

Petrological Analysis of Early Anglo-Saxon Pottery from Brandon Road, Thetford (37158 THD)

Alan Vince

A collection of early Anglo-Saxon pottery was recovered from excavations at Brandon Road, Thetford and divided visually into ten fabrics by Paul Blinkhorn. Samples of each fabric were selected and submitted to the author for thin section analysis (Table 1). The aims of the analysis were to provide a description of the rock and mineral inclusions present in the fabrics and to use these to suggest the raw materials used to make the vessels and their source.

Table 1

Context	TSNO	Fabric	class	Cname	Subfabric	Form	Part	Description
522	V2806	01	CBM	ECHAF	CHAFF;ANG FLINT;SAQ;SHELL	BOWL	BS	
53	V2807	02	CBM	ESAX	CHAFF;CHALK	JAR	BS	
640	V2808	03	CBM	SST	CHAFF;SAQ	JAR	BS	BOSSSED;SHARP SHOULDER;LINEAR DEC
640	V2809	04	CBM	SST	SSTMG;BIOT GRANITE;FINE-GRAINED SST	JAR	BS	LINEAR DEC;CORDONS AT NECK
507	V2810	05	CBM	SST	CHAFF;SSTMG;SHELL	JAR	BS	
677	V2811	06	CBM	SST	GSQ;ACID IGNEOUS	JAR	BS	LINEAR DEC
522	V2812	07	CBM	LIM	OOLITIC LST	JAR	BS	SHOULDERED GLOB
590	V2813	08	CBM	SST	SAQ;RED GROG	JAR	BS	
454	V2814	09	CBM	FE		JAR	BS	BOSSSED;INCISED DEC
609	V2815	10	CBM	CHARN	BIOTITE GRANITE	JAR	BS	ROUNDED RIM

Description

Thin sections of each sample were produced by Steve Caldwell, University of Manchester, and stained using Dickson's method, to distinguish between ferroan calcite, non-ferroan calcite and dolomite (Dickson 1965).

Fabric 1 (V2806)

In the hand specimen, chaff, angular flint, subangular quartz and shell were seen.

The following inclusions were noted in thin section:

- Quartz. Abundant fragments ranging from c.0.2mm to 1.5mm. Most are either angular or subangular but some well-rounded grains with embayments are present which are likely to be of Lower Cretaceous origin.
- Opaque grains. Abundant angular opaque grains up to 2.0mm across, containing quartz and phosphate inclusions and sparse ferroan calcite up to 0.2mm across. These may be iron pan or fragments of an iron-cemented sandstone (such as occurs in the Lower Cretaceous).
- Sandstone. A single fragment containing angular quartz in a silicious matrix, 1.0mm across.
- Flint. Sparse rounded fragments of unstained flint.
- Biotite. A single sheave of biotite laths, 0.4mm long.
- Grog/relict clay. Sparse rounded fragments containing quartz and other inclusions, similar in colour and texture to the remaining fabric.
- Phosphate. Angular brown-stained fragments up to 0.5mm across.
- Organics. Sparse elongated inclusions up to 1.0mm long surrounded by a darkened halo.

The groundmass consists of optically anisotropic baked clay minerals with moderate quartz and muscovite up to 0.05mm across.

The biotite suggests that there may be some material from the Charnwood inlier present in the fabric, whilst some of the quartz grains appear to have originated in Carboniferous sandstones. However, no material of Permo-Triassic or Jurassic origin was noted. The remaining inclusions are either likely to be of Lower Cretaceous or Upper Cretaceous origin whilst the rounded flint fragments are probably derived from a Tertiary deposit. In sum, therefore, the inclusions suggest that this vessel was made from a boulder clay (or tempered with a fluvio-glacial sand) derived from the Midland drift (i.e. from ice flowing east-southeast over northeast Leicestershire).

Fabric 2 (V2807)

In the hand specimen, chaff and chalk inclusions were seen.

The following inclusions were noted in thin section:

- Chalk. Moderate rounded fragments up to 1.5mm across.

- Quartz. Abundant rounded grains up to 0.4mm across.
- Chert. Sparse rounded grains up to 0.4mm across.
- Opaque grains. Rare well-rounded grains up to 0.2mm across.
- Organics. Moderate elongated organic inclusions up to 2.0mm long.
- Shell. Sparse fragments of thin-walled, bivalve shell, with little or no curvature. The shell is mainly composed of prismatic non-ferroan calcite although some have layers of ferroan calcite. Probably includes inoceramids of Upper Cretaceous origin.
- Flint. Sparse brown-stained angular fragments up to 1.5mm long.
- Sandstone. Sparse rounded grains of fine-grained sandstone of fine sandstone/coarse siltstone grain with a silica cement.

The groundmass consists of optically anisotropic baked clay minerals, sparse ferroan calcite, muscovite laths and quartz all up to 0.1mm across. The clay fraction is probably calcareous.

The inclusions in this fabric indicate the presence of Permo-Triassic sand (the rounded quartz, chert, opaque and sandstone grains) together with material of upper Cretaceous origin (the chalk, flint and shell). Permo-Triassic sand is widespread in the East Midlands, as well as being found in boulder clays deposited south of the Humber and east of the Lincolnshire Wolds. It may be that the origin of this fabric is a boulder clay derived from southerly-flowing ice somewhere between the Lindsey Marshes and Cambridgeshire.

Fabric 3 (V2808)

The following inclusions were noted in thin section:

- Quartz. Abundant fragments of subangular and rounded quartz up to 0.4mm across. Also larger, subangular to angular grains with at least one flat face. These are probably of Carboniferous origin.
- Chert. Sparse rounded fragments up to 0.4mm across.
- Feldspar. Sparse subangular un-twinned fragments up to 1.0mm across.
- Sandstone. Sparse rounded fragments up to 0.4mm, as in Fabric 2.
- Organics.

The groundmass is dark brown to black, probably due to a high organic content, obscuring the optical properties of the clay minerals and contains sparse angular quartz and muscovite laths up to 0.1mm across.

The inclusions in this fabric are probably derived from a mixture of Carboniferous sandstone and Permo-Triassic sands. Such sands have a wide distribution in the midlands and East Anglia (although East Anglian sands normally contain flint and rounded quartzes of Lower Cretaceous origin).

Fabric 4 (V2809)

The following inclusions were noted in thin section:

- Quartz. Abundant grains of rounded, subangular and angular quartz. The rounded grains are mainly less than 0.4mm across. The angular grains include quartz of metamorphic origin with sutured boundaries.
- Feldspar. Sparse rounded fragments of perthite up to 0.4mm across and larger subangular fresh microcline up to 1.0mm across.
- Sandstone. Sparse rounded fine-grained sandstone fragments, as in Fabric 2 and larger subangular fragments up to 3.0mm across. The latter are composed of overgrown quartz grains with pores filled with kaolinite.
- Igneous rock. Moderate angular and subangular fragments of igneous rock of various lithologies, up to 2.0mm across. Rock fragments include altered feldspar, biotite and quartz. In one case the alteration products of the feldspar have a light green colour
- Metamorphic rock. A single fragment of a rock composed of plagioclase feldspar, an opaque mineral and a pale green pyroxene.
- Chert. Sparse rounded grains up to 0.4mm across.

The groundmass consists of dark brown to black clay (optical status obscured).

The range of igneous and metamorphic rocks in this fabric indicate that it is derived from North Sea drift rather than Midland drift, although it contains Permo-Triassic sand and Carboniferous sandstone fragments as present in Fabric 3.

Fabric 5 (V2810)

The following inclusions were noted in thin section:

- Quartz. Moderate rounded grains up to 0.4mm across. These include mosaic quartz, metamorphic quartz with sutured boundaries, well-rounded grains of probable Lower Cretaceous origin with iron-rich veins. Some larger, angular fragments are also present.
- Chert. Rounded fragments up to 1.0mm across. These include one fragment of bioclastic origin in which brown staining of the original fossil content has been leached from the outer surface of the grain.
- Organics. Moderate fragments surrounded by a blackened halo, up to 1.5mm across.
- Dark brown clay/iron. Rounded fragments up to 0.5mm across.
- Non-ferroan calcite. A single rounded fragment composed of sparry calcite, 0.5mm across.
- Shell. A single fragment of bivalve shell, similar to those in Fabric 2.
- Flint. A single unstained angular fragment 1.5mm long.
- Sandstone. Sparse fragments of fine-grained sandstone, as in Fabric 2, and coarse-grained sandstone with a kaolinite cement.
- Opaques. Sparse rounded tabular fragments, up to 1.5mm long.
- Feldspar. Sparse rounded fragments of plagioclase feldspar, up to 0.4mm across.

The groundmass consists of optically anisotropic baked clay minerals with sparse angular quartz, ferroan calcite up to 0.2mm across and muscovite laths up to 0.1mm long. Some lenses of lighter coloured clay of similar texture are present.

The inclusions in this fabric are probably derived from Carboniferous sandstones, Permo-Triassic sands and Upper Cretaceous deposits (angular unstained flint, the bivalve shell and possibly the calcite). The ferroan calcite specks present in the clay matrix suggest a similar clay source to that of Fabric 2.

Fabric 6 (V2811)

The following inclusions were noted in thin section:

- Quartz. abundant well-sorted angular quartz grains, c.0.1-0.2mm across. These are overgrown with flat faces and clearly derived from a fine-grained orthoquartzite. Well-rounded grains of Lower Cretaceous origin, some with iron-rich veins, rounded

grains with a high sphericity and larger angular grains, probably of Carboniferous origin, are present but sparse.

- Igneous rock. Sparse angular fragments up to 0.5mm across composed of altered feldspar, biotite, fresh plagioclase and quartz.
- Sandstone. Sparse angular fragments of a fine-grained sandstone composed of well-sorted, overgrowth grains c.0.1-0.2mm across.
- Chert. Sparse rounded fragments up to 0.4mm across.
- Dark brown clay/iron. Sparse rounded fragments up to 0.5mm across.
- Opaques. Sparse rounded fragments up to 0.5mm across.
- Feldspar. Sparse rounded fragments of plagioclase feldspar up to 0.4mm across.
- Organics. Sparse rounded voids surrounded by a darkened halo, up to 0.5mm across. Probably roots.
- Metamorphic rock. A single angular fragment containing strongly pleochroic pyroxene and altered feldspar.

The groundmass consists of optically anisotropic baked clay minerals and rare quartz and muscovite up to 0.5mm across. Sparse microfossils and represented by voids.

The groundmass in this fabric is similar to that in Fabrics 2 and 5 but, if so, has been decalcified. The inclusions are similar in origin to those in Fabric 4 and indicate a North Sea drift origin. The source of the fine-grained orthoquartzite, which forms the majority of the inclusions, is not known. Similar sandstones occur in the Jurassic and a possible source would be the middle Jurassic rocks of North Yorkshire, which would be consistent with a Northern origin for the sand.

Fabric 7 (V2812)

The following inclusions were noted in thin section:

- Quartz. Rounded, subangular and angular quartz grains, ranging from 0.2mm to c.0.5mm across. Examples of probable Permo-Triassic sand and Carboniferous sandstone origin were noted.
- Shell. Moderate fragments of non-ferroan calcite shell, with a nacreous structure and adhering ferroan calcite cement, up to 1.5mm across.

- Bioclastic Limestone. Moderate fragments of varying lithologies, all of which have a ferroan calcite matrix. Bivalve and gastropod shell fragments are visible, with varying quantities of clay minerals present alongside the calcite. The fragments are irregular in shape and range up to 2.0mm in length.
- Oolitic Limestone. Sparse fragments of oolitic limestone ranging up to 2.0mm across. The ooliths have a light brown micrite coating with ferroan calcite as a secondary cement.
- Opaques. Sparse rounded fragments up to 0.5mm across.
- Flint. A single subangular fragment, 0.5mm across, may be flint or chert.
- Chert. Sparse rounded fragments, including some with brown-stained fossils.

The groundmass consists of optically anisotropic baked clay minerals and rare quartz, ferroan calcite and muscovite up to 0.5mm across. Sparse microfossils and represented by voids.

The clay matrix is similar to that in fabrics 2, 5 and 6. The distinctive feature of the inclusions is the presence of Jurassic limestones. The other inclusions are of Carboniferous and Permo-Triassic origin. It may be significant that no inclusions of Cretaceous origin are present, except for a single putative flint fragment.

Fabric 8 (V2813)

The following inclusions were noted in thin section:

- Quartz. Moderate rounded, subangular and angular grains, ranging from c.0.2mm to 1.5mm across. Well-rounded grains of Permo-Triassic origin and overgrown grains of Carboniferous origin were noted.
- Sandstone. Sparse fragments of coarse-grained sandstone with a kaolinite cement of Carboniferous character, up to 1.0mm across.
- Organics. Sparse elongated voids, some with carbonised contents remaining, surrounded by a darkened halo, up to 1.0mm long.
- Grog/clay/ironstone. Sparse rounded fragments of similar texture and colour to the groundmass but without the carbon content, up to 2.0mm across.
- Opaques. Abundant rounded angular fragments, some opaque. Some contain abundant angular quartz grains c.0.1mm to 0.2mm across.

- Basic igneous rock. Two angular fragment, 2.0mm across consisting of phenocrysts of altered plagioclase feldspar in a groundmass of altered glass. One has one curved edge suggesting that they may have been formed by breakage of a larger pebble.

The groundmass consists of optically anisotropic dark brown baked clay minerals with sparse muscovite laths up to 0.1mm long.

The clean groundmass and the abundant opaque material are both similar to Fabric 1. The basic igneous rock fragments might be of North Sea drift origin but it is suspicious that they are both clearly of exactly the same lithology and it is possible that they might be from a pebble of volcanic origin from the Sherwood Sandstone.

Fabric 9 (V2814)

The following inclusions were noted in thin section:

- Phosphate. Abundant, dark brown fragments, up to 2.0mm across, mostly angular and including some possible rectangular bone fragments, c.0.1mm wide and c.0.3mm long.
- Dark brown clay. Abundant rounded fragments, some merging into opaque grains, up to 2.0mm across.
- Quartz. Moderate angular fragments up to 1.5mm across. Mostly mono-crystalline and un-strained. Some with one or more straight faces and traces of kaolinite adhering to surfaces.
- Feldspar. Sparse subangular fragments of perthite up to 1.5mm.
- Opaques. Abundant rounded grains, mostly well-rounded and c.0.2mm across but including some up to 1.5mm across, some of which have angular quartz inclusions c.0.2mm across.
- Sandstone. Sparse fragments of probable Carboniferous sandstone, up to 1.5mm across.

The groundmass consists of dark brown, optically-anisotropic baked clay minerals with few visible inclusions.

The clean groundmass of this fabric links it with Fabrics 1 and Fabric 8 whilst the phosphate, opaques and dark brown clay inclusions, the presence of quartz, feldspar and sandstone of Carboniferous character and the lack of Permo-Triassic sand also link

this fabric with Fabric 1. Phosphate beds occur within the Lower Cretaceous and this fabric is likely to have been made from such a bed, although whether it was *in situ* or redeposited by glacial action is unknown.

Fabric 10 (V2815)

The following inclusions were noted in thin section:

- Quartz. Abundant subangular and rounded grains, ranging from c.0.1mm to 1.5mm across. The larger fragments are probably derived from the igneous rock. The remaining grains are mostly less than 0.4mm across and include some well-rounded grains, and well-rounded grains which have been cracked and subsequently rounded, typical of the desert sand grains found in Permo-Triassic sands.
- Igneous rock. Moderate angular fragments of an acid igneous rock composed of quartz and feldspar. The feldspars are mainly altered orthoclase, some of which are zoned, but include fresh microcline and perthite. No biotite is present in section and must therefore be a minor constituent of the rock.
- Fine-grained sandstone. Sparse rounded fragments of sandstone similar to those in Fabric 2.
- Coarse-grained sandstone. Sparse angular fragments of a rock composed of angular quartz grains in a dark brown cement, up to 2.0mm across. This may be a breccia.
- Opaques. Moderate rounded fragments up to 0.5mm across.
- Voids. Sparse rounded voids, some of which have a low sphericity and range up to 2.0mm across whilst others are spherical and c.0.5mm across.
- Phosphate. A single rounded light brown grain, 0.4mm across, with a structure suggestive of bone.

The groundmass consists of dark brown, optically anisotropic baked clay with sparse quartz, muscovite, microfossils and voids up to 0.1mm across.

The groundmass of this fabric links it with Fabrics 6 and 7. The inclusions are mainly Mountsorrel Granodiorite and Permo-Triassic sand. The voids possibly once held Jurassic limestones, including oolitic limestones.

Discussion

All of the ten samples submitted have distinctive and different petrological characteristics. However, similar inclusion types occur in several of the fabrics, suggesting that they can be grouped. These are summarised in Table 2.

Fabric	Fabric 1	Fabric 2	Fabric 3	Fabric 4	Fabric 5	Fabric 6	Fabric 7	Fabric 8	Fabric 9	Fabric 10
Mountsorrel Granodiorite	Yes?	No	No	No	No	No	No	No	No	Yes
Carboniferous sandstones	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No
Permo-Triassic Sand	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Jurassic Limestones	No	No	No	No	No	No	Yes	No	No	Yes
Lower Cretaceous rocks	Yes	No	No	No	Yes	Yes	No	No	Yes	No
Upper Cretaceous rocks	No	Yes	No	No	Yes	No	No	No	No	No
Erratics	No	No	No	Yes	No	Yes	No	Yes	No	No
Microfossils	No	No	No	No	No	Yes	Yes	No	No	Yes
Ferroan calcite in groundmass	No	Yes	No	No	Yes	No	No	No	No	No

In each case, there is a mixture of inclusions of different origins. Where these are quartzose (e.g. quartz, chert, sandstones) these could be transported over large distances from the outcrop by fluvial action. Softer materials, such as chalk and Jurassic limestones, would have survived less well in detrital deposits, but could have been redeposited in boulder clay, in which case, again, they might be transported over large distances without further weathering. It is likely that most, if not all, of these fabrics contain material of fluvio-glacial origin.

Without further detailed knowledge of the composition of Quaternary deposits in the neighbourhood of the site it is impossible to locate the sources of these fabrics, but it is likely that they come from several different sources rather than a single, variable, source. Two different groups of inclusions can be recognised: Midland Drift, containing Mountsorrel Granodiorite and Jurassic Limestones (Fabrics 1 and 10); and North Sea Drift, containing glacial erratics of Northern British or Scandinavian origin (Fabrics 4, 6, and 8). However, the groundmasses of several of these fabrics share distinctive characteristics, namely microfossils or specks of ferroan calcite and the microfossils are found in fabrics with both North Sea and Midlands drift inclusions.

Of the remaining fabrics, those with inclusions of Lower Cretaceous origin could have been made from local clays, either boulder clays or *in situ* Lower Cretaceous clays, although they

could have been made almost anywhere within East Anglia, where Lower Cretaceous quartz grains are ubiquitous in detrital sands and boulder clays.

In summary, it is not yet possible to localise the source of these fabrics but the varied and distinctive inclusions which they contain suggest that with further work in the south-east Midlands and East Anglia we will gain more knowledge of the character of Quaternary sands and clays and therefore be able to localise their sources more accurately.

Bibliography

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