Petrological Analysis of Anglo-Saxon Pottery from Kilverstone, Norfolk

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Excavations at Kilverstone, Norfolk, by the Cambridge Archaeology Unit, revealed an early Anglo-Saxon settlement, the pottery from which has been studied by J Tipper. All of this pottery was then examined at x20 magnification by the author and Dr Tipper and ten samples selected for petrological analysis. The main aim of this analysis was to test the visual classification made by the author, which is based on identifying the major inclusion type present and listing minor inclusions (Table 1). A second aim was to determine whether thin-section analysis could aid the characterisation of the pottery and determine the nature and if possible the location of the raw materials used.

The thin-sections were prepared by S Caldwell at the University of Manchester and stained using Dickson's method. The staining distinguishes ferroan and non-ferroan calcites from dolomite. For each thin-section a qualitative analysis was carried out, listing the inclusion types present, their roundness, size range and any distinguishing features. Frequency was simply classed as abundant, moderate, sparse or rare.

Table 1

REFNO	TSNO	Cname	Description	Subfabric
930	V1671	CHARN		+CALC
930	V1672	SSTMG		FINE TEXTURED
1663	V1673	SSTMG		+CALC
319	V1674	SSTCL		SSTMG;HAEM-CEMENTED FINEGRAINED SST;FINEGRAINED SST;ROUNDED VOIDS
1461	V1675	ECHAF		S GSQ
1473	V1676	ECHAF		S SSTMG
1672	V1677	CHARN	ADDED CLAY ON EXT	+CALC
576	V1678	ECHAF		+GROG, SST
319	V1679	CHARN		+GROG
319	V1680	FE		+CHAFF

Petrological Analysis

V1671

This vessel was identified by eye as containing biotite granite together with some unidentified calcareous inclusions. The granite was thought most likely to be Mountsorrel Granodiorite, implying a source of the vessel in north-east Leicestershire, 100 miles to the West of Kilverstone.

In thin-section the following inclusions were noted:

- Abundant angular fragments of biotite granite ranging from 0.2mm to 2.0mm across. The rock contains biotite with a distinct green- blue colour, feldspar, quartz and hornblende with accessory magnetite.
- Moderate rounded quartz grains up to 1.0mm across.
- Sparse angular fragments shelly limestone, consisting of non-ferroan calcite bivalve shells in a matrix of sparry, ferroan calcite.
- Sparse organic inclusions up to 0.5mm long.

The groundmass consists of anisotropic baked clay minerals, an opaque black core, sparse angular quartz, sparse muscovite flakes and rare siliceous microfossils up to 0.1mm long.

The igneous rock does not appear to be typical of the Mountsorrel granodiorite: the colour of the biotite and the presence of hornblende are unusual. Furthermore, the feldspars show no sign of zoning. Nevertheless, none of these features is sufficient to show for certain that the rock is the Mountsorrel granodiorite. The shelly limestone fragments are very similar to the Cornbrash as seen in thin-section in pottery from the Lincoln area. It is very likely that the formation has a similar petrology further south. The rounded quartz and other inclusions cannot be characterised.

No other examples of an Anglo-Saxon pottery fabric containing this mixture of abundant biotite granite and moderate shelly limestone fragments is known to the author. The lack of rounding of the limestone and granite fragments suggests that they come from a till deposit. Tills are found extensively in East Anglia but whether any of these contain igneous rock fragments in the concentration found in this fabric is unknown. The geological memoir for East Anglia would suggest that high concentrations of erratic igneous rocks ought to be limited to the Hunstanton Boulder Clay in north Norfolk but work would have to be undertaken on the composition of East Anglian boulder clays.

V1672

By eye, this sample was classified as SSTMG, ie containing a sand composed of sandstone fragments of Millstone Grit type.

In thin section, the following inclusions were noted:

- Abundant subangular quartz grains up to 0.5mm across
- Sparse rounded clay pellets
- Sparse rounded quartz grains up to 1.0mm across

- Sparse subangular opaque grains up to 1.0mm across
- Sparse sandstone fragments up to 1.0mm across. These contain subangular quartz grains up to 0.5mm across in a siliceous matrix
- Sparse rounded pellets of phosphate up to 0.5mm across.
- Sparse subangular sandstone fragments up to 2.0mm across. The sandstone contains well-sorted quartz grains up to 0.2mm across, some with signs of overgrowth and with a brown cement.
- Sparse organic inclusions up to 0.5mm across.
- Rare rock fragments containing chalcedonic chert and phosphate up to 0.3mm across.

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

No Millstone Grit-type sandstones were noted in thin-section. Instead, a much finer sandstone was present. At present this sandstone has not been identified. The inclusions are typical of detrital sands derived from lower Cretaceous strata. The clay matrix is also similar to clays of Lower Cretaceous age, such as the Gault.

Both the clay and inclusions therefore probably originate in an area of Lower Cretaceous rocks and there is no evidence, in this section, for an erratic component such as the Millstone Grit.

V1673

Under x20 magnification this sample was also classified as SSTMG, with minor, unidentified calcareous inclusions. In thin section the following inclusions were noted:

- Moderate sandstone fragments of Millstone Grit type up to 1.5mm across
- Moderate fragments of chalk up to 2.0mm across
- Sparse angular feldspar up to 2.0mm across
- Sparse rounded quartz up to 0.5mm across
- Sparse shelly limestone fragments up to 0.5mm across, composed of sparry ferroan calcite cement and bivalve shells of non-ferroan calcite.
- Sparse possible fish bone, 1.0mm long by 0.3mm wide
- Sparse altered glauconite up to 0.3mm across

- Sparse subangular flint up to 0.5mm across
- Sparse muscovite up to 0.5mm long
- Sparse rounded chert up to 0.3mm across
- Rare opaque grain, 1.0mm across, with angular quartz inclusions up to 0.3mm across

The groundmass consists of anisotropic baked clay minerals, opacified in the core through the presence of carbon, containing sparse angular quartz grains up to 0.1mm across and moderate muscovite up to 0.1mm across.

These inclusions come from a variety of sources including Lower Carboniferous, Jurassic, Lower Cretaceous and Upper Cretaceous strata. The subangular flint may also indicate the presence of Tertiary material. The grain size distribution and roundness does not suggest a detrital source and it is most likely that the raw material used was a boulder clay.

V1674

After x20 binocular microscope study this sample was classified as SSTCL, containing a mixed sandstone/limestone gravel mainly composed of material from Jurassic and earlier strata. By eye, the following inclusions were identified: Sandstone of Millstone Grit type, a fine-grained sandstone with a haematite cement, a light coloured fine-grained sandstone and rounded voids.

In thin section the following inclusions were noted:

- Sparse rounded brown phosphate pellets up to 0.5mm across
- Sparse fragments of sandstone up to 1.5mm across containing quartz grains up to 0.2mm across. These grains are overgrown and have a brown cement.
- Sparse sandstone fragments up to 1.0mm across containing subangular quartz grains up to 0.5mm across and a brown cement.
- Sparse sandstone fragments up to 1.0mm across containing glauconite grains and subangular quartz grains up to 0.3mm across in a phosphate cement.
- Sparse subangular flint fragments up to 1.0mm across.
- Rare rounded opaque grains up to 0.5mm across. In outline these grains seem to be oolitic.
- Sparse rounded altered glauconite up to 0.3mm across.
- Rare rounded phosphate pellets up to 0.5mm across containing circular voids.

The groundmass consists of anisotropic baked clay minerals, with an opaque, carbon-rich core, sparse angular quartz up to 0.1mm across and moderate muscovite laths up to 0.1mm across.

Despite the fact that no calcareous inclusions survive it is nevertheless clear that despite its visual appearance, this fabric differs radically from the central Lincolnshire SSTCL fabric, in that the majority of the inclusions have a lower Cretaceous origin, with some of upper Cretaceous origin (the flint). Some of the inclusions, those containing phosphate or glauconite, are of types which would not survive for long in detrital sands. If the inclusions are from a detrital sand, therefore, it probably originated in an area of lower and upper Cretaceous rocks. Alternatively, it may have been a boulder clay.

V1675

This sample was classified as ECHAF with Lower Cretaceous quartz sand after x20 binocular microscope examination.

In thin section the following inclusions were noted:

- Moderate organic inclusions up to 2.0mm long
- Moderate rounded quartz grains up to 0.5mm across. Some of these have the characteristic outlines of sands from lower Cretaceous deposits but others appear to be more spherical and may be of Triassic age
- Sparse rounded brown-stained chert up to 0.5mm across
- Sparse sandstone fragments up to 1.5mm across. The quartz grains in these are euhedral, demonstrating overgrowth in optical uniformity to the original crystal lattice. The sandstone has a brown cement.
- Sparse rounded opaque grains up to 0.3mm across. One has the ‘squashed pea’ outline found in lower Cretaceous glauconite pellets and may be replacement of an original glauconite grain.
- Sparse sandstone fragments up to 0.5mm across, with varying textures and grains up to 0.3mm across.
- Rare angular perthite up to 1.0mm across
- Rare rounded sandstone fragments up to 2.0mm across containing rounded altered glauconite pellets and a phosphatic cement.
- Sparse rounded flint up to 1.0mm across
- Sparse light brown angular flint up to 1.0mm across.

The groundmass consists of anisotropic clay minerals, an opaque, carbon-rich black core, sparse angular quartz up to 0.1mm across and sparse muscovite laths up to 0.1mm long.

The organic inclusions are probably deliberately-added chaff or dung. The remaining inclusions are a mixture of probable erratics (the perthite might be from Charnwood Forest, or NE England/Scotland/Scandinavia, the coarse-grained sandstone with euhedral grains may be Millstone Grit, although it does not have the distinctive kaolinite cement, and some of the rounded quartz grains may have been transported from the midlands), lower Cretaceous rocks and minerals and some Upper Cretaceous (flint). The presence of rounded flint suggests that the grains underwent a cycle of erosion before being incorporated into the raw materials rather than being derived from local Norfolk chalk. This suggests that they too are erratic grains, perhaps of Eocene age and originating in deposits in the North Sea. On balance, therefore, it is most likely that the inclusions indicate a fluvio-glacial origin.

V1676

By eye, this sample was classified as ECHAF, because the principal inclusion type was organic matter, probably cereal chaff. Sparse sandstone fragments of Millstone Grit type were also noted.

In thin section, the following inclusions were noted:

- Moderate angular fragments of acid igneous rock up to 2.0mm across. Individual fragments containing feldspar and quartz, feldspar, magnetite and biotite, hornblende and feldspar and biotite, quartz and feldspar were seen. The biotite fragments have a blue-green colour.
- Sparse organic inclusions up to 1.0mm across
- Sparse rounded quartz up to 0.5mm across, including some grains of possible Lower Cretaceous type and some polycrystalline grains with high sphericity
- Rare quartz breccia fragments up to 1.0mm across.
- Rare subangular brown flint up to 1.5mm across.
- Rare angular flint up to 0.5mm across

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

These characteristics probably indicate that the raw materials were derived from boulder clay originating in the north (possibly Scottish igneous rocks, Lower and Upper Cretaceous rocks and, possibly Tertiary reworked flint).

V1677

By eye, the principal inclusion type seen in this sample was acid igneous rock, with unidentified calcareous inclusions as a minor constituent.

In thin section, the following inclusion types were noted:

- Moderate sandstone fragments of Millstone Grit type, up to 0.5m across
- Moderate rounded quartz up to 0.3mm across
- Sparse angular flint up to 0.5mm across
- Sparse subangular opaque grains up to 0.5mm across
- Sparse muscovite laths up to 0.5mm long
- Sparse ferroan calcite fragments up to 0.2mm across
- Sparse organic inclusions up to 1.0mm long
- Sparse angular fragments of acid igneous rock up to 3.0mm across, including a composite quartz/perthite fragment.
- Sparse rounded chalk fragments up to 4.0mm across.
- Sparse sandstone fragments with a kaolinite matrix up to 1.0mm across, with subangular quartz grains up to 0.3mm across.

The groundmass consists of anisotropic baked clay, sparse angular quartz up to 0.1mm and rare siliceous microfossils.

This fabric too seems to have originated in a boulder clay. The source of the inclusions ranges from the Upper Carboniferous to the Upper Cretaceous. This fabric also contains igneous rock fragments, but whether they are of Scottish or Midlands origins is not clear (perthite is common in the Mountsorrel granodiorite). On balance, it is likely that the raw materials come from a deposit of chalky-Jurassic drift (1961, 67) and that the igneous inclusions are of Leicestershire origin, but transported by ice.

V1678

By eye, this fabric was seen to have been tempered with organic material (and was therefore classified as ECHAF) but contains some rounded inclusions which appear to be grog, ie crushed pottery or tile added deliberately as pottery temper. Sandstone fragments were also noted.

In thin-section, the following inclusion types were noted:

- Abundant organic inclusions up to 2.0mm long.

- Moderate rounded fragments of grog up to 3.0mm across. These fragments have a totally different texture and composition from the groundmass and are clearly not relict clay. They contain abundant subangular and rounded quartz grains, up to 0.2mm across, together with sparse muscovite laths up to 0.2mm long and rounded pinkish clay pellets up to 1.0mm across. The general character of the material is matched in the Triassic marls, where light coloured, calcareous clay pellets are common. The fragments have a groundmass of isotropic baked clay minerals. One of these fragments is unusual in that it is black rather than red and appears to have a thin white slip. If so, then it is clearly a pot fragment and, equally clearly, of Romano-British date. The fabric is otherwise similar to that of the remaining fragments.

- Moderate rounded quartz grains up to 1.0mm across. These include some of probable Lower Cretaceous origin.

- Sparse fragments of euhedral quartz up to 1.0mm across. These are most likely to have come from Millstone Grit-type sandstone.

- Sparse rounded opaque grains up to 0.3mm across.

- Rare rounded red phosphate, possibly bone, up to 0.5mm across.

The groundmass consists of anisotropic clay minerals with few large inclusions.

The presence of this grog is remarkable, especially since most of the grains appear to have been rounded, which would imply that they were not obtained through deliberate crushing but had previously been subjected to river transport or came from a beach. It is difficult to envisage circumstances in which this might happen. Another possibility is that the inclusions are of a naturally baked material, perhaps a baked aureole surrounding an igneous intrusion. However, unless that baked zone extended for some distance from the intrusion it is difficult to see why no fragments of intrusive rocks were present. Furthermore, the black 'slipped' fragment seems to be incontrovertible evidence for the material being pottery. Excluding the grog, the remaining inclusions suggest a mixture of erratic material of midlands/northern English origin and lower Cretaceous material. The clay itself is similar to many Jurassic clays.

V1679

This sample was classified by eye as CHARN because it contains primarily inclusions of biotite-rich acid igneous rock consistent with an origin in the Charnwood inlier. Rounded 'grog' fragments were noted as a minor inclusion type.

In thin section the following inclusions were noted:

- Abundant rounded quartz up to 0.5mm across
- Moderate rounded grog fragments up to 0.5mm across and identical to those in V1678.
- Moderate subangular fragments of acid igneous rock up to 1.5mm across. These include fragments with biotite and quartz grains, and those with feldspar, perthite and magnetite grains. The biotite has a brown to almost colourless pleochroism.
- Sparse sandstone fragments up to 1.5mm across containing quartz grains up to 0.2mm across and a brown cement.

The groundmass consists of anisotropic baked clay minerals with few visible inclusions (very like V1678).

Despite the very different suites of inclusions in V1678 and V1679 the grog and the nature of the groundmass link the two samples. Thus it seems likely that this vessel was also made from locally available raw materials, probably boulder clay, rather than being an import from Leicestershire.

V1680

Visually, the main inclusion type in this sample consisted of iron ore and consequently it was classed as FE. Chaff was noted as a minor inclusion.

In thin-section the following inclusions were noted:

- Abundant rounded quartz grains up to 0.3mm across. Some of these have brown veins and outlines typical of Lower Cretaceous quartz grains.
- Moderate angular opaque fragments up to 1.5mm across, containing moderate quantities of rounded quartz grains up to 0.3mm across.
- Moderate organic inclusions up to 4.0mm long.
- Moderate rounded clay pellets up to 2.0mm across with a similar colour and texture to the groundmass.
- Sparse angular brown flint up to 0.5mm across.
- Rare rounded brown flint fragments up to 1.5mm across.
- Rare rounded brown chert grains up to 0.3mm across.

The groundmass consists of anisotropic baked clay minerals and moderate angular quartz up to 0.2mm across.

The opaque inclusions are probably iron oxide and their shape suggests that they are not detrital grains. However, it is not possible to say what their source or origin might have been. The remaining inclusions are of Lower and Upper Cretaceous origins. However, as with V1675, the presence of rounded flint grains suggests the presence of some material from Tertiary deposits. A local origin is likely.

Discussion

These ten samples show a bewildering range of inclusion types, many of which originated far from East Anglia. However, in most cases it is likely that the raw materials were obtained from fluvio-glacial deposits available locally. Without detailed knowledge of variability in these deposits it is not possible to say how significant the observed variations in inclusion types and clay matrices might be. In this regard, the difference in inclusion suites between V1678 and V1679 contrasting with the presence of an almost identical groundmass and grog inclusions, offer a warning against placing too much emphasis on inclusions as an indication of source. Nevertheless, these sections do indicate that potentially, there is considerable variability in pottery fabrics which may enable vessels to be grouped. Whether these groups would represent different sources, or different batches of potting clay used in the same settlement is a moot point.

Table 2 summarises the evidence for the source of the inclusions observed in thin section. In almost every case the samples contain mixed suites of inclusions and in many cases we can demonstrate that lower Cretaceous or more recent rocks and minerals are included. This suggests an origin to the southeast of a line drawn between Kings Lynn and Bedford. This suggests that the pots were probably made from East Anglian raw materials, even where the principal inclusion type is acid igneous rock. Tentatively, these rocks have been assigned to either a northern source (Scotland/Scandinavia) or a midlands source (the Charnwood inlier) based on the character of the associated inclusions. The high frequency of these inclusions in V1671, V1676 and V1679 may have been due to deliberate selection of gravel or even rock of these types for inclusion in the pottery fabric but the sparse fragments noted in V1673, V1675 and V1677 were probably present either in the clay, if a boulder clay was used, or in added sand, if they were tempered with a fluvio-glacial sand. The contrast between V1678 and V1679 argues for the deliberate addition of granitic sand/crushed rock to the latter whilst the grain-size distribution of the granitic fragments in V1671 suggests the use of a boulder clay.

Finally, these sections have revealed a previously unknown inclusion type in Anglo-Saxon pottery, rounded grog. The petrological identification of these inclusions seems secure and yet the idea that there might be detrital sands composed mainly of water-rolled grog which were then used as potting temper seems outlandish. A geological alternative origin for these inclusions should therefore be sought.

Bibliography

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

Table 2

TSNO	ACID IGNEOUS	CARB	TRIASSIC	JURASSIC	LOWER CRETACEOUS	UPPER CRETACEOUS	TERTIARY	INCLUSIONLESS CLAY	SPARSE SILT	COARSE SILT
V1671	ABUNDANT			POSS					YES	
V1672					POSS					YES
V1673	SPARSE	MOD		SPARSE	SPARSE	MOD	POSS		MOD MUSC	
V1674					POSS	POSS	POSS		MOD MUSC	
V1675	RARE		POSS		POSS	SPARSE	SPARSE		YES	
V1676	MOD				POSS	SPARSE	POSS		YES	
V1677	SPARSE	MOD		POSS	POSS	SPARSE			YES	
V1678		POSS			POSS			YES		
V1679	MOD				POSS			YES		
V1680					ABUNDANT	SPARSE	POSS			YES