Characterisation Studies of Anglo-Saxon and Medieval Pottery from Church Way, Doncaster (DCW94)

Alan Vince

A series of samples of Anglo-Saxon and Medieval Pottery from the Askews Site, Church Way, Doncaster, were selected by Jane Young (shelly wares); Chris Cumberpatch (medieval glazed wares) and the author (Anglo-Saxon and Saxo-Norman wares). The results of these analyses are presented in detail here and summarised in the pottery reports.

Thin sections were produced by Steve Caldwell, University of Manchester, and stained using Dickson's method (Dickson 1965). This distinguishes ferroan calcite from non-ferroan calcite and dolomite. Chemical analysis was carried out at Royal Holloway College, London, under the supervision of Dr J N Walsh using Inductively-Coupled Plasma Spectroscopy. In addition to the standard rock programme, lead was measured, as a guide to potential contamination by glaze. All data were normalised to aluminium before analysis using the multivariate statistical package, WinStat, an add-on for Microsoft Excel (Fitch 2001).

Early to Mid Anglo-Saxon Wares

Two residual sherds of handmade, coarse-gritted vessels were recovered from the excavation. Similar wares occur in both the Iron Age and early to Mid Anglo-Saxon periods although pottery is rare in both periods in the Doncaster area. Both were large enough for thin section and chemical analysis.

Erratic Rock-tempered ware

In thin section the fabric of this vessel (V4212) is seen to contain angular fragments of coarse-grained igneous rock ranging from c.0.2mm up to over 4.0mm. The fragments show no rounding but the largest piece has iron staining on its edges, indicating that the rock may have been weathered. It could be derived from a natural breccia or it might have been crushed/fire-cracked by the potter. The fragments all have a similar petrology and consist of interlocking crystals of plagioclase feldspar, hornblende and minor quartz. The rock is foliated and may be a coarse-grained metamorphic rock. It does not contain biotite and zoned feldspars, both of which are characteristic of the Mountsorrel Granodiorite although this does not preclude a Leicestershire source, since the igneous rocks of the Charnwood Forest inlier are quite varied (1969, 7-9, 27). However, none of the published descriptions of Leicestershire igneous rocks match this rock and they are more likely to be northern erratics. The groundmass consists of anisotropic baked clay minerals, moderate angular and subangular quartz and sparse muscovite and dark brown clay/iron inclusions up to 0.1mm across. The groundmass suggests the use of a glacial/post-glacial lacustrine clay and contains a higher silt content than fabrics definitely derived from the Leicester area (Williams and Vince 1997).

The ICPS data was compared with that of 104 samples of igneous-rock tempered wares of early to mid Anglo-Saxon date, some of which are identified as containing erratics and others where the evidence is ambivalent or the vessels are more likely to be of Leicestershire source. None of these samples match closely with the Doncaster example although the closest matches are with samples from East Yorkshire. This would be consistent with the possibility that the rock is metamorphic, since such metamorphic erratics of Scandinavian origin are found in East Yorkshire glacial deposits. Examination of the data indicates that the Doncaster sample is low in silica, lead and the rare earth elements and high in aluminium, titanium and magnesium. Other elements fall within the range found for known erratic-tempered wares.

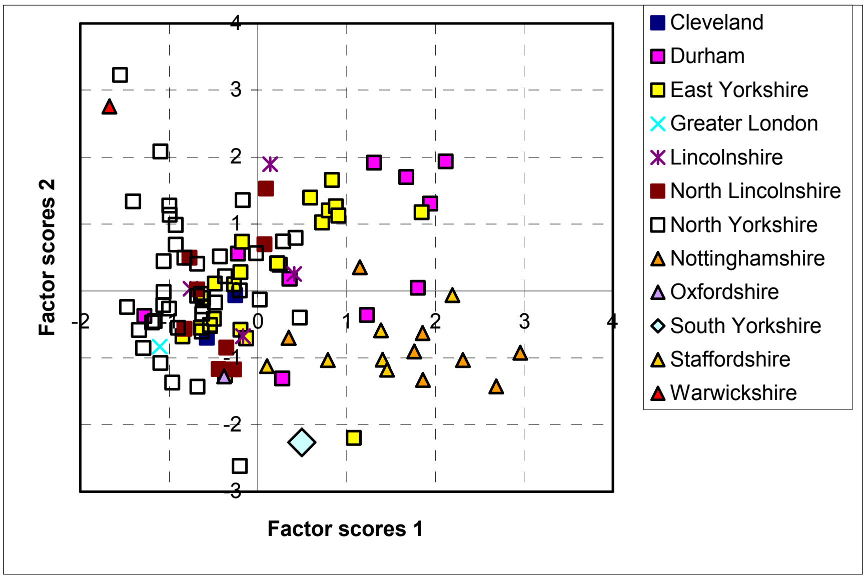

Figure 1

The vessel is therefore probably an erratic-tempered ware and the thin section and chemical analysis together suggest a source using glacial lacustrine clay tempered with erratic rock of a single unusual lithology. This description matches some Iron Age pottery of the Vale of York more closely than it matches early to mid Anglo-Saxon vessels.

Granite-tempered ware

The fabric of this vessel (V4194) in thin section contains sparse angular fragments of an igneous rock, moderate rounded quartzose sand typical of Triassic measures (quartz, chert and fine-grained sandstones, all with a high sphericity) and a groundmass of laminated clay containing sparse angular quartz. The igneous rock fragments are fresh and consist of plagioclase feldspar, orthoclase feldspar, biotite and minor quartz. Some feldspar of perthitic texture is also present and some of the feldspars are zoned. This rock is therefore consistent with the Mountsorrel Granodiorite. Similarly, the presence of rounded quartzose sand of Triassic derivation is consistent with an East Midlands origin (although also consistent with a local, south Yorkshire, source). The groundmass is finer-textured that that of the Erratic-tempered vessel and lacks muscovite.

Factor analysis of the ICPS data for this sample shows that it has a higher estimated silica content and lower aluminium content than the erratic-tempered ware but that the normalised data is very similar, with both vessels having lower rare earth elements and lead than is normal and higher magnesium. In comparison with likely Leicestershire products the sample also has higher potassium. There is therefore a conflict between the evidence from the thin sections, which suggests that this is an East Midlands product and the ICPS data which suggests a similar composition to the erratic-tempered ware for which an origin north of the Humber has been suggested.

Possible Late Saxon Greyware

Three samples of wheelthrown greywares were selected for analysis. Visually, two of these could have been either residual Roman greywares or unusual Late Saxon types (V4193 and V4192 and the third (V4179) has a lid-seated rim similar to those found on other Late Saxon/Anglo-Scandinavian jars, but also found on some later Roman greywares (such as Derbyshire ware).

In thin section all three contain a similar quartzose sand in which the larger grains are both well-rounded and have a high sphericity. Some grains of medium-grained sandstone and chert are also present in all three samples. The groundmass of V4193 contains very little quartz or other visible inclusions whilst those of the other two fabrics contain moderate angular quartz grains up to 0.1mm across.

The quartzose sand in all cases is similar to that found in the Trent valley terrace sands but since these are derived almost entirely from Triassic sandstones and sands this does not preclude a local, South Yorkshire origin, since these sandstones outcrop immediately to the east of Doncaster and form a major element in local cover sands. The extremely fine-textured groundmass of V4193 is not consistent with the use of a Triassic marl or mudstone but is matched by Lower Jurassic clays in the Trent valley, including those used at Torksey.

Thus, the thin section analysis suggests that V4193 might be a Torksey ware whilst the other two samples might be Torksey-type wares, made at other sites in the Trent valley, or perhaps local, South Yorkshire, wheelthrown greywares of Roman or Late Saxon origin.

The ICPS data for these three samples was therefore compared with samples of red-firing Doncaster wares (Hallgate A and Doncaster Fabric C); wheelthrown greywares from Lincoln (LSLS and SNLS); and samples from the seven kilns excavated at Torksey by Barley and samples of production waste of Torksey-type ware from Newark. Factor analysis of this dataset revealed three factors and a plot of the first two factors showed that none of the three samples were comparable with Newark Torksey-type ware; Lincoln sandy wares or Torksey wares from kilns 6 or 7. The analysis was therefore repeated omitting these three groups and again three factors were found. A plot of the first two factor scores showed that the second factor distinguished the Doncaster products from the remainder, including the three Askews samples, of which one formed an outlier and the other two plotted with the remaining Torksey kiln samples whilst the third factor distinguished two groups within the Torksey products. The Doncaster samples were then omitted and the data re-analysed. Again three factors were found, of which the second distinguished one of the Askews samples from the remainder and the third distinguished another of the Askews samples. The third Askews sample, V4193, could not be distinguished from the remaining Torksey samples by any of the three factor scores. The data was then analysed again omitting the two non-matching samples and four factors were found. Bi-plots of F1 against F2 and F3 against F4 enabled the Askews sample to be distinguished from the products of Kilns 1, 3, 4 and 5. The sample, therefore, is identified as a probable product of Kiln 2. This kiln produced vessels which are rather different in appearance to those from the other kilns (the products are reduced throughout rather than having the “sandwich” firing typical of later Torksey products) and from its typology it is dated to the late 9th to early 10th centuries.

This sample, V4193, is therefore identified as a product of Kiln 2 at Torksey both by its petrology and chemical composition. The other two samples, V4179 and V4192, and more similar to Torksey products than to any of the other comparanda but do not precisely match any of the 7 kilns excavated by Barley. The lid-seated vessel does appear from its typology to be an Anglo-Scandinavian vessel and may be a product of a Torksey kiln which has not been yet been sampled. The grey body sherd could be a product of one of the Roman greyware industries in the Trent valley (some of which, such as Little London, occur in the Torksey area itself).

Shell-Tempered wares

Twelve samples of shell-tempered ware were selected for analysis. These were of four groups:

- Lincolnshire Early Medieval Shelly ware (LEMS)
- North Lincolnshire Early Medieval Shelly ware (NLEMS)
- North Lincolnshire Limestone-tempered ware (NLST)
- North Lincolnshire Limestone-tempered ware or Potterhanworth ware (NLST/POTT)

Thin section analysis of Lincolnshire shell-tempered wares reveals that they were tempered with nacreous bivalve shell (i.e. with a mother-of-pearl structure) with few other shell types present. Occasional ferroan calcite coating was present on the shell fragments or as loose fragments, indicating that the geological deposit from which the shells were obtained was a marl or limestone. In addition they contain small quantities of rounded quartz sand, probably originally of Triassic origin but present as blown sand of quaternary date which is ubiquitous throughout the county. The groundmass contains few visible inclusions. Chemical analysis was therefore chosen to investigate potential differences in the composition of the clay groundmass.

Factor analysis was undertaken of these twelve samples and four factors were found. The first factor separates the LEMS and NLEMS samples from the remainder and the second factor separated one of the NLST/POTT samples from the remainder. The third and fourth factors did not reveal any obvious patterning. Examination of the data indicates that these differences are due mainly to three elements: zinc, manganese (higher in LEMS/NLEMS) and vanadium (higher in NLST and NLST/POTT). The separation of the two NLST/POTT samples is due to higher sodium and potassium values in the anomalous sample.

Taken together, these results indicate that the LEMS and NLEMS samples cannot be separated by their chemical composition and either the two wares are from the same source or the LEMS sample is a mis-identified NLEMS vessel. Samples of LEMS from Lincoln have not been analysed and such an analysis would determine which option is correct (Young and Vince 2006, LEMS). It is likely that one of the NLST/POTT samples is actually NLST but whether the other is a Potterhanworth product cannot be determined from this analysis since there are no comparative chemical analyses of Potterhanworth ware (apart from six NAA samples analysed by Dr Mike Hughes for the East Midlands Anglo-Saxon pottery project. Unfortunately, only a handful of elements analysed in that study are also analysed in the RHCL ICPS setup). Fig 1 shows a plot of the first two factors after re-assigning the LEMS and NLST/POTT samples.

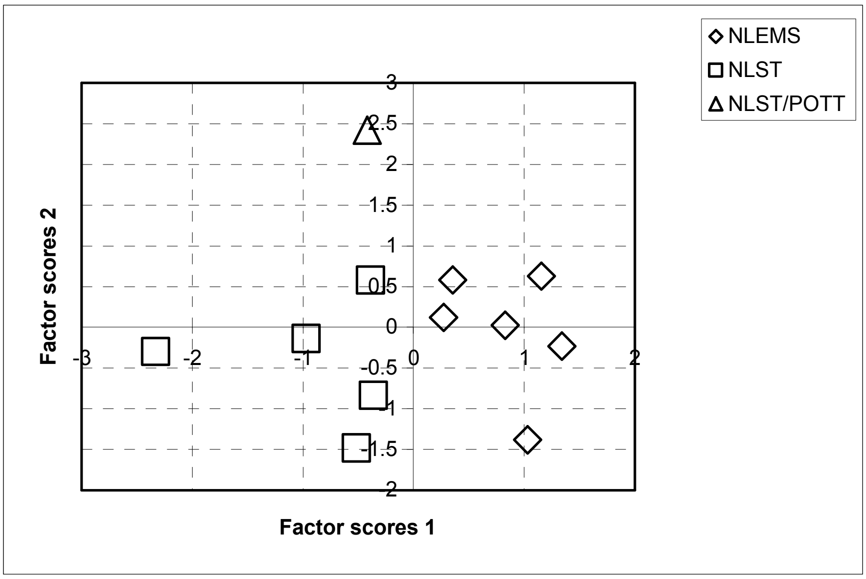

Figure 2

The Askews data was then compared with that from a range of shell-tempered wares from Lincolnshire and East Yorkshire. These consist of:

- Lincoln Kiln Type ware, produced in the lower city of Lincoln and its eastern suburb between the late 9th and the early 11th centuries (Young and Vince 2006, LKT).
- Lincolnshire Fine-Shelled ware and North Lincoln Fine-Shelled ware (Young & Vince 2006, LFS, incorporating samples identified as NLFS by Jane Young).
- Early Lincolnshire Fine-Shelled ware (Young and Vince forthcoming, ELFS).
- Two Iron Age shell-tempered wares from Melton, East Yorkshire, thought to have been produced from Lower Jurassic clays north of the Humber (IALST1 and IALST2)
- Two samples of LEMS from the medieval port of Hartlepool (LEMS – HP).

Factor analysis of this dataset reveals two factors and these in combination serve to distinguish three chemical groups: firstly, the IALST1, IALST2, NLST, NLEMS and LEMS – HP group, which have high F2 scores and negative F1 scores; secondly, the LKT samples, which have lower F2 scores but also negative F1 scores and, thirdly, the ELFS and LFS samples.

These results suggest that the negative F1 scores are associated with Lower Jurassic clays. The sources of ELFS and LFS have not been identified but are thought to be utilising Middle Jurassic clays from the dip slope of the Jurassic ridge (i.e. the same geological location as Potterhanworth). The distinction between the Lincoln samples and the IALST/LEMS/NLST group may be due to the use of different strata within the Lower Jurassic since the clay used at Lincoln is the Upper Lias whereas the clays used for the Melton shelly wares are probably earlier deposits. There is also a difference in the character of the lower Jurassic deposits as one travels north from Lincoln to the north side of the Humber and this is reflected in higher vanadium and chromium levels, two of the distinguishing features of those samples with high F2 scores.

These features suggest that LEMS - HP, NLEMS and NLST were all produced using Lower Jurassic clays from locations north of Lincoln. This in turn would suggest that the aberrant NLST/POTT sample, which has similar F1 and F2 scores, is also produced in that area. The lack of separation of NLST and NLEMS samples in Fig 2 probably indicates that although the two wares are chemically distinct this difference is minor compared with the differences between them and the Lincoln and LFS samples. A source for NLEMS and NLST north of the Humber is geochemically possible but archaeologically unlikely, given that both wares are less common north of the Humber than they are in North Lincolnshire.

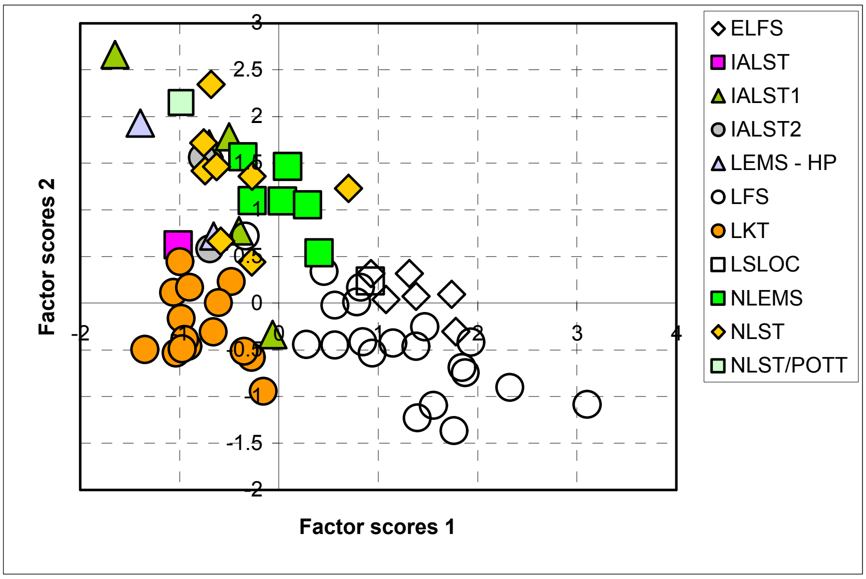
Factor scores 2
Factor scores 1
-2
-1
0
1
2
3
4
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
ELFS
IALST
IALST1
IALST2
LEMS - HP
LFS
LKT
LSLOC
NLEMS
NLST
NLST/POTT

Figure 3

Thetford-type ware and Early Medieval Handmade Ware

A remarkable feature of the Askews pottery assemblage was the number of sherds of East Anglian Saxo-Norman sandy wares. These are of two types based on method of manufacture and typology: Early Medieval Handmade Ware (EMHM) and Thetford-type ware (THETT). Study of examples of EMHM from Lincoln suggested that some were probably East Anglian products (similar vessels were produced at Blackborough End, just south of King's Lynn) whilst others had a rounded quartz sand which was very similar in the hand specimen and in thin section to that produced at Torksey. These two types were distinguished by subfabric letters, EMHM A and EMGM T respectively. Examples of both types were present at the Askews site, but, in addition, some examples appeared to be transitional between the two, having occasional polished quartz grains and angular flint inclusions, which are characteristic of EMHM A, alongside an abundant rounded quartz sand which appears identical to that found in EMHM T. This suggested that perhaps EMHM T was not a Trent valley product but was produced further east, where cover sands containing both types of quartz are found. A similar sand has recently been identified in a later Roman shelly ware on a consumer site at Partney, which it is suggested was produced in the central clay vale which separates the Jurassic ridge from the Wolds. Similar sands, however, probably occur immediately south of the central clay vale where islands of glacial deposits outcrop surrounded by more recent silts and muds.

The Thetford-type ware consists of large storage jars decorated and strengthened by the addition of thumbed clay strips. These are a distinctive product of the Grimston Thetford-type industry. Grimston is situated about 6 miles east of Kings Lynn and 6 miles north-east of Blackborough End. It is therefore quite possible that the two production sites were utilising the same raw materials.

Nine samples were thin-sectioned. They consisted of three examples of THETT storage jars; four samples of EMHM jars; one sample from what might be either a THETT or EMHM vessel and one sample from a jar which might be EMHM or Torksey ware. Three fabric groups were identified corresponding to THETT, EMHM and Torksey or EMHM.

THETT

Four samples have a distinctive appearance in thin section, containing abundant rounded altered glauconite grains, most of which are now opaque, and well-rounded quartz grains which are likely to be of Lower Cretaceous origin, in a groundmass of highly birefringent baked clay minerals with few visible inclusions. Rarer rounded chert and siltstone grains and organic voids surrounded by a blackened halo were also present. One of the sections (V4178) has specks of ferroan calcite, perhaps microfossils, in the groundmass. These are certainly not present in the other three sections, although this may be due to post-burial leaching rather than their never having been present.

The lack of silt-sized inclusions in the groundmass is characteristic of marine clays and it is possible that the parent clay is an Upper Jurassic clay. However, the Lower Cretaceous Gault clay outcrops at Grimston where it includes marly clay, limestone and red marl (Chatwin 1961, 23). Similar glauconitic clays with no silt-sized quartz or mica occur in the Lower Cretaceous of the Vale of Pickering (Speeton Clay) and at Ely, where a group of samples of medieval cooking pots submitted as Ely products have this fabric. However, it is only a supposition that these are locally-made and they certainly have a different composition from other Medieval Ely wares.

The quartz sand appears to have a high proportion of grains of Lower Cretaceous origin (recognised at x20 magnification by their polished surfaces and in thin section by their complex outlines and often the presence of an opaque coating and staining of veins. However, the sand also includes some grains which probably have a Triassic origin. These could have been brought south or east in fluvio-glacial sands and imply that the sand comes from a Quaternary cover sand rather than directly from a Lower Cretaceous deposit.

The ICPS data from these samples was compared with that from one other Askews sample, not thin-sectioned; another find from Doncaster (DCH/Y); samples from Barton-upon-Humber and Selby; samples of the three glauconitic jars from Ely and samples from the production sites of Thetford and Grimston. Factor analysis of this data found three factors and a plot of the first two factors indicated that the Doncaster and Selby samples have similar chemical compositions. The Ely samples formed a separate cluster but were closest to the Doncaster/Selby group whilst the Grimston and Thetford samples were distinguished by their negative F2 scores and the Barton sample by its negative F1 score (Fig 3). The main distinguishing feature of the Thetford samples was their higher potassium values and their lower nickel and chromium values. The Barton sample was distinguished by its higher sodium value and lower nickel value. It is therefore likely that the Selby and Doncaster samples come from the same source but it is unclear whether that source is Grimston, although the Grimston and Thetford samples were analysed at a different laboratory using a different procedure (ICP-MS instead of ICP-AES). It is also possible that the Grimston samples differ in date from the Doncaster and Selby ones, since the Pott Row, Grimston, site was in operation in the later 11th through to the 14th or 15th centuries (Leah 1994 and Jennings and Rogerson 1994).

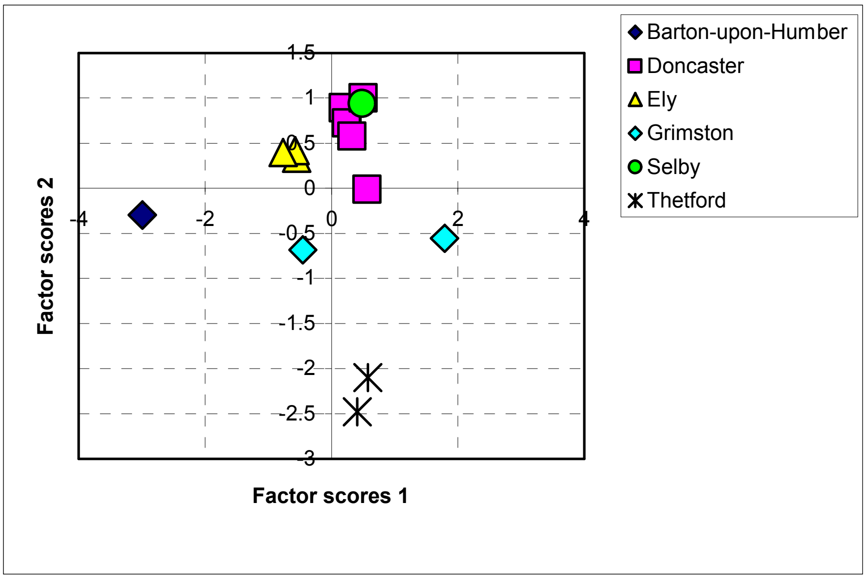

Figure 4

EMHM A

One of the EMHM samples from the Askews site (V4195) has a similar, but finer-textured, fabric to that of the Grimston Thetford-type samples and is similar to those samples in chemical composition. This thinness of the body, however, makes it clear that this is indeed a sample from a globular-bodied jar of EMHM type and not a mis-identified Thetford-type ware vessel. In the hand specimen, abundant polished quartz inclusions could be seen, identifying the fabric as subfabric G.

No chemical data from samples of Blackborough End ware have been analysed and so this source remains possible and the chemical composition of this sample is closer to that of the Thetford-type wares than it was to either the Ely glauconitic coarseware or the two Grimston samples.

EMHM T

Two samples, V4177 and V4181, come from bead-rimmed handmade globular jars of EMHM type. In thin section they contain a rounded quartz sand, similar to but more varied than Torksey ware, containing spherical quartz grains of Triassic character, plagioclase feldspar, chert, basic igneous rock, granite, sandstone, volcanic glass containing small laths of feldspar and rounded opaque grains. One of the samples also contains a rounded, stained fragment of bivalve shell and sparse angular flint. The groundmass in these two samples contains abundant quartz and moderate muscovite laths, both up to 0.1mm long.

The range of inclusions found in these two sections suggests that they come from a fluvioglacial sand including material of northern origin (northeast England or the Scottish borders) and such sands are typical of Quaternary deposits along the east coast. In the hand, polished quartz grains are present and these preclude an origin in the Holderness claylands or the Lindsey Marshes but are consistent with the central clay vale in Lincolnshire, inliers of boulder clay and Quaternary sands in the fens and much of East Anglia.

The ICPS data from these two samples were compared with that of Torksey ware, Roman shell-tempered ware from Partney, which contains a similar quartzose sand; Yarmouth ware from Norwich, Melton fabrics 1 and 2 from Melton, Nr. Woodbridge, in Suffolk (Anderson 1998-9), and samples of a ware with sparse shell and rounded quartz inclusions from sites along the east coast, from Newcastle-upon-Tyne in the north to Orby in Lincolnshire (GSS). The Melton fabric 3, Partney shelly ware and Torksey wares could be clearly distinguished from the remainder are were therefore omitted and the analysis repeated. In this second analysis two factors were found (Fig 4) and the GSS samples have higher mean F2 scores than the remainder. The Melton 1 and Yarmouth-type ware samples have high F1 scores, as does sample V4177 and several of the GSS samples whilst V4181 and the remaining GSS samples have negative F1 scores.

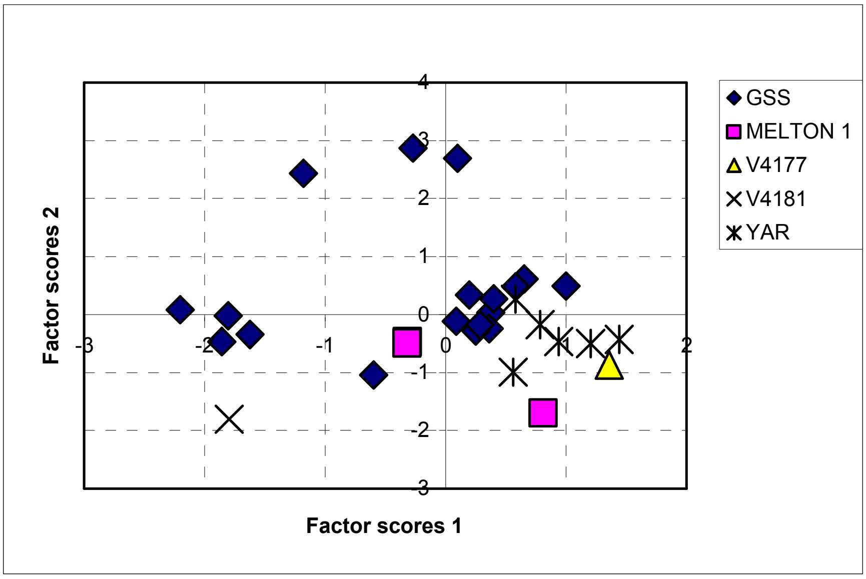

Figure 5

Thin section comparison of the EMHM samples with the Yarmouth-type and Melton 1 samples indicates that the former has a finer-textured groundmass and the latter a coarser-textured groundmass than the EMHM sherds.

These results suggest that there are close similarities between the GSS samples and the EMHM samples in thin section and in their chemical composition but that they are nevertheless from different sources. The best match chemically appears to be with East Anglian wares. However, neither Yarmouth-type ware nor Melton ware is a close match in thin section (nor are these round-bottomed jars a known product of either industry).

EMHM or Torksey ware

Two samples were taken of vessels which in the hand might have been either Torksey ware or EMHM. V4190 comes from a vessel with a sharp base angle and sagging base, which suggests a Torksey-type ware whilst V4191 comes from the base of a thin-walled vessel. The base sherds do not include a base angle but the curvature suggests either that the vessel was extremely large or that it too had a sagging base. At x20 magnification, neither sample contained polished quartz grains, flint or any other inclusions which preclude a Torksey origin but, despite this, neither vessel shared all the manufacturing or firing characteristics of Torksey ware, justifying analysis.

In thin section both samples contain similar rounded quartz sands, including in addition rounded chert, fine-grained sandstones, plagioclase feldspar and opaque grains. The groundmass is fine-textured and contains rounded clay pellets, some stained by manganese, but of the same colour and texture as the groundmass. These characteristics are consistent with a Torksey origin and are different from the two EMHM T vessels.

The chemical data from these two samples was compared with that for Torksey ware from the Torksey kilns, Newark Torksey-type ware and with the Partney Roman shell-tempered ware described above. Three factors were found and a plot of the first two factors indicates that V4191 has a higher F1 score than either the Torksey or Partney samples. The V4190 sample has similar F1 and F2 scores to the Torksey wares, although the combination of F1 and F2 scores places the sample with the Partney samples. Its strong negative F3 score separates sample V4190 from the remainder. Examination of the data indicates that both samples have several element values which distinguish them from Torksey products. However, the distinguishing elements are different for each sample (iron, chromium and vanadium for sample V4190 and barium, chromium and zinc for V4191) indicating that neither sample is likely to be a Torksey product and that they are quite probably from different sources. The fine-textured groundmass suggests the use of a Jurassic clay, indicating that neither is a local product, but no closer identification is possible.

East Yorkshire Quartz and Calcareous Ware

A single vessel was identified at x20 magnification as a likely example of East Yorkshire Quartz and Calcareous ware (EYQC). This is a distinctive coarseware which contains a mixed sand, composed mostly of quartz with some oolitic limestone and other rocks, and has a fine-textured groundmass quite unlike that of most East Yorkshire pottery. Analysis of thin sections and chemical composition suggests that the ware was produced in that part of east Yorkshire where Jurassic clays outcrop (or were redeposited as boulder clay), immediately to the west and south of the Chalk scarp. Samples from Wawne; Melton; and North Newbald were examined in thin section and using ICPS and all have a similar composition, although with sufficient internal patterning to suggest both post-depositional alteration of the chemical composition (affecting two of the Wawne samples) and possibly the presence of two or more distinct fabric groups. The Askews sample, V4196, contains a subangular quartz sand; fragments of a sandstone containing a similar quartz sand with a ferroan calcite cement; opaque grains; oolitic limestone with a ferroan calcite cement and non-ferroan calcite ooliths mostly altered to micrite; organic inclusions; angular flint; bivalve shell, and ironstone concretions with fine quartz inclusions. This suite of rock and mineral fragments is precisely paralleled and identify this sample as an example of EYQC.

The chemical composition of the Askews sample differs from that of the comparanda in three elements: sodium, phosphorus and zinc, each of which is higher than in the comparative samples, having values which are more than 4 standard deviations from the overall mean. All three, however, are mobile elements affected by burial conditions.

Whitewares

Fifteen samples of whiteware were selected for analysis. Two of these were thought to be Stamford ware unglazed jars. One was a sample of a yellow-glazed, roller-stamped vessel paralleled at Lincoln, where it was published as an import, Brunssum ware (Young and Vince 2006, BRUNS). One was a gritty whiteware vessel with roller-stamped decoration, classed by Vince as Doncaster Gritty ware (DONCG) as a result of analysis of sherds from previous excavations in Doncaster and comparison with York Gritty ware. The remaining samples were submitted as examples of Coal Measures Whiteware or Doncaster Hallgate B ware.

Factor analysis of the chemical data for these 15 samples indicates that the majority form a single cluster whilst the two Stamford vessels form a separate group and the BRUNS, DSR02 and DONCG samples form outliers.

Stamford ware

The two Askews Stamford ware sherds were compared with chemical data from three production sites in Stamford: the castle, which is a late 9th century kiln site (Kilmurry 1977); Wharf Road, which is a late 11th to mid 12th century site (Mahany and Simpson 1982) and Pantiles which is mid 12th century (Kilmurry 1980). Samples of Stamford ware from consumer sites at Perth (probably mid 12th century or later); Doncaster (probably late 11th century) and Ingmanthorpe Manor, near Wetherby (probably late 11th century or later).

Factor analysis of this data found three factors (Figs 2 and 3). These distinguish the Castle and Wharf Road samples from the remainder and place the two Askews samples in the same group as the Developed Stamford ware cluster, which is itself similar to the Pantiles kiln material. This suggests that the two samples are indeed Stamford products and probably date to the 12th century. Both the Pantiles site and the Stamford Grammar School, which produced Developed Stamford ware, were located on the northeast fringes of the medieval town and it is likely that their similarity in composition is due to the use of a local outcrop of clay. The Castle and Wharf Road fabrics are both noticeably coarser than the Pantiles and Developed Stamford ware fabrics.

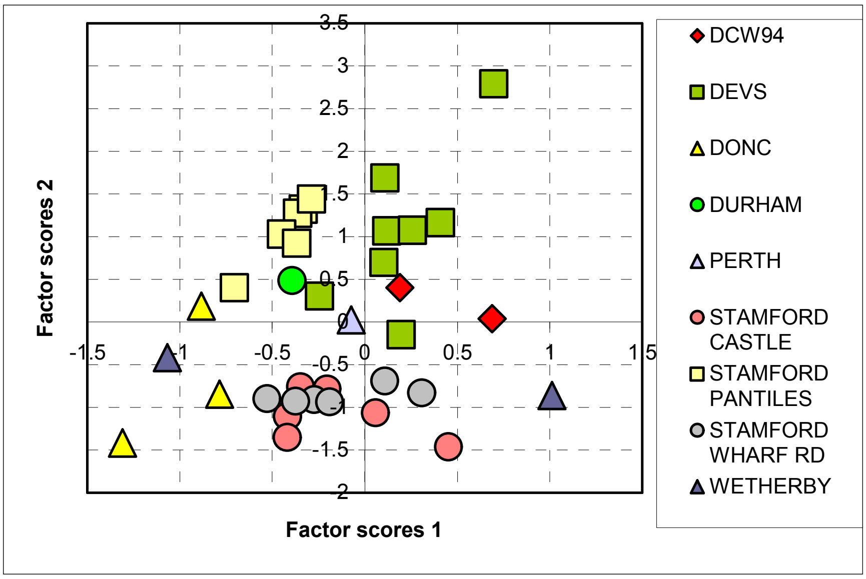

Figure 6

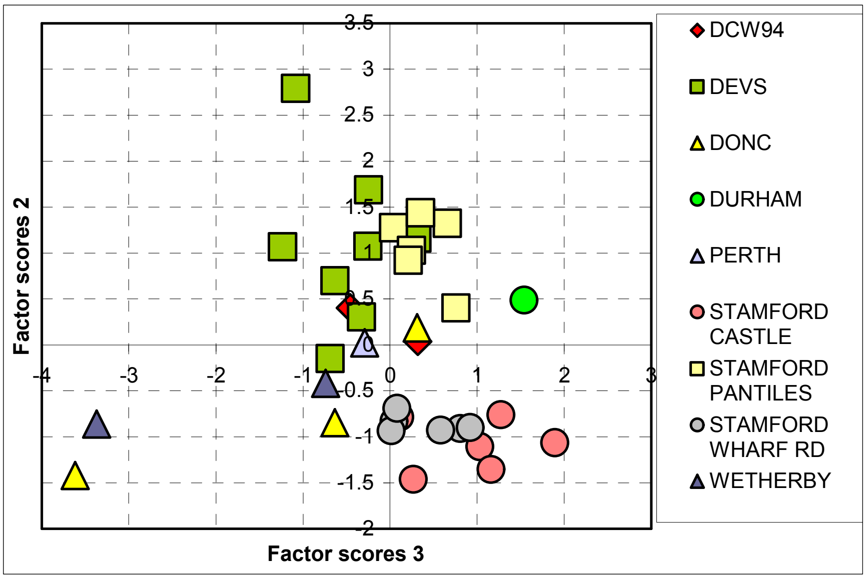

Figure 7

Brunssum Ware

This sherd was identified by Jane Young as being visually similar to a group of glazed roller-stamped flasks from Lincoln and Goltho, dating to the later 12th century (Young and Vince 2006, BRUNS). The was was termed “Brunssum-type” because the Goltho vessel was identified as an import from Brunssum, Limburg, by Glynn Coppack (Coppack 1987). However, analysis of thin sections of the Lincoln and Goltho vessels found that those from Lincoln had an extremely fine-textured fabric with abundant silt-sized quartz and muscovite laths whilst the Goltho vessel had a similar groundmass but contained moderate rounded quartzose sand similar in character to that found in the Trent and Witham Valley terrace sands. This sand is composed in the main of material of Triassic origin, derived from the Sherwood Sandstone and other Triassic sandstones.

The Askews sample (V4180) has a similar appearance in thin section with one large quartz grain, 1.0mm across, but no other inclusions larger than c.0.2mm.

Unfortunately, such fine, white-firing clays occur widely and without large inclusions it is not possible to determine the source of this clay using thin sections alone, especially when an imported origin has been suggested and the vessels are rare (the Askews vessel is only the 6^{th} example known). .

The data from the Brunssum ware sample was therefore compared with that of medieval whitewares from a range of English and western European sources. These include the Rhineland and Meuse valley (Andenne-type ware; Paffrath ware; Pingsdorf ware; Langewehe stoneware); Stamford (as above); North Yorkshire (Brandsby-type ware and York Glazed ware), Derbyshire (Brackenfield ware) and South Yorkshire (Firsby ware, Doncaster Hallgate B and Rawmarsh wares). In addition, post-medieval clay pipes and other pipeclay artefacts from a range of sites in the Welsh Marches, Severn Valley and southwest England were compared.

None of these groups precisely matched the Askews sample, although all were similar. There is a white clay occurring in the Lincoln area, which was exploited in the early Roman period, at South Carlton and the Technical College, Lincoln, in the late Roman period at Swanpool, producing colour-coated vessels, and in the late medieval period to produce green-glazed finewares (Young and Vince 2006, LMF). This clay is thought to occur in the Middle Jurassic Lower Estuarine Beds, which outcrop at the top of the Jurassic scarp, immediately below the Lincolnshire Limestone. It is therefore similar in age to the clays used in North Yorkshire and Stamford. No examples of these Lincoln whitewares have been analysed using ICPS although an unpublished NAA study of the Roman whitewares was carried out by Peter Rush, then of Bradford University. Only four elements measured by Rush were also measured by RHCL, Sodium, Potassium, Lanthanum and Samarium. All of Rush's data were normalised to Scandium. In order to compare these data with the Askews's vessel the data were calibrated to Sodium using three ICPS samples from Melton, which were thought to be Lincoln or South Carlton mortaria.

Fig 5 shows these normalised data for various whiteware mortaria, the South Carlton and Lincoln NAA samples and the Askews sample. This indicates that there is a close similarity between the Askews sample and the Melton and South Carlton samples. By contrast, the Aldborough whiteware mortaria differs in three of the elements whilst the Ratcliffe-on-Soar, Low West Farm (Elloughton, East Yorkshire), Rocester and Lincoln Technical College samples all have higher sodium.

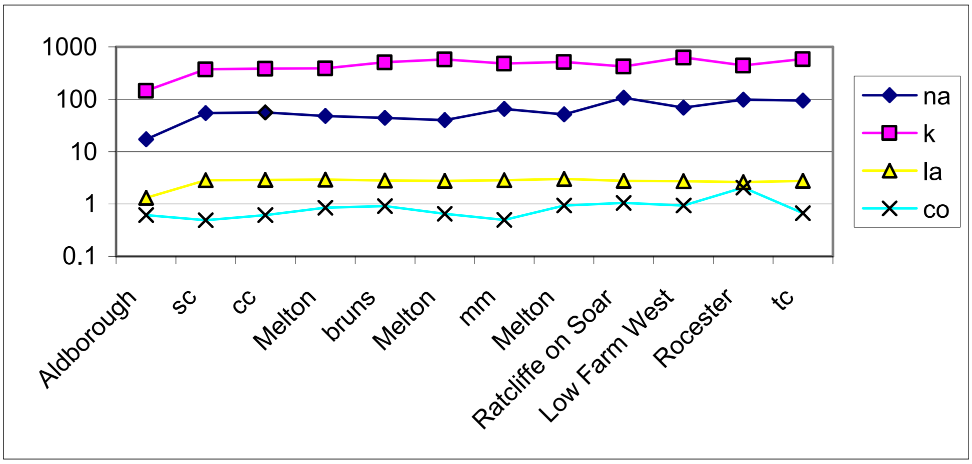

Figure 8

Factor analysis of the ICPS data for these whiteware mortaria and the Askews sample shows that the Askews sample is close in composition to the Melton samples, which could be either South Carlton or Lincoln Technical College products. Therefore, given the lack of close comparisons from elsewhere, the Askews vessel is suggested to be a Lincoln product although the attribution requires further testing.

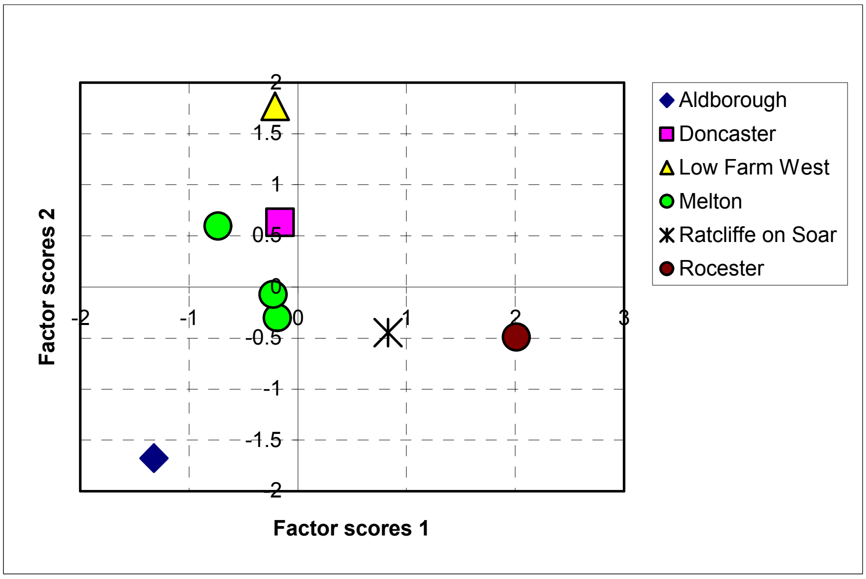

Figure 9

South Yorkshire Whitewares

The data from the ten Askews Coal Measure whitewares were compared with the ICPS data from various South Yorkshire whitewares.

The estimated silica content for these samples was plotted against the aluminium content (Fig 7). This shows that the Doncaster Hallgate samples have more silica than the Rawmarsh and Firsby samples and that the Firsby samples have a higher aluminium count for any given silica estimate than the Rawmarsh samples. All but four of the Askews samples have similar silica and aluminium values to the Firsby samples. The magnesium content of the samples separates the Askews samples into a group which have similar low magnesium values to Firsby and a group which have higher magnesium values, comparable with those found in the Rawmarsh and Hallgate samples.

However, factor analysis of the least mobile elements fails to produce the expected split and the data was therefore examined, element by element. This found that there are probably consistent slight batch differences in the measurement of certain elements. For the oxides and most frequent trace elements these differences are negligible but for the rarer trace elements the batch-by-batch differences influence the factor analysis. Probably, these errors affect the whitewares more than others because they tend to have lower frequencies of trace elements. This problem is illustrated by Fig 8 where Chromium values for Firsby and Rawmarsh are seen to be higher than for the Askews whitewares whilst the Cobalt values for the Rawmarsh samples vary for the samples taken for the South Yorkshire and Derbyshire reference collection (RAWMARSH) and the Northern Whitewares pilot project (RAWMARSH MC), even though both probably come from the same production site.

Examination of each element in turn found that this division based on magnesium content was mirrored for several other elements. In addition, calcium values are higher in the Hallgate samples than the remainder. Potassium values distinguish the Firsby and Low-Mg Askews samples from the Rawmarsh and high-Mg samples.

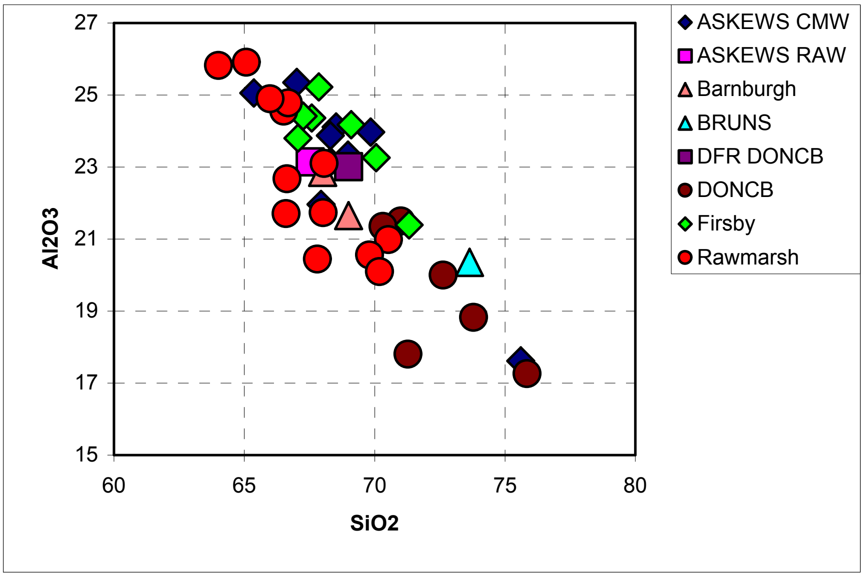

Figure 10

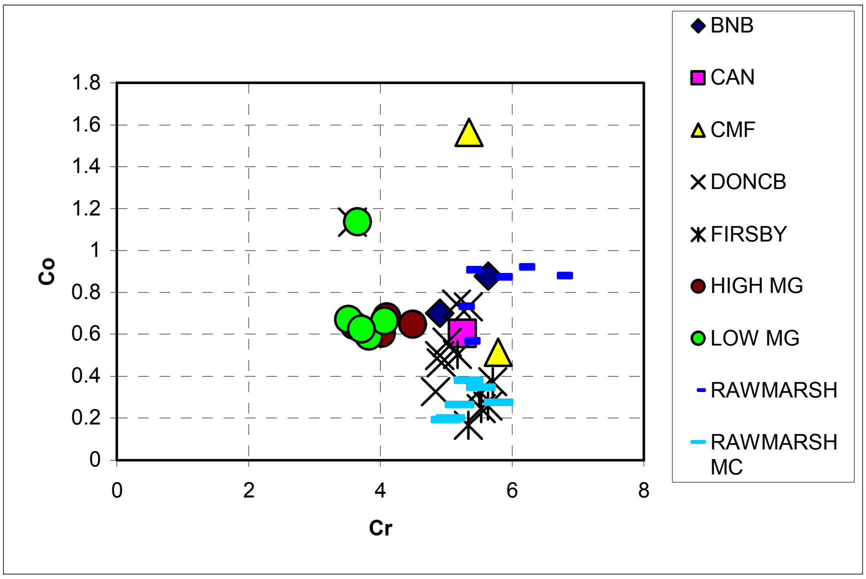

Figure 11

The factor analysis was repeated including estimated silica content and aluminium and excluding suspect elements. This produced two factors (Fig 9). The Rawmarsh samples include two separate batches, although the analysis was carried out at Royal Holloway College in both cases. These batches are distinguished in Fig 8 (Rawmarsh MC = A Vince/N Walsh data and Rawmarsh = M J Hughes data). The lack of any differentiation between the two batches gives confidence in the analysis.

In addition to these known production sites the South Yorkshire and Derbyshire type series includes whiteware fabrics which do not appear to come from these three sources. They are Barnburgh Hall-type, BNB, Coal Measures Fineware, CMF and a sample of Coal Measures Whiteware from Canklow Woods (CAN).

Fig 9 plots the F1 and F2 scores for this whiteware data. None of the Askews samples match those from Hallgate (DONCB) and the analysis was therefore repeated omitting the Hallgate samples. This produced a clear split between Rawmarsh and Firsby wares (Fig 10). The CMF samples and the low-mg Askews samples plot with the Firsby samples whilst the BNB CAN and high-mg samples plot with the Rawmarsh samples. It is likely that the CAN sample is a Rawmarsh product whilst distinct visual difference between the CMF and BNB wares may suggest either that they were specialist products of the Firsby and Rawmarsh industries or were made by separate groups of potters who were using similar clays.

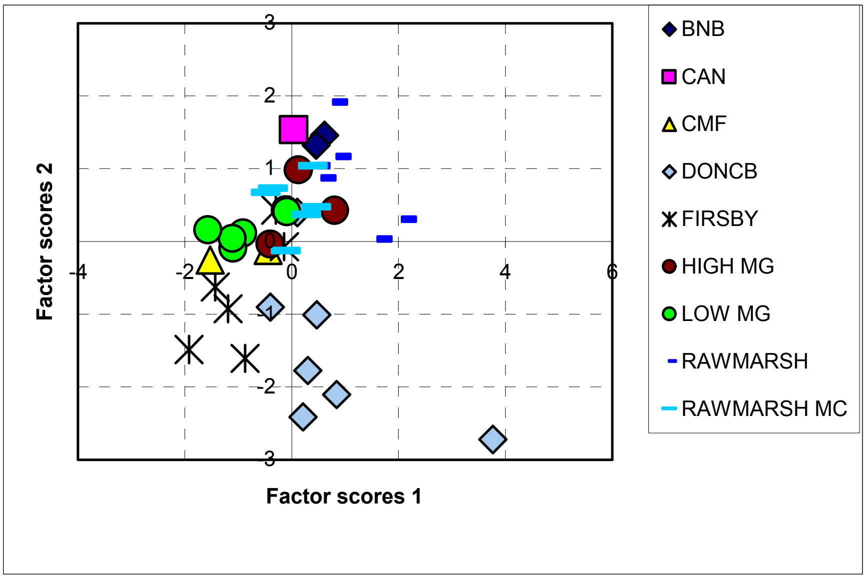

Figure 12

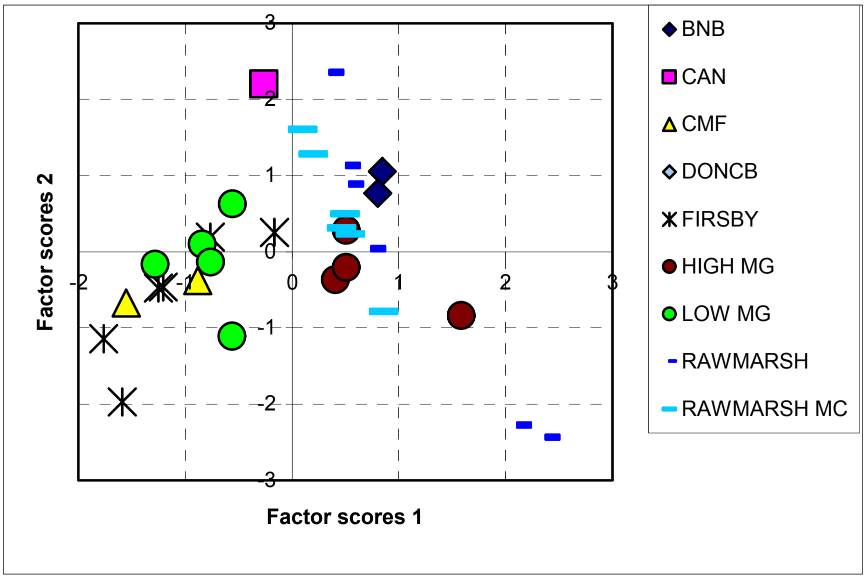

Figure 13

The whiteware samples from Askews therefore fall into two chemical composition groups, one of which (low mg) is matched by samples from Firsby and the other (high mg) by samples from Rawmarsh (Table 1).

Table 1

TSNO	Context	REFNO	cname	Form	Description
V4204	109	7	high mg	JUG	SAMPLE 05
V4210	147	2	high mg	JUG	SAMPLE 03;EXT CUGL
V4207	167	3	high mg	JUG	SAMPLE 08;INT + EXT PLAIN GL
V4208	167	6	high mg	JUG	SAMPLE 06;PLAIN EXT GL CF STAM
V4197	147	4	low mg		SAMPLE 02

V4199	101	14	low mg	JUG	SAMPLE 01;PLAIN EXT GL SPOTTED BROWN FROM FE INCLUSIONS IN SAND TEMPER
V4206	167	3	low mg	JUG	SAMPLE 07;EXT PLAIN GL
V4209	147	6	low mg	JUG	SAMPLE 10;EXT PLAIN SPLASH GL
V4211	590	2	low mg	JAR/JUG	SAMPLE 04;UNGLAZED
V4203	167	6	low mg	JUG	SAMPLE 09

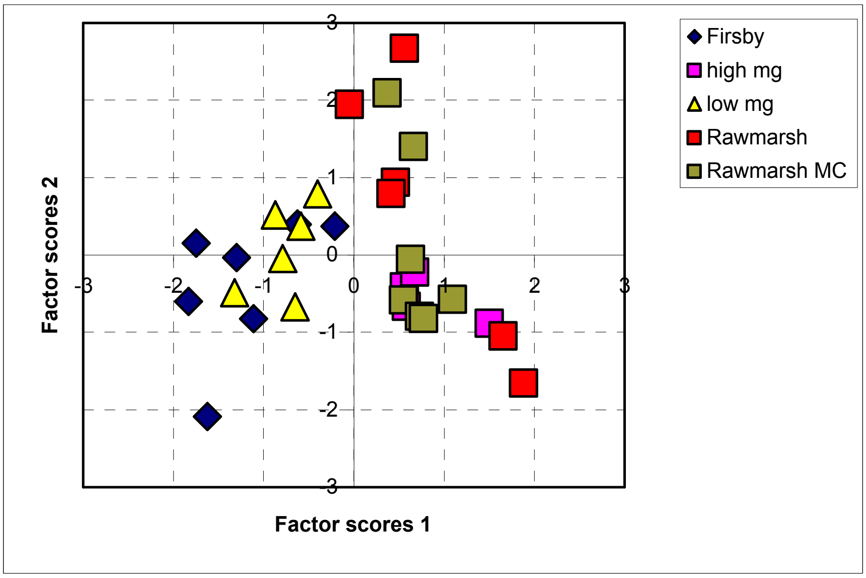

Figure 14

Doncaster Gritty ware

One of the submitted samples was a white gritty ware with a band of roller-stamped decoration on the shoulder.

Thin section analysis indicates that it was tempered with a coarse quartzose sand composed mainly of quartz grains up to 1.5mm across which are probably derived from the Millstone Grit or similar coarse-grained Carboniferous sandstone. In addition, fragments of medium-grained sandstone with a red iron-rich cement and rounded fragments of opaque and almost opaque clay/ironstone up to 1.5mm across were present. The groundmass contains sparse angular quartz up to 0.2mm across in a matrix of light-coloured anisotropic baked clay minerals.

These features are similar to those of York Gritty ware which is now thought to have been produced in West Yorkshire, with at least one production site being located at Potterton. However, sections of this ware have an even finer body, contain sparse to moderate pellets of light-firing mudstone and do not contain the red sandstone and clay/ironstone inclusions. The latter are a distinctive feature of Doncaster ceramics (Doncaster Fabric C).

Factor Analysis of the ICPS data indicates that this Askews sample is distinguishable from York Gritty samples from York, Thorner (termed Hillam ware by Cumberpatch and Roberts, Cumberpatch and Roberts 1998-1999), Ingmanthorpe Manor (near Wetherby) and Knaresborough but matches samples of unglazed white gritty ware from other sites in Doncaster. Two samples from Doncaster, however, match the York Gritty group. The factor analysis of the least mobile elements found only one factor and the factor scores are plotted against aluminium values, indicating that the Doncaster gritty group has both higher F1 scores and lower aluminium. All of the non-mobile elements apart from barium are higher in the Doncaster fabric and this is consistent with the presence of rare fragments of barytes in thin sections of the York Gritty fabric. Two of the York Gritty samples have anomalously high barium values whereas the remainder are similar to or lower than the values found in the Doncaster Gritty samples.

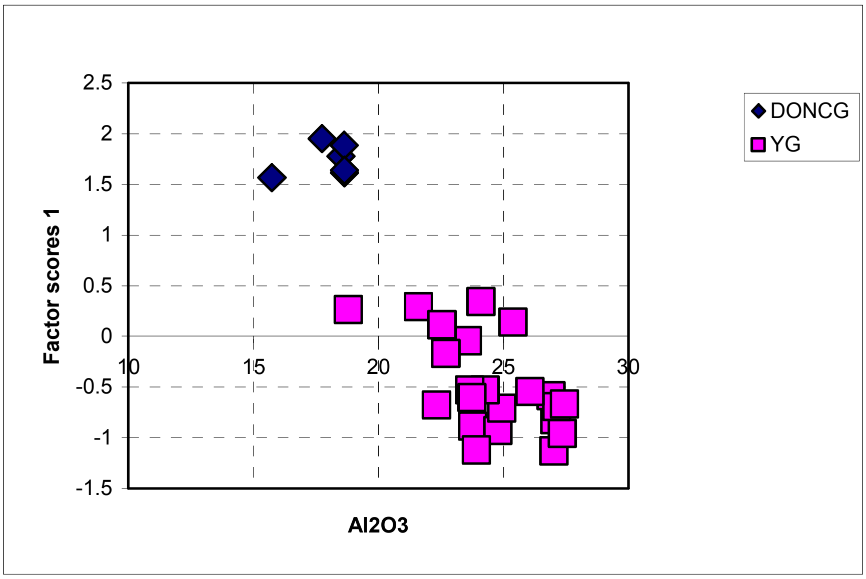

Figure 15

The Doncaster gritty samples were then compared with a range of probable Doncaster products: Hallgate A; Hallgate B, Doncaster Fabric C and samples from the Market Hall waste. Three factors were found in this dataset but only the first two show any patterning.

Fig 13 indicates that the Doncaster Gritty samples have higher F1 scores than the Hallgate A and most of the Hallgate B samples. In addition, the F2 scores distinguish Hallgate A and Hallgate B samples, with the Doncaster Gritty samples having intermediate scores overlapping with both fabrics. This data suggests that the Doncaster Gritty, Hallgate A and Hallgate B fabrics form three distinguishable chemical groups. However, the Doncaster Market samples do not form a separate group but instead split, with three clustering with Hallgate A, two with Hallgate B and three with the Doncaster Gritty ware samples.

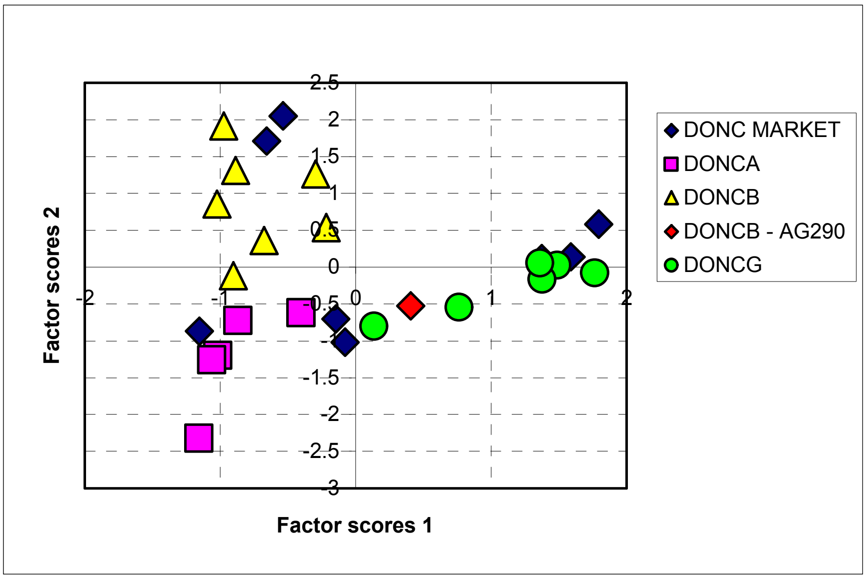

Figure 16

The separation of the Doncaster Gritty ware and the three Doncaster Market samples from the remainder is due almost entirely to high values for barium, nickel and zinc whereas the single Hallgate B sample (AG290) in this group has similar manganese and barium values but its nickel value is within the range for other Hallgate B samples. It is extremely likely that the high nickel and zinc values are due to the presence of these elements in the opaque and semi-opaque clay/iron inclusions which are a feature both of Doncaster Gritty and Doncaster Market fabrics. The separation of two of the Doncaster Market samples and the remaining Hallgate B samples is due almost entirely to high lithium and consistently lower values for most other elements.

Thus, the chemical data are consistent with Doncaster Gritty ware being a Doncaster product, being similar in composition to some of the Doncaster Market samples.

Glazed Red Earthenwares

Doncaster Red Sandy Wares

Two samples assigned to Doncaster Red Sandy Ware by Cumberpatch were submitted for analysis.

DRS01 contains a medium-grains subrounded quartz sand, similar to that found in Trent Valley sands and probably derived from Triassic sandstones. The groundmass contains abundant angular quartz and sparse muscovite and rare biotite laths. These characteristics are matched by some Lincoln products. However, the chemical analysis places this sample with samples of wasters of Hallgate Fabric A and Doncaster Market fabrics and not with Lincoln sandy wares (SNLS and LSLS) and this suggests a Doncaster origin.

DRS02 contains a mixed quartzose sand, including well-rounded grains, fragments of red sandstone, red siltstone, and angular grains which may be of Carboniferous sandstone origin. The groundmass is fine-textured and light-firing, similar to, but finer in texture than, the Doncaster Gritty sample. Factor analysis places this sample with the Doncaster Gritty samples (Fig 14). It therefore appears to be a Doncaster product, perhaps a finer, glazed equivalent to the Doncaster Gritty ware.

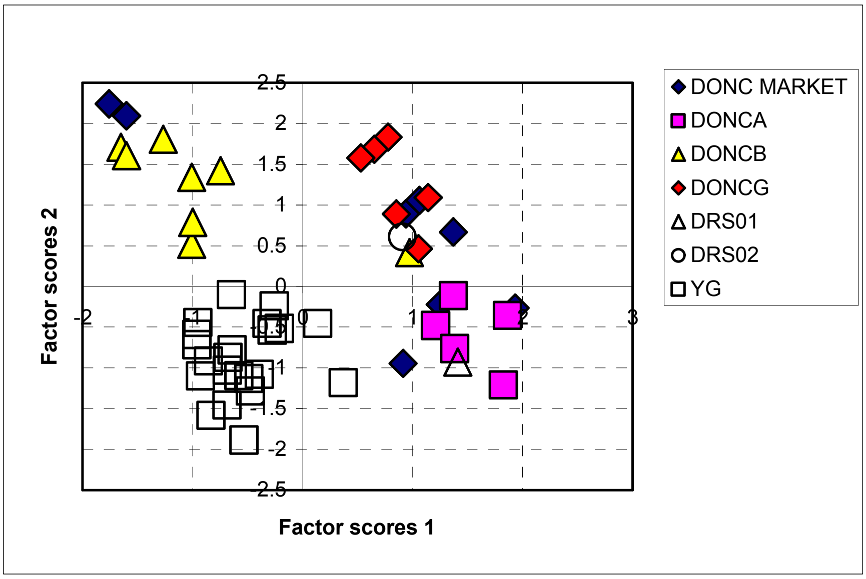

Figure 17

Beverley-Type wares

Two samples of Beverley-type ware were submitted for analysis. One, V4202, has a calcareous sand temper whilst the other, V4198, does not. Both have the silty, micaceous groundmass typical of Beverley-type wares. Analysis of similar vessels from York, Barton-upon-Humber, Ingmanthorpe Manor (nr Wetherby) together with wasters from Beverley indicates that the calcareous Beverley products (BEVO1 in Watkins' scheme, Watkins 1991) contain not only calcareous inclusions (which may be Jurassic limestones or chalk) but also fragments of basic igneous rock. These, however, may be absent from the finer-textured non-calcareous fabric which superceded it in the later 12th century (BEVO2 in Watkins' scheme). No basic rock inclusions are present in the York or Wetherby sections, suggesting that there may be a second source of Beverley-type ware, perhaps utilising the same estuarine muds as were used at Beverley but in the Humber wetlands west of the chalk Wolds.

The calcareous fabric, V4202, does contain basic igneous rock fragments and can be positively identified as a Beverley product of the mid to late 12th century. The non-calcareous fabric does not but does contain well-rounded grains of probable Triassic origin, siltstone and fine-grained sandstone fragments which are similar to those of the Middle and Upper Jurassic rocks which outcrop to the west and south of the Yorkshire Wolds and which lack the iron-rich cement found in the sandstones found in Doncaster products, and possible fragments of flint. These features would discount a Doncaster origin but would be conceivable in a fabric made from estuarine muds in the Humber wetlands.

The two Askews samples were therefore compared with Beverley-type wares from Beverley and the consumer sites of York, Ingmanthorpe Manor, and Barton-upon-Humber, together with redware Doncaster products (Doncaster Fabric C, Hallgate A and Doncaster Market. Factor analysis of this dataset showed that the Doncaster Market and Doncaster C samples were so different from the remainder that they acted to force all the other Beverley samples, the two Askews samples and the Hallgate A ware into a single large cluster. These were then omitted and the analysis carried out again. This time, samples V4202 had similar scores to the Beverley wasters and samples from Barton-upon-Humber, whilst samples V4198 had scores similar to York and Ingmanthorpe samples whilst the Hallgate A samples plotted midway between the two extremes.

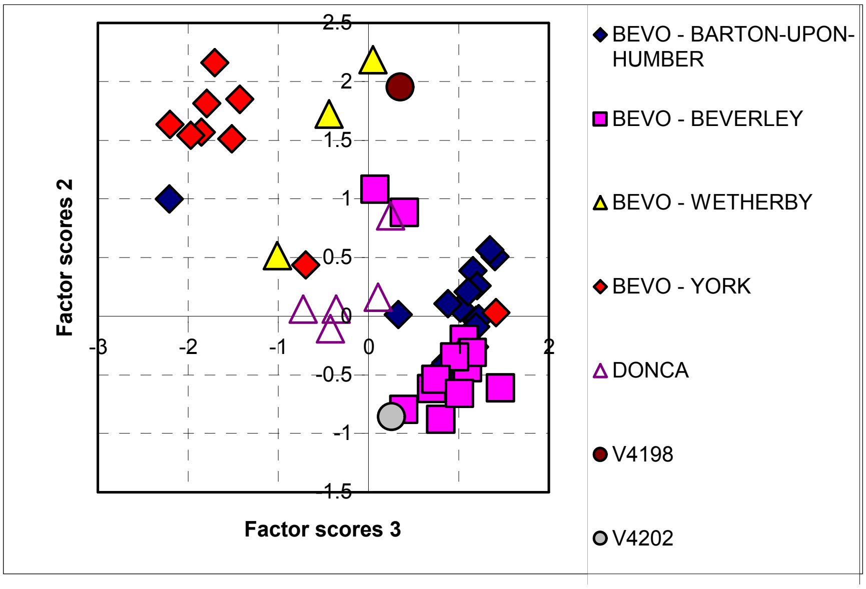

Figure 18

As a further test, the Beverley-type wares, the Askews samples and Hallgate A ware were analysed alongside samples of Humberware from production sites at York, Holme-upon-Spalding Moor and West Cowick. This analysis showed that sample V4198 again plotted with Beverley waste and samples from Barton-upon-Humber whilst V4202 plotted with the York and Wetherby Beverley-type samples and the West Cowick, Holme-upon-Spalding Moor and York Humberwares, all from production sites. This suggests that we should class V4198 as Beverley ware, being a definite product of the Beverley kilns, but that we should class V4202 as Beverley-type ware and suggest that it was made somewhere in the Humber wetlands between York and Brough-upon-Humber.

Hallgate A

A single sample was identified by eye as a possible example of Hallgate A ware.

In thin section a mixed sand composed of angular quartz (overgrown iron-cemented grains from a Carboniferous sandstone); rounded quartz (probably of Triassic origin); rounded mudstone fragments (probably of Coal Measures origin) and fine-grained sandstone fragments (probably of Triassic origin) was present, with grains ranging from 0.2mm to 1.5mm across. The groundmass was composed of almost isotropic baked clay minerals, abundant angular quartz up to 0.05mm across and moderate muscovite laths up to 0.1mm long. Laminae of finer, light coloured anisotropic clay were present.

These features are consistent with the use of an alluvial clay derived in part from white-firing Coal Measures mudstones and tempered with a sand derived from a mixture of Coal Measures and Triassic deposits. Such materials are locally available in the Don valley at Doncaster.

The ICPS data were compared with samples of red earthenwares from Doncaster including samples from the Hallgate kiln, the 1995 Hallgate production site, the Market waste and samples of Doncaster Fabric C. Factor analysis found no clear patterning within this data, suggesting that all these wares were produced from similar raw materials, although the third factor scores showed a different mean for Fabric C than for the remainder. This is due to lower sodium and titanium values in the Fabric C samples. However, the three factor scores for the Askews sample were always closest to those of the Hallgate A samples and this supports the identification. The Hallgate A samples consist of two from the 1970s excavations of Buckland *et al* and two from the 1995 excavations by Cumberpatch. The Askews sample is close to both groups but is consistently more similar to the 1995 samples than the 1970s ones. This is true not only for the three factor scores but also for individual element values, in particular for potassium, chromium, zirconium, lanthanum, samarium, dysprosium, europium and ytterbium. However, five of these elements are rare earths which tend to behave similarly and so are strongly correlated whilst zirconium is not completely dissolved in this ICPS procedure and is therefore potentially affected by batch errors. Therefore, the separation of the two groups of Hallgate A samples may be due to measurement errors rather than real differences between the groups.

Bibliography

Chatwin, C P (1961) *East Anglia and Adjoining Areas*. British Regional Geology London, HMSO

Coppack, G. (1987) "Saxon and medieval pottery ." in G. Beresford, ed., *Goltho: The development of an early medieval manor c.850-1150*, Engl Heritage Archaeol Rep 4 134-69

Cumberpatch, C. and Roberts, I. (1998-1999) "A medieval pottery kiln from Stead Lane, Thorner, Leeds."*Medieval Ceram*, 22-23, 145-7

Dickson, J. A. D. (1965) "A modified staining technique for carbonates in thin section."*Nature*, 205, 587

Hains, B. A. and Horton, A. (1969) *British Regional Geology: Central England*, HMSO, London

Jennings, S. and Rogerson, A. (1994) "The distribution of Grimston Ware in East Anglia and beyond." in M. Leah, ed., *The Late Saxon and Medieval Pottery Industry of Grimston, Norfolk: Excavations 1962-92*, E Anglian Archaeol Rep 64 Field Archaeol Division Norfolk Mus Service, Dereham, 116-120

Kilmurry, K. (1977) "The production of red-painted pottery at Stamford, Lincs."*Medieval Archaeol*, XXI, 180-6

Kilmurry, K (1980) *The pottery industry of Stamford, Lincs, c AD 850-1250*. Brit Archaeol Rep 84

Leah, Mark (1994) *The Late Saxon and Medieval Pottery Industry of Grimston, Norfolk: Excavations 1962-92*. E Anglian Archaeol Rep 64 Dereham, Field Archaeol Division Norfolk Mus Service

Mahany, C Burchard A and Simpson, G (1982) *Excavations in Stamford Lincolnshire 1963-1969*. Soc Medieval Archaeol Monogr Ser 9 Soc Medieval Archaeol

Watkins, G. (1991) "The Pottery." in P. T. D. Armstrong and D. H. Evans, eds., *Excavations at Lurk Lane Beverley, 1979-82*, Sheffield Excavation Rep 1 J R Collis Publ , Sheffield, 61-103

Williams, D. and Vince, A. (1997) "The Characterization and Interpretation of Early to Middle Saxon Granitic Tempered Pottery in England ."*Medieval Archaeol*, XLI, 214-219

Young, Jane and Vince, Alan (2006) *A Corpus of Anglo-Saxon and Medieval Pottery from Lincoln*. Lincoln Archaeological Reports Oxford, Oxbow

Young, J. and Vince, A. (forthcoming) "Chapter 12. The Anglo-Saxon Pottery." in C. Loveluck, ed., *Flixborough. Vol 2. The Inhabitants: artefact reflections on their lifestyle*, Kingston upon Hull