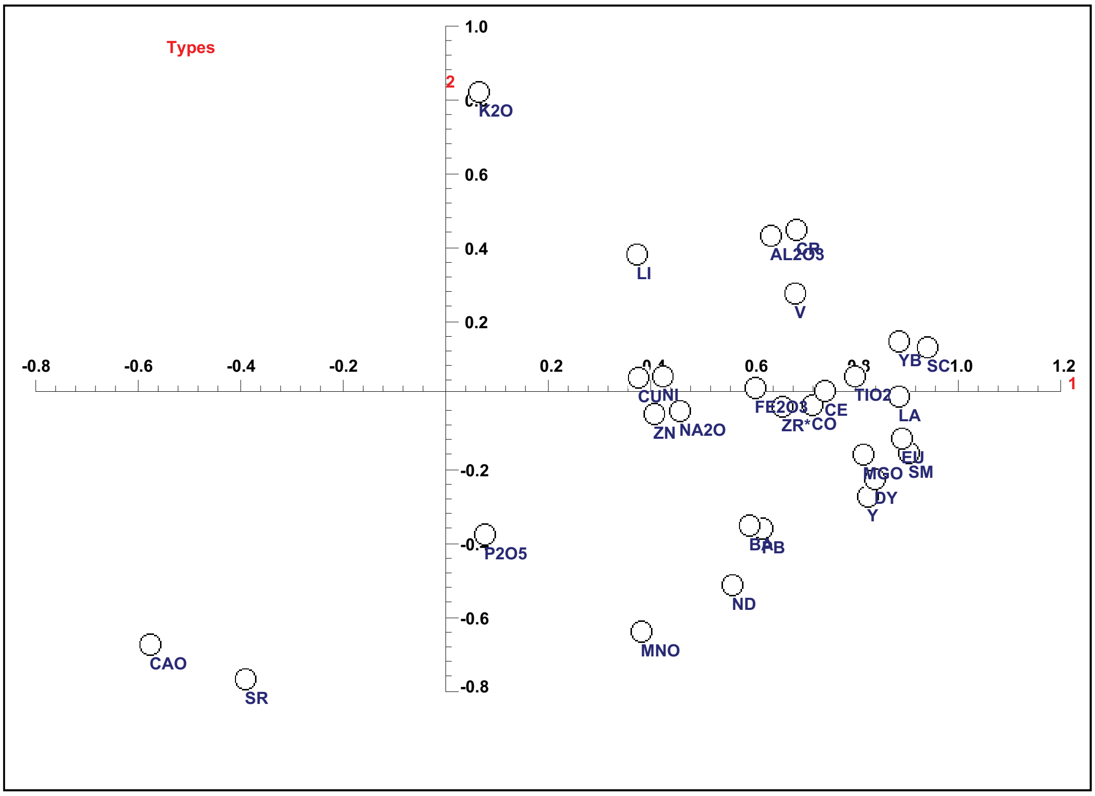

Fig. 859: Plot showing elements contributing to PCA shown in fig. 858

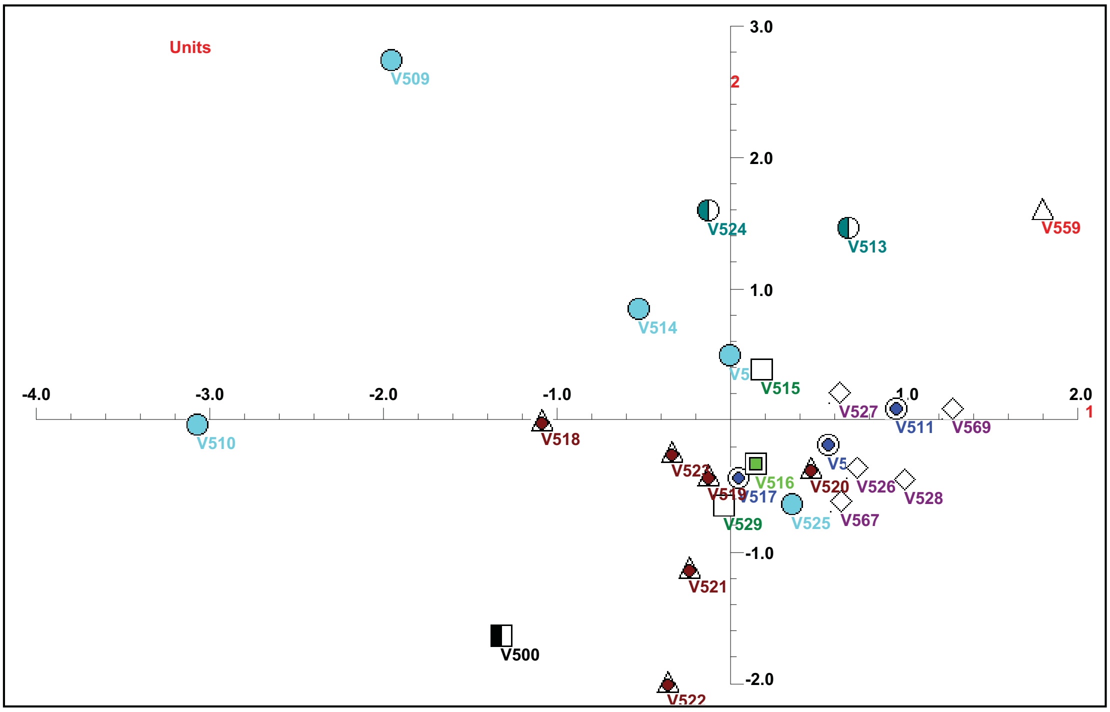

Fig. 860: *Principle component analysis plot of early to mid Saxon wares excluding* CaO, P_2O_5, K_2O and Sr.