Characterisation Studies of the Anglo-Saxon Pottery from Sancton I

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The Anglo-Saxon cemetery at Sancton, East Yorkshire, was the largest known early Anglo-Saxon cremation cemetery in Yorkshire. It lay on the Chalk Wolds, just to the east of the Roman road from Brough on Humber to Malton. Pottery from the cemetery can be found in the Ashmolean Museum in Oxford and in the Hull and East Riding Museum in Kingston-upon-Hull. A catalogue of the Hull Museum collection was published by Myres and the vessels also feature in his Corpus of Early Anglo-Saxon pottery. Fabric analysis has been carried out by D F Williams using thin sections as part of the publication of a second cemetery, Sancton II, by J R Timby. Dr Timby classified the fabrics of the Hull Museum Sancton collection using a binocular microscope. A copy of her catalogue was kindly made available to the author who used it as the basis for the current study, which was undertaken as part of the Kingdom of Northumbria Anglo-Saxon Pottery Survey.

Visual examination

All the decorated vessels and a high proportion of the plain vessels from Sancton I were examined under x20 magnification. Initially, the intention was simply to check the classification made by Williams and Timby but subsequently it became clear that the petrographic groups were more complex and that further thin section analysis would be required to try and understand the variation in inclusions found. A code based on the character of the principal inclusions was assigned to each vessel and a list of the inclusion types seen at x20 magnification was made for each vessel.

On the basis of this study samples were chosen to reflect the variation in fabric. Table 1 shows the breakdown by fabric group of the 36 samples. Ten fabric groups were recognised by eye. CHARN contained moderate to abundant fragments of acid igneous rock, including biotite. CLSST contained moderate or abundant fragments of medium-grained sandstones and mixed calcareous inclusions. ECHAF contained moderate to abundant organic inclusions, ERRA contained moderate to abundant fragments of fine-grained basic igneous rocks, ESGS contained moderate to abundant rounded, water-polished quartz grains, FE contained moderate to abundant fragments of black or red iron-rich compounds, LIM contained moderate to abundant fragments of oolitic limestone, or spherical voids where the limestone had leached out, ROUND contained moderate to abundant coarse-grained rounded quartz, SST contained moderate to abundant sandstone inclusions and where these could be identified visually as being of Millstone Grit type the fabric was classified as SSTMG.

Table 1

cname	TSNO	Total
CHARN	V1844	1

	V1868	1
CHARN Total		2
CLSST	V1866	1
	V1867	1
	V1869	1
	V1870	1
	V1871	1
	V1874	1
	V1878	1
CLSST Total		7
ECHAF	V1854	1
	V1856	1
	V1864	1
	V1875	1
ECHAF Total		4
ERRA	V1846	1
	V1847	1
	V1849	1
	V1872	1
ERRA Total		4
ESGS	V1861	1
ESGS Total		1
FE	V1858	1

FE Total		1
LIM	V1852	1
	V1860	1
	V1879	1
LIM Total		3
ROUND	V1853	1
	V1855	1
	V1857	1
	V1863	1
	V1865	1
ROUND Total		5
SST	V1843	1
	V1845	1
	V1850	1
	V1851	1
	V1859	1
	V1862	1
	V1877	1
SST Total		7
SSTMG	V1873	1
	V1876	1
SSTMG Total		2
Grand Total		36

The binocular microscope study showed, however, that many of the inclusion types which characterised these groups were also present in lesser quantities in vessels classified as belonging to other fabric groups and it was unclear which, if any, inclusion types were significant in terms of classification and characterisation and which were not. Table 2 shows this additional inclusion data for the 36 sampled vessels.

Table 2

cname	TSNO	subfabric
CHARN	V1844	BIOTITE GRANITE;SST;SA Q;VOIDS;SHELLY LST
	V1868	BIOTITE GRANITE
CLSST	V1866	SUGARY SST;SSTMG;LIMESTONE
	V1867	SUGARY SST;SSTMG
	V1869	SUGARY SST;SSTMG;SA WHITE FLINT
	V1870	SUGARY SST;RED SUGARY SST;S VOIDS
	V1871	SUGARY SST;SSTMG;BIOTITE GRANITE;S VOIDS
	V1874	SUGARY SST;THIN BLACK SHEETS - HAMMERSCALE? TABULAR IRON ORE? COAL?
	V1878	SUGARY SST;RED SUGARY SST;CHAFF;S VOIDS
ECHAF	V1854	CHAFF;QUARTZ SILT/FINE SAND;ANGULAR WHITE FLINT >2.0MM
	V1856	CHAFF;MGSST;RQ;ROUNDED VOIDS
	V1864	CHAFF;ROUNDED FE;MGSST;BIOTITE
	V1875	CHAFF;MGSST;RQ
ERRA	V1846	MGSST;QUARTZITE (VEIN Q);MUSC LATHS
	V1847	FE;SAQ;RQ;MUSC IN GROUNDMASS
	V1849	BIOTITE GRANITE;PINK FELDSPAR;SA Q
	V1872	M A ACID IGNEOUS ROCK (BIOTITE, FELDSPAR, MUSCOVITE) >2.0MM;S SA WHITE FLINT >3.0MM

ESGS	V1861	GSQ;ROUNDED VOIDS;SUGARY SST
FE	V1858	FE;MGSST;RQ;BIOTITE GRANITE
LIM	V1852	ABUNDANT SPHERICAL VOIDS;RQ;SA WHITE FLINT;R FE
	V1860	ROUNDED VOIDS
	V1879	OOLITIC LIMESTONE;INCLUSIONLESS MATRIX
ROUND	V1853	RQ >3.0MM;SA WHITE FLINT >3.0MM;R FE >2.0MM
	V1855	RQ;ANGULAR WHITE FLINT;CHAFF
	V1857	ROUNDED VOIDS;RQ;SA WHITE FLINT
	V1863	SA WHITE FLINT;SA Q;GSQ?;ROUNDED VOIDS;INCLUSIONLESS MATRIX
	V1865	ROUNDED VOIDS;RQ;ROUNDED FE
SST	V1843	(MG?)SST;ANGULAR WHITE FLINT;ROUNDED FEORE;RQ;CHAFF
	V1845	MGSST
	V1850	MGSST - SOME FE-STAINED [ARKOSE SAND? 29/08/03]
	V1851	MGSST [ARKOSE SAND? 29/08/03]
	V1859	MGSST
	V1862	MGSST
	V1877	MGSST;RQ;GSQ?
SSTMG	V1873	A FINE SAND INC OVERGROWN GRAINS >0.5MM;MUSC >0.5MM;S R MICRITE >2.0MM
	V1876	SSTMG;CHAFF;INCLUSIONLESS MATRIX

Thin Section Analysis

Thin sections of each sample were prepared by S Caldwell, University of Manchester, and stained using Dickson's method (Dickson 1965). Each section was examined quickly to establish the range of inclusion types present and then all the sections were examined again at x40 magnification, searching for and describing each inclusion type more fully. Details were noted of the size, frequency and roundness of the inclusion type, together with further description if appropriate. The character of the groundmass was examined at x100, recording the birefringence, texture and inclusions less than 0.1mm across.

The results of this analysis call into doubt the visual identification of some inclusion types as well as the interpretation of the fabric groups as being the products of distinct and separate source areas.

Inclusion types

Quartz sand

Quartz sand was ubiquitous in the samples except for one of the LIM samples where it was scarce and fine-grained (less than 0.3mm across). Despite the visual identification of water-polished grains of Lower Cretaceous origin no positive identification of this type could be made in thin section, suggesting either that the visual identification was faulty or that the inclusion type was too rare to be present in the thin sections.

Grains with a very spherical cross-section were noted in three sections (V1861, V1871 and V1875). These are probably “millet grain” quartz derived from a Permo-Triassic sandstone. Such grains are widespread in Quaternary deposits in the region and have been noted in sands in the Vale of York and in samples of boulder clay from the coast.

The majority of the quartz grains found have a euhedral outline and are clearly derived from an orthoquartzite such as the Millstone Grit, in which the quartz grains are overgrown. In fact, they are only absent in four sections, three of which contain abundant rounded quartz grains between 1.0mm and 3.0mm across (V1852, V1857 and V1863). These grains appear to come from a beach sand.

Acid igneous rock

Fragments of acid igneous rock were noted in 18 sections. In several of these, however, the composite quartz/feldspar grains are probably present as clasts in Millstone Grit type sandstone. Microcline feldspar was particularly common in the latter. Fresh angular acid igneous rock, with biotite as a major component, was only abundant in one section, V1849, and moderately common in two more, V1868 and V1872.

Basic igneous rock

Fine-grained basic igneous rock fragments were noted in 10 sections. In three of these, the rock fragments were angular (V1849, V1867 and V1872) and in the remaining seven sections they consisted of sparse rounded fragments.

Ironstone

Six sections contained fragments of ironstone consisting of an opaque groundmass with angular quartz inclusions up to 0.3mm across. The ratio of inclusions to matrix suggests that these should be classified as iron concretions or ore deposits rather than as iron-cemented sandstones. The fragments are mainly angular and up to 3.0mm across but in one case the grains are rounded (V1863) and in one they include both angular and subangular fragments (V1854).

Other rounded opaque inclusions

In 15 thin sections, rounded or angular inclusionless opaque grains were noted. In many cases the grains included abundant fragments less than 0.1mm across suggesting that they may have been present in the clay before tempering.

Slag and Hammerscale

Three sections (V1870, V1874 and V1879) included thin, tabular opaque grains. In one of these sections (V1874) these were accompanied by vesicular fayalite slag inclusions and these suggest that the tabular inclusions are probably hammerscale, as was suggested for V1874 following x20 binocular microscope examination.

Millstone Grit type sandstone

Fragments of Millstone Grit sandstone were noted in 22 sections and in most of these sections they were the most common inclusion type present. They were recognised because of the overgrowth of the quartz grains and the presence of light-coloured kaolinite cement. The sandstones vary somewhat in texture and in most cases all of the quartz and sandstone inclusions are of the same size. In the case of the coarser sandstones the grains range from 0.5mm to 2.0mm across whilst in the finer ones the grains are less than 0.5mm across. In two samples, V1859 and V1864, sandstones of both coarse and finer grade were present. The finer grade sandstones include muscovite laths absent from the coarser ones. Several of the coarser grade sandstones include a high proportion of feldspar grains and might be classified as arkoses.

Chaff

In 10 sections sparse to moderate fragments of chaff were noted. These were usually aligned with the walls of the pot and between 1.0mm and 3.0mm long. In most cases these were probably deliberate tempering and in five cases (V1843, V1853, V1855, V1864 and V1876) almost certainly so. Other organic inclusions were probably roots or other organic matter accidentally included in the potting clay (V1852, V1862, V1863 and V1874).

Mudstone

Nine sections contained rounded fragments of mudstone, often of similar texture and colour to the groundmass, but sometimes of slightly lighter or darker colour and always with evidence for lamination. These mudstones are similar in appearance to those from Jurassic clays observed both in the Lincoln area and in the North Yorkshire Moors. They have the appearance of relict clay, present in the potting clay as dug, rather than detrital grains, and in two instances they are moderately common (V1873 and V1876).

Limestone

Limestone fragments or voids which probably contained limestone were noted in ten sections. Of these, six were sparse rounded voids. In one case traces of the inclusions remained, suggesting that they were an oolitic limestone with a sparry ferroan calcite cement (V1844). In one case the voids were rhombic in outline, suggesting the former presence of sparry calcite (V1866) and in two they were abundant and almost certainly from oolitic limestone. In one of these, traces of an echinoid shell were noted, probably once the core of an oolith.

Clay pellets

Spherical nodules consisting of concentric layers of iron- and/or manganese-stained clay are often a common feature of pottery fabrics, being naturally present in the potting clay. In these 36 sections, however, only two samples contained such nodules, V1847 and V1858.

Flint

Large angular and subangular fragments of flint up to 3.0mm long, often white in hand specimen and sometimes brown-stained in thin-section, were noted in four sections (V1852, V1853, V1855 and V1863). In addition, they were noted in hand specimen in five further samples.

Chert

Rounded fragments of chert were noted in six sections and were moderately common in one, V1853. One of these fragments, in V1863, is in the form of chalcedony.

Fine-grained sandstone

Four thin sections contained sparse rounded fragments of fine-grained sandstone (with grains less than 0.3mm across). In two cases these had a silica matrix and in one of these cases some of the grains were chalcedony. Similar sandstones have been noted in the Jurassic strata of the North Yorkshire Moors.

Groundmass types

Twenty nine of the 36 sections have a groundmass containing little or no quartz or muscovite silt, sparse to moderate opaque and dark brown clay inclusions and a highly birefringent anisotropic clay matrix. These characteristics are typical of Jurassic clays.

Seven samples contain either sparse quartz and muscovite silt (V1847, V1854 and V1858) or abundant ill-sorted quartz of silt and fine sand grade. The latter (samples V1846, V1849, V1864 and V1875) is typical of the boulder clays found in East Yorkshire whereas the former is too widely distributed a groundmass type to be tied to any specific stratum.

Interpretation

Although, as shown in Table 2, there is considerable overlap in the occurrence of inclusion types in the Sancton pottery the potential source area of the vessels can be limited because of the distinctive character of the groundmass. In the area around Sancton the only outcrops of similar clay occur along the western scarp of the Wolds, where the chalk overlies Upper Jurassic Oxford Clay and earlier Jurassic strata, including oolitic Lincolnshire Limestone. This outcrop stretches from Market Weighton in the north to the Humber in the south. Lower Cretaceous strata are absent and the chalk unconformably rests on the Oxford Clay. It is, of course, possible that some or even all of these vessels come from more distant sources of fine-textured clay, for example in the Vale of Pickering. However, analysis of the fabric of the early to mid Anglo-Saxon pottery at West Heslerton demonstrates that most of the pottery used there was made from glauconitic Speeton Clay and the Oxford Clay is mainly masked by Quaternary deposits in the centre of the Vale. It is possible that some of the vessels were made south of the Humber and several visually similar fabrics are known from northwest and central Lincolnshire. However, several of the inclusion types found in the Sancton pots either do not occur in pottery south of the Humber or occur only in the northeast of the county (for example at Barton-upon-Humber).

Nineteen of these probable Jurassic clay vessels contain a Millstone Grit-derived sand. such sands occur in the Vale of York and may outcrop at the foot of the Wolds. In addition to Millstone Grit fragments and Millstone Grit-derived quartz grains they include sparse rounded quartz grains, variable quantities of acid igneous rock fragments, ironstone, variable quantities of chaff, sparse possible oolitic limestone, sparse rounded chert and sparse rounded fine-grained sandstone fragments. Basic igneous rock fragments and flint are complete absent.

Of the remaining probable Jurassic clay vessels four contain fine-grained basic igneous rock fragments. These occur frequently in sands, gravels and boulder clays in East Yorkshire but they have not been noted to the west of the Wolds, which probably marked the westward boundary of the ice sheets which brought them into Yorkshire. The samples also contain abundant rounded quartz sand and angular flint fragments (V1852, V1853, V1855 and V1863). Other inclusions are variable in their occurrence. It is difficult to think where the Jurassic clays and this erratic-rich flinty gravel might overlap in nature and it is possible that the gravel was obtained at a different site from the clay.

The remaining five probably Jurassic clay vessels can be divided into three groups: two samples (V1867 and V1872) contain moderate angular fragments of basic and acid igneous rock and angular quartz (not of Millstone Grit origin); Two samples (V1860 and V1879) contain abundant voids, probably from oolitic limestone. There are no other shared characteristics between the two samples. Finally, the last sample (V1861) is tempered with a sand composed of Permo-Triassic quartzose grains, including “millet grain” quartz and rounded chert. The groundmass of this sample is less clearly of

Jurassic origin than the remainder but similar sands occur in the Trent valley, where they overlie Lower and Middle Jurassic clays.

The seven samples which do not have a probable Jurassic clay groundmass include four (V1846, V1847, V1849 and V1875) which can be paralleled in texture and inclusion range in samples of boulder clay from East Yorkshire, two which contain a Millstone Grit type sand and have a fine sandy groundmass (V1858 and V1864) and one sample containing abundant angular fragments of ironstone. This sample cannot be provenanced further on present evidence.

The thin section study therefore suggests that despite the wide variety of tempering materials used, which include both natural sands and gravels and artificial materials such as chaff , hammerscale and slag, the majority of the Sancton pottery samples were made from materials available within a few miles of the cemetery. Whether the groups recognised here on the basis of their inclusions were made at different places utilising the same or similar clay outcrops or in the same place but with tempering materials brought to the site is a matter which can be considered using chemical analysis.

Chemical Analysis

Sub-samples from every sampled vessel were taken for chemical analysis. The outer surface and broken edges of the sub-sample were mechanically removed to minimise the effect of contamination and the remainder was crushed to a fine powder and submitted to Dr J N Walsh, Royal Holloway College, London, for analysis using Inductively Coupled Plasma Spectroscopy. This analysis measures the frequency of a range of elements, including major constituents as well as minor and trace elements. The major elements are measured as percent oxides and the remainder as parts per million.

Silica, the main constituent of quartz sand and a major component of the clay minerals, is not measured and its frequency has been estimated by subtracting the total of measured major elements from 100%. This estimate will, however, also include chemically-combined water and organic molecules, principally carbon. The estimate is therefore affected by firing conditions and temperature. Table 3 shows the estimated silica content grouped by the petrological groups suggested by the thin section analysis (JC = Probably Jurassic Clay groundmass). The mean value is 73.8% and for each of the groups there is a normal distribution of values, with a multi-modal overall distribution. The oolitic limestone-tempered vessels have a low silica content which would have been lower still if the limestone inclusions had not been leached. The low value for the ironstone-tempered fabric is presumably due to the high iron content in the temper.

Table 3

SiO2	IRONSTONE	JC - ANG ERRATICS	JC - BC	JC – LIM	JC - MG SAND	SST	MGTILL	TRIASSIC SAND	Grand Total
62-63	1								1

65-66					1				1
67-68				1					1
69-70		1	1	1	1				4
71-72			1		2		1		4
72-73			1			2			3
73-74		1	1		2		2		6
75-76			1		2				3
76-77					4		1		5
77-78			1		3			1	5
78-79					2				2
80-81					2				2
Grand Total	1	2	6	2	19	2	4	1	37

The chemical dataset was transformed by normalising all the measurements by dividing them by the Al_2O_3 value. This is intended to counteract the dilution effect caused by the variable silica content.

Factor analysis of the full normalised dataset shows no clear separation into fabric groups, either based on their groundmass or inclusions (Fig 1). It is clear, however, that some of the petrological groups have different chemical compositions, for example the two oolitic limestone-tempered samples (JC – LIM) and the five samples tempered with a rounded beach sand (JC – BS).

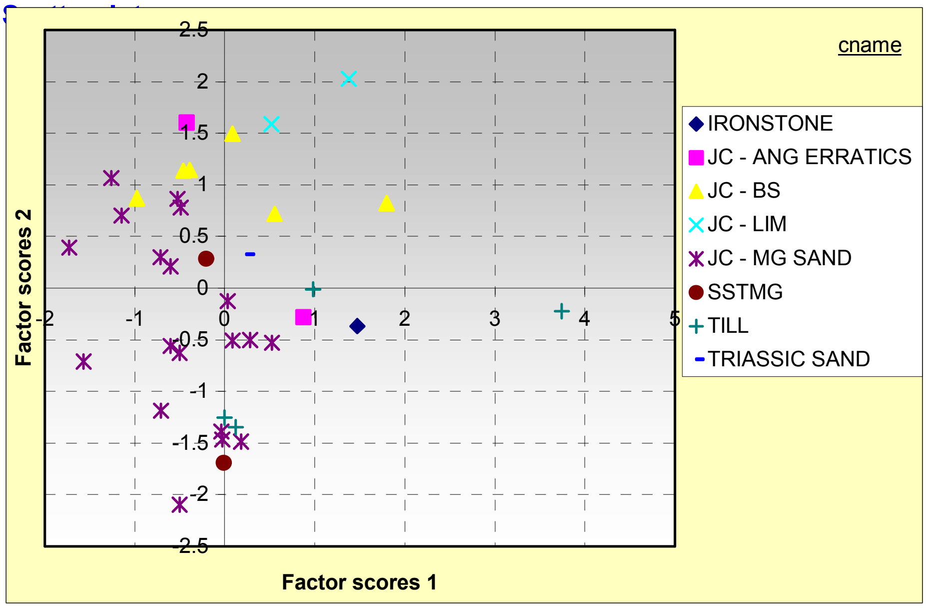

Figure 1

Since it is not immediately clear what contribution to these results was caused by the tempering and what, if any, to the groundmass, a second analysis was undertaken omitting all elements which are likely to be present mainly in the sand fraction. Since iron is evidently a distinguishing feature of the Jurassic clay groundmass it was not possible to exclude either Fe_2O_3 or elements which are potentially correlated with iron content. Fig 2 shows a plot of the two main factor scores for this reduced subset. There is a central cluster comprising the four main tempered Jurassic clay groups whilst the two samples with a Millstone Grit-derived sand but a silty, micaceous matrix (SSTMG), the ironstone-tempered fabric (IRONSTONE) and two of the four probable Boulder Clay fabrics (TILL) were distinguished. The sample with the rounded quartzose sand temper of Permo-Triassic character (TRIASSIC SAND) and two of the TILL samples plotted with the Jurassic clay samples. The oolitic limestone tempered samples plot on the edge of the large cluster. The main characteristics of Factor 1 are high Rare Earth Element scores and negative scores for Cr and V. For Factor 2 they are high MnO, Cu and Fe_2O_3 and negative scores for Zn and Li.

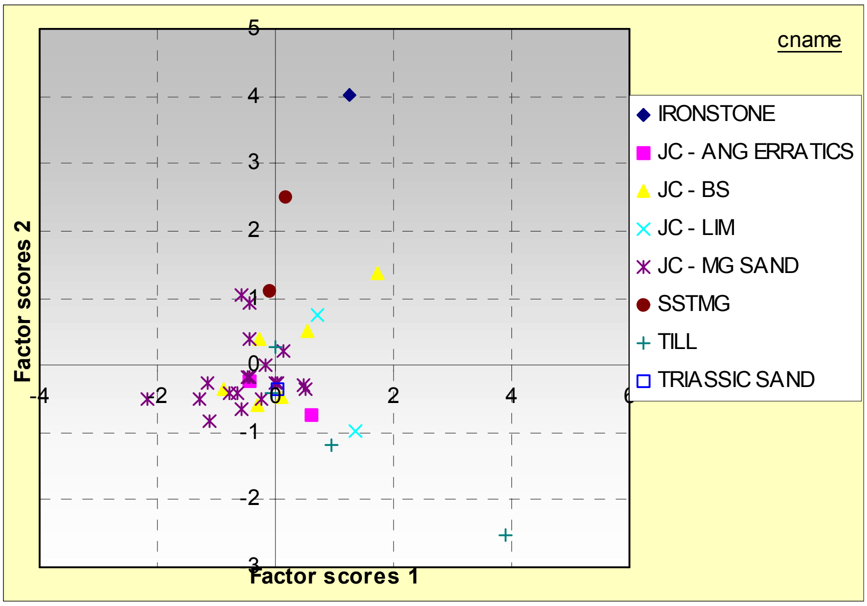

Figure 2

A plot of the 3rd and 4th factor scores (Fig 3) separates the Triassic sand-tempered fabric from the remainder whilst the SSTMG and JC – LIM samples plot on the edges of the JC cluster. There is clearly a difference in composition, but within the cluster, between the Millstone Grit sand and Beach Sand groups whilst there are too few samples of the Angular Erratic-tempered group to tell. Factor 3 depends on high V and Cr scores and negative Li ones. For Factor 4 the positive scores depend on high La weightings and the negative ones on Zn.

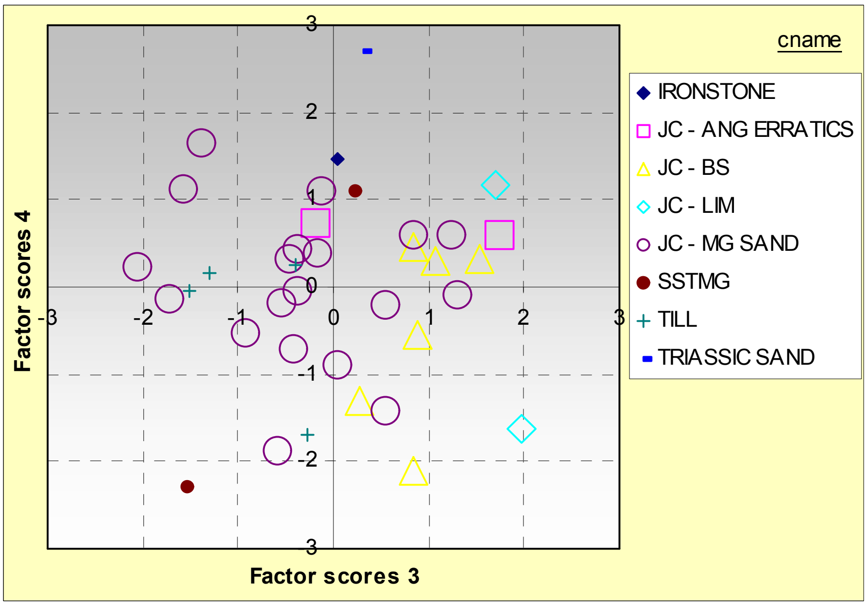

Figure 3

These analyses tend to suggest that the division into a Jurassic Clay and Other groups on the basis of their groundmass has some support from the chemical composition. This composition group is distinguishable from others found at Sancton by its Cr, V, Li, La and Zn values. It also suggests that the Oolitic limestone-tempered samples might be from a distinct , albeit still Jurassic, clay and that there are chemical differences which are probably not due to the tempering, between at least some of the different tempering groups.

Discussion

The thin section and chemical analyses provide complementary evidence for the provenance and preparation of the Sancton pottery fabrics. Only four samples, grouped here as TILL, were possibly produced from a self-tempered clay without further treatment. The remainder were produced by the addition of tempering materials. These tempering materials either consisted of artificial material such as chaff, slag or hammerscale or naturally-occurring sands or gravels. In a few instances it is possible that the tempering material was broken up before being added (for example in the case of the angular erratic rock-tempered group) but mainly, even with tempers such as the ironstone, the inclusions are at least subangular and probably come from natural sands or gravels. It is not clear whether the sparse angular erratic rocks are deliberate temper or simply erratics naturally present in these sands and gravels.

Having established that the parent clay, in all but seven cases, was obtained locally, we can re-examine the interpretation of the petrological evidence. Firstly, the two samples classified as CHARN by eye have been re-interpreted as being local clay tempered with a Millstone Grit-derived sand with the biotite granite inclusions being interpreted as erratics, perhaps in this case of Shap Granite. Secondly, the group of samples interpreted by eye as containing mixed medium-grained orthoquartzites and calcareous inclusions, CLSST, have in the main been re-interpreted following this analysis as containing Millstone Grit-derived sands, with one (V1867) being interpreted as containing angular erratic rock fragments. The four samples classed by eye as containing mainly chaff, ECHAF, have been shown in this analysis to contain four different temper types: ironstone, Jurassic clay with a Millstone Grit-derived sand, Other clay with a Millstone Grit-derived sand and boulder clay. The four samples identified by eye as containing finegrained basic igneous rock fragments have been divided following this analysis into three which are interpreted as boulder clays and one which is interpreted as a local clay with angular erratic rock temper. The single sample thought by eye to contain a Lower Cretaceous derived quartz sand, ESGS, was shown following thin section to contain a Permo-Triassic quartz sand. The one sample identified by eye as containing predominantly ironstone, FE, was shown in thin section to contain a Millstone Grit-derived sand in a non-local groundmass. Three samples were identified by eye as being tempered with an oolitic limestone-derived sand but only two of these were confirmed by thin section analysis. The third sample was instead classified as being a local clay with a rounded beach sand temper. Six samples were identified by eye as containing a rounded sand or gravel, ROUND, and five of these were confirmed by thin section. However, the sixth sample was re-interpreted as containing a Millstone Grit-derived sand in a local clay. Seven samples were identified by eye as containing a sandstone sand temper and in thin section this identification was refined to show that the sands were in each case derived mainly from Millstone Grit and that the clay was probably locally derived. Finally, in two cases Millstone Grit-derived sand was identified by eye as the main inclusion type, SSTMG, and these identifications were also confirmed in thin section, with the additional information that the clays were probably locally derived. The success rate in identifying these fabrics by eye is not particularly high. This may in part be due to an attempt to fit the data into a pre-conceived framework. In most cases the identification of inclusion types was not at fault (although the ESGS/Triassic sand instance is quite worrying) but an accurate interpretation could not be made on the basis of the inclusions seen by eye.

Following this analysis the interpretation of the Sancton pottery requires some thought. It now seems likely that most of the Sancton pottery was made from a clay that could be obtained very close to the cemetery, in the sides of valleys on the scarp slope of the Wolds, immediately underlying the Chalk. It is unfortunate that the pottery is almost completely decalcified as the incidence of chalk fragments might provide a good clue as to whether it was this Upper Jurassic clay or one of the clays earlier in the sequence, and outcropping further to the west, which was being used. The chemical data suggests that there may be several sources of clay used, corresponding to the differences in tempering. Nevertheless, the picture is certainly one of production within at most 10 miles of the cemetery in most cases.

Most of the fabric groups noted at Sancton are also found in collections of Anglo-Saxon pottery elsewhere in Yorkshire and Lincolnshire. These groups should probably be seen as reflecting preferences for certain temper types by the Anglo-Saxon potters as well as reflecting differences in the source of the pottery. For example, the use of an angular quartzose sand temper is common throughout the Vale of York, from Catterick and Piercebridge in the north down to Sancton itself. However, there are variations in the clay groundmass and the chemical composition of these clays which suggest that we are looking at local production utilising quartz sands which are widely occurring in the valley. Fig 4 shows a plot of the third and fourth factors determined by analysis of a dataset consisting of groups of sandstone-sand-tempered vessels from sites throughout northern England, and some from Brough, in the Trent valley in Nottinghamshire (the first two factors indicate similarity between all of the samples with some outliers). CaO and other elements likely to be affected by burial conditions were omitted. The Sancton samples plot in the centre of this graph and do not overlap with the samples from York, Jarrow or Catterick at all but do have similar compositions to those from Norton, Scorton, Sewerby, West Lilling and West Heslerton. A re-examination of the thin sections of these samples will be required to determine whether any in the latter group have the same groundmass as Sancton.

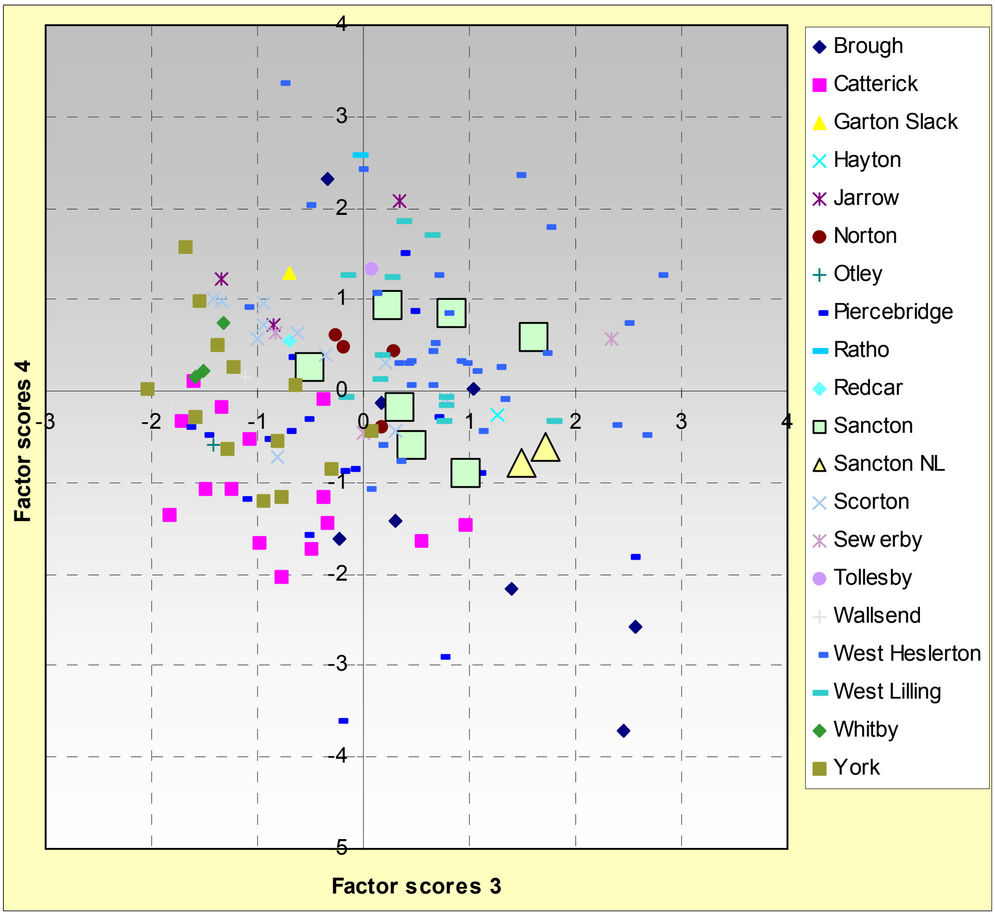

Figure 4

A similar analysis of samples with a rounded beach gravel, ROUND, indicates again a close similarity of the samples using the first two factors but separation using the third and fourth (Fig 5).

In this case, the Sancton and Elmswell samples form a separate grouping whilst samples from Brough on Humber, Easington and West Heslerton form a second group. Samples from Sewerby have a chemical composition intermediate between these two groups. Again, the interpretation of these results will have to depend on re-examination of the thin sections and then possibly further study of the underlying factors responsible for the factor analysis results.

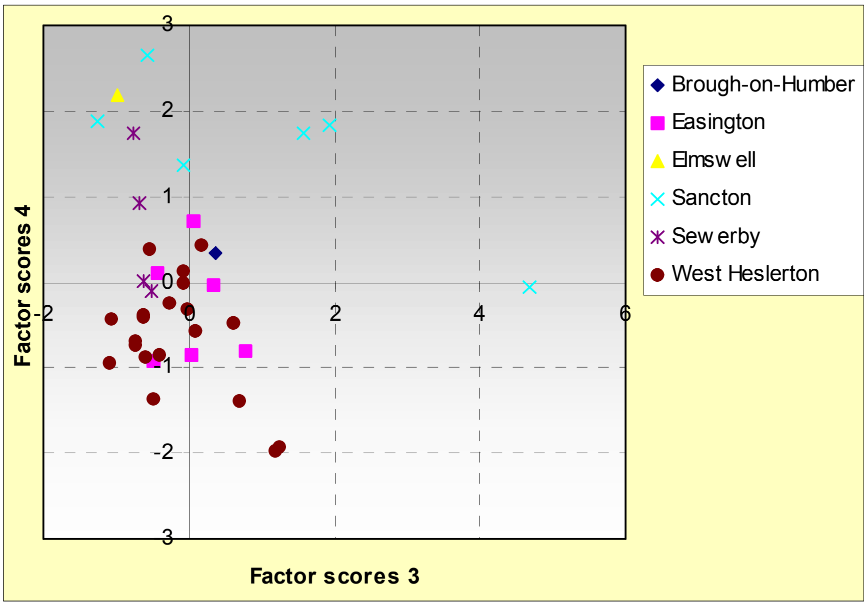

Figure 5

Acknowledgments

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Bibliography

Dickson, J. A. D. (1965) "A modified staining technique for carbonates in thin section." *Nature*, 205, 587.