Characterisation Studies of Anglo-Saxon Pottery from Lundenwic: 2) Non-local coarsewares

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A small proportion of the pottery found on the 7th to 9th-century trading settlement of *Lundenwic* is handmade and clearly bonfire fired but contains rocks and minerals which distinguish them from the majority of coarsewares used in the settlement, which were chaff-tempered. Their very scarcity suggests that although these vessels were probably made in Anglo-Saxon England they were probably not made at Lundenwic itself.

Visual Examination

All of the 'non-local' wares from the sites in Table 1 were examined visually at x20 magnification using a binocular microscope. It was possible to classify most of these samples into a small number of fabric groups, defined on the basis of the principal inclusions over 0.5mm across and the broad character of the clay groundmass. There were a number of sherds which would not fit into these groups but that without further analysis could not be definitely identified as distinct fabric groups either, since they might have been examples of the main groups which for some reason (abnormal firing, alterations post-burial or simply variation in the raw materials) were visually different from the main groups. Table 2 lists these groups and the petrological group to which they were assigned following thin section analysis. There is clearly more variability in this collection than could be adequately described given the financial constraints of this project since some visually distinct groups could not be sampled and in most cases only two or three thin sections were made for any group.

Table 1. List of Sites Studied

Sitecode	Total
BOB91	6
BRU92	47
DRY90	15
KIN88	3
SGA89	2
SOT89	18
Grand Total	91

Table 2

Cname	Subfabric	TSNO	Total
MSAXX	A ANG RED GROG >3.0MM		1
	A CHAFF;A RQ (GSQ);M LGCHERT? POSSIBLY PHOSPHATE CEMENT NOT SILICA		1
	A CHAFF;M ANG GROG >2.0MM;S ?SLAG;SILTY MICACEOUS MATRIX		1
	A GROG;S RQ GSQ;SILTY MICACEOUS GROUNDMASS		1
	A RQ >0.3MM;M FRESHWATER MOLLUSC?		1

MSAXX-BR	MICACEOUS SILTY GROUNDMASS;CF BRICKEARTH	V1717, V1749, V1750	3
MSAXX-GIA	A ANG ACID IGNEOUS - FELDSPAR, BIOTITE, QUARTZ;S CHAFF;S LCSST (?CALC CEMENT) >2.0MM;INCLUSIONLESS MATRIX	V1721	1
MSAXX-GS	A RQ SOME GSQ SOME SPHERICAL MATT;S SA BROWN FLINT;MICACEOUS GROUNDMASS	V1738	1
	M RQ - GSQ;S FRESHWATER MOLLUSC;S SA WHITE FLINT;MICACEOUS GROUNDMASS	V1743	1
MSAXX-ISF	A RQ SOME GSQ, MAINLY HAEM COATED;FINE MICACEOUS GROUNDMASS	V1718, v1753, v1772	3
	IPSM?;A RQ SOME HAEM COATED;LOWISH IRON BODY?	V1764	1
	A RQ SOME HAEM COATED;LOWISH IRON BODY?	V1773	2
	A RQ SOME HAEM COATED;LOWISH IRON BODY?;M ANG ROCK FRAGS		1
MSAXX-ISS	A RQ SOME HAEM COATED;LOWISH IRON SILTY BODY?;M CHAFF		1
	A RQ SOME HAEM COATED;LOWISH IRON SILTY BODY?	V1719	6
	A RQ SOME HAEM COATED;LOWISH IRON SILTY BODY?;A CHAF	V1752	2
MSAXX-LCLST	M LIMESTONE,POLISHED WHITE FLINT, POLISHED SA BROWN FLINT,POLISHED QUARTZ >3.0MM;MICACEOUS GROUNDMASS	V1741	3
MSAXX-OOL	M OOLITHS;SILTY MICACEOUS MATRIX	V1728, v1734, v1736, v1745	27
	M OOLITHS;SILTY MICACEOUS MATRIX;M SA BROWN FLINT	V1723	1
MSAXX-SS	A SA Q >05MM;M SUGARY SST >2.0MM	V1769, v1774	2
	M ANG SUGARY SST >3.0MM;A SA Q >0.3MM (EUHEDRAL)	V1727	1
	A RQ SOME GSQ >0.5MM, MAINLY HAEM COATED;FINE MICACEOUS GROUNDMASS;M R MICRITE	V1735	3
MSAXX-TFC	R POLISHED Q, BROWN FLINT >2.0MM;S TERT? SHELL >2.0MM	V1761, v1762, v1771	3
MSAXX-TFF	POLISHED WHITE FLINT, BROWN FLINT,RQ >3.0MM;MICACEOUS GROUNDMASS	V1737	4
	A RQ SOME GSQ, MAINLY HAEM COATED;FINE MICACEOUS GROUNDMASS	V1733, v1767, v1768	13
	R POLISHED Q, POLISHED SA WHITE FLINT;BROWN FLINT >2.0MM	V1744	1
	A RQ SOME GSQ, MAINLY HAEM COATED;FINE MICACEOUS GROUNDMASS;M R MICRITE2	V1724, v1731	6
Grand Total			91

Thin Section Analysis

Twenty five thin sections were made. They were selected after a consideration of previous work and in general were intended to study the main wares present and variations within those groups rather than to identify isolated fabrics which might not occur again on Lundenwic sites and which probably add little to knowledge of the range of pottery found on the site and its sources.

MSAXX-BR

Visually, this fabric is typical of samples of the Thames valley brickearths. They contain a very high proportion of ill-sorted quartzose sand in which the largest grains are rounded whilst the remainder are subangular. Most of the chaff-tempered ware from Lundenwic has a similar groundmass. One thin section was made, V1749. The following inclusions were noted:

- Sparse rounded quartz grains up to 0.5mm across with brown veins.
- Abundant angular quartz up to 0.2mm across
- Sparse unidentified accessory minerals, some rounded, some fragments of rounded grains and others angular, up to 0.2mm.
- Moderate rounded opaque grains up to 0.2mm across.
- Sparse rounded (and broken rounded) grains of chert up to 0.3mm across.
- Sparse muscovite up to 0.2mm long.

The groundmass consists of anisotropic clay minerals and sparse quartz silt.

This thin section is consistent with the visual identification of this as a brickearth. The homogenous texture argues against the sample being a mixture of brickearth with another clay.

MSAXX-GIA

The thin section of this fabric, V1721, contained the following inclusions:

- Abundant angular fragments of an acid igneous rock up to 4.0mm across. This rock contains quartz, orthoclase feldspar (partly altered) and a dark brown biotite. The rock appears to be banded, some of the quartz grains are strained and the finer-grained bands include some mosaic quartz. These factors suggest that the rock may be a coarse-grained metamorphic rock, a gneiss.
- Sparse blocks of sandstone, up to 3.0mm long. The rock consists of ill-sorted rounded and subangular quartz and sparse chert ranging up to 0.3mm. The cement is siliceous. Although not particularly diagnostic this may be a lower cretaceous sandstone.

- Sparse fragments of a coarser-grained sandstone up to 1.0mm across, with subangular quartz grains c0.5mm across. The grains are overgrown with no trace of the original grain boundary. This might be lower Carboniferous sandstone.

- Sparse well-rounded quartz grains up to 0.3mm across. These grains may be 'millet seed' quartz originating in the lower Permian of midland and northern England.

- Abundant angular quartz grains c.0.2mm.

The groundmass consists of anisotropic baked clay minerals with streaks and lenses of semi-opaque faecal pellets less than 0.1mm across.

The characteristics of this fabric are similar to wares containing angular coarse-grained biotite-rich rocks from midland England (Williams and Vince 1997), northern England and Jutland. All three can contain coarse-grained sandstones. Coarse-grained metamorphic rocks have been noted in the Jutish and northern English wares but not in those from the midlands. Inclusionless clays have been used in Jutland, although they are uncommon but in detail they are not comparable. The inclusionless clay with faecal pellets is typical of Jurassic clays.

Perhaps the most likely source for this sample is therefore a boulder clay derived from a mixture of Scottish/Scandinavian and northern English erratics but which had travelled over Jurassic and perhaps Lower Cretaceous rocks. The Anglian till matches this description (1996, 118-9) and outcrops extensively to the north and north-east of Lundenwic. The closest source to Lundenwic is at Finchley (1996, Figs 29 and 32).

MSAXX-GS

The two sections of this fabric (V1738 and V1743) have similar characteristics. The following inclusions were noted:

- Abundant rounded, well-sorted quartz grains, c.1.0mm across. Many of these grains have haematite-stained veins but not cement on the surfaces.

- Moderate rounded opaque grains, similar in size to the quartz.

- Sparse angular white flint up to 2.0mm long.

- Sparse subangular brown-stained flint up to 1.5mm long.

The clay matrix consists of anisotropic baked clay containing sparse angular quartz and muscovite laths up to 0.1mm long. Rare chalcedonic microfossils were also noted. The colour of the clay matrix is obscured in the main by carbon.

The sand in this fabric is very similar to that seen in Kingston-type ware, medieval greyware from Kingston and other wares found and presumably made in the Thames valley to the west of London whilst the slightly silty, micaceous groundmass is similar to that of medieval greyware produced in Kingston, where it was thought that the clay might have been an alluvial Thames clay derived from the London Clay (2001).

MSAXX-ISF

One thin section of this fabric was made (V1772). The following inclusions were noted:

- Abundant well-sorted rounded quartz grains c.0.5mm across. Most of these grains have haematite veins and an opaque coating.
- Moderate angular fragments of opaque material up to 1.0mm across
- Sparse rounded chert up to 0.5mm across, also sometimes with an opaque coating.
- Sparse angular fragments of ferruginous sandstone (or iron-pan cemented sand) up to 2.0mm across

The groundmass consists of anisotropic baked clay minerals, sparse quartz silt up to 0.1mm across and sparse muscovite laths up to 0.2mm long.

The closest parallels to this fabric are of 11th/12th century coarseware (ESUR) and Coarse Border ware (CBW), both probably produced over a wide area of Surrey and utilising clays from the Bagshot Formation or the Bracklesham Beds (1996, 105). Ironstones are noted in the Bracklesham Beds and these may be the source of much of the sand temper. The lack of rounding of the iron cement suggests an origin close to the outcrop.

MSAXX-ISS

This group was defined on the basis of its silty/fine sandy matrix in contrast to the inclusionless matrix of MSAXX-ISF. Two sections of this fabric were made, V1718 and V1719). They show rather different characteristics.

V1719 contains sparse to moderate inclusions of ironstone and iron-cemented quartz with no signs of rounding of any of these grains. The groundmass, however, contains abundant angular quartz and sparse muscovite of fine sand grade. The opaque inclusions in the groundmass are mostly angular fragments of cement but some of the outlines of these fine fragments suggest that they may be microfossils.

V1718 contains the same range of inclusions as are found in MSAXX-ISF but the inclusions are rounded and better-sorted.

Thus, although visually these two samples are very similar in texture their petrology suggests that they were made from different raw materials, albeit possibly all from the same area.

MSAXX-LCLST

The visual appearance of this sample (V1741) suggests an origin in the southeast of England, containing as it does polished angular flint fragments, polished rounded quartz grains and a micaceous groundmass similar to those of many of the fabrics described here. However, the thin section suggests a more far-flung source since the sample contains inclusions of a bioclastic limestone not seen in any other samples from the southeast of England together with rounded and subangular fragments of lava.

The following inclusions were noted in thin section:

- Moderate subangular fragments of bioclastic limestone up to 2.0mm across. The clasts consist of rounded grains of non-ferroan bivalve shell, echinoid shell and unidentified fossils, rounded sparse quartz grains and sparse rounded opaque grains all up to 0.5mm across. The cement consists of sparry ferroan calcite.

- Moderate subangular fragments of fine-grained basalt up to 1.5mm across containing feldspar, clinopyroxene and magnetite crystals c.0.2mm across.

- Sparse euhedral voids up to 1.5mm across.

- Sparse rounded quartz grains up to 3.0mm across.

- Sparse angular unstained flint fragments up to 4.0mm long.

- Rare subangular brown stained flint fragments up to 0.5mm long.

The groundmass consists of anisotropic baked clay minerals, sparse angular quartz silt and moderate muscovite.

No suggestions as to the source of this fabric can be made. The basalt fragments have undergone some mechanical weathering, although there is no sign of alteration or staining of the surfaces. The limestone fragments, similarly, are unlikely to have been deliberately crushed but neither do they show signs of the degree of rounding one might expect in a detrital gravel. The identity of the euhedral mineral which once existed in the voids is unknown. The most likely candidate would be calcite, but it is unlikely that the composition of this calcite would be sufficiently distinct from that of the limestone that all of the calcite has been leached and none of the limestone fragments.

With the exception of these inclusions, which were probably deliberate additions to the fabric, the remaining inclusions might all be found in a Thames valley sediment.

MSAXX-OOL

Two samples of the oolitic limestone tempered ware were thin sectioned (V1723 and V1736). There is very little variation between them, nor was there much variation in the appearance of this group at x20 magnification.

The following inclusions were noted in thin section:

- Moderate fragments of oolitic limestone up to 1.5mm across. Although many of the fragments are rounded, this is probably because they have disaggregated into individual ooliths or fossils. Several of the fragments have sharp edges and the overall appearance is that this limestone was deliberately crushed but was already only loosely aggregated. The limestone is composed of dolomite and consists mainly of ooliths but with some gastropod and bivalve shell fragments. The matrix of the limestone seems to have consisted of a thin (c.0.1mm) coating of sparry dolomite surrounding each oolith or shell fragment with clay in the interstices. There is no difference in composition between the ooliths and shell fragments, which are both mainly dolomitic micrite.
- Moderate angular fragments of flint up to 1.5mm across.
- Moderate organic inclusions up to 3.0mm long.
- Sparse subangular brown-stained flint up to 1.0mm across
- Sparse rounded chert up to 1.0mm across
- Sparse rounded quartz with brown-stained veins up to 1.5mm across.

The groundmass consists of anisotropic baked clay minerals and abundant angular quartz c.0.1-0.2mm across.

The identity of this limestone is unknown. It is likely to be one of the Jurassic oolites, but they are usually composed of non-ferroan calcite. The closest description to the rock found in these samples appears to be part of the White Limestone Formation, which forms part of the Great Oolite Group and outcrops in Oxfordshire, Buckinghamshire and Bedfordshire. However, the brown flint and the general character of the remaining inclusions would suggest that the parent clay was obtained within the London basin.

MSAXX-SS

Three thin sections were made of vessels with moderate fine-grained sandstone inclusions. The identify of this sandstone is unknown to the author (V1727, V1735 and V1769). Similar fabrics are known from early Anglo-Saxon sites in the Thames valley, west of London.

The following inclusions were noted:

- Moderate angular fragments of sandstone up to 3.0mm long. The sandstone consists of overgrown quartz grains in which the original grain boundary is usually visible, indicating that the grains were originally subangular in the finer-grained examples and rounded in those over c.0.5mm across. The rock is either completely cemented with silica or there are pores which are filled with a light-coloured clay. The larger, rounded are usually found loose which may indicate that the coarser textured rock was poorly cemented.

- Rounded quartz up to 1.0mm across. Much of this quartz appears to have the same overgrowths as that in the sandstones. However, some appear to be different but it is not clear how much quartz from other sources is present.

- Rounded chert up to 1.0mm across.

The groundmass consists of anisotropic baked clay minerals, sparse angular quartz up to 0.1mm across and sparse muscovite laths up to 0.1mm long.

The groundmass of the three samples is identical to that of most of the fabrics discussed here and it is possible that they were produced by deliberately adding crushed fine-grained sandstone to a local Thames basin clay.

MSAXX-TFC

This fabric group consists of vessels tempered with a mixed coarse gravel which includes subangular brown-stained flint.

Three thin sections were made (V1761, V1762 and V1771) and the following inclusions were noted:

- Abundant rounded brown-stained flint up to 3.0mm across. Some angular fragments are present but some of these have one curved edge which suggests that they were formed by the shattering of rounded flint gravel.

- Sparse rounded micrite up to 1.0mm across. This may be chalk although no characteristic microfossils were seen.

- Sparse rounded bivalve shell fragments up to 1.0mm long.

- Sparse angular white flint fragments up to 1.5mm across.

- Sparse rounded quartz up to 0.5mm across.

- Sparse rounded lower Greensand chert up to 1.5mm across

The groundmass consists of anisotropic baked clay minerals, sparse angular quartz silt and sparse muscovite up to 0.1mm long.

The inclusions in this fabric are clearly from a flint gravel derived mainly from reworked Tertiary flint beds. Such flint pebble beds exist within the Thames basin but the fabric is extremely similar to that of the flint-tempered pottery from the mid Saxon settlement at Hamwic. This would be consistent with the presence of detrital chalk fragments in the fabric.

MSAXX-TFF

This fabric too contains rounded fragments of brown-stained flint but alongside well-rounded quartz grains, probably derived from the Triassic sands of the west Midlands. Three thin sections were made, V1733, V1737 and V1744. The following inclusions were noted:

- Moderate angular and subangular brown-stained flint up to 1.5mm across.
- Abundant well-rounded quartz grains up to 1.0mm across. There is no sign of iron stained veins. Broken grains are present.
- Sparse rounded opaque grains up to 0.5mm across.
- Moderate organic inclusions up to 3.0mm long.

The groundmass of V1744 consists of anisotropic baked clay minerals, sparse angular quartz silt and sparse muscovite up to 0.1mm long whereas that of V1733 and V1737 contains abundant angular quartz up to 0.2mm across and sparse altered glauconite grains up to 0.2mm across.

Chemical Analysis

Samples of 30 sherds were selected for chemical analysis using Inductively Coupled Plasma Spectroscopy (ICP-AES). The samples were prepared by Peter Hill, who removed an offcut about 2mm thick and mechanically removed all potentially contaminated surfaces. The resulting block, weighing 2-3gm, was then crushed to a fine powder. The analyses were carried out at Royal Holloway College, London, in the Department of Geology under the supervision of Dr N Walsh (Appendix 1) and the unused powder is retained at AVAC.

A selection of major, minor and trace elements was measured. The major elements as percent oxides (App 1a) and the remainder as parts per million (App 1b).

The dataset was examined using the *Winstat for Excel* statistical package. The first step was to examine the data for outlying values, defined as those being more than 4 sd from the mean value for the measured element. Such values can occur either where a sample from a completely different source is included in the dataset or where a sample has an atypically high or low value for an element as a result of the presence of a detrital grain rich in that element within the sample, post-burial contamination or leaching or perhaps laboratory error. Six sampled were affected (Table 00). In four instances these values are indeed explicable in terms of the original fabric characteristics: V1721 contains feldspar inclusions rich in Na_2O, V1723 contains oolitic limestone and V1772 contains haematite cemented sand grains. No thin section was made of sample V1728 and it is not possible to say whether this high P_2O_5 value is the result of the presence of bone, phosphate nodules or post-burial phosphate encrustation. No explanation for the high Pb value in sample V1743 or the high Cr value in V1750 can be provided. In order that these samples did not skew the results of further statistical analysis they were omitted from the dataset.

TSNO	Sitecode	Context	Cname	Details
V1721	BRU92	380	MSAXX-GIA	Na2O
V1723	BRU92	496	MSAXX-OOL	CaO
V1728	BRU92	57	MSAXX-OOL	P2O5
V1743	dry90	220	MSAXX-GS	Pb
V1750	dry90	9	MSAXX-BR	Cr
V1772	sot89	23	MSAXX-ISF	Fe2O3 and MnO

On the basis of the thin section analysis it was surmised that there were three or four potential routes by which the elements might be present in the sample:

a) they could be present in the clay matrix of the sample, either chemically bound to clay minerals or in the form of clay- or silt-sized grains.

b) They could be associated with iron, which might be present in the groundmass, or as iron-rich inclusions, coatings on detrital grains or as iron concretions formed in the pores of the sample after burial.

c) They could be present in calcareous inclusions which might be original inclusions, such as limestone or shell or might be present through post-burial contamination, either in the form of calcite or calcium phosphate.

d) They might be associated with phosphate, either in the form of detrital minerals (such as apatite or monazite), bone inclusions, or as post-burial phosphate encrustation.

To determine which, if any, of these routes was the most important for each element correlation coefficients were calculated for all the measured elements against 'silica' (not measured, but estimated by subtracting the total of the oxide values from 100%), Al_2O_3, CaO and P_2O_5. The results are summarised in Table 00).

From this table we can see that most elements have a mixed origin. MgO, for example, is clearly not correlated with 'silica' but is presumably present in the clay groundmass, and in association with iron and, to a much lesser degree, with phosphate. However, its main route of entry into the samples was probably in calcareous inclusions. If only the samples tempered with oolitic dolomitic limestone are included then the correlation coefficient rises to 0.88 whereas if those samples are excluded then the coefficient falls to 0.29, still higher than the correlation with either Al2O3 or P2O5 although both of those elements are positively correlated with MgO.

Since in this stage of the study of Lundenwic's pottery the main question is the source of the pottery it makes sense to limit analyses to those elements which were present solely in the parent clay since this excludes any potential contamination effect and also excludes the effect of deliberate tempering.

Table 3 Pearson's Correlation Coefficients

element	SiO2	Al2O3	Fe2O3	CaO	P2O5	correlate
SiO2	1	-0.530277569	-0.370488339	-0.675841821	-0.249077508	s
Al2O3	-0.530277569	1	-0.345428935	0.593610637	-0.358984958	al/c
Fe2O3	-0.370488339	-0.345428935	1	-0.293702033	0.376141581	fe
MgO	-0.717180756	0.244611761	0.106506245	0.522577499	0.078008819	Al/fe/c/p
CaO	-0.675841821	0.593610637	-0.293702033	1	0.042457794	al/c/p
Na2O	-0.215835987	-0.042681555	-0.196032165	0.239336478	-0.041472643	c
K2O	-0.663337859	0.279989834	-0.026996665	0.534318713	0.062460715	al/c/p
TiO2	-0.28756936	0.488065423	-0.442374226	0.362115965	-0.409517263	al/c
P2O5	-0.249077508	-0.358984958	0.376141581	0.042457794	1	fe
MnO	-0.133660488	-0.146626963	0.107076753	0.192039366	0.587877876	fe
Ba	-0.396904138	-0.121015981	0.15411068	0.326140142	0.465353579	fe
Cr	-0.657696779	0.34156325	0.008879058	0.537431819	0.064368127	Al/fe/c/p
Cu	-0.350152948	0.041035865	0.252603229	-0.006791057	0.115135827	al/fe/p
Li	-0.541882465	0.809661539	-0.131930917	0.498027515	-0.254425068	al/c
Ni	-0.697852436	0.541036795	0.09413647	0.500868901	0.043029405	Al/fe/c/p
Sc	-0.522549797	0.782660394	-0.343296743	0.477850857	-0.195143288	al/c
Sr	-0.616769801	0.162063518	0.172857946	0.598765964	0.721314544	Al/fe/c/p
V	-0.776649832	0.551394948	0.300929769	0.396519208	-0.094740045	al/fe/p
Y	-0.550977317	0.52446964	-0.139805689	0.403780799	-0.10495509	al/c
Zr*	-0.297622466	0.621780948	-0.375767607	0.340440798	-0.108628654	al/c
La	-0.478313842	0.54189092	-0.289397672	0.416122045	-0.104126405	al/c
Ce	-0.455338243	0.463753429	-0.033663225	0.308238086	-0.129398112	al/c
Nd	-0.494960512	0.550768417	-0.262214887	0.408403814	-0.120846644	al/c
Sm	-0.397647431	0.647961533	-0.309130439	0.385805791	-0.360787801	al/c
Eu	-0.515095063	0.521367582	-0.002704541	0.239729612	-0.248891656	al/c
Dy	-0.51954108	0.520916229	-0.061736649	0.301458667	-0.201901122	al/c
Yb	-0.538707067	0.517274346	-0.009967214	0.261130025	-0.189593193	al/c
Pb	0.043238996	-0.321700923	0.239009001	-0.291544569	0.093824052	fe
Ag	0	0	0	0	0	na

Zn	-0.580401892	-0.074523673	0.485034957	0.134666792	0.515265888	fe
Co	-0.626521112	0.357968463	0.229803814	0.327560957	-0.034979053	al/fe/p

Fifteen elements are more closely correlated with Al2O3 than with the other four tested elements but the degree of correlation varies. In rank order they comprise Li, Sc, Sm, Zr, V, Nd, La, Ni, Y, Eu, Dy, Yb, TiO2, Ce and Co. Because the last of these elements is also positively correlated with iron it was omitted from the next stage of analysis which consisted of factor analysis of a dataset consisting of the remaining 14 elements, normalised to Al2O3 in order to account for fluctuations in temper frequency.

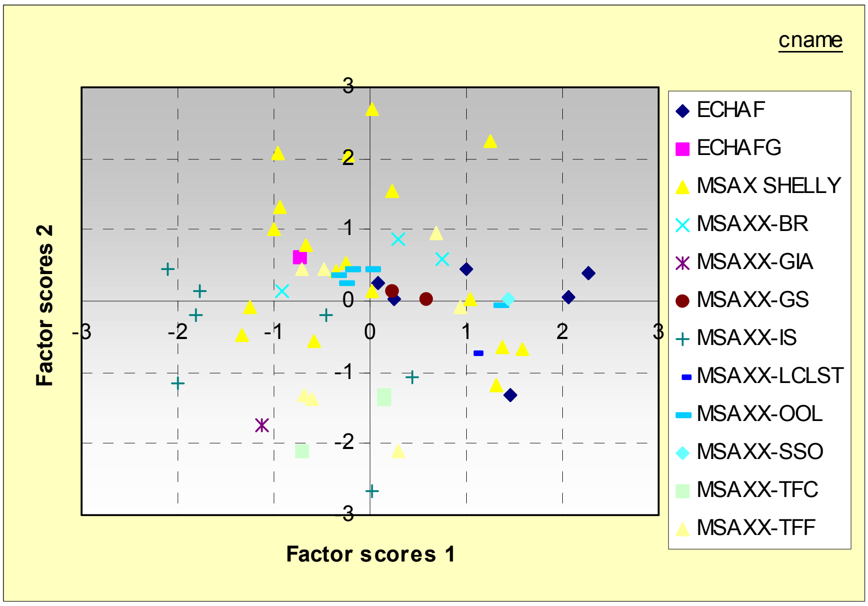

Figure 1

Fig 1 shows a plot of Factor 1 against Factor 2 scores for this clay-linked element group. Alongside the coarsewares studied in this report the shell-tempered wares and the chaff-tempered wares have been included. There is a high degree of overlap between the samples but the following points can be made:

a) the shell-tempered wares mainly have similar clay compositions to the coarsewares and chaff-tempered wares

b) The iron-cemented quartz sand tempered ware (MSAXX-ISF and MSAXX-ISS) has a different clay composition

c) The Tertiary flint gravel tempered ware (MSAXX-TFC) has a different clay composition

d) The sample with angular igneous rock temper (MSAXX-GIA) has a different clay composition.

Plotting the third factor against the first (Fig 2) confirms these conclusions but distinguishes the iron-cemented quartz sand tempered ware more convincingly and separates most of the shell-tempered wares from the remainder.

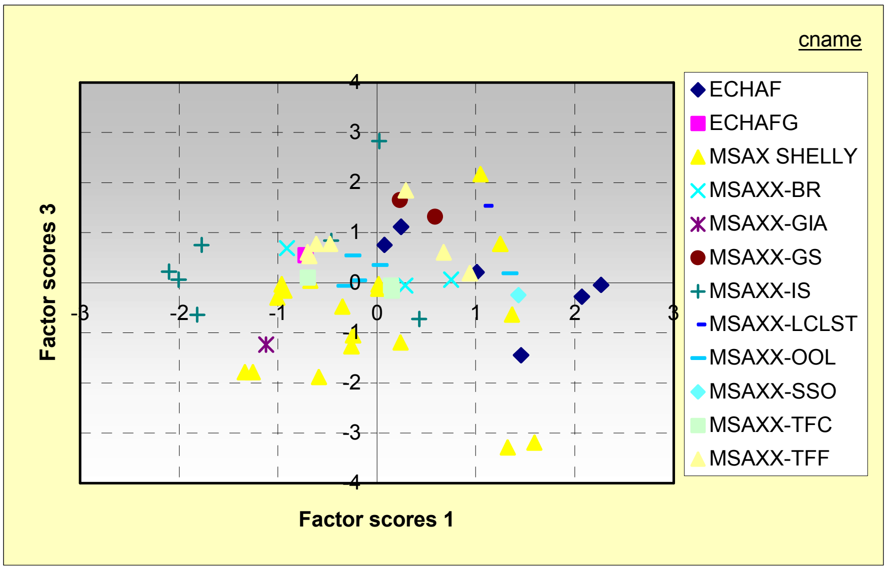

Figure 2

To examine the source of the sample with angular acid igneous rock inclusions a factor analysis was carried out on a dataset including this sample together with samples of similar wares from midland England and Jutland (Figs 3 and 4). The Lundenwic sample is clearly closer in composition to the midland English samples although these clearly have widely differing clay compositions.

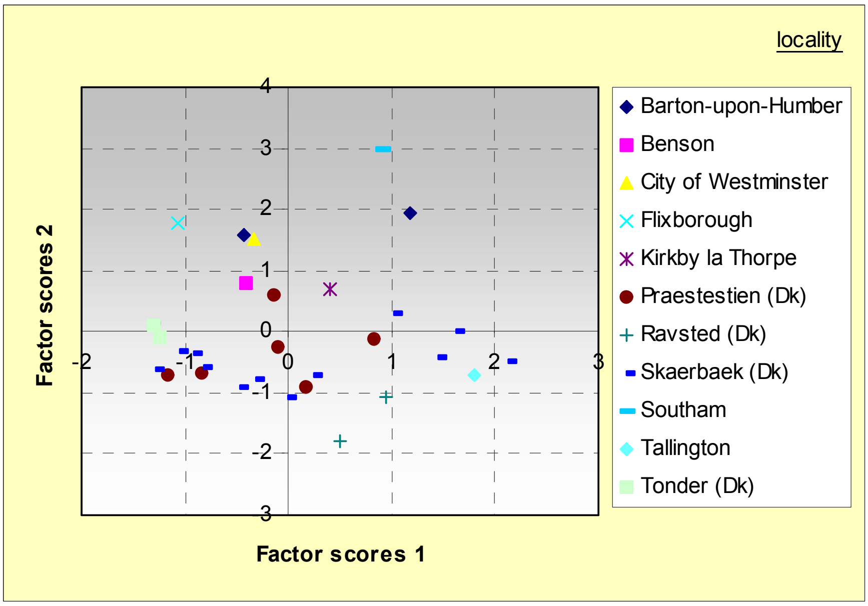

Figure 3

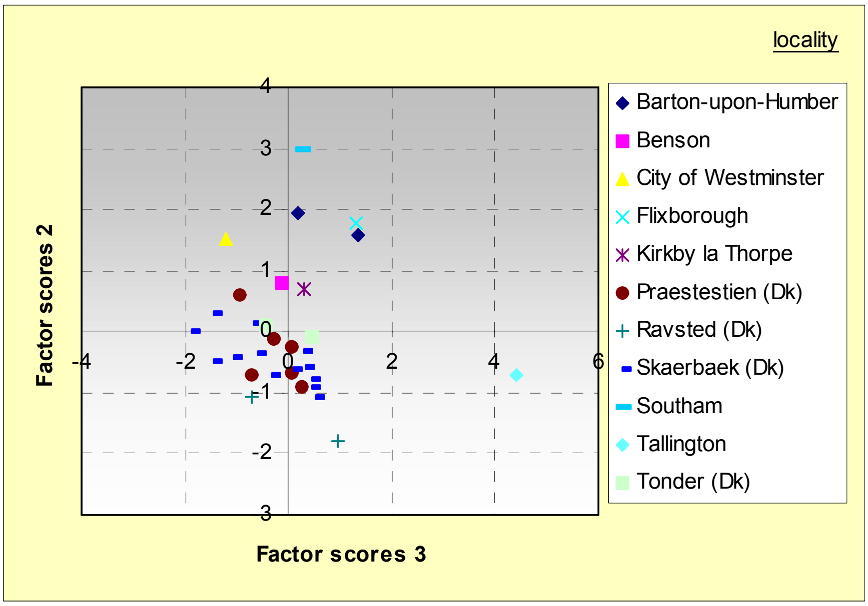

Figure 4

Finally, the Lundenwic coarseware and chaff-tempered data were compared with a database of medieval wheelthrown greyware analyses based on the sampling of kiln waste (Fig 5). This indicates that the data plot into two broad groups distinguished by a combination of Factor 1 and Factor 2 scores and that within these groups individual sites can be recognised. To the bottom right of Fig 5 (ie higher F1, negative F2) are the majority of greyware kiln sites and to the top left and the majority of Lundenwic samples. However, two greyware kilns plot in the 'Lundenwic' cluster: that at Kingston-upon-Thames and that in the Fleet Valley (City of London). Within the 'Greyware' cluster there is also patterning, as can be seen by plotting the data against county. The broad interpretation of this data would seem to suggest that the Lundenwic samples are more likely to have been made in the Thames valley than further afield in the Thames basin or beyond. A plot of Factor 3 against Factor 2 also produces this geographical separation in the greyware samples but also separates the two Thames-side kiln groups from the Lundenwic samples.

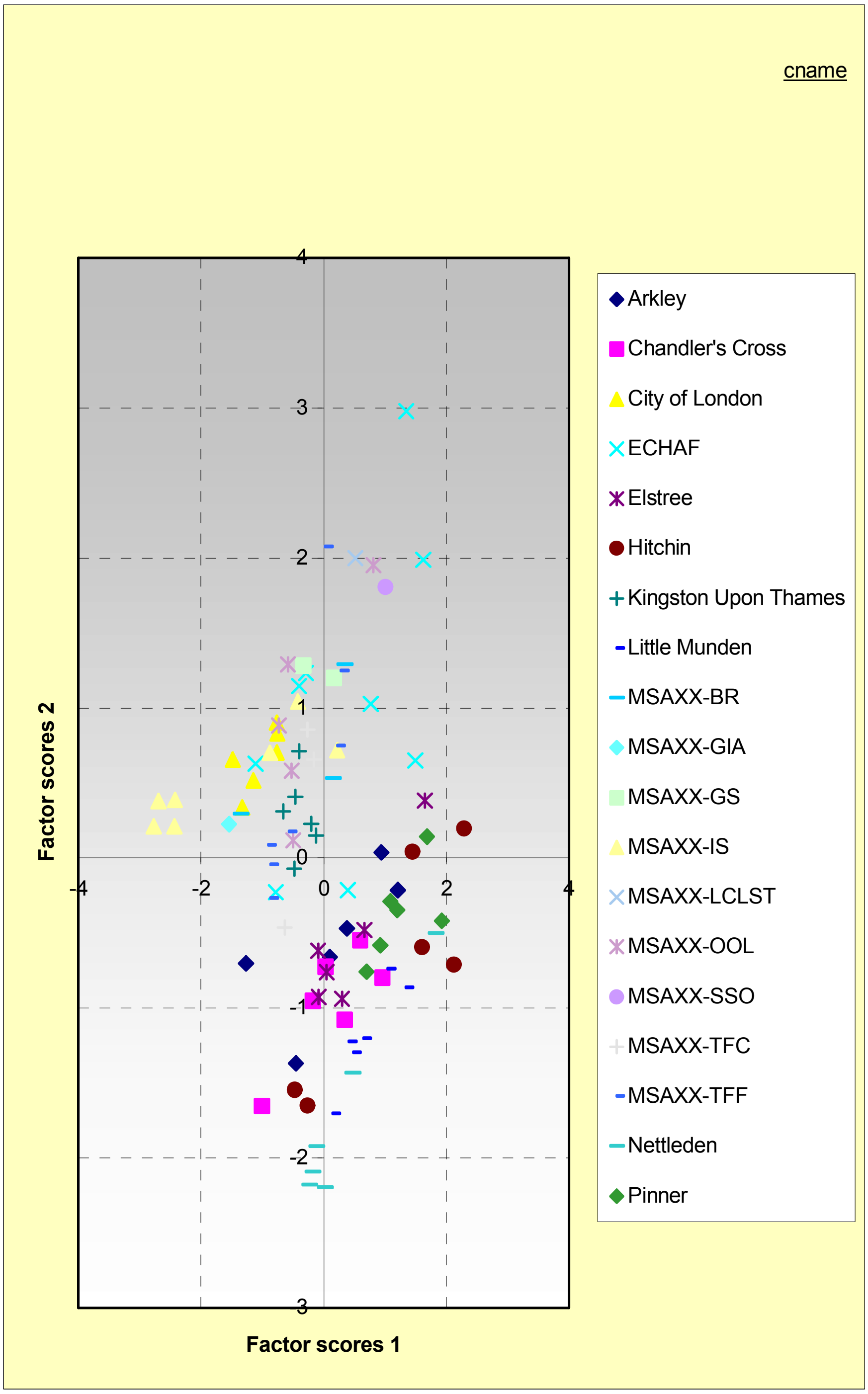
cname
Factor scores 2
Factor scores 1
4
3
2
1
0
-1
-2
-3
-4
-2
0
2
4
Arkley
Chandler's Cross
City of London
ECHAF
Elstree
Hitchin
Kingston Upon Thames
Little Munden
MSAXX-BR
MSAXX-GIA
MSAXX-GS
MSAXX-IS
MSAXX-LCLST
MSAXX-OOL
MSAXX-SSO
MSAXX-TFC
MSAXX-TFF
Nettleden
Pinner

Figure 5

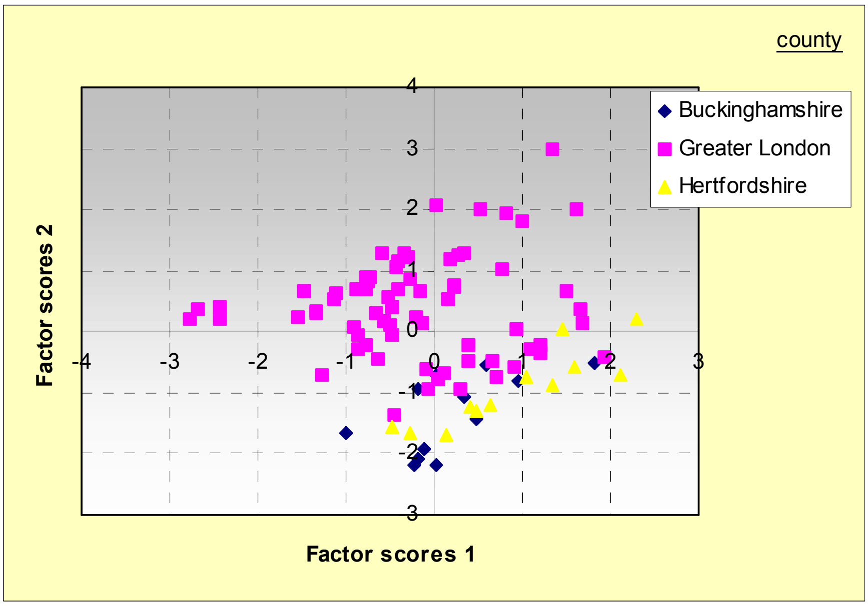

Figure 6

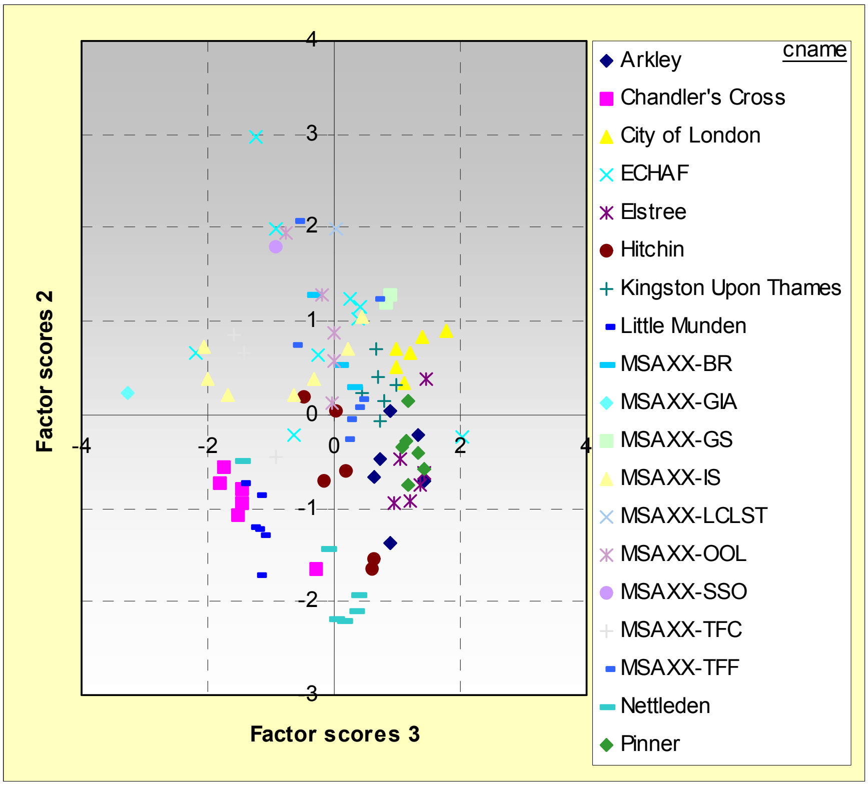

Figure 7

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upon-Thames, Lincoln.

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