Characterisation Studies of Medieval Pottery from the A4146, Stoke Hammond and Linslade Western Bypass, Buckinghamshire

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Excavations on the line of the A4146, Stoke Hammond and Linslade western bypass undertaken by Network Archaeology Ltd revealed two sites which appear to have been occupied principally during the 12th to early 13th centuries. These sites provide an opportunity to study pottery of this period undisturbed either by residual earlier material or any substantial later medieval occupation.

The pottery can be divided into two major groups, sand-tempered and shell-tempered wares, and the sand tempered ware can then be subdivided by method of manufacture and firing into a handmade, low-fired group and a higher fired, reduced, wheelthrown group. Samples of all three groups were selected for thin section and chemical analysis in order to determine their source and relationships.

The samples were prepared by Peter Hill and then thin sections were prepared by Steve Caldwell, University of Manchester, and chemical analyses carried out under the supervision of Dr J N Walsh, Royal Holloway College, London. The thin sections were stained using Dickson's method (Dickson 1965) which distinguishes between dolomite (unstained), ferroan calcite (stained blue) and non-ferroan calcite (stained pink). The chemical analysis was carried out using Inductively Coupled Plasma Spectroscopy (ICP-AES) and the frequency of range of major elements was measured, in percent oxides (App 1) whilst a range of trace elements was measured in parts per million (App 2). Silica context was estimated by subtracting the total element counts in App 1 from 100% and the data was normalised to aluminium before multivariate statistical examination using factor analysis.

Shell-tempered wares

Thin Section Analysis

Ten thin sections of shelly ware vessels were examined. These indicate a similar fabric in each case, although in six samples all of the calcareous inclusions were leached and in three samples (all leached) the groundmass contains sparse quartz silt, absent or rare in the other samples. The quartz silt is less than 0.05mm across and it is possible that this supposed difference is due to these three sections being ground slightly thinner than the others.

Description

The following inclusion types were noted:

- Bivalve shell.
- Punctate brachiopod.
- Echinoid shell.
- Sparry ferroan calcite.
- Rounded quartz.
- Flint.
- Fine-grained sandstone.
- Rounded chert.
- Relict clay.

The groundmass consists of light brown optically anisotropic baked clay minerals, moderate rounded dark brown grains, ferroan calcite and sparse non-ferroan fragments up to 0.1mm across, and sparse angular quartz up to 0.1mm across.

Comparanda

The A4146 shell-tempered thin sections were compared with sections from a number of sources in the southeast midlands:

- A medieval waster sherd from Harrold Middle School, sampled for this project.
- Early Roman shell-tempered ware from Haddon, near Peterborough (Vince 2003).
- St Neot's-type ware from Botolph Bridge, Orton Longueville, Peterborough.
- Peterborough shell-tempered ware, from Botolph Bridge.
- Developed St Neot's-type ware from Botolph Bridge.
- Lyveden-type shell-tempered ware from Botolph Bridge.

The Peterborough shell-tempered ware and Lyveden-type shell-tempered ware samples both lack punctate brachiopod and echinoid shell fragments. The remaining samples contain the same range of calcareous inclusions as is present in the A4146 shell-tempered ware. The calcareous inclusions in the St Neot's-type ware sections have a finer grain size than the remainder and this is also true of the Roman shell-tempered ware from Harrold (not re-examined for this project). However, the Haddon shell-tempered ware contains inclusions of very similar size range and character, thus indicating that there is no simple chronological difference between the fabrics.

The Harrold and Haddon samples both come from production sites, about 35 miles apart. At Harrold, the Roman pottery industry was situated on boulder clay but utilised Cornbrash shelly marls, exposed on the valley sides (Brown 1994, 19-20). In a report on the shelly marl, Clements (in Brown 1994, 98-99) notes the presence of terebratulids (which are punctate brachiopods) and also states that echinoid plates and bivalve shell, mostly oysters, are common.

Chemical analysis

The estimated silica content of the samples ranged from 60.5% to 67% and is lower in three of the unleached samples than in the remainder. There is no difference in estimated silica content between those samples with more visible silt in the groundmass than the others. This suggests that the observed variation in silt content may well be an artefact of section preparation.

There is a correlation between the incidence of several elements and the observed leaching of the samples and this is best explored by calculating correlation co-efficients between calcium oxide and other elements. The results of this calculation, using Pearson's co-efficient, indicate a negative correlation with aluminium, lithium and silica, suggesting that these elements may well be present filling the voids left by the shell, and a positive correlation with strontium and magnesium, indicating that these elements were present, in the leached shell.

Factor analysis of the dataset, excluding silica, aluminium, lithium, strontium and magnesium, shows that the ten samples show no obvious patterning in the first three factors revealed by the analysis but both Factors 4 and 5 separate a group of three samples from the remainder. Two of these were unleached and one leached. They have higher aluminium values and lower iron, magnesium, potassium, titanium, chromium, nickel, scandium, lanthanum, cerium, neodymium, samarium and zinc (Fig 1).

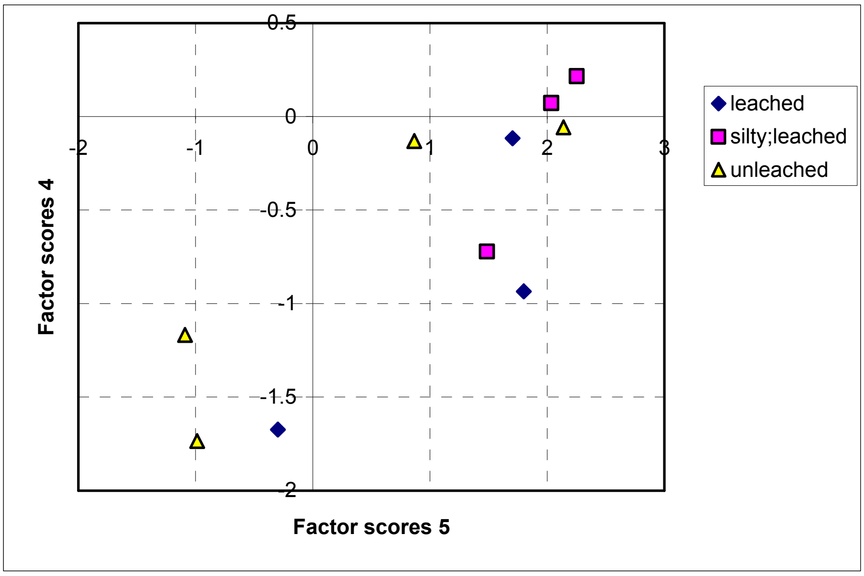

Figure 1

The A4146 shelly ware data was then compared with chemical data from other shell-tempered groups. The comparative data consist of production waste from Middle School, shelly ware from Lyveden, where it has been postulated that it was produced alongside the well-known glazed wares, and a series of groups from the consumer site of Botolph Bridge, Orton Longueville, near Peterborough. These include St Neot's type ware, Developed St Neot's type ware, handmade, black-fired shelly-tempered ware (Peterborough fabric SHW, coded PSHW here) and another group of Lyveden-type shelly ware (STANLY). The three samples separated by their higher aluminium content are coded A4146 shelly 2 in this analysis.

Factor analysis of the dataset, excluding those elements recognised above as being depleted or enriched after burial was carried out and five factors found. The first two separated the Peterborough handmade shelly ware and the St Neot's-type ware samples from the remainder but shows the remainder as a single cluster (Fig 2). The second two are more discriminating and show that the three high aluminium samples plot with the Harrold wasters whilst the remainder plot with the Peterborough handmade shelly wares (Fig 3)

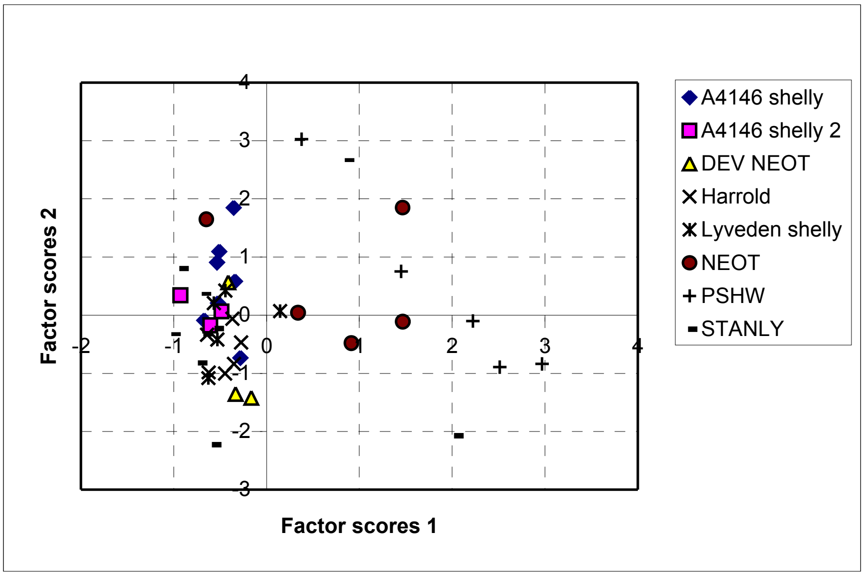

Figure 2

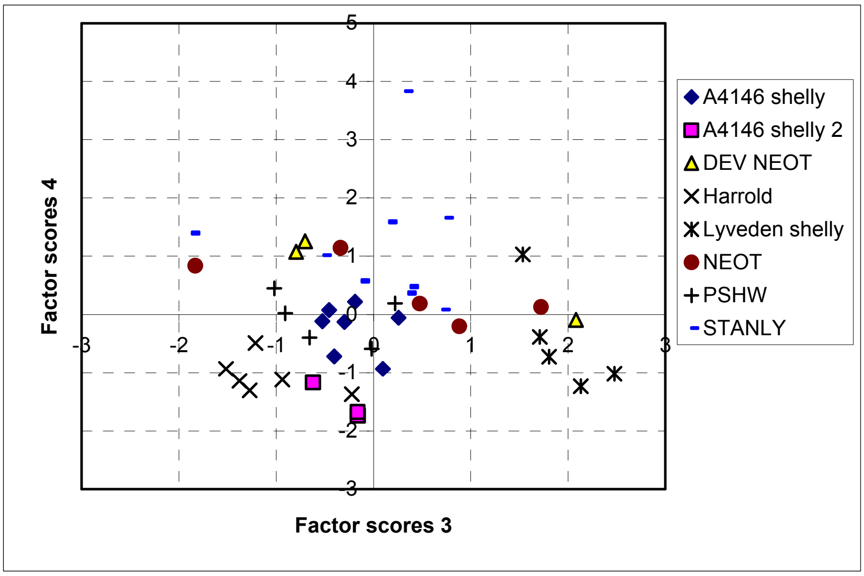

Figure 3

The factor analysis was then repeated, using only those elements which distinguish the two A4146 groups. Only two factors were found and, again, the Harrold and shelly 2 samples come out as similar (together with one of the St Neot's-type sherds.

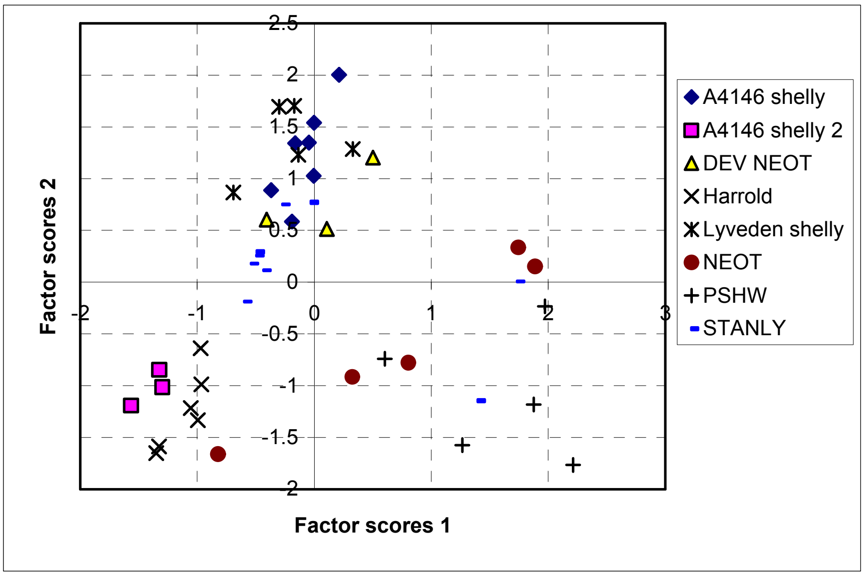

Figure 4

Discussion

The most likely source of the A4146 shell-tempered wares is Olney Hyde but samples of waste from this site were not available in time for this project. However, three of the samples are very similar to (though distinguishable from) the waste from Harold Middle School. The similarity in chemical composition between all these various groups of shell-tempered ware is perhaps to be expected, since they clearly all employed middle to upper Jurassic clays laid down in similar environmental conditions in the same sea.

Petrologically, the wares can be divided into three groups: those containing predominantly bivalve shell, (PSHW and Lyveden-type shelly ware from Lyveden and Botolph Bridge); those containing limestone fragments characterised by bivalve shell, punctate brachiopod and echinoid shell (Developed St Neot's type, Harrold Middle School, A4146 shelly 1 and 2) and those containing a shell sand also characterised by bivalve shell, punctate brachiopod shell and echinoid shell (St Neot's type). In addition, the Roman shell-tempered ware from Harrold has the same shell sand temper as the St Neot's type ware, and is therefore distinguishable in thin section from the medieval waste from the same area. There is only a limited correlation of these groups with the chemical composition of the groundmass but a better correlation with the two elements shown to be present in the calcareous fraction, magnesium and strontium (fig 5). Strontium is more common relative to magnesium in the shell sand-tempered St Neot's type ware than in the remainder whilst manganese is more common in the bivalve shell and shell-sand groups than in those containing material derived from a mixed shelly limestone. This pattern needs to be confirmed with a larger sample.

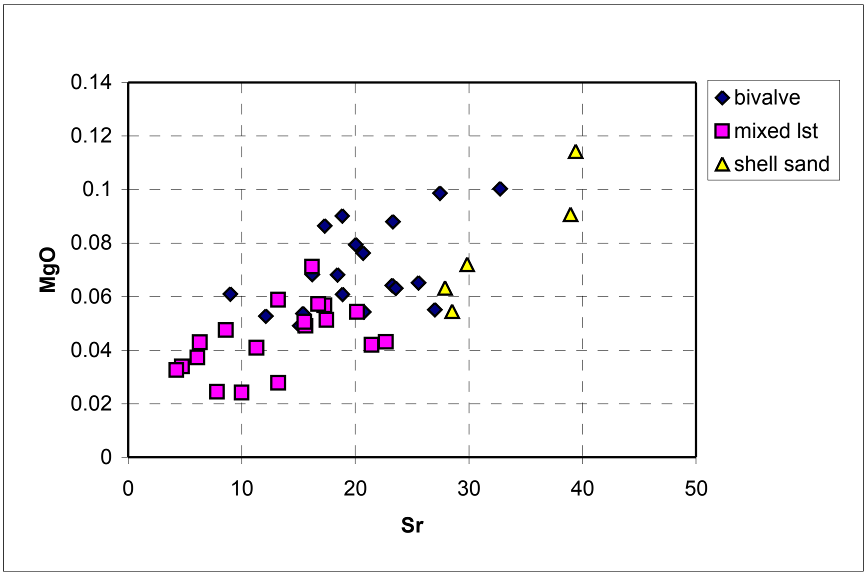

Figure 5

Sand-tempered wares

Sand-tempered wares were common on the A4146 sites and there was considerable visual variation in fabric appearance. A sample of 19 handmade vessels and 6 wheelthrown vessels was thin sectioned and chemically analysed.

Thin Section Analysis

The majority of the thin sections have a similar range of inclusion types but some are sufficiently distinct to be classed as separate fabrics. There was no clear-cut difference between the wheelthrown and handmade vessels, suggesting that some of the handmade vessels were made from similar raw materials to the wheelthrown ones. One major fabric was recognised, together with five minor fabrics, represented either by single sherds or in one case, fabric 2, by two samples.

Fabric 1

The following inclusion types were noted in the 19 thin sectioned samples of sand-tempered ware (handmade and wheelthrown):

- Well–rounded quartz grains. Moderate to abundant. Several contain brown-stained veins but there is little trace of any cement coating. The grains range from c.0.3mm to 2.0mm. Most are unstrained, monocrystalline quartz but some strained, polycrystalline grains are present. In the hand, these grains are highly polished and some have a rose tint.
- Opaque grains. Sparse to moderate rounded opaque grains up to 0.4mm across.
- Chert. Sparse rounded grains, including one with a thick brown-stained crust, up to 1.0mm across.
- Organic voids. Sparse irregular voids up to 1.0mm across, some with carbonised contents, surrounded by a blackened halo.
- Clay concretions. Rounded pellets up to 1.5mm across, with a darkened crust and similar texture to the clay groundmass.
- Clay pellets. Rounded grains up to 2.0mm across with a similar texture to the clay groundmass. Some have a lighter colour and some are the same colour as the groundmass.
- Altered glauconite. Sparse rounded light brown isotropic grains c.0.2mm across.
- Flint. Sparse angular and subangular fragments of light brown flint up to 1.0m long. The subangular grains are brown-stained.

The clay groundmass consists of light brown, optically anisotropic or isotropic baked clay minerals with sparse to moderate angular quartz, muscovite laths and rounded dark brown grains up to 0.1mm across.

Fabric 2

. In the hand specimen, this fabric can be distinguished from Fabric 1 because of the lack of mica in the groundmass and the lower quantity of polished quartz. One of the two sectioned sherds comes from a spouted pitcher, of later 11th/12th-century date and both are handmade. The following inclusion types were present in the two thin sections of fabric 2

- Rounded and subangular quartz. Moderate grains, mostly subangular and up to 0.3mm across with sparse rounded grains up to 0.5mm across. Some of the larger grains have a dark brown cement adhering but there are no iron-stained veins. In the hand, the larger grains are polished.
- Microcline feldspar. Sparse subangular grains up to 0.3mm across.
- Opaque grains. Moderate rounded grains, some completely opaque and some with an opaque core and dark brown crust, up to 0.3mm across. Some grains show cracks (like squashed peas).
- Altered glauconite. Sparse light brown isotropic grains up to 0.3mm across.
- Phosphate nodules. Sparse dark brown grains up to 1.5mm across.

The groundmass consists of optically anisotropic baked clay minerals, sparse angular quartz and rounded opaque inclusions up to 0.1mm across.

Fabric 3

Fabric 3 is recognisable in the hand specimen by its well-sorted subangular quartz and calcareous sand. The calcareous inclusions, however, have been completely leached in the sectioned sample.

The following inclusion types are present in thin section:

- Subangular quartz. Abundant subangular grains up to 0.5mm across. A number of these grains, perhaps a quarter, are polycrystalline grains, either strained or unstrained mosaic quartz.
- Shell voids. Sparse voids up to 0.5mm long and c.0.1mm thick with a slight curvature.
- Limestone voids. Moderate rounded voids, mostly filled with brown phosphate. Some appear to have had an oolitic structure. Most are up to 0.3mm across by larger voids, up to 1.5mm across are present.
- Rounded opaques. Sparse grains up to 0.3mm across.
- Flint. Sparse angular flint up to 0.3mm long.

The groundmass consists of light grey isotropic baked clay and abundant vesicles, either the result of a relatively high firing or leached calcareous inclusions.

Fabric 4

Visually, Fabric 4 appears very similar to fabric 3 and the range of inclusions is also similar. However, there are some differences in thin section which warrant distinguishing the two fabrics, although some of these may well simply be due to the sample has been fired at a lower temperature and others may be due to taking two samples from a variable fabric. The following inclusion types are present:

- Subangular quartz. Abundant subangular grains up to 1.5mm across and sparse rounded grains. A number of these grains, perhaps a quarter, are polycrystalline grains, either strained or unstrained mosaic quartz. The rounded grains in the hand specimen can be seen to be polished.
- Phosphate nodules. Moderate rounded grains. Some appear to have had an oolitic structure. Most are up to 0.3mm across by larger voids, up to 1.5mm across are present. Some contain brown dendritic structures, possibly of biological origin.
- Rounded opaques. Sparse grains up to 0.3mm across.
- Flint. Sparse angular flint up to 1.0mm long.

The groundmass consists of light brown anisotropic baked clay with few quartz or mica inclusions but moderate rounded dark brown grains.

Fabric 5

Fabric 5 is distinguished from Fabric 1 solely by the higher quantity of opaque grains and altered glauconite. It is presumably a variant of fabric 1 and probably comes from the same source.

Fabric 6

Fabric 6 is distinguished from Fabric 1 solely by the coarser texture of the rounded quartz sand, some grains of which are over 3.0mm across. It is presumably a variant of fabric 1 and probably comes from the same source.

Chemical Analysis

The estimated silica content of the samples ranged from 71.5% to 83.3%. The wheelthrown samples have a lower mean silica content than the handmade ones although their ranges entirely overlap (in other words, some of the handmade samples are sandier than the wheelthrown vessels whilst others are similar). Two samples of fired clay (Iron Age loom weights) from the A4146 have a lower silica content.

The silica content was compared with that of a range of wheelthrown greywares, of South Hertfordshire Reduced ware (SHER) and Late Medieval Reduced ware (LMRW) types. Most of these wares have a lower silica content than the A4146 samples, with the exception of samples from Nettleden and Grove Priory, Linslade.

The chemical data was then normalised to aluminium and examined. The fired clay samples have a higher iron, chromium, vanadium and zinc content than the pottery but with those exceptions the elements have similar ranges for all three groups of samples. The wheelthrown vessels also have lower sodium and manganese values and higher cerium values than the fired clay. Since none of the other rare earth elements show this difference it is likely that the cerium difference is not significant. On these grounds alone it can be stated that the pottery was not made from the same raw materials as the fired clay.

Factor analysis was carried out using both the full set of elements and omitting elements likely to be affected by burial conditions (calcium, phosphorous, strontium and the rare earth elements).

Five factors were found in the first analysis and a bi-plot of the first two failed to distinguish any of the three groups but did distinguish three of the petrofabric groups, 3, 4and 6, which have strong negative scores for factor 1. An examination of the data suggests that this is due to low values for a number of elements rather than the high frequency of any element or elements.

A plot of the third against the fourth factors separated the fired clay from the pottery and also isolated eight samples of handmade sandy ware from a group consisting of the wheelthrown samples and the remaining 11 handmade samples. This split does not correspond to any petrological grouping. One of these eight samples was distinguished from the remainder by a strong negative factor 3 score (this was petrofabric 3).

Fig 6 shows a bi-plot of Factor 1 against Factor 4 scores and demonstrates that the majority of the pottery forms a single chemical group, separated from the fired clay samples (which have higher F4 scores) and from the samples of petrofabrics 3 and 4, and less clearly petrofabric 6.

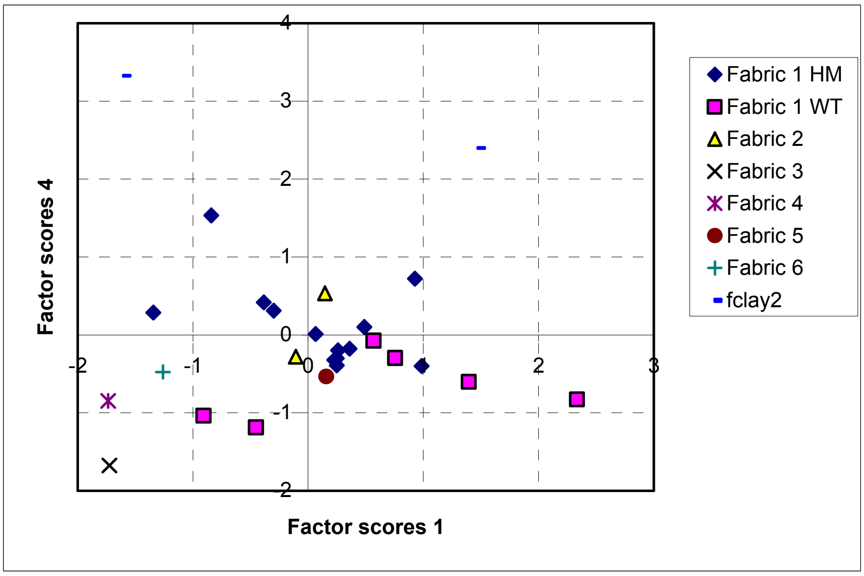

Figure 6

The second analysis found only three factors and a plot of F1 against F2 again distinguishes the fired clay samples (high F2 scores) and fabrics 3, 4 and 6 (with strong negative F1 and F2 scores).

Factor 3 distinguishes fabrics 3 and 4 from the remainder (stronger negative values) but also reveals a difference between the handmade and wheelthrown samples, with ten of the 13 handmade fabric 1 samples having higher F3 scores than the wheelthrown vessels. This is due primarily to their higher titanium and zirconium values, which when plotted against estimate silica content appears to be only partially explained as being due to higher silica content.

Considered on their own, therefore, the chemical data from the sand-tempered wares from the A4146 indicate that there is a chemical difference between some of the handmade vessels and the wheelthrown vessels although both groups belong to petrological fabric 1.

The data were then compared with other analysed groups of sand-tempered ware from the south midlands, omitting calcium, strontium and the rare earth elements. Four factors were found. A bi-plot of the first and second factor scores distinguishes some of the handmade Fabric 1 samples, Fabric 3, Fabric 4, Fabric 6, the Grove Priory samples, and the Nettleden samples from the remainder (which includes the wheelthrown Fabric 1 samples, some of the handmade Fabric 1 samples and Fabric 5). The separated samples have negative F1 and F2 scores, which are due mainly to low magnesium, potassium, iron, nickel, zinc and vanadium values.

A plot of F3 against F4 shows that the A4146 samples have negative F4 scores, which distinguishes them from both Nettleden and Grove, and variable F3 scores. Some of the handmade fabric 1 samples have higher F3 scores than any of the comparanda whilst fabrics 2, 3, 4 and 6 all have negative F3 scores.

The chemical composition of the sand-tempered wares distinguishes them from most of the comparanda, the exceptions being a group of samples from Grove Priory, which is another consumer site, mainly of later date than the A4146 sites, and Nettleden, a production site to the north of Hemel Hempstead, about 14 miles to the southeast of the A4146 sites. The thin section analysis of the Nettleden and Grove vessels indicated that they were similar to each other and contain no inclusion types not present in the A4146 fabrics. Factor analysis of a dataset consisting solely of the A4146, Grove and Nettleden samples found three factors. Factor 2 scores distinguished the fired clay and the Fabric 3, 4 and 6 samples from the remainder whilst high Factor 1 scores distinguished 11 of the A4146 samples from the Grove and Nettleden samples. These high F1 samples include the Fabric 2 and 5 samples and eight fabric 1 samples (2 wheelthrown and the remainder handmade). High F1 scores are due to lithium, nickel, magnesium, potassium, sodium and barium. Both the sodium and barium are particularly high in Fabric 2.

In conclusion, therefore, it seems that the majority of the Fabric 1 samples from the A4146 sites, which include most of the wheelthrown samples could have come from Nettleden, and at least were made from raw materials with similar petrological and chemical characteristics. Of the five minor sand-tempered fabrics, one, Fabric 5, might be from a similar source whilst the remainder all have petrological or chemical characteristics which distinguish them from the Nettleden samples, and, with one exception, from all other sampled comparanda. The exception is fabric 2, where a close match was found with samples from Flitwick, and especially with samples of Late Medieval Reduced ware sherds recovered from the Willington to Steppingley pipeline.

Discussion

The thin sections suggest that Fabrics 1, 5 and 6 are probably from the same source and the factor analysis of the chemical data consistently places fabrics 1 and 5 in the same groups whilst fabric 6 is distinguished by its slightly lower iron, magnesium, copper, nickel, vanadium, samarium, and ytterbium values, all of which serve to place fabric 6 on the edge of the fabric 1 and 5 clusters. The polished quartz grains which form the majority of the quartz sand inclusions are derived from lower Cretaceous deposits, such as the Woburn sands, which outcrop at Leighton Buzzard and form a major constituent of cover sands in the area. The silty, micaceous groundmass can also be paralleled locally, in the Gault Clay which overlies the Woburn Sands in the Leighton Buzzard area. The presence of altered glauconite and opaque grains which might be haematite replacement of glauconite is also possibly an indicator of a Gault clay source and therefore a relatively local source. The presence of flint, however, definitely indicates that the sand was not directly obtained from the Woburn sands, since it originated in the upper Cretaceous chalk. Another possible indicator of a non-local origin is the chemical similarity of the Fabric 1/5/6 group to samples from Nettleden. The source of the clay and sand used at Nettleden is not known although the site lies in the Thames basin, within the chalk escarpment. Clay with flints and chalky boulder clay both outcrop in the area.

The chemical differences between the wheelthrown and handmade samples might indicate a separate source, but could simply be due to the contemporary but separate production of the handmade and wheelthrown wares in the same general area, or to a different in date, and clay source, within a single industry.

Fabrics 3 and 4 are probably rather different samples from the same source. Combining their petrological characteristics, it seems likely that the parent clay is either a Jurassic mudstone, either *in situ* or redeposited in a boulder clay. The sand temper includes some lower Cretaceous-derived grains, but the majority of the sand has a different, unknown, origin. The rounded phosphate grains and possible shell/limestone inclusions could occur in Jurassic or lower Cretaceous deposits in the southeast midlands whilst the lack of chemical parallels with samples of Buckinghamshire and Bedfordshire sand-tempered wares may suggest a source further to the north or west.

Finally, Fabric 2 appears to have a good match at Flitwick, a major late medieval pottery production centre. However, both of the samples are from handmade vessels and one comes from a spouted pitcher, a type unlikely to be in production much later than the mid 12th century. This may suggest that the Flitwick industry had its origins in the 12th century.

Calcareous Algae-tempered ware

Sherds with abundant rounded voids and angular flint inclusions were a common component of the A4146 medieval assemblages. Visually, there are identical to London fabric EMCH (Vince and Jenner 1991) in fabric, manufacture and typology. However, since the A4146 sites are over 50 miles from London, whereas the distance over which pottery was transported overland in the 11th and 12th centuries appears usually to have been much less (with the exception of fine wares such as those produced at Stamford), it was decided to test this identification. Six samples from the A4146 sites were taken for thin section and chemical analysis and compared with the published petrological description of the London fabric and a sample of 6 sherds taken from consumer sites in the city of London.

Thin Section Analysis

The six samples consist of three with surviving calcareous algae inclusions and three in which the calcareous algae have been leached and the voids either left empty or filled with unfired soil. The following inclusion types were noted in the thin sections:

- Calcareous algae. Abundant rounded and subangular fragments up to 1.5mm across. These are stained purple by Dickson's method. The fragments consist of a mass of calcareous tubes arranged in bunches and are surrounded by a darkened halo, indicating a burnt-out organic content.
- Flint. Abundant angular, unstained fragments up to 1.5mm across. Some of these have calcareous algae growths encasing them.
- Rounded quartz. Sparse grains up to 1.0mm across. Most of these grains are polished in hand specimen.
- Subangular quartz. Sparse grains up to 0.4mm across. These include examples of polycrystalline mosaic quartz.
- Dark brown clay/iron. Sparse rounded grains up to 0.5mm across.

The groundmass consists of dark brown optically anisotropic baked clay minerals, moderate angular quartz up to 0.1mm across and sparse muscovite laths and altered subangular glauconite up to 0.1mm long.

Chemical Analysis

There is a difference in the estimated silica content of the leached and unleached samples from the A4146 sites and this confirms that soil, presumably including quartz sand or silt has contaminated the voids left by the algae. The leached samples have estimated silica contents ranging from 68% to 76% whilst the un-leached samples range from 63% to 67%.

Variation within the A4146 samples

The unleached samples contain higher frequencies of magnesium, calcium, lithium, strontium, and zirconium. Three of these elements (magnesium, calcium and strontium) were clearly present in the calcareous algae grains but the other two are unlikely constituents and perhaps have a higher frequency in the unleached samples because their frequencies are diluted in the leached samples, through contamination with soil.

The frequency of a few other elements, relative to aluminium, is enhanced in the leached samples. These elements are: nickel, scandium, and vanadium and all three are likely to have been present in contaminating soil.

The samples from the City of London include three with similar estimate silica contents to the unleached A4146 samples and one with an estimated silica content comparable to the leached and contaminated A4146 samples. The frequency of most other elements, relative to aluminium, is in the same range as those from the A4146. The only exception is barium, which is lower in the London samples (292-478 ppm versus 411 to 765 ppm in the A4146 samples). This difference is likely to be due to contamination since the highest barium values occur in two of the leached samples.

The data from the A4146 and City of London samples was then compared with that from wheelthrown sandy wares of medieval and late medieval date from Greater London through to Bedfordshire and Northamptonshire (the SHER and LMRW projects). Calcium, magnesium, phosphorus, strontium, nickel and vanadium were all excluded from analysis and four factors were found. A plot of factor 1 against factor 2 indicated that factor 2 effectively produced two groups of samples, one of which contained the calcareous algae-tempered sherds. A plot of the F3 against the F4 scores allowed further samples to be excluded. The groups with a similar chemical composition to the calcareous algae-tempered ware samples are mostly from production sites (and consumer sites) in Bedfordshire and Northamptonshire (Caldecote, Everton, Flitwick, Higham Ferrers, Hitchin and Riseley) whilst those with a different composition consist of Nettleden, Little Munden, Grove Priory, Arkley, Pinner, Elstree and the wheelthrown greyware from the A4146, i.e. all sites within the Thames basin. However, the high F2 group also contains two groups of samples probably made from Thames alluvium, from the Fleet valley in the City of London and from Kingston upon Thames. Therefore, based on this comparison of the clay composition, two sources for EMCH are possible: a) north of the chalk escarpment or b) in the Thames valley itself.

Discussion

Although at first glance the groundmass seems likely to be derived from the Gault clay, the glauconite grains appear to be detrital rather than authigenic and the source might be a redeposited chalky boulder clay or a Tertiary clay, although the difference in chemical composition between this ware and those produced within the Thames basin favours a Gault clay source, albeit probably redeposited as a silty alluvial clay. The rounded quartz grains are probably derived from the Woburn Sands, but these too are common in more recent deposits, on either side of the chalk. The clue to the source, however, is that the calcareous algae lived in bodies of slowly-moving calcium-rich hard water and the thin section evidence indicates that the substrate consisted of angular flint sand. Together, the clay and inclusions suggest that this ware was produced from alluvium in the valley of a chalk stream, either at the foot of the scarp slope of the Chalk escarpment or, just possibly, in the Thames valley further down stream from the point where the Thames passes through the chalk. Given that fabric EMCH is the second most common fabric at Moor Lane, Staines, in the late 11^{th} to 12^{th} centuries, a source in that area is not impossible. The similarity in composition, both petrological and chemical, with the EMCH samples from the City of London does, however, suggest that both have the same source.

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Appendices

Appendix 1

TSNO	Action	Context	cname	subfabric
V3397	TS;ICPS	4129	MEDLOC	FAB1
V3407	TS;ICPS	60073	MEDLOC	FAB2
V3406	TS;ICPS	4138	MEDLOC	FAB1
V3399	TS;ICPS	4129	MEDLOC	FAB1
V3370	DR;TS;ICPS	60069	MEDLOC	FAB2
V3369	DR;TS;ICPS	60043	SHER	FAB1
V3405	TS;ICPS	4138	MEDLOC	FAB1
V3403	TS;ICPS	4136	SHER	FAB1
V3367	DR;TS;ICPS	40208	SHER	FAB1
V3396	TS;ICPS	4129	MEDLOC	FAB1
V3408	TS;ICPS	60073	MEDLOC	FAB1
V3404	TS;ICPS	4138	MEDLOC	FAB1
V3381	DR;TS;ICPS	22019	FCLAY	FAB2
V3400	TS;ICPS	4135	MEDLOC	FAB1
V3375	DR;TS;ICPS	4116	MEDLOC	FAB1
V3398	TS;ICPS	4129	MEDLOC	FAB1
V3394	TS;ICPS	4109	MEDLOC	FAB1
V3380	DR;TS;ICPS	32214	FCLAY	FAB2
V3395	TS;ICPS	4002	MEDLOC	FAB5
V3368	DR;TS;ICPS	60002	SHER	FAB1
V3402	TS;ICPS	4136	MEDLOC	FAB6
V3378	DR;TS;ICPS	4129	MEDLOC	FAB1
V3376	DR;TS;ICPS	4135	EMCH	EMCH
V3374	DR;TS;ICPS	4138	SHER	FAB1
V3373	DR;TS;ICPS	4008	SHER	FAB1
V3393	TS;ICPS	4000	SHER	FAB1
V3392	TS;ICPS	60106	EMCH	
V3390	TS;ICPS	60043	EMCH	
V3388	TS;ICPS	60105	OLNEY HYDE	
V3389	TS;ICPS	4129	EMCH	
V3379	DR;TS;ICPS	4129	EMCH	EMCH
V3401	TS;ICPS	4135	MEDLOC	FAB3
V3409	TS;ICPS	60102	MEDLOC	FAB4
V3391	TS;ICPS	60073	EMCH	
V3387	TS;ICPS	40207	OLNEY HYDE	
V3384	TS;ICPS	4117	OLNEY HYDE	
V3382	TS;ICPS	4000	OLNEY HYDE	
V3383	TS;ICPS	4007	OLNEY HYDE	
V3372	DR;TS;ICPS	4007	OLNEY HYDE	
V3385	TS;ICPS	4129	OLNEY HYDE	

V3386	TS;ICPS	60031	OLNEY HYDE
V3371	DR;TS;ICPS	60112	OLNEY HYDE
V3377	DR;TS;ICPS	4135	OLNEY HYDE

Appendix 2

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V3367	12.25	4.69	1.01	0.9	0.18	1.53	0.55	0.21	0.014
V3368	14.05	4.84	1.03	0.8	0.19	1.86	0.59	0.19	0.017
V3369	11.8	7.06	0.68	1	0.1	0.55	0.52	0.34	0.028
V3370	11.41	4.71	0.71	0.63	0.26	1.44	0.49	0.77	0.038
V3371	22.22	4.48	0.62	7.56	0.21	1.25	0.93	0.81	0.068
V3372	20.58	7.12	0.7	0.65	0.24	2.29	0.9	0.56	0.05
V3373	14.57	6.34	0.64	0.79	0.15	0.83	0.71	0.24	0.017
V3374	14.53	6.62	0.69	0.62	0.11	0.84	0.65	0.24	0.034
V3375	12.87	5.46	0.94	0.85	0.18	1.73	0.55	1.46	0.046
V3376	14.5	5.31	0.57	0.23	0.22	2.03	0.75	0.41	0.032
V3377	24.48	5.16	0.6	1.3	0.2	1.5	1.01	0.33	0.053
V3378	14.3	6.92	0.67	0.28	0.11	1.59	0.74	0.35	0.009
V3379	17.74	5.43	0.93	0.45	0.25	2.51	0.9	0.86	0.026
V3380	13.62	8.26	0.76	0.78	0.22	2.02	0.55	1.47	0.091
V3381	12.62	8.5	0.75	0.71	0.19	1.44	0.53	0.24	0.096
V3382	20.21	7.14	0.87	1.29	0.3	2.52	0.94	0.75	0.042
V3383	20.24	8.16	0.83	1.29	0.24	2.33	0.87	2.5	0.084
V3384	20.16	8.67	0.66	0.56	0.21	2.38	0.91	0.98	0.161
V3385	20.6	8.06	0.77	0.61	0.18	2.28	0.93	1.84	0.054
V3386	21.88	5.06	0.53	4.74	0.18	1.4	0.88	0.42	0.08
V3387	19.51	6.37	0.93	1.49	0.29	2.56	0.89	1.13	0.035
V3388	16.91	6.31	0.92	11.27	0.27	2.15	0.72	1.13	0.08
V3389	17.66	6.94	1.43	0.92	0.23	2.43	0.91	1.53	0.044
V3390	16.45	5.47	1	8.86	0.21	2.31	0.8	0.44	0.034
V3391	18.72	6.38	1.54	0.95	0.3	3.08	1.01	0.48	0.026
V3392	16	5.44	1.37	9.33	0.27	2.64	0.82	0.55	0.03
V3393	15.75	6.46	0.85	0.43	0.1	1.65	0.8	0.34	0.01
V3394	13.29	5.93	0.64	0.58	0.17	1.46	1.02	0.4	0.032
V3395	13.92	6.24	1.08	0.96	0.25	1.95	0.59	0.6	0.031
V3396	12.43	4.57	0.3	0.56	0.12	0.4	0.71	0.26	0.008
V3397	9.3	3.84	0.65	0.41	0.14	1.01	0.59	0.75	0.02
V3398	13.18	5.25	0.51	0.47	0.12	0.65	0.7	0.33	0.017
V3399	11.15	5.65	0.32	0.34	0.16	0.78	0.57	0.78	0.013
V3400	12.73	4.92	0.4	0.43	0.09	0.36	0.7	0.14	0.033
V3401	18.02	5.05	0.97	1.1	0.21	2.3	0.56	0.22	0.014
V3402	14.12	3.33	0.24	0.4	0.09	0.62	0.66	0.37	0.025
V3403	11.91	4.15	0.24	0.37	0.12	0.38	0.68	0.12	0.019
V3404	12.59	5.55	0.67	0.52	0.19	1.58	0.8	0.71	0.023

V3405	11.86	4.86	0.31	0.52	0.09	0.44	0.7	0.5	0.092
V3406	10.81	6.5	0.74	0.49	0.17	1.26	0.77	0.85	0.053
V3407	10.49	4.87	0.68	0.79	0.25	1.33	0.43	1.1	0.041
V3408	12.58	6.14	1.21	0.94	0.18	1.43	0.83	0.74	0.055
V3409	18.25	5.2	0.73	1.26	0.2	1.52	0.49	0.68	0.035

Appendix 3

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V3367	243	75	20	69	75	12	67	105	17	98	31	84	31	5	1	3	2	26	67	18
V3368	272	80	24	58	137	13	85	119	15	58	29	73	30	5	1	3	2	42	85	28
V3369	398	81	16	40	42	13	90	92	17	55	41	59	41	4	1	2	2	37	46	17
V3370	574	71	18	48	97	12	108	92	18	65	27	68	28	5	1	3	2	38	60	23
V3371	701	114	41	112	49	20	294	152	28	123	32	62	35	7	1	5	2	31	62	13
V3372	672	145	34	59	70	21	98	139	30	89	49	93	51	9	2	5	3	20	114	14
V3373	223	94	17	16	41	15	66	106	36	65	47	77	48	7	1	4	2	30	60	14
V3374	211	84	15	19	45	14	64	102	39	52	57	88	58	8	1	5	3	72	59	19
V3375	792	77	21	55	49	13	155	91	21	63	30	59	31	6	1	3	2	31	84	13
V3376	411	106	25	31	52	17	53	143	17	65	30	60	31	6	1	3	2	30	79	14
V3377	796	142	44	75	58	24	192	191	38	142	47	87	50	11	2	7	3	28	57	15
V3378	372	88	25	21	51	15	55	120	19	67	38	65	38	6	1	3	2	27	69	13
V3379	606	123	26	37	58	21	104	168	54	81	69	140	73	15	3	9	4	27	105	14
V3380	455	113	23	39	77	14	85	149	34	80	46	66	49	8	2	6	3	40	130	16
V3381	360	110	22	25	73	13	59	155	11	89	21	47	23	3	1	4	2	36	142	12
V3382	526	156	36	66	59	21	128	137	38	109	60	115	63	13	2	7	4	84	138	15
V3383	879	147	42	71	61	21	229	138	48	133	62	123	66	14	2	8	4	33	132	16
V3384	546	156	36	64	88	22	86	141	32	112	50	101	54	11	2	7	3	27	156	20
V3385	739	151	39	64	59	22	126	154	35	129	55	106	57	11	2	6	3	35	131	14
V3386	625	121	39	94	50	21	219	156	34	151	42	94	45	9	2	6	3	19	62	15
V3387	678	149	33	77	67	20	168	127	37	104	55	103	57	10	2	6	3	28	121	15
V3388	727	116	32	57	41	17	341	116	32	100	49	97	52	9	2	6	3	23	98	13
V3389	765	129	29	70	79	20	148	171	44	112	59	107	61	11	2	6	4	28	148	21
V3390	528	113	27	58	43	17	132	142	33	88	46	90	47	8	2	4	3	24	84	15

V3391	523	139	31	65	39	22	103	171	21	105	42	78	42	6	1	3	2	22	82	16
V3392	474	118	28	65	44	18	127	148	26	92	43	81	44	6	2	4	3	27	94	16
V3393	408	118	26	26	35	17	49	145	26	91	41	92	42	8	2	4	3	26	72	15
V3394	308	76	25	50	79	16	66	135	27	153	38	112	41	8	2	5	3	31	84	21
V3395	456	90	23	73	104	15	149	116	27	103	35	86	36	7	1	3	2	30	89	20
V3396	160	93	17	17	34	12	46	110	33	96	28	59	30	5	1	4	3	38	42	17
V3397	317	58	17	39	63	9	60	88	17	80	25	65	26	5	1	3	2	24	61	16
V3398	159	96	15	17	31	13	55	93	27	90	34	80	35	3	1	3	2	43	46	19
V3399	346	83	15	22	27	10	65	98	14	67	29	52	29	3	1	2	1	42	43	11
V3400	255	97	16	27	29	13	46	103	27	90	25	55	27	4	1	3	2	31	42	14
V3401	253	76	23	37	24	16	74	97	14	111	23	55	24	4	1	2	2	34	60	13
V3402	176	100	12	32	23	12	43	79	17	104	26	50	27	2	1	2	2	34	58	14
V3403	192	92	13	30	24	10	33	95	21	97	18	38	19	2	1	2	2	36	36	14
V3404	461	89	21	47	61	13	73	123	19	117	34	99	35	7	1	3	2	39	70	25
V3405	252	94	15	23	38	11	50	99	20	89	22	49	24	2	1	4	2	27	52	18
V3406	371	76	20	42	72	12	61	117	21	127	36	93	37	6	1	4	2	41	80	25
V3407	795	77	17	56	97	10	129	93	18	78	28	69	29	5	1	3	2	32	65	20
V3408	604	71	22	92	95	14	88	114	23	141	35	87	37	6	1	4	2	44	101	23
V3409	439	98	26	54	39	17	161	123	11	114	28	58	28	3	1	2	2	30	68	12

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