Petrological and Chemical Analysis of Some Iron Age Pottery from Leicestershire

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A selection of Iron Age pottery from two sites in Leicestershire was submitted for thin section analysis. A small number of sherds were also selected for chemical analysis using Inductively-Coupled Plasma Spectroscopy. The samples come from Manor Farm, Humberstone, and Hallam Fields, Birstall, and were divided visually into 19 fabrics by Leicester University Archaeology Services (App 1).

Methodology

The sample sherds were examined at x20 magnification and the main inclusion types present were noted. Subsamples were then taken for thin section and chemical analysis. The thin sections were prepared by Steve Caldwell, University of Manchester, and stained using Dickson's method (Dickson 1965). Offcuts for chemical analysis were sawn from the sample and the outer surfaces mechanically removed. The remaining block was then crushed to a fine powder and analysed using Inductively-Coupled Plasma Spectroscopy (ICP-AES) at Royal Holloway University College, London, under the supervision of Dr J N Walsh. A range of major elements was measured and the values presented as percent oxides (App 3). A range of minor and trace elements were measured and presented as parts per million (App 4). Silica was not measured but an estimate was obtained by subtracting the total measured oxides from 100%.

The data were normalised to aluminium and the normalised data were analysed using the multivariate statistical package, WinSTAT for Excel (2002). Factor Analysis was the main procedure used. In this analysis the original variables (element values) were replaced by a smaller series of Factors which still express the same variation between samples. The contribution of each element to the new factor is shown by a weighting table and in general those elements with strong positive or negative weightings are found to be correlated. The weighting table and plots of one set of factor scores against another can be used to visualise and interpret the structure of the dataset.

Thin Section Analysis

The principal inclusions present in each section were used to attribute the samples to ten groups whilst differences between samples in the same group were used to assign the samples to Petrofabrics. These petrofabrics are correlated with the ULAS fabrics in Table 1.

Acid Igneous Rock

Eight sections contained angular fragments of acid igneous rock as a major inclusion type. These could be divided into three fabric groups on the basis of the texture of quartz inclusions. AI1 contains abundant subangular and sparse rounded quartz grains; AI2 contains abundant rounded quartz grains and AI3 contains only rare quartz grains. One sample, AI4, was distinguished from AI1 because of the presence of mudstone.

AI1. Five sections were assigned to this fabric group. The following inclusion types were noted:

- Acid Igneous Rock. Moderate angular fragments of rock up to 2.0mm long composed of zoned plagioclase feldspar, with slight alteration; hornblende; opaques and quartz. In some cases the feldspar grains are zoned. The rocks can be divided into two on the basis of their grain size. In most cases the grains average 1.0mm to 1.5mm across but in few instances they average 0.3mm to 0.5mm across.
- Rounded quartz. Sparse well-rounded grains up to 0.5mm across.
- Angular quartz. Abundant grains up to 0.2mm across.

The groundmass consists of optically anisotropic baked clay minerals with abundant angular quartz grains up to 0.1mm.

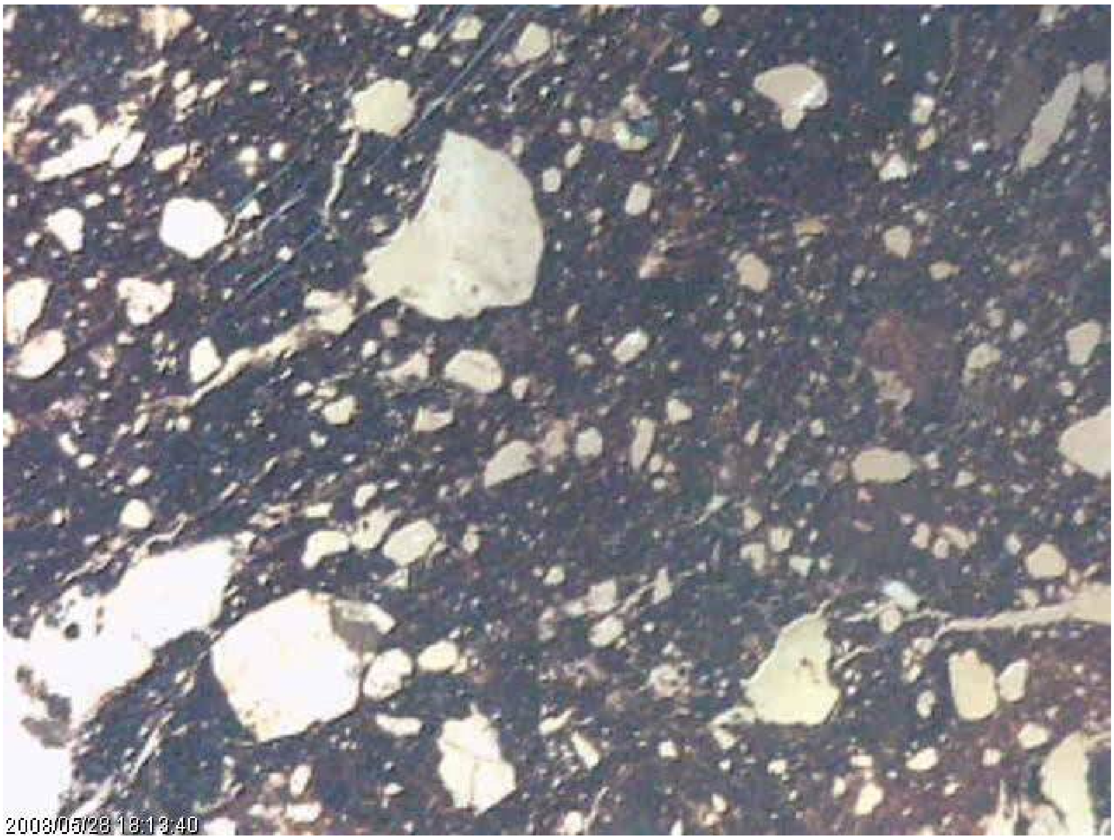

Figure 1 V4934

AI2. A single sample of this group was present, V4938. The following inclusion types were present:

- Acid Igneous Rock. As in AI1.
- Rounded quartz. Moderate grains similar in character to those in AI1.
- Sandstone. Rare well-rounded fragments up to 1.0mm across with well-sorted subangular quartz grains c.0.2mm across.

The groundmass consists of optically anisotropic baked clay and sparse angular quartz grains up to 0.1mm across.

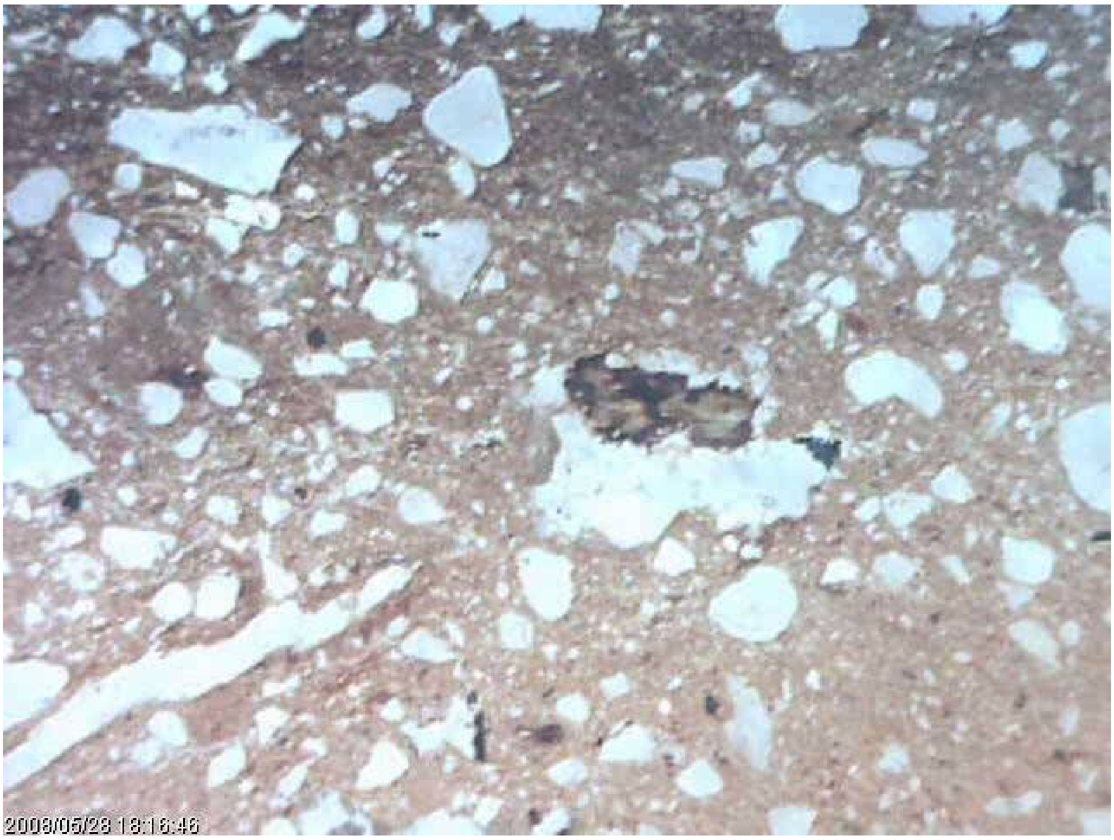

Figure 2 V4938

AI3. A single sample of this groups was present, V4940. The following inclusion types were present:

- Acid Igneous Rock. As in AI1 and AI2.
- Grog. A single large angular fragment, containing angular acid igneous rock fragments and angular quartz similar in texture to AI1.
- Opaque grains. Moderate well-rounded dark brown to opaque grains up to 0.5mm across.

The groundmass consists of optically anisotropic baked clay minerals and angular and subangular dark brown grains up to 0.1mm across.

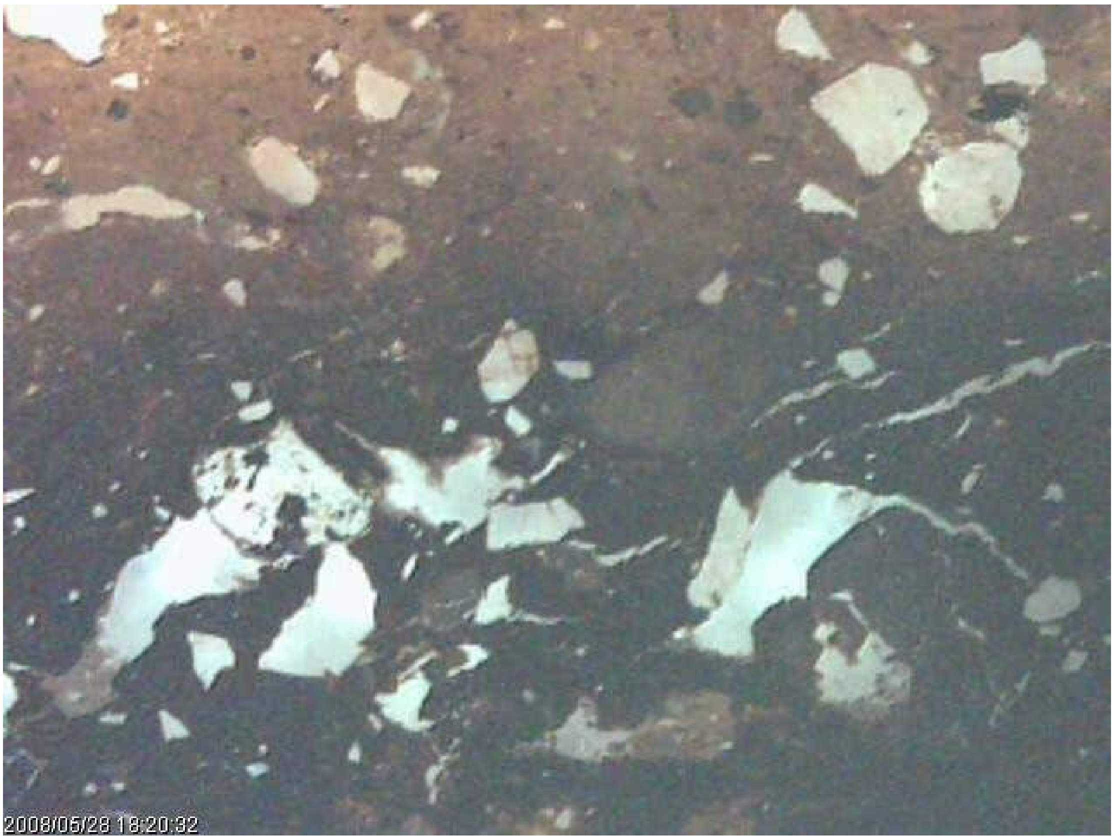

Figure 3 V4940

AI4. A single sample of this group was present, V4939. The following inclusion types were present:

- Acid igneous rock. As in AI1, AI2 and AI3.
- Mudstone. Moderate, rounded pellets up to 1.5mm across, some similar in colour and texture to the groundmass and others with a vesicular texture suggesting the previous presence of finely-divided carbonate. No bedding is present.

The groundmass consists of optically anisotropic baked clay minerals.

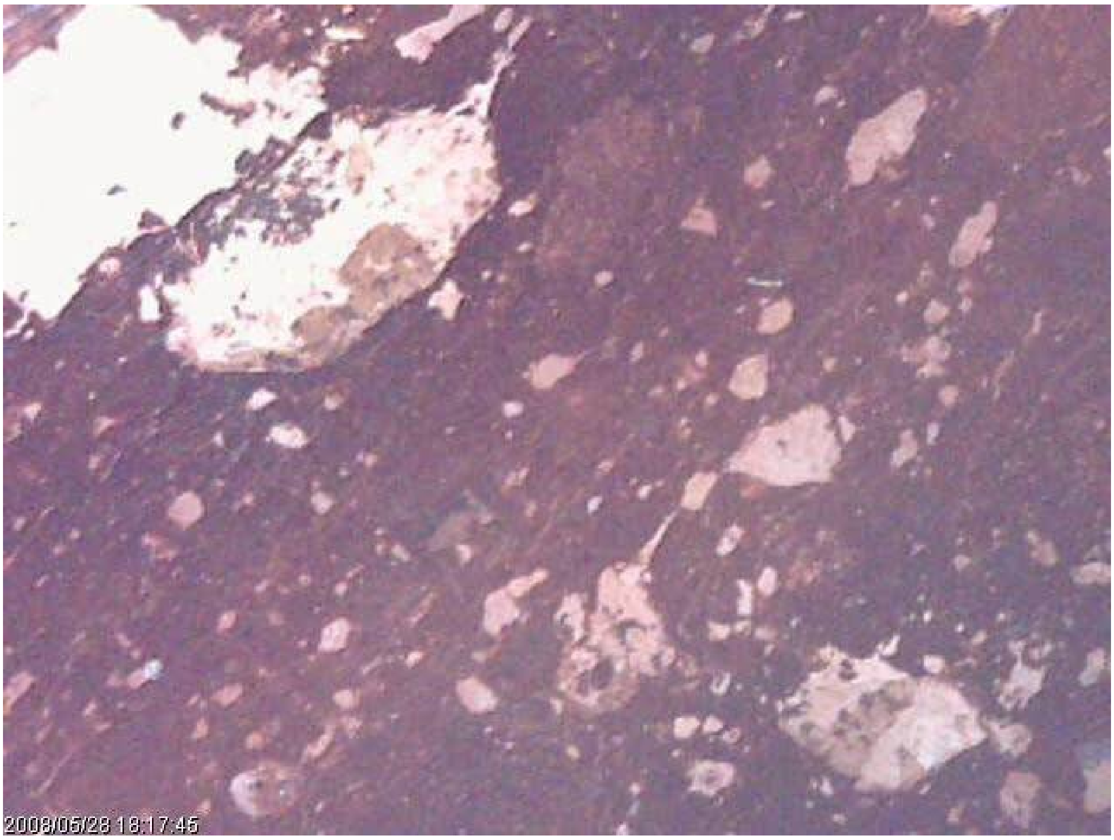

Figure 4 V4939

Interpretation

The zoned feldspar in the acid igneous rock, and the low quantity of quartz, suggest that this is Mountsorrel granodiorite. Whether the finer-grained rock is a facies of this granodiorite or another rock from the same Charnwood complex is not known.

The well-rounded quartz grains and the well-rounded sandstone grains in AI2 originate in Triassic deposits. The inclusionless groundmass of AI4 and the mudstone inclusions suggest that the parent clay in this fabric is of Triassic Mercian Mudstone, either derived directly from weathered mudstone or from a glacial till.

The origin of the parent clays of fabrics AI1, AI2 and AI3 is not known but it is possible that all four fabrics were obtained from a single clay source with a variable texture, such as boulder clay.

Angular Quartz

AQ1. A single sample, V4947, contained coarse angular fragments of quartz. The following inclusion types were noted in thin section:

- Angular quartz. Sparse fragments up to 1.5mm across. These vary from monocrystalline, unstrained to polycrystalline strained and unstrained grains with mosaic quartz developed along crystal boundaries. There are moderate inclusions within the quartz, all probably vesicles. There are too few grains of too small a size to determine their origin.

- Grog. A single angular fragment of light brown grog 1.0mm across containing moderate angular quartz grains up to 0.1mm across. An opaque fragment with similar texture probably has a high organic content.

The groundmass consists of dark brown, slightly variegated, optically anisotropic baked clay minerals with no visible inclusions.

Bone

A single sample, V4949, contained angular fragments of fresh bone as the main inclusion type.

BONE1. The following inclusion types were noted:

- Bone. Moderate angular fragments, often sliver-shaped and up to 3.0mm long and only c.0.3mm wide. Osteons, containing canaliculi and a central Haversian canal are discernable. The lack of staining suggests that the bone is fresh.
- Sandstone. Sparse rounded fragments up to 0.5mm across. The sandstone consists of illsorted subangular quartz grains in a brown cement.
- Grog. Sparse angular fragments differing slightly in colour and texture from the groundmass.
- Quartz. Sparse rounded grains up to 0.3mm across.

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

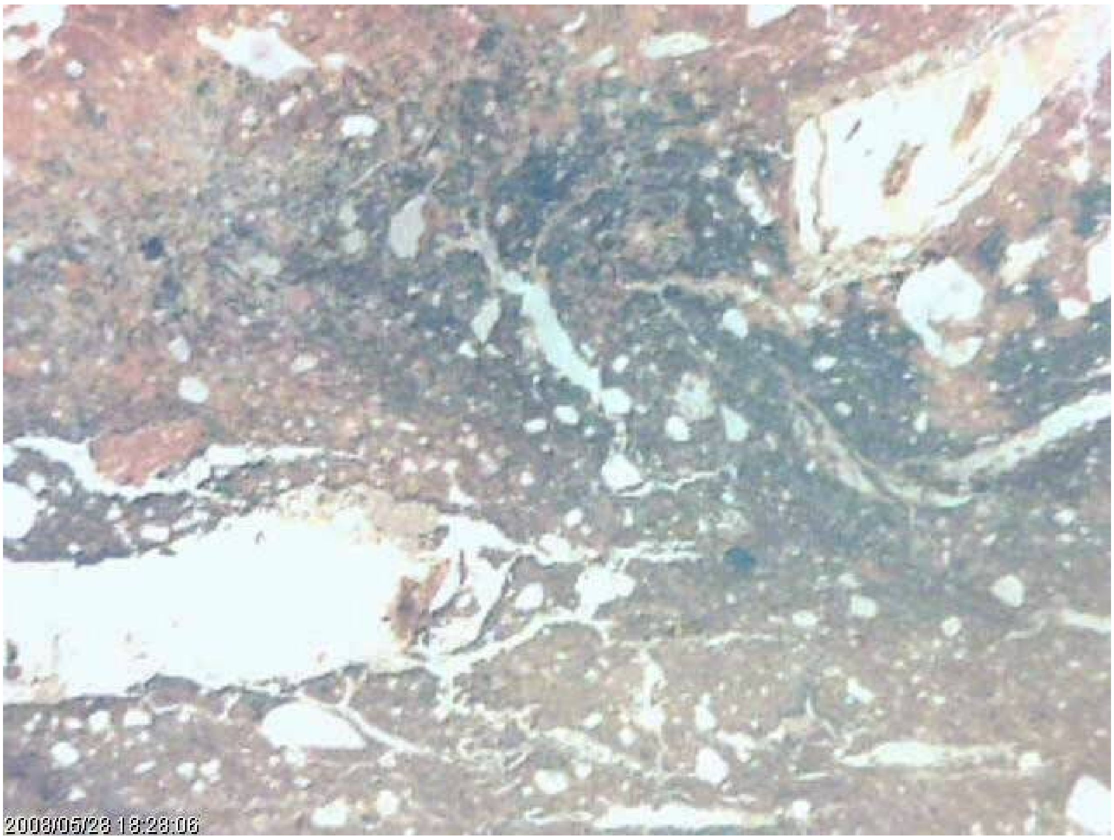

Figure 5 V4949

Interpretation

The bone was probably calcined, crushed and added to the potting clay. The remaining inclusions and the character of the groundmass suggest a Triassic source – Mercian mudstone with a slight admixture of Trias-derived sand.

Flint

Four samples contain fresh, angular flint fragments as a major inclusion type (V4942, V4946, V4948 and V4950). All can be grouped into a single fabric.

FLINT1. The following inclusion types were noted in thin section:

- Flint. Moderate angular fragments up to 2.0mm across with no sign of weathering or staining.
- Quartz. Sparse subangular grains up to 0.3mm across.
- Grog. Sparse angular fragments up to 1.0mm across.
- Opaques. Sparse rounded grains up to 0.5mm across.
- Bone. Rare angular, brown-stained fragments up to 1.0mm across.
- Organics. Sparse fragments up to 1.0mm long and 0.2mm wide.

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

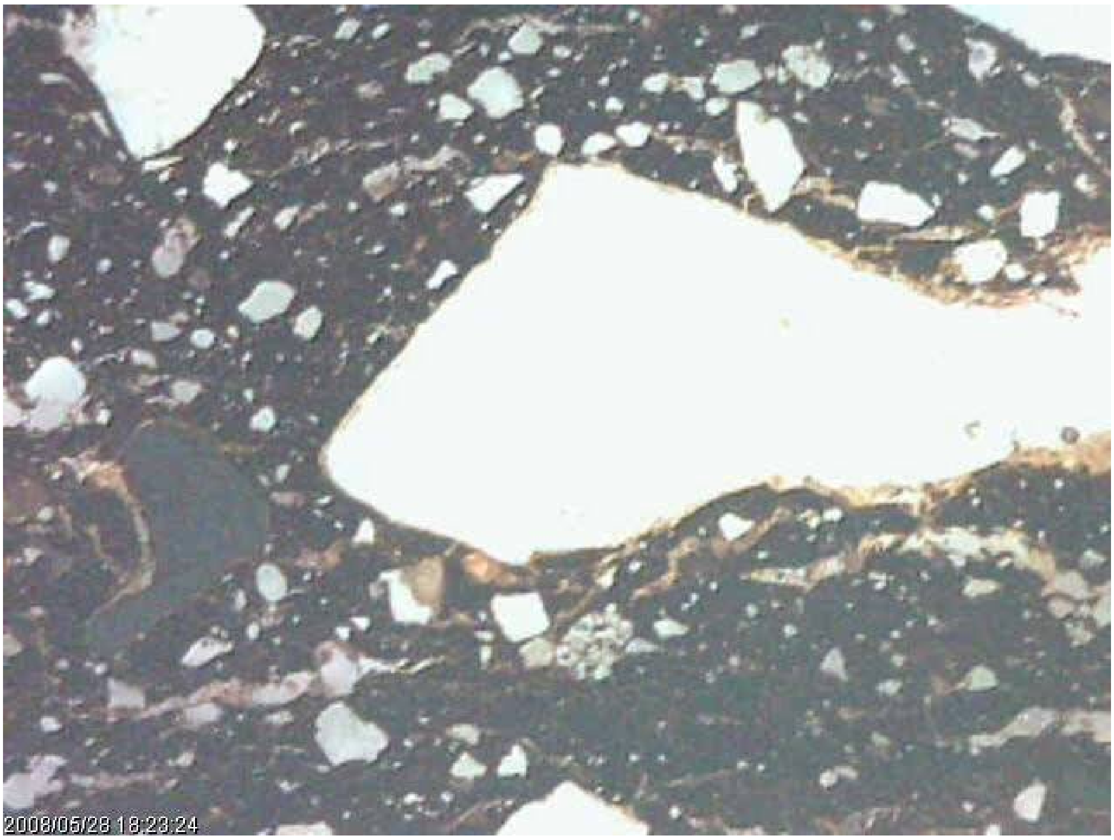

Figure 6

Interpretation

The flint fragments appear to be added to the fabric, either as calcined flint or debitage. There is no sign of crazing which might be expected with calcined flint.

None of the remaining inclusions clearly indicate a source, but the character of the groundmass is similar to that of the bone-tempered ware and others for which a local Leicestershire source is likely. Therefore, despite the fact that Upper Cretaceous flint is not a major component of local gravels and in those gravels is usually stained and rolled, it is likely that the flint-tempered ware samples were made locally.

Grog

In three samples, angular grog was the one of the principal inclusion types present. These could be divided into two fabric groups. In the first, GROG1, the grog is accompanied by a range of other inclusions, including rounded quartz, but in the second, GROG2, the grog is the main inclusion type and rounded quartz is absent.

It should be noted that in the hand specimen all three were thought by the author to contain leached calcareous inclusions but the character of the inclusions in thin section does not support the theory that they are post-burial infilling of the voids left by leached calcareous inclusions. Furthermore, similar grog inclusions have been noted in several other sections as minor inclusions.

GROG1. Two examples of this fabric were present, V4953 and v4954. The following inclusion types were noted:

- Grog. Abundant angular fragments up to 0.5mm across. These mainly have a slightly lighter colour (light brown) to the oxidized groundmass and stand out against the carbon-rich dark grey core. The fragments contain sparse subangular quartz are have a higher birefringence than the groundmass.
- Quartz. Sparse rounded grains up to 0.3mm across.
- Chert. Rare rounded grains up to 0.5mm across.
- Clay/iron. Sparse dark brown rounded grains up to 1.0mm across.
- Opaques. Rare rounded grains up to 1.0mm across.

The groundmass consists of optically anisotropic baked clay minerals, sparse subangular quartz and dark brown clay/iron inclusions up to 0.2mm across.

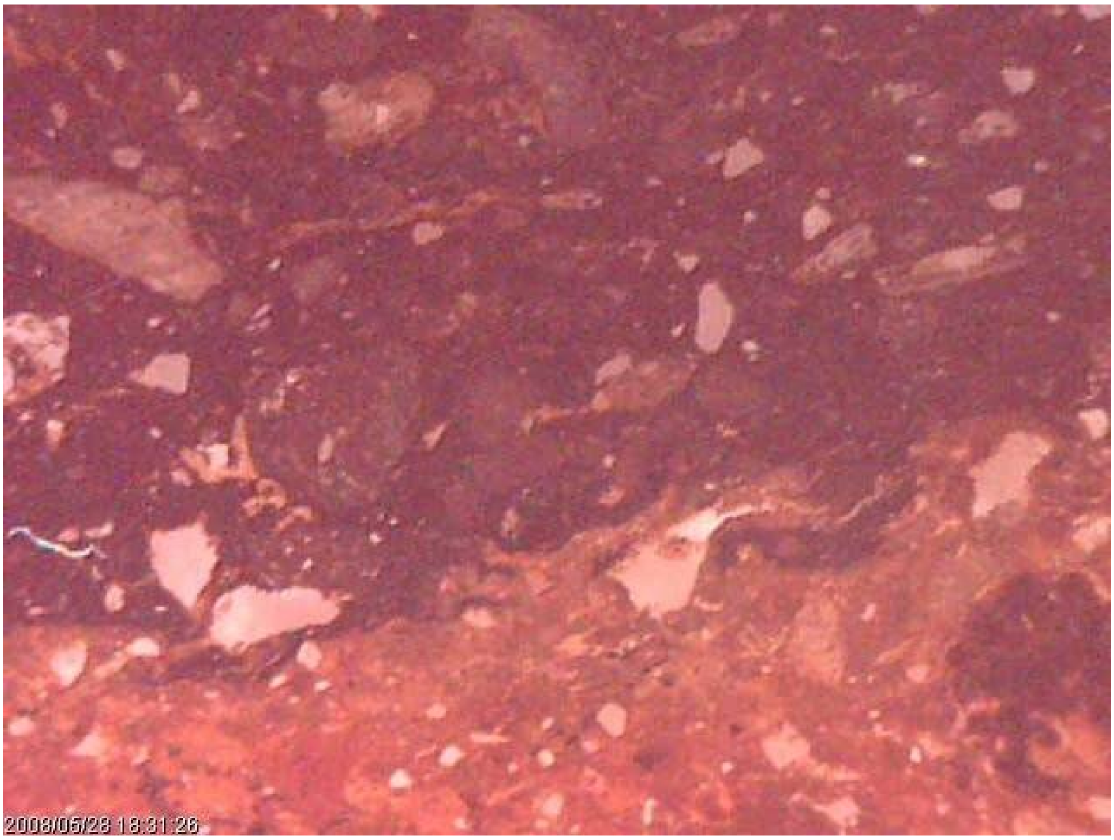

Figure 7 V4954

GROG2. One example of this fabric was present, V4928. The following inclusion types were noted:

- Grog. Abundant angular fragments up to 1.0mm across. None of these fragments contain quartz inclusions, unlike those in GROG1. As in that fabric, however, the inclusions are consistently oxidized throughout, even when surrounded by dark grey, carbon-rich clay groundmass.

The groundmass consists of dark grey baked clay minerals which are too infused with carbon for any birefringence to be seen. Rare angular quartz grains up to 0.1mm across are present.

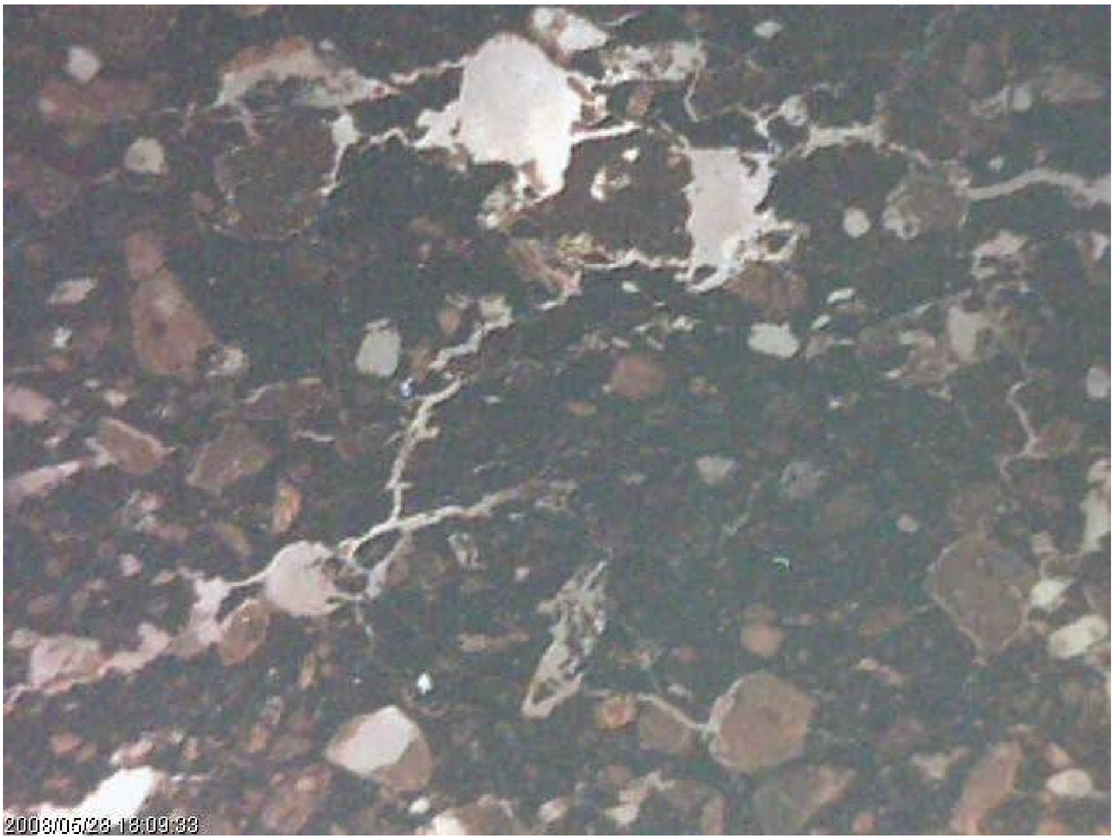

Figure 8 V4928

Interpretation

The inclusions present in GROG1 indicate the presence of a Trias-derived quartzose sand. There is no indication of the origin of GROG2.

In both fabrics, the grog probably has a similar origin to the groundmass and made, indeed, have been formed by recycling broken vessels made by the same potters, or by firing and crushing some of the potting clay and then adding it to the unfired clay.

Limestone

LST1. A single sample contained abundant limestone inclusions (V4932). The following inclusions were noted:

- Limestone. Sparse fragments up to 1.0mm across containing a mixture of echinoid shell, echinoid spines and bivalve shells in a cement of clay/calcium carbonate marl.
- Echinoid shell. Moderate fragments of ferroan calcite echinoid shell up to 1.0mm across.
- Echinoid spines. Moderate fragments of ferroan calcite spine up to 0.4mm in diameter.
- Rounded quartz. Sparse rounded grains up to 0.3mm across.
- Sandstone. Rare well-rounded grains composed of subangular quartz up to 0.2mm across with a brown cement.
- Bivalve shell. Moderate non-ferroan calcite nacreous bivalve shell up to 1.0mm long.
- Punctate brachiopod shell. Sparse non-ferroan calcite shell up to 0.5mm long.
- Organics. Rare carbonised fragments up to 0.5mm long and 0.2mm wide.

The groundmass consists of optically anisotropic baked clay minerals, although mostly opaque and dark grey due to carbon content. Moderate angular quartz and muscovite up to 0.1mm across are present.

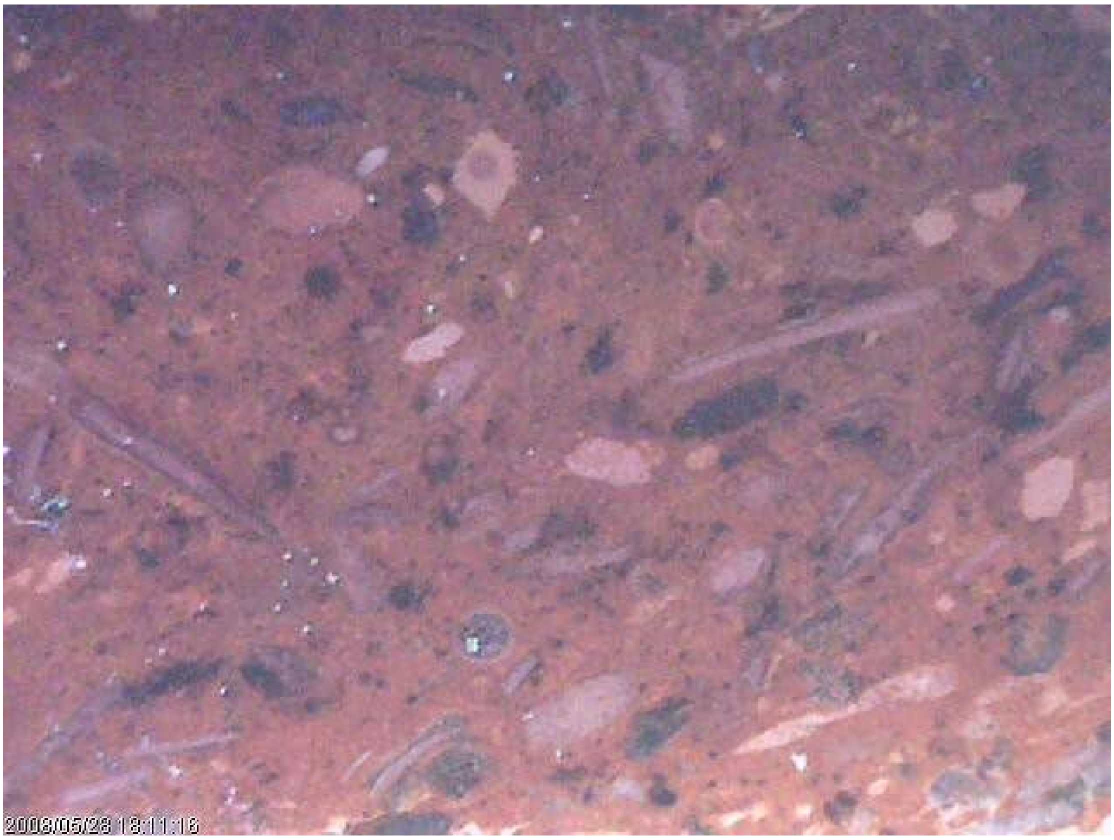

Figure 9 V4932

Interpretation

The various fossils and the limestone fragments originated in the same deposit, a limestone or marl. Similar suites occur in the lower Jurassic deposits of East Yorkshire and Northwest Lincolnshire. Lower Jurassic fossils occur in till deposits in Leicestershire, however, and it is possible that this clay and its fossil content was redeposited locally during the Ice Age. Echinoid remains are also common in the Middle Jurassic Cornbrash, which outcrops as a thin band on the dip slope of the Jurassic limestone escarpment from Northwest Lincolnshire down to Gloucestershire. Cornbrash seems to have been the source of much of the shell-tempered pottery of Cambridgeshire in the Iron Age and Roman periods (Vince 2003).

OOL1. A single sample contained angular fragments of three types of limestone and rounded quartzose sand. The following inclusion types were noted in thin section:

- Limestone. Moderate angular fragments ranging up to 1.5mm across. Three distinct lithologies were present:
    - An oolitic limestone with a ferroan calcite cement.
    - A calcite mudstone composed of dolomite(?) with thin-walled ferroan calcite bivalve shells.
    - A silty limestone containing abundant angular quartz silt c.0.1mm across and sparse non-ferroan bivalve shell up to 1.0mm long with a ferroan calcite cement.
- Rounded Quartz. Moderate grains up to 0.4mm across. The larger grains are well-rounded and the smaller ones more subrounded.

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

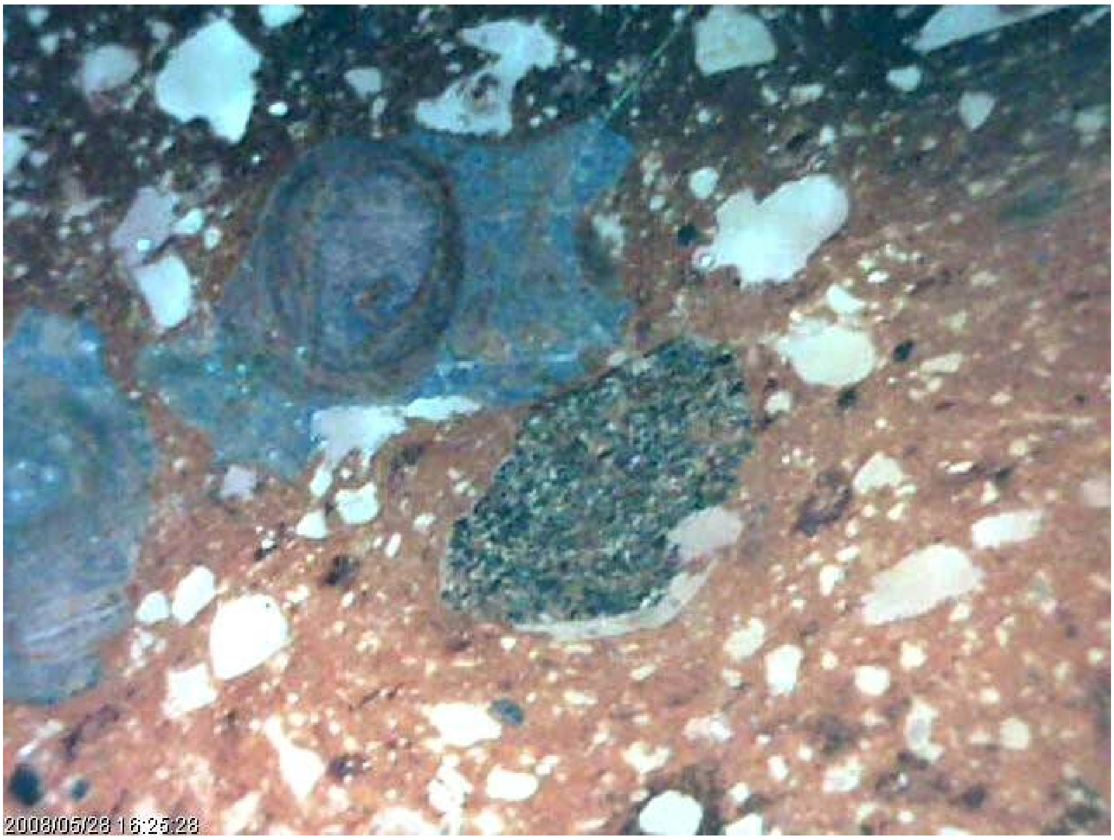

Figure 10 V4929

Interpretation

The limestones with a ferroan calcite cement are almost certainly of Jurassic age. Some lower Jurassic limestones replaced by dolomite occur in East Yorkshire and probably further south as more localised outcrops (Kent 1980). Rocks derived from these outcrops may well be present in boulder clay in the Leicester area (*gryphaea* have been noted by the author in boulder clays in the Mountsorrel area). A source in East Yorkshire is also possible, but in fabrics tempered with Lower Jurassic limestones from Melton, near Brough-on-Humber, no rounded quartz sand was present and instead medium/fine-grained overgrown quartz grains derived from Upper Jurassic sands and sandstones occurred (Vince 2007). A local source is therefore more likely.

Rounded Quartz

Seven samples contained rounded quartz sand as their major inclusion. They vary in the frequency and presence/absence of other inclusions and could not be subdivided into fabric groups based on the available evidence (Table 1).

Table 1

TSNO	Rounded	Rounded	Subangular	Rounded	Rounded	Acid	Organics	Angular

	Quartz	Chert	Quartz	Clay/iron	Sandstone	Igneous		Flint
V4927	S	S	A	M	S	N	N	N
V4930	A	S	S	S	S	N	N	N
V4931	S	S	M	M	S	S	N	N
V4944	S	R	S	S	R	N	N	N
V4955	S	S	S	M	R	N	M	N
V4957	S	S	A	M	S	N	N	N
V4960	A	S	M	S	S	N	N	S

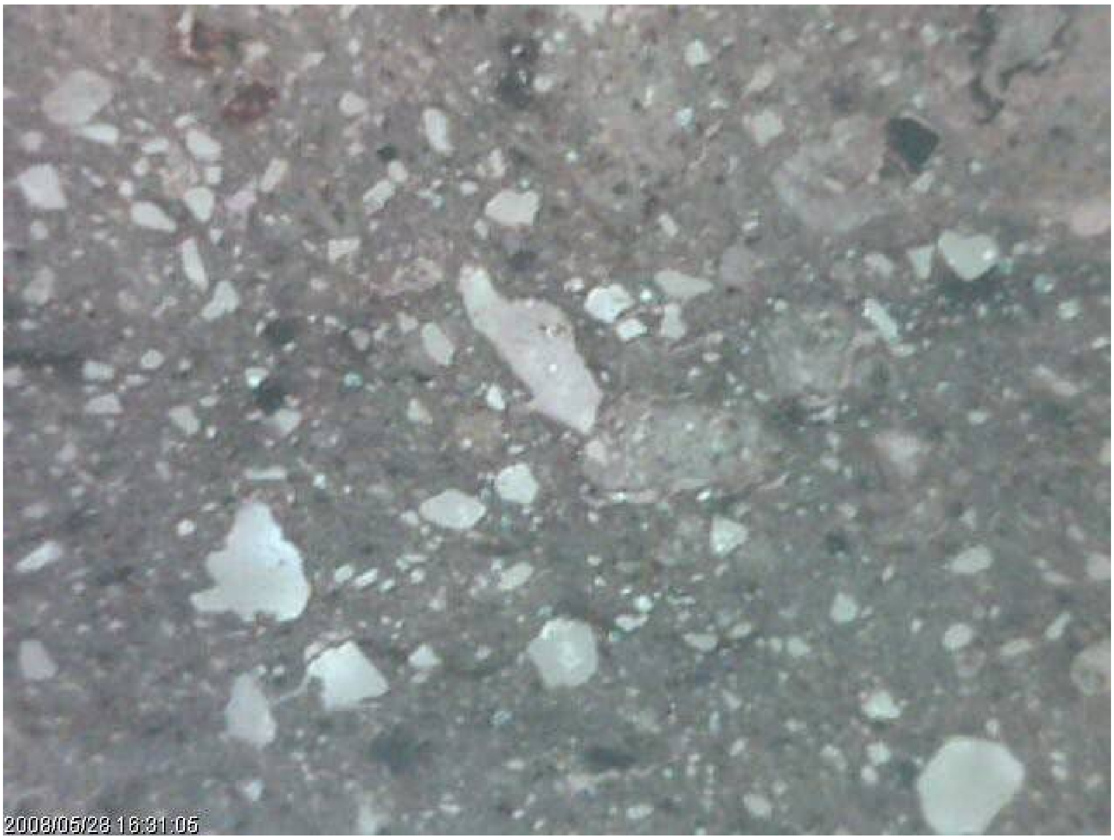

Figure 11 V4927

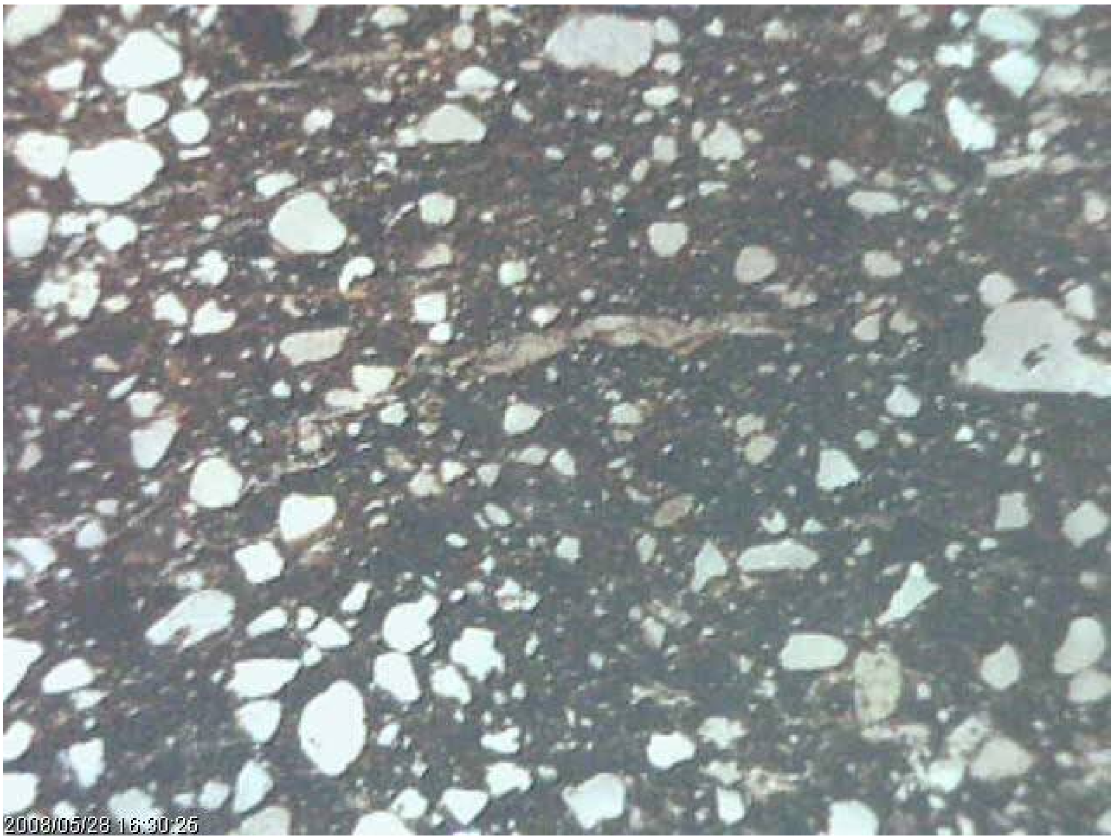

Figure 12 V4930

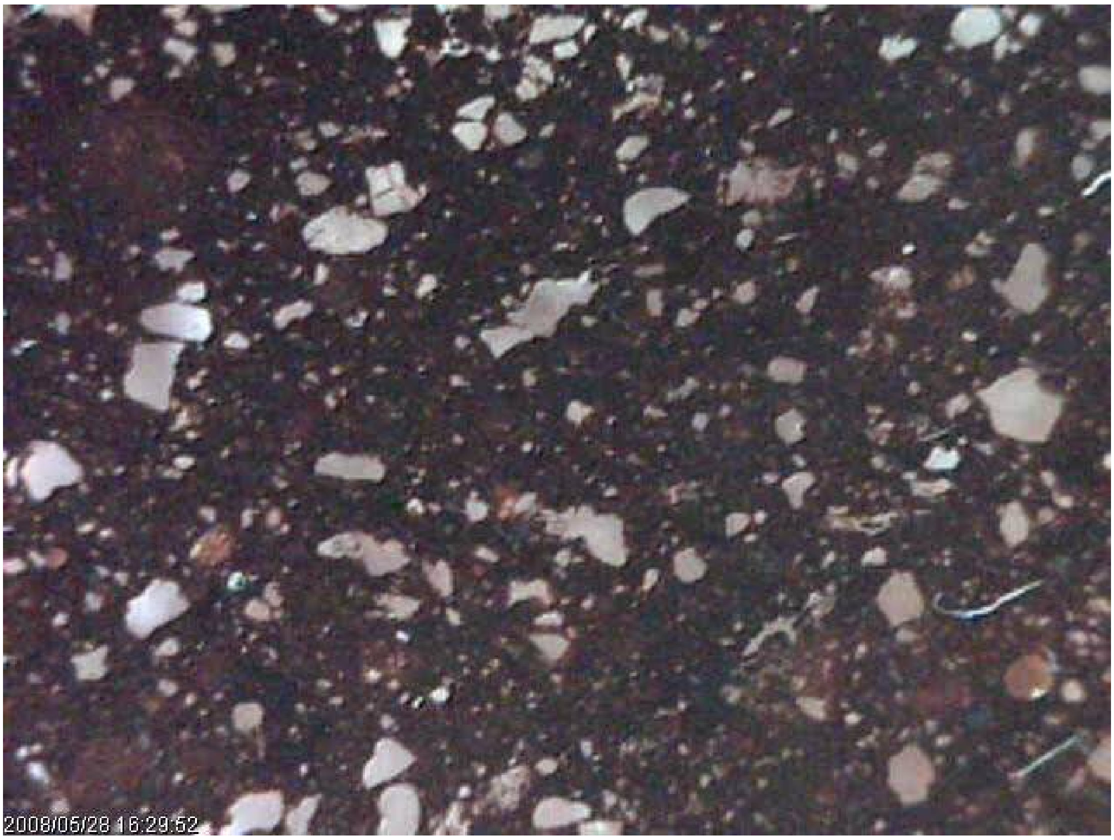

Figure 13 V4931

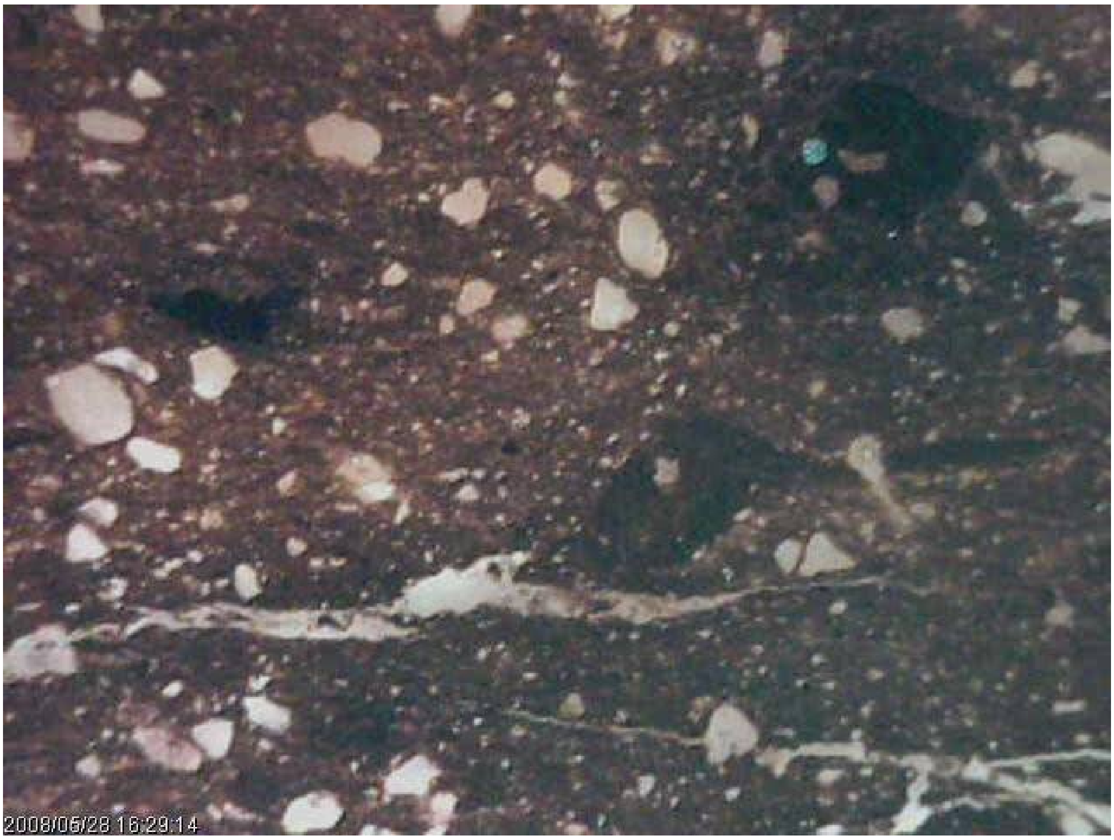

Figure 14 V4944

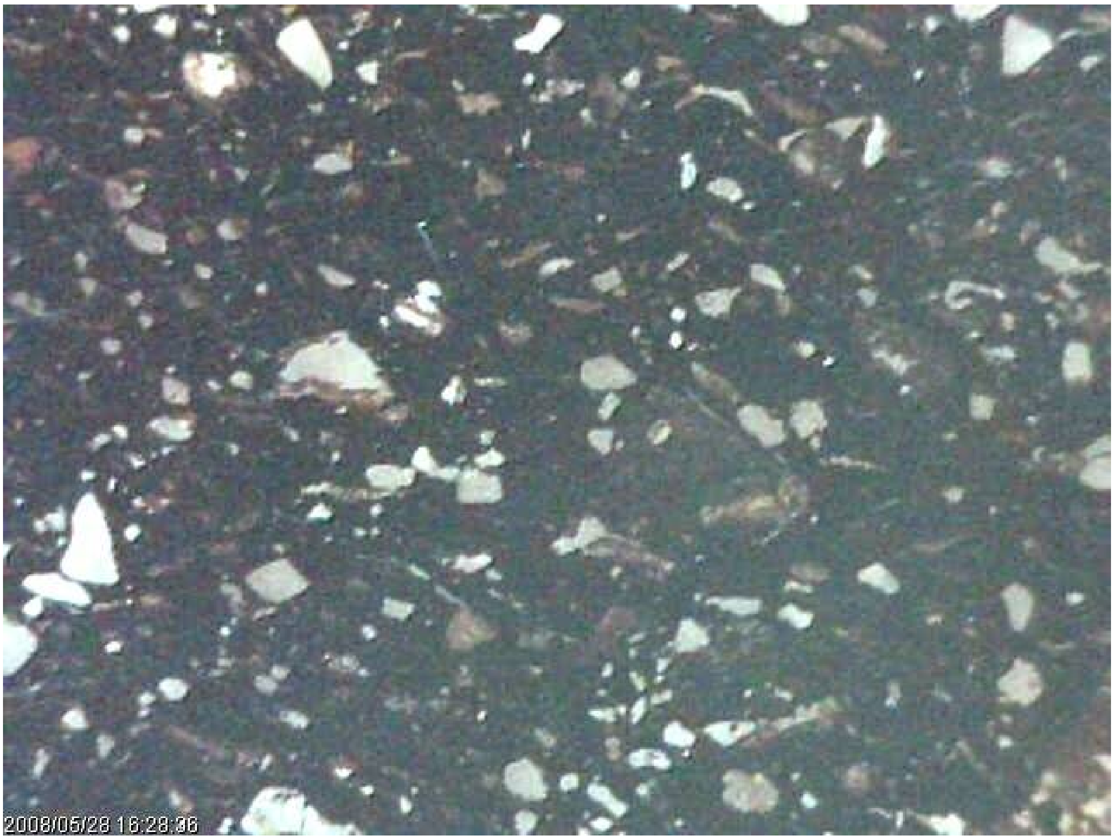

Figure 15 V4955

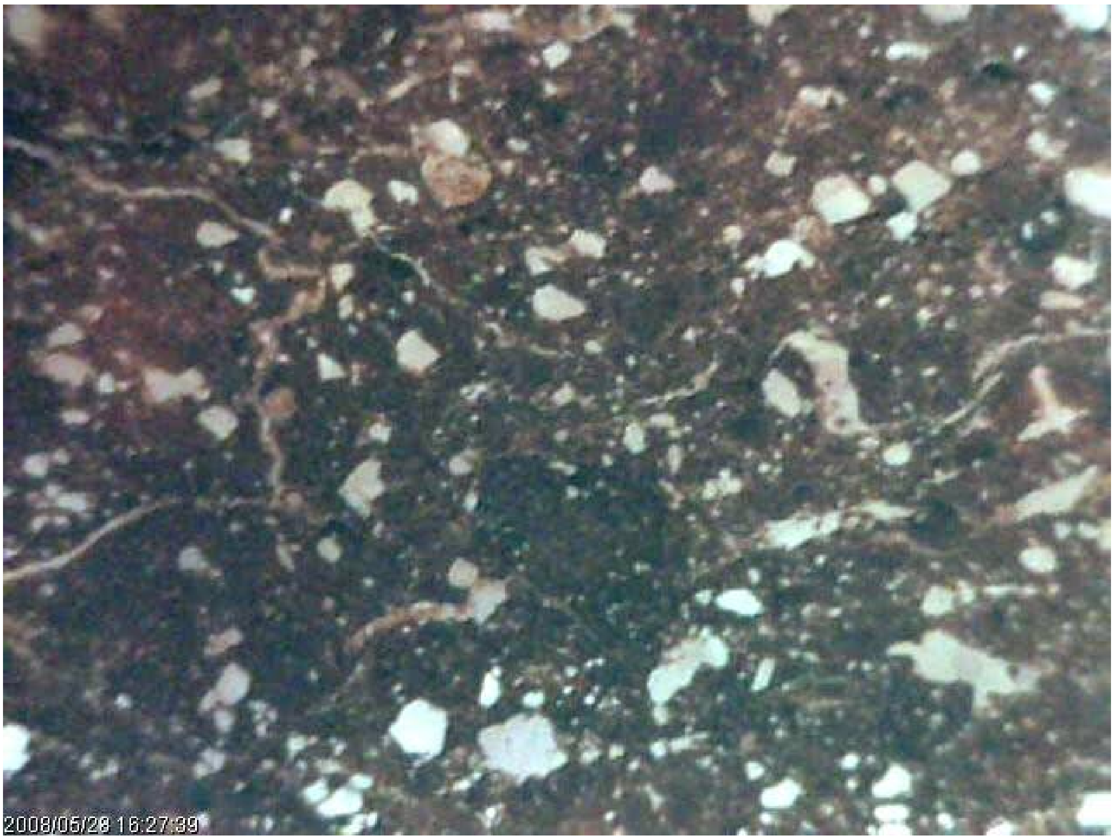

Figure 16 V4957

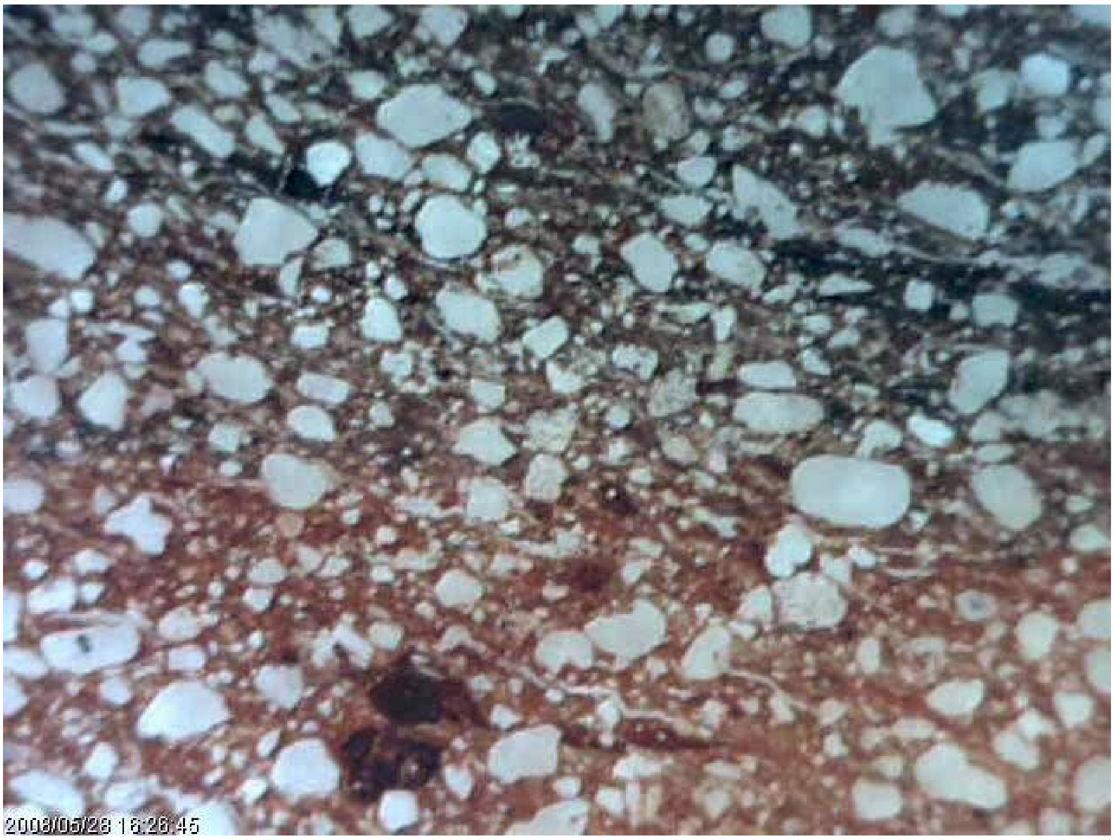

Figure 17 V4960

Interpretation

The rounded quartz, chert and sandstone inclusions all originate in a Triassic sand, such as those which outcrop in the Leicester area (but also much more widely). The samples could be divided into those with abundant rounded quartz (V4930 and V4960) and the remainder, in which the sand is much less common, but in terms of their origin this division is not important. The rounded clay/iron grains occur in all the samples and are more common in those with less sand, indicating that they were present in the parent clay before tempering. Such iron-rich concretions occur in many clay outcrops and cannot be used to localise production. One section contained angular flint, which may have been deliberately added, as probably in the Flint-tempered ware. There is certainly no sign of either rounding or staining, such as occurs on the rare flint found in Trent valley sands. Finally, one of the samples contains fragments of acid igneous rock. These are probably from the Charnwood inlier and if so indicate a source to the south or east of that outcrop.

Shell

Five samples contain shell fragments as the main inclusion type. In four instances the shell inclusions themselves have been leached and the resulting voids are partially filled with phosphate and clay minerals. The groundmass allows the samples to be divided into two groups, one silty and the other silt-free, and the size and frequency of the shell inclusions allows further subdivision of the silt-free group into two.

SHELL1. A single example of this fabric is present (V4935). The following inclusion types are present:

- Bivalve shell. Moderate nacreous non-ferroan bivalve shell up to 1.0mm long. Often with a thin coating of ferroan calcite.
- Marl. Moderate fragments up to 0.5mm across containing a mixture of clay minerals, finely-divided ferroan calcite and sparse angular quartz up to 0.1mm across.
- Mudstone. Sparse rounded fragments up to 0.7mm long containing no visible inclusions. Bedding is visible but not prominent.

The groundmass consists of optically anisotropic baked clay minerals, moderate angular quartz grains and ferroan calcite fragments up to 0.1mm across.

Figure 18 V4935

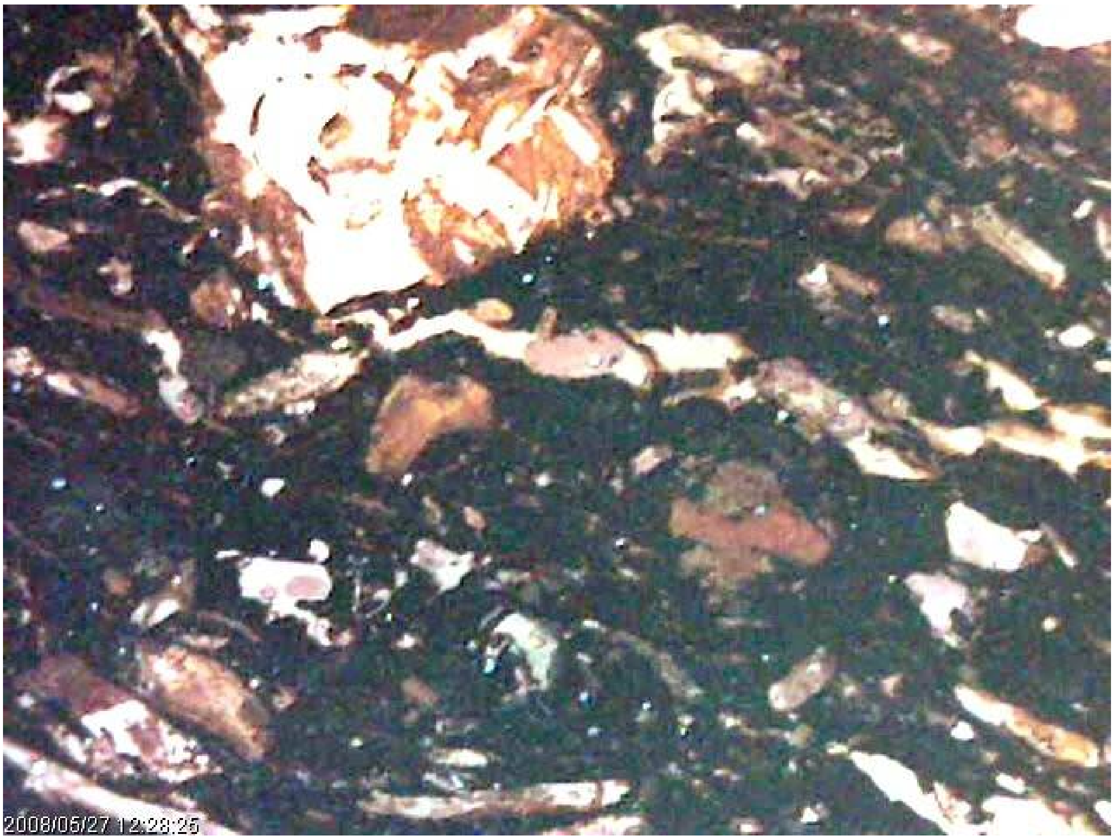

Figure 19 V4951

SHELL2. Two examples of this group were present, V4943 and V4945. The following inclusion types were noted:

- Bivalve shell. Sparse voids up to 1.5mm long probably once filled with bivalve shell, but possibly once containing organic inclusions.
- Organics. Sparse voids up to 1.5mm long containing carbonised remains of organic inclusions.

The groundmass consists mainly of opaque black burned clay minerals, seen at the margins of the sherds to be optically anisotropic, and abundant angular quartz up to 0.1mm across and sparse muscovite laths up to 0.1mm long.

Figure 20 V4945

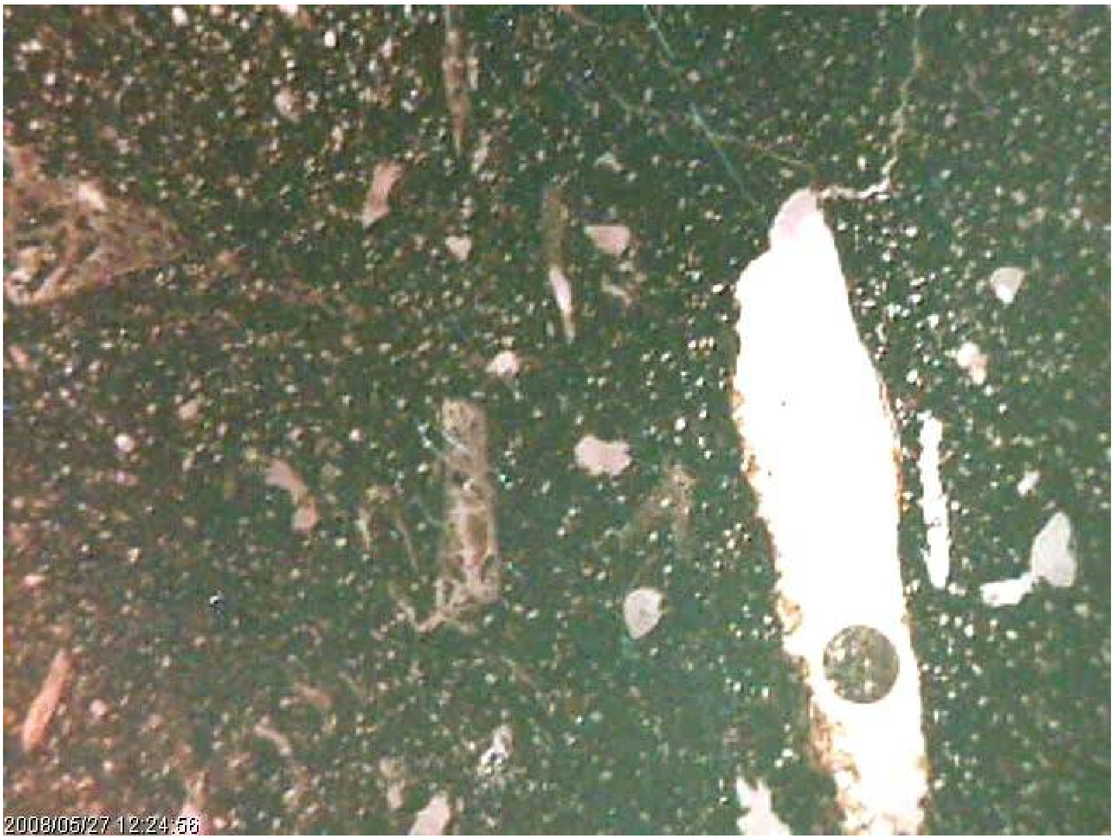

Figure 21 V4943

SHELL3. A single example of this fabric was present, V4952. The following inclusion types were present:

- Bivalve shell. Abundant voids up to 1.00mm long once containing bivalve shell fragments.
- Rounded quartz. Rare well-rounded grains up to 0.3mm across.

The groundmass consists of optically anisotropic baked clay with no visible inclusions.

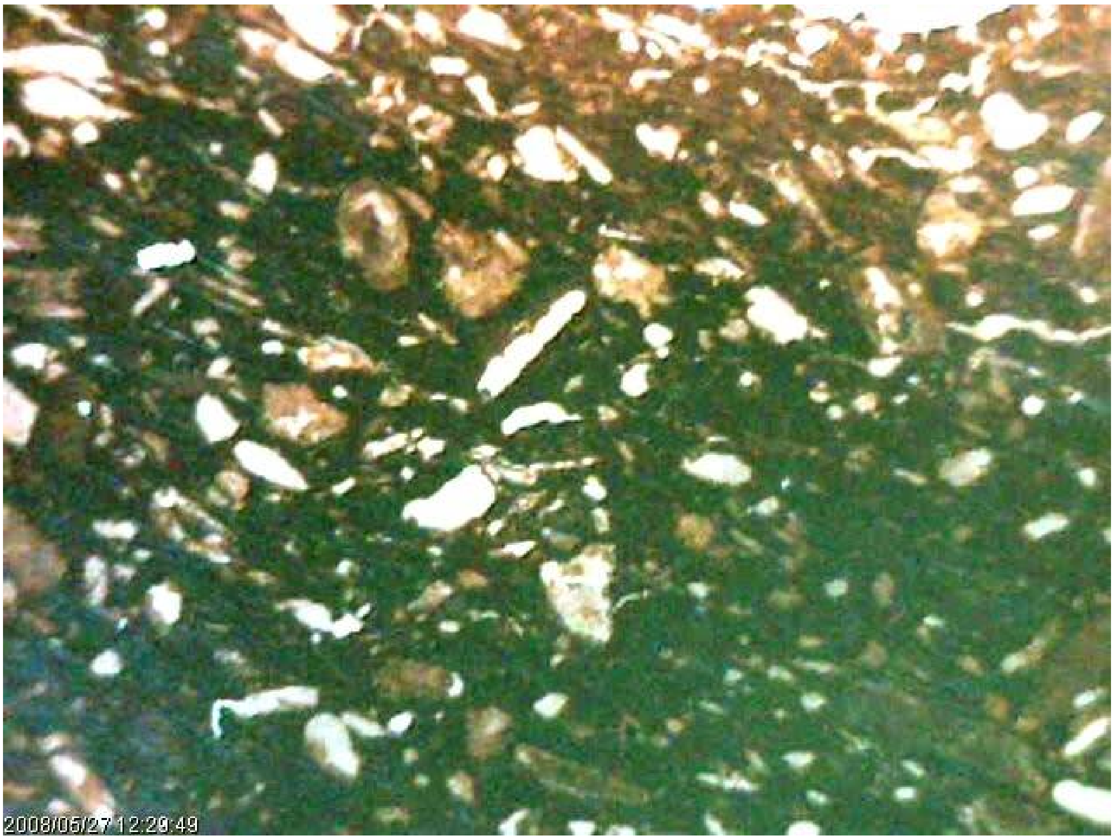

Figure 22 V4952

Interpretation

Table 2 summarises the characteristics of the three shelly fabrics. The difference between Fabric SHELL2 and the others is much greater, to the extent that it is not even certain that SHELL2 contained any shell! However, even allowing for the difference in preservation, it is fairly clear that SHELL1 and SHELL3 have different sources. SHELL1 and SHELL3 are almost certainly of Jurassic origin and similar shell inclusions occur in Roman and later shelly wares from both Lincolnshire and Cambridgeshire. Where the sources are known, they were made from Middle and Upper Jurassic clays or, in the case of Lincoln shelly wares, Middle Jurassic shell tempering in Lower Jurassic clay.

Table 2

Fabric	Quartz silt	rounded quartz	bivalve shell	organics	Marl	Mudstone
SHELL1	SPARSE	NONE	MODERATE	NONE	MODERATE	SPARSE
SHELL2	ABUNDANT	NONE	SPARSE	MODERATE	NONE	NONE
SHELL3	NONE	RARE	ABUNDANT	NONE	NONE	NONE

Sandstone

Three samples contain a quartzose sand derived from fragments quartz sandstone, together with some quartz sandstone fragments. The size range distribution of the sand distinguishes V4941 from the other two samples, V4933 and V4936, both of which also contain a higher proportion of sandstone fragments to quartz grains and organic inclusions absent from V4941. The samples are therefore assigned to two fabrics, SST1 and SST2.

SST1. The two samples of this fabric contain the following inclusion types:

- Subrounded quartz. Moderate ill-sorted grains ranging up to 3.0mm across. Some have one or more flat faces and are overgrown, with no sign of the original grain boundary. The grains include polycrystalline mosaic quartz.
- Sandstone. Sparse fragments up to 3.0mm long. These contain overgrown quartz grains with kaolinite infilling of interstitial pores.
- Organics. Moderate carbonised fragments, up to 1.5mm long.
- Opaques. Sparse rounded grains up to 0.3mm across.

The groundmass is mainly opaque and black but at the surfaces is seen to consist of optically anisotropic baked clay minerals, moderate angular quartz and muscovite laths up to 0.1mm long.

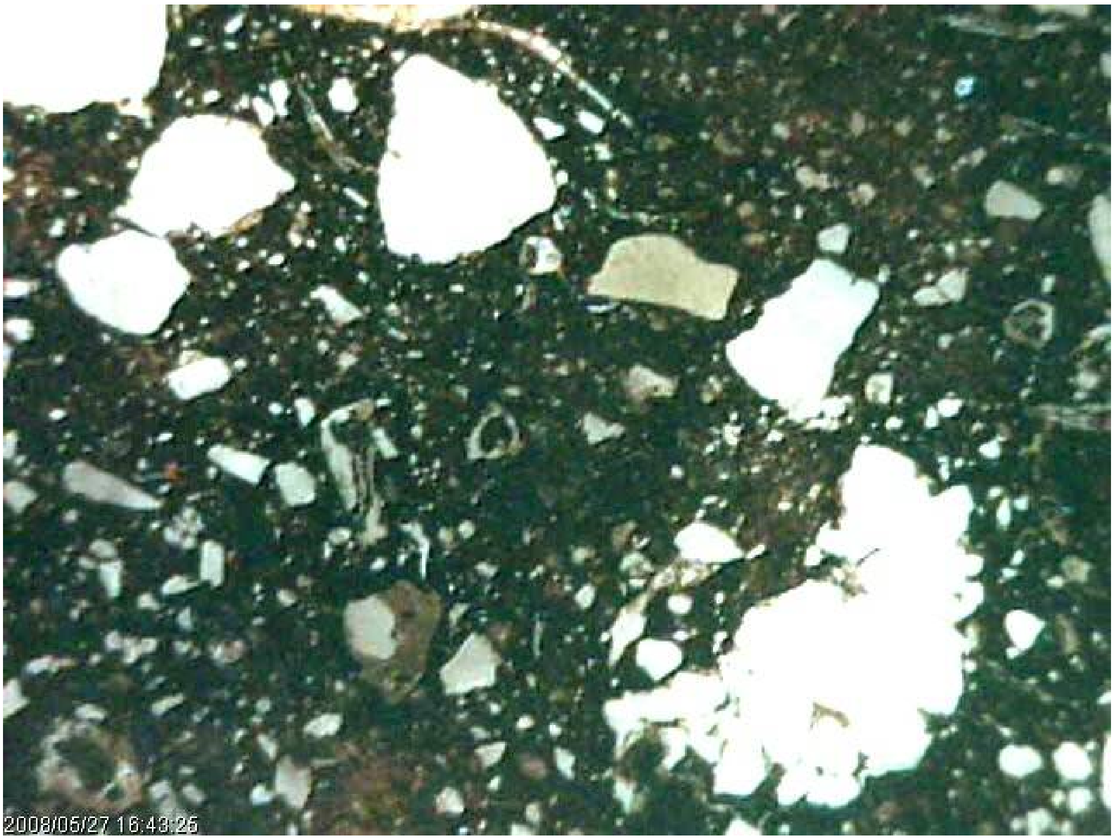

Figure 23 V4936

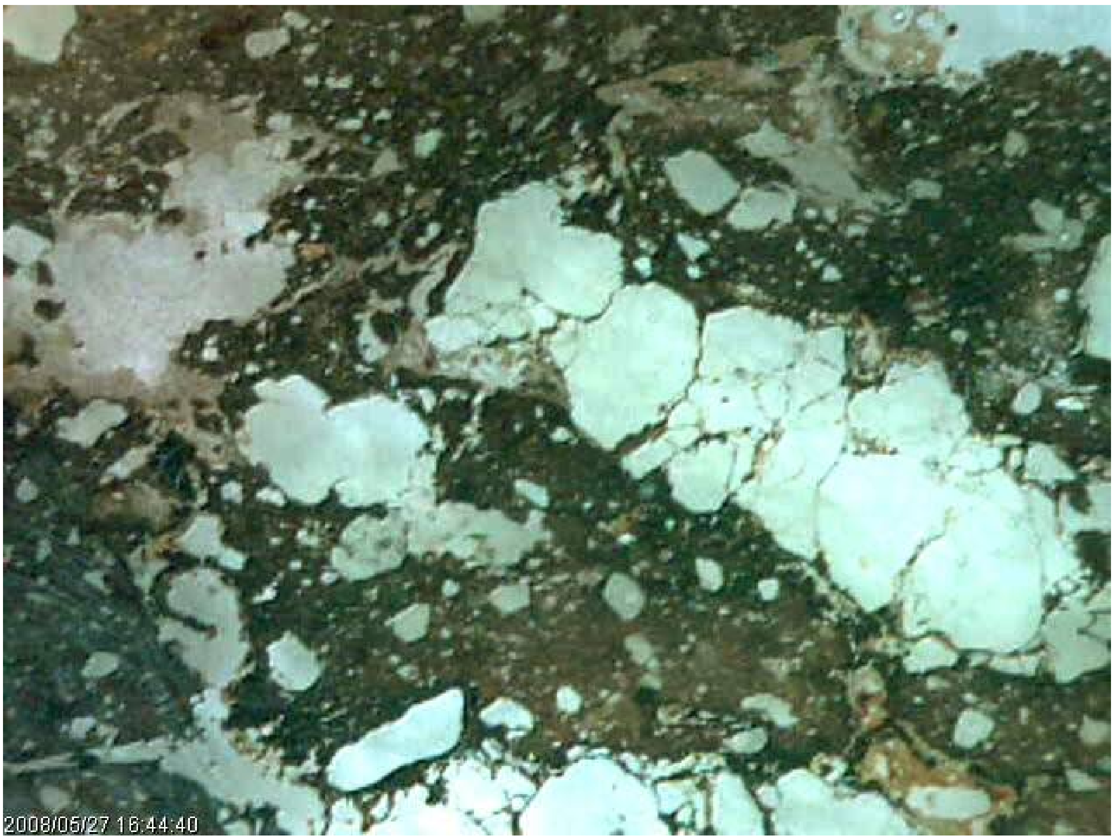

Figure 24 V4933

SST2. The single sample of this fabric contains the following inclusion types:

- Subrounded and Rounded quartz. Abundant grains up to 0.3mm across. The larger grains are well-rounded and the smaller ones subrounded.
- Clay/iron. Moderate dark brown, rounded grains up to 0.5mm across. These may be detrital mudstone pellets but show no sign of bedding or elongate habit. Rare examples up to 1.5mm across with quartz inclusions similar to those in the main fabric may be concretionary.
- Sandstone. Sparse fragments up to 1.5mm across. Similar in character to those in SST1.

The groundmass consists of optically anisotropic baked clay minerals with few visible inclusions.

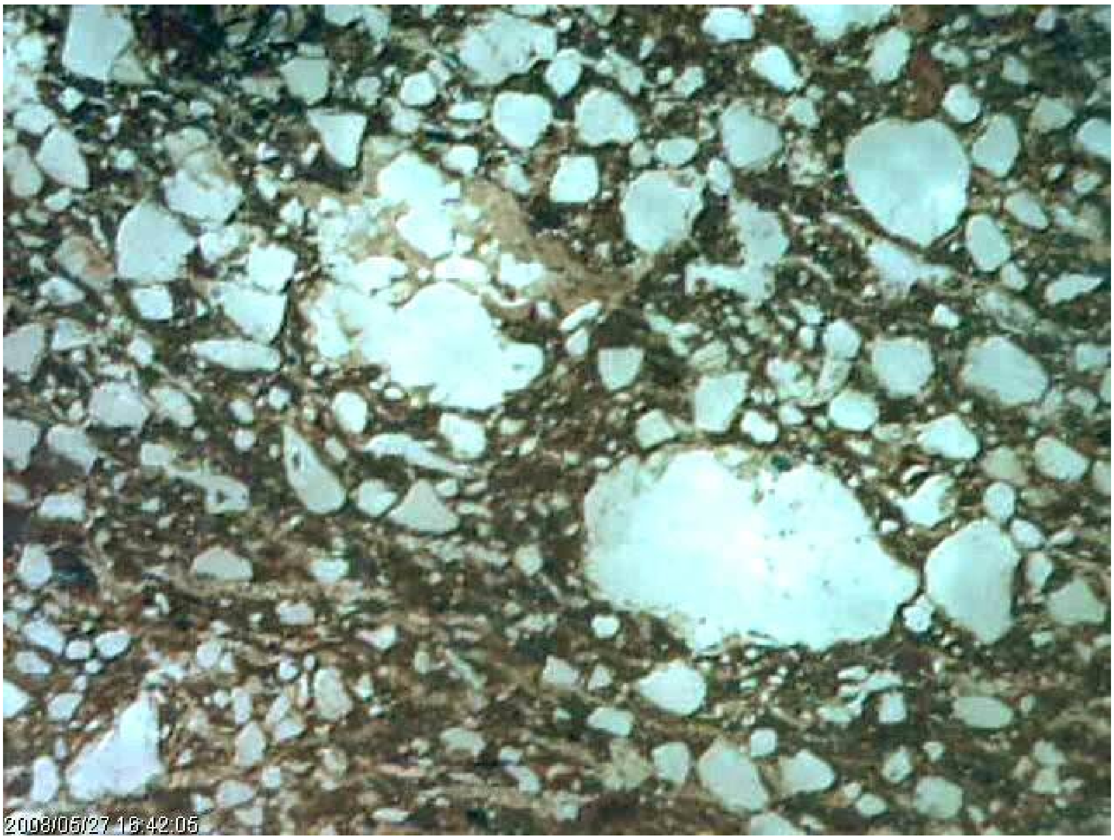

Figure 25 V4941

Interpretation

The sandstone in both SST1 and SST2 is probably of Carboniferous age, and matches the Millstone Grit well. However, Millstone Grit fragments, and quartz grains derived from the Millstone Grit, form a prominent element in Quaternary sands over much of midland England and neither fabric can therefore be provenanced from its petrological characteristics alone.

Chemical analysis

Samples of the shell-tempered and limestone-tempered vessels were taken for chemical analysis using Inductively-Coupled Plasma Spectroscopy. This was because it was realised that the inclusions were unlikely to be of local origin and therefore either indicated the use of boulder clay derived from Jurassic deposits in Lincolnshire or Yorkshire or the trading of vessels from Yorkshire, Lincolnshire or further south to the Leicester area.

The analysis was carried out at Royal Holloway College, London, under the supervision of Dr J N Walsh. Each sample was prepared by mechanically removing the surfaces to a depth of 1mm or so, to minimise the effect of post-burial alteration to the chemical composition. The resulting block was crushed to a fine powder and the frequency of a range of major elements was determined and expressed as percent oxides (App.1). The frequency of a range of minor elements was measured and expressed as parts per million (App.2). The frequency of silica was not measured but was estimated by subtracting the total measured oxides from 100%.

Since the frequency of calcite, phosphorus, silica and strontium could all be affected by tempering and post-burial alteration these elements were omitted from study and the remainder were normalised to aluminium. The normalised data were then examined using the WinSTAT for Excel add-in (2002). The normalised data were analysed using the Factor Analysis program within WinSTAT. In this technique, a large number of variables (in this case element frequencies) are replaced by a smaller number of factors. The contribution of each element to the Factors is given by a weighting table and elements with similar weightings are correlated and therefore may have be subjected to similar processes.

For the six Leicestershire samples four Factors were found. A plot of the first two factor scores (Fig 00) indicates that the LST1 sample has a high F1 score but that the remaining samples show no clear patterning.

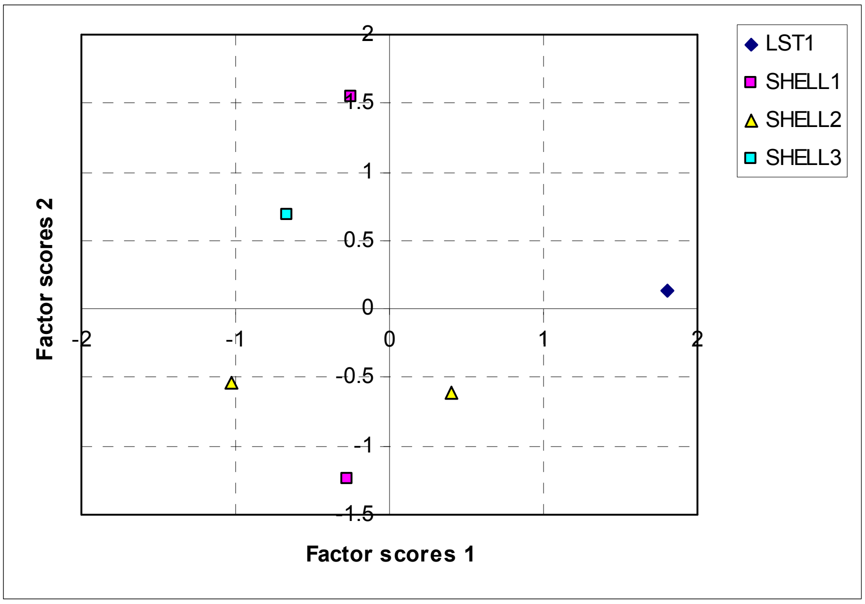

Figure 26

A plot of the Factor 3 against the Factor 4 scores shows that the two SHELL2 samples have high F3 scores.

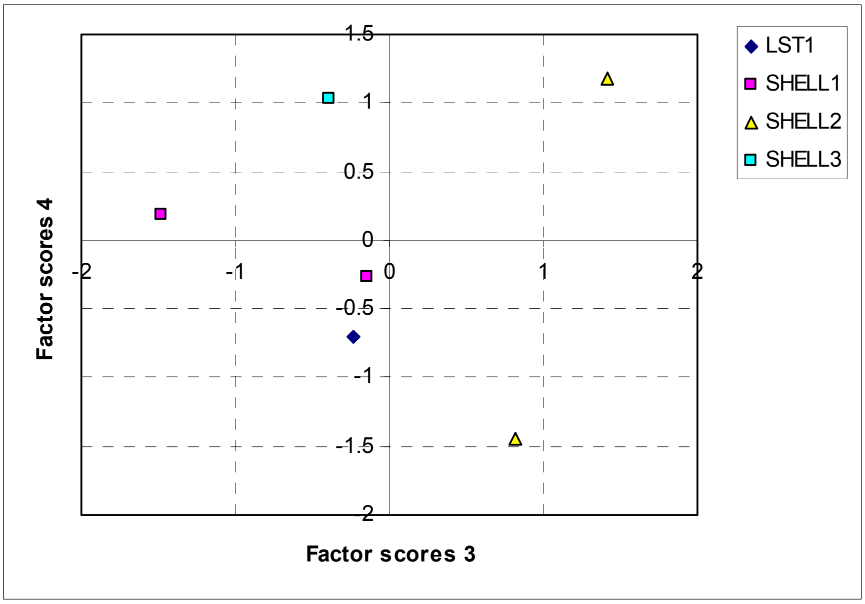

Figure 27

The weighting table indicates that the high F1 score of the LST1 sample is due to high weightings for the rare earth elements and for manganese, potassium, and magnesium whilst the high F3 scores of the SHELL2 samples are due to high copper and chromium weightings and a strong negative weighting for lithium.
The ICPS data were then compared with those for a range of shelly wares from Lincolnshire and Cambridgeshire and for Iron Age wares of various fabrics from

Leicestershire. Factor analysis of this data separated medieval shell-tempered wares from the Peterborough area and mid-Saxon shell-tempered wares from sites in southern Lincolnshire and Cambridgeshire. Data for these samples were then omitted and the analysis repeated. In this analysis, many of the Iron Age non-shelly fabrics were separated. This analysis also separated the LST1 sample from the remainder, which consisted of the three shelly fabrics, two shelly fabric samples from Thurcaston (Fig.28 IASH) and samples of mid-Saxon Maxey ware, produced from Middle Jurassic clays in central and northern Lincolnshire (Fig. 00 MAX). A small number of Early Bronze Age samples from Thurcaston also have similar compositions (Fig.28 EBAGROG, EBASAND, EBAVESICULAR).

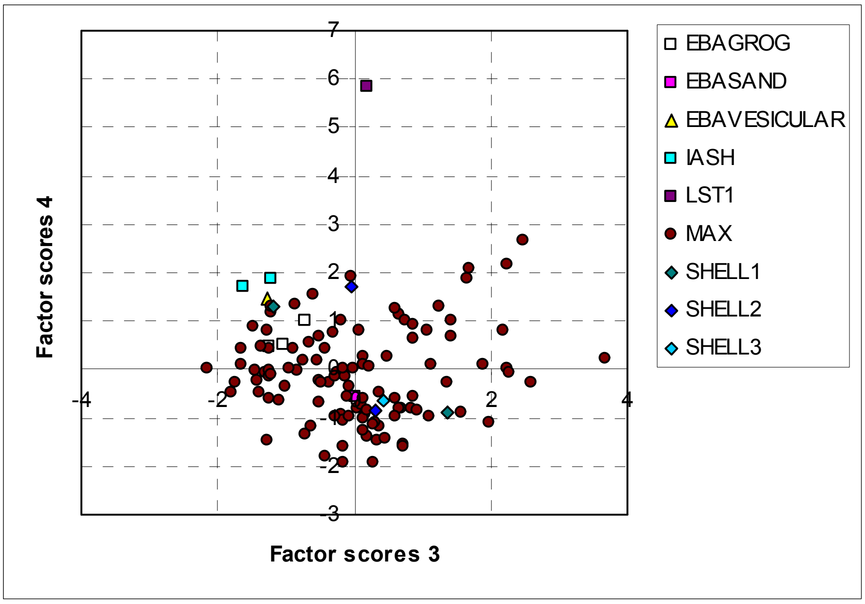

Figure 28

A further Factor Analysis was carried out omitting the Northern Maxey wares and including Late Saxon Lincoln shelly wares and East Yorkshire Iron Age shelly wares. This analysis found that the Lincoln samples were distinct from the remainder and that the LST1 sample could be separated from the remainder (Fig 29).

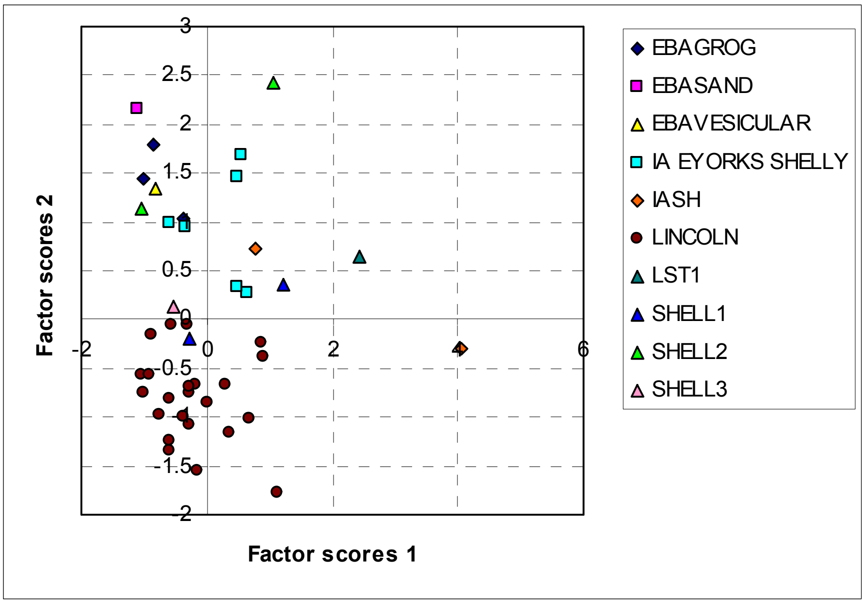

Figure 29

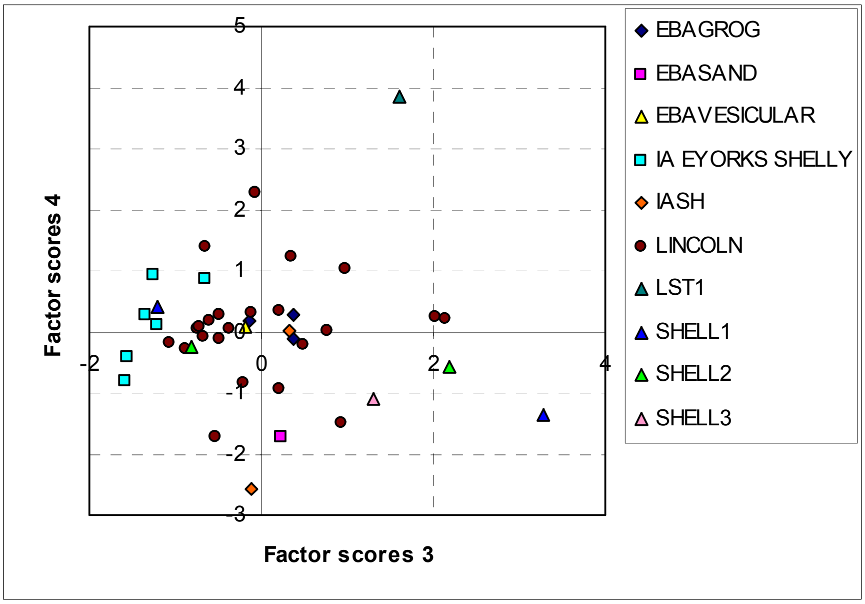

Figure 30

Conclusions

Thin section analysis confirms the visual identification of numerous fabrics within the submitted samples although there is some variation between the classification developed by eye and that arrived at through thin section analysis (App 2). In most cases, the rock and mineral fragments identified in thin section are consistent with an origin in northeast Leicestershire and the pottery might therefore be of local origin. In several cases, however, the inclusion suite present is found over a wide area and thin sections on their own cannot demonstrate the source of the fabric.

In the case of six samples with abundant shell or limestone inclusions chemical analysis was carried out. This analysis demonstrates that five of the samples are similar to shell-tempered wares from East Yorkshire and Lincolnshire, but not with those from Cambridgeshire. However, in most cases, boulder clay derived from the erosion of Jurassic clays in the Trent Valley or the Yorkshire Wolds could be the immediate source of the clay and temper. In one case, LST1, no precise parallel for the chemical composition could be found nor is there a precise parallel for the rock and mineral inclusions in either East Yorkshire or Lincolnshire. However, a Jurassic origin is likely and perhaps in this case the source does lie to the south or southwest of Leicestershire, in which case the vessel would have had to be traded to northeast Leicestershire.

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Appendix 1

TSNO	Sitecode	Context	GROUP	subfabric	Action
V4927	A6.1999	41	RQ1	G2	TS
V4928	A6.1999	77	GROG2	G1	TS
V4929	A6.1999	655	OOL1	S2	TS
V4930	A6.1999	1016;1015	RQ2	Q1	TS
V4931	A6.1999	615	RQ3	Q1	TS
V4932	A6.1999	261	LST1	S1	TS
V4933	A6.1999	807	SST1	R4	TS
V4934	A6.1999	433;415	AI1	Q2	TS
V4935	A6.1999	575;577	SHELL1	S1	TS
V4936	A6.1999	808	SST1	R5	TS
V4937	A6.1999	542	AI1	R2	TS
V4938	A6.1999	456	AI2	Q2	TS
V4939	A6.1999	137;127	AI4	R1	TS
V4940	A6.1999	778;777	AI3	R1	TS
V4941	A6.1999	424	SST2	Q4	TS
V4942	XA25.2001	645;644	FLINT1	FL1	TS
V4943	XA25.2001	645;644	SHELL2	GR1	TS
V4944	XA25.2001	643;642;617	RQ4	SA1	TS
V4945	XA25.2001	691;608	SHELL2	SH1	TS
V4946	XA25.2001	756;757	FLINT3	Q4	TS
V4947	XA25.2001	838	AQ1	Q5	TS

V4948	XA25.2001	672	FLINT2	FL2	TS
V4949	XA25.2001	989	BONE1	GR2	TS
V4950	XA25.2001	645;646	FLINT1	QU1	TS
V4951	XA25.2001	835	SHELL1	S1	TS
V4952	XA25.2001	471	SHELL3	S1	TS
V4953	XA25.2001	458	GROG1	G1	TS
V4954	XA25.2001	800	GROG1	S2	TS
V4955	XA25.2001	468	RQ5	S2	TS
V4956	XA25.2001	808	AI1	R2	TS
V4957	XA25.2001	843	RQ6	Q1	TS
V4958	XA25.2001	776	AI1	R1	TS
V4959	XA25.2001	695	AI1	R2	TS
V4960	XA25.2001	659	RQ7	R2	TS

Appendix 2 Correlation of Visual and Thin-section-Derived Fabric Groups

GROUP	FL1	FL2	G1	G2	GR1	GR2	Q1	Q2	Q4	Q5	QU1	R1	R2	R4	R5	S1	S2	SA1	SH1	Grand Total
AI1								1				1	3							5
AI2								1												1
AI3												1								1
AI4												1								1
AQ1										1										1
BONE1						1														1
FLINT1	1										1									2
FLINT2		1																		1
FLINT3									1											1

GROG1			1														1			2
GROG2			1																	1
LST1																1				1
OOL1																	1			1
RQ1				1																1
RQ2							1													1
RQ3							1													1
RQ4																		1		1
RQ5																	1			1
RQ6							1													1
RQ7													1							1
SHELL1																2				2
SHELL2					1														1	2
SHELL3																1				1
SST1														1	1					2
SST2									1											1
Grand Total	1	1	2	1	1	1	3	2	2	1	1	3	4	1	1	4	3	1	1	34

Appendix 3

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V4932	7.65	4.58	1.26	23.85	0.19	1.68	0.29	1.1	0.184
V4935	10.1	4.4	0.85	22.8	0.19	1.37	0.46	0.66	0.076
V4943	15.67	5.31	0.97	1.07	0.24	2.18	0.56	2.21	0.088
V4945	12.79	4.25	0.77	1.07	0.2	1.79	0.63	1.16	0.199
V4951	19.86	9.45	1.2	1.78	0.17	2.44	0.76	4.61	0.093
V4952	17.96	6.4	1.12	1.38	0.17	1.96	0.75	2.25	0.095

Appendix 4

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V4932	417	48	28	40	40	7	238	53	20	35	27	43	31	5	1	6	2	5	80	10
V4935	354	64	23	54	30	10	302	67	18	51	30	55	31	5	1	3	3	12	51	11
V4943	1,281	111	62	29	53	14	72	107	20	78	31	43	33	5	1	4	2	14	155	19
V4945	533	93	56	22	46	12	51	90	29	71	34	57	39	6	1	7	3	13	84	21
V4951	1,518	123	72	63	86	17	195	105	30	104	46	88	48	8	2	5	4	21	369	15
V4952	650	121	47	94	65	15	87	116	24	103	42	78	44	7	1	4	3	23	308	14