Petrological and Chemical analysis of Anglo-Saxon pottery from Dunholme, Lincolnshire

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Introduction

The Anglo-Saxon pottery from Dunholme, recovered by Pre-Construct Archaeology Lincolnshire (Site Code SLD01). A high incidence of unusual fabrics was found. Two possible reasons for this were postulated: on the one hand it might be due to the fact that these wares were being produced very locally whereas on the other hand it might be due to the Anglo-Saxon inhabitants of this site having far-flung connections, such as kinship ties with groups located some distance away.

Sixteen samples were chosen for further analysis (Table 1). They had been assigned to four groups on the basis of binocular microscope study: SST is a code used for any fabric in which the predominant inclusions are sandstone fragments or quartz sand derived from sandstones; LIMES is a code used for limestone-tempered fabrics; ASSHQ is a new code, used to denote the presence of shell and quartz sand and ESGS is used for wares containing polished, rounded quartz grains derived from the lower Cretaceous Greensand.

As a result of the thin-section analysis, these identifications must be modified (Table 1, Petrological Group).

Table 1

TSNO	CNAME	PETROLOGICAL GROUP	FABRIC NO	COMMENTS
V1134	SST	SST+ERRA	3	
V1135	LIMES	SHELLY LST+RQ	1	
V1136	ASSHQ	SHELLY LST+RQ	1	
V1137	SST	GRANITE+SST	2	
V1138	SST	GRANITE+SST+RQ	2	
V1139	ASSHQ	SHELLY LST+RQ	1	
V1140	ASSHQ	SHELLY LST+RQ	1	LEACHED
V1141	ESGS	GRANITE+SST+RQ	2	
V1142	SST	GRANITE+RQ	2	
V1143	SST	GRANITE+RQ	2	
V1144	ASSHQ	SHELLY LST+RQ	1	
V1145	SST	SST+ERRA	3	
V1146	ASSHQ	SHELLY LST+RQ	1	
V1147	SST	SST+ERRA	3	
V1148	SST	FINE SST+SLAG	5	
V1149	SST	COARSE SST	4	

Methodology

The thin-section samples were cut from the submitted sherd and a thin-section, 30 microns thick, was prepared by Paul Hands, Department of Earth Sciences, University of Birmingham. The sections were polished to allow reflected light microscopy, and stained using Dickson's method to distinguish different forms of calcite from each other and from dolomite.

The chemical samples were prepared by removing a large fragment from the submitted object (where sufficient material existed to justify this destructive approach), mechanically removing all exposed surfaces and margins and grinding the remainder to a powder. The resulting powders weighed between 3gm and 5gm. These powders were analysed using Inductively Coupled Plasma Spectroscopy (ICPS) at the Department of Geology, Royal Holloway College, by Dr J N Walsh. Only a fraction of this sample was actually consumed during analysis but the heterogeneous nature of most archaeological ceramics means that smaller samples are likely to be more variable, as a result of the presence of non-quartzose inclusions. The samples were given an identity number and a record added to a computer database held by AVAC. The unused portion of the sample will be returned to PCA Lincolnshire following completion of the project.

The following elements are measured as percentage oxides: Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O, TiO_2, P_2O_5 (App 1a). From these, a rough indication of the silica content was obtained by subtracting these percentages from 100%. In addition, the following minor and trace elements are measured, as parts per million: Ba, Co, Cr, Cu, Li, Ni, Sc, Sr, V, Y, Zn, Zr*, La, Ce, Nd, Sm, Eu, Dy, Yb and Pb.

Lead is measured mainly as a guide to potential glaze contamination and because it can indicate where unglazed vessels were fired alongside glazed ones.

The dataset will be studied using Principal Components Analysis. In this analysis, a series of 14 Principal Components (PC) are computed for each sample. PC1 is that loading which accounts for most of the variation between samples, PC2 the next and so on. For each PC the contribution of each element to the component is also computed. This analysis allows similarities and dissimilarities of each sample's data to be explored.

It is usual to run this analysis several times, excluding elements which dominate the analysis and those elements which are closely linked to such elements (this is particularly true of Ca and Sr) or which may have been affected by leaching or post-burial enhancement (eg P_2O_5).

For any identified fabric group mean values and standard deviations for each element are calculated and presented.

Petrological analysis

From Table 2 it can be seen that in one case the visual attribution (to ESGS) seems to have been incorrect. The distinction between ASSHQ and LIMES is not borne out by thin-section analysis whilst the SST can be subdivided into six fabric groups. The significance of the division of the granitic wares into three groups is uncertain, and these are described together below.

Table 2

PETROLOGICAL GROUP	ASSHQ	ESGS	LIMES	SST	Grand Total
COARSE SST				1	1
FINE SST+SLAG				1	1
GRANITE+RQ				2	2
GRANITE+SST				1	1
GRANITE+SST+RQ		1		1	2
SHELLY LST+RQ	5		1		6
SST+ERRA				3	3
Grand Total	5	1	1	9	16

Fabric 1: ASSHQ and LIMES

This fabric is characterised by moderate to abundant bivalve shell and similar quantities of rounded quartz sand. The shell fragments in thin-section are stained pink and surround by a sparry blue-stained calcite matrix. This indicates that they are derived from a shelly limestone. The group can be divided into two: the first subfabric contains bivalve shell (and a single fragment of echinoid shell) whilst the second contains limestone fragments, with a sparry calcite groundmass, some of which are ferroan calcite and some non-ferroan. The shell fragments are rounded and ooliths are also present. There is also a difference in the groundmass, with the second group containing fragments of rounded mudstone of similar colour and texture to the groundmass.

Fabric 2: SST - Granitic wares

Wares tempered with angular fragments of biotite granite are common in Lincolnshire. Their distribution indicates a source to the southwest of the county since assemblages in southwest Lincolnshire have a much higher percentage of these wares than assemblages in the northeast of the county. This distribution pattern is not consistent with a source in the county, for example utilising fragments of glacial erratic, which are common in the boulder clays underlying the Lindsey Marshes, and is consistent with an origin in Leicestershire, where deposits of granitic sand derived from the Mountsorrel granodiorite, which outcrops in the Charnwood Forest inlier.

However, the samples from Dunholme are quite distinct from this 'standard' Charnwood ware fabric. The granite inclusions are smaller, mainly between 1.0mm and 2.0mm across, and they are accompanied by a rounded quartz sand and, in some of the samples, by sandstone fragments. The thin-sections confirm the identify of the granitic inclusions, which are not petrologically distinguishable from the Mountsorrel granodiorite. However, the grains are subangular or rounded, and there is less biotite present. Both of these features suggest that the granitic rocks are detrital grains, whereas in some of the standard Charnwood ware vessels they may be derived from crushed, weathered rock. This fabric, therefore, probably utilises different raw materials, even if they also originate in NE Leicestershire. The fabric has not been recognised before but may be present and coded as 'SST' on other sites.

Fabric 3: SST - sandstone and erratic rock tempered wares

This fabric contains rounded fragments of basic igneous rock and fragments of sandstone in a quartzose sand. Although the occasional rounded erratic rock can be found in the superficial sand deposits in the Dunholme area it is more likely that the inclusions in these samples came from a sand in the northeast of the county, to the north or east of the Lincolnshire Wolds, where such inclusions are much more common.

Fabric 4: SST - Coarse sandstone tempered ware

A single sample was shown in thin-section to contain a sand composed of Lower Carboniferous sandstone. Such sands are widespread along the eastern fringes of the Pennines, where those sandstones outcrop, but do not occur in Lincolnshire. It is likely, therefore, that this sample came from a vessel made in Yorkshire, to the west of the Yorkshire Wolds.

Fabric 5: SST - fine sandstone and slag-tempered ware

A single sample contained a fine-grained sandstone, of unknown origin, and moderate quantities of angular fayalite. Fayalite occurs naturally, and can be formed during firing through the vitrification of iron-rich inclusions. However, in this case the angular nature of the inclusions shows that the material was already formed when it entered the pot fabric and it is most likely that it consisted of crushed iron slag. Slag is increasingly being recognised as a tempering material in both prehistoric and Anglo-Saxon pottery but is still a rare discovery, even now that ceramic specialists are aware of the possibility of slag tempering. It is likely therefore that slag-tempered pottery was never common. It is not possible from such small fragments (less than 2.0mm across) to say what process the slag was associated with and in order to determine the source of the vessel we must ignore the slag and concentrate on the other inclusions. Fine-grained sandstones occur within the Northampton sands, which outcrop along the Lincoln edge but no thin-sections of this rock are at present available for comparison with the Dunholme sample.

Chemical Analysis

The ICPS dataset was analysed using PCA. This showed a large degree of similarity between all of the samples and when comparing the first and second principal components (Fig 1). Three clusters were revealed. The major cluster contained all of the Fabric 2 samples and most of the Fabric 1 samples. This result is counter-intuitive, since it is clear that Fabric 1 contains high quantities of CaO and Sr, as a result of the shelly limestone temper, and Fabric 2 should contain higher quantities of K2O as a result of the feldspar grains in the granite.

The second cluster contained two of the Fabric 3 samples (V1145 and V1147) and the Fabric 5 sample whilst the third cluster consisted of the Fabric 5 sample and two of the Fabric 1 samples (V1135 and V1140). The third Fabric 3 sample, V1134, plotted on the fringe of the main, Fabric 1 and 2, cluster (Fig 1).

There are several possible interpretations of these results. The most likely is that the samples were contaminated during burial on the site. It is extremely difficult to remove all of the soil matrix from friable Anglo-Saxon potsherds, which are, in any case, often traversed by voids and laminae along which groundwater, bearing dissolved elements, would have flowed. Normally, however, the samples from one site would have similar burial conditions and therefore this contamination would be cancelled out during analysis. It is noteworthy in this context to recall that sample V1140 was noticeably leached, which would both reduce the CaO and Sr content and boost the apparent Al2O3 content. It is likely, therefore, that cluster 3 includes two samples which have lost most of their calcareous content during burial.

The second possibility is that the three clusters do actually reflect the source of the raw materials. The second cluster is characterised by high Na2O values. This would be consistent with the use of briny clays such as would be expected along the Lincolnshire coast. The third cluster is characterised by high Al2O3 values (ie low amounts of tempering) and high values for TiO and Cr (usually present in Titanium oxide grains such as rutile but possibly in this case also present in the fayalite slag). It is likely that the TiO values are higher in the two leached shelly limestone tempered sherds simply because of the absence of shell. The ratio of Al2O3 to TiO is consistent with this interpretation, being fairly constant for all the Fabric 1 samples, leached and unleached..

The next stage in the study of these samples will be to compare the chemical data from Dunholme with that obtained from Anglo-Saxon pottery from other sites. Two datasets are available for comparison, one comes from Anglo-Saxon pottery recovered during the excavation of St Peter's Church, Barton-upon-Humber, and the other consists of samples of SST tempered with Lower Carboniferous sandstone-derived sand from sites in Yorkshire. This study will be part of a forthcoming project to characterise the Anglo-Saxon pottery of the north of England.

Appendix 1a

TSNO	AL2O3	FE2O3	MGO	CAO	NA2O	K2O	TIO2	P2O5	MNO
V1134	14.10	8.40	1.09	1.37	0.28	2.30	0.71	0.85	0.06
V1135	18.40	4.85	0.96	3.13	0.05	2.04	0.87	1.94	0.05
V1136	12.61	6.48	0.99	3.46	0.08	1.81	0.57	2.48	0.08
V1137	11.54	4.80	0.65	2.05	0.21	2.06	0.58	1.99	0.02
V1138	11.65	4.57	0.85	1.12	0.33	2.15	0.56	1.39	0.03
V1139	13.21	6.40	1.08	2.65	0.09	1.81	0.67	1.67	0.06
V1140	16.37	7.44	2.53	1.57	0.36	2.96	0.72	1.24	0.16
V1141	13.21	9.63	0.98	1.42	0.18	2.22	0.68	2.17	0.04
V1142	12.62	5.15	0.94	1.24	0.49	2.28	0.59	1.22	0.03
V1143	13.30	6.10	0.88	0.87	0.10	1.66	0.65	1.59	0.06
V1144	14.06	5.98	1.05	9.39	0.04	1.93	0.62	2.73	0.07
V1145	12.13	5.70	0.86	0.68	0.24	2.24	0.54	1.79	0.03
V1146	12.69	6.36	1.03	3.72	0.10	2.04	0.56	2.29	0.06
V1147	12.12	3.63	0.50	0.65	0.15	1.34	0.72	1.15	0.02
V1148	15.95	9.34	0.83	1.35	0.14	2.10	0.67	1.67	0.07
V1149	12.87	3.52	0.52	1.08	0.14	1.89	0.66	1.40	0.01

Appendix 1b

TSNO	BA	CO	CR	CU	NI	SC	SR	V	ZN	ZR*	LA	CE	ND	SM	EU	DY	YB	PB	LI	Y
V1134	441.00	13.00	77.00	36.00	58.00	12.00	122.00	95.00	254.00	99.00	70.00	144.00	71.72	12.00	2.56	6.30	3.30	32.38	26.00	30.00
V1135	372.00	8.00	120.00	35.00	39.00	17.00	238.00	136.00	258.00	123.00	32.00	51.00	33.65	3.28	1.02	3.80	2.70	26.32	71.00	25.00
V1136	502.00	12.00	72.00	38.00	49.00	12.00	244.00	81.00	499.00	89.00	53.00	104.00	54.90	8.86	1.95	5.40	2.80	30.17	22.00	27.00
V1137	416.00	7.00	63.00	30.00	30.00	10.00	231.00	69.00	126.00	82.00	46.00	93.00	52.17	12.60	3.02	9.50	2.80	47.25	21.00	43.00
V1138	383.00	13.00	58.00	37.00	36.00	10.00	127.00	68.00	256.00	79.00	42.00	92.00	43.80	8.62	1.84	4.60	2.20	53.12	25.00	21.00
V1139	406.00	17.00	77.00	34.00	48.00	13.00	175.00	91.00	256.00	102.00	54.00	111.00	55.84	9.30	1.96	5.40	2.90	29.55	27.00	28.00
V1140	691.00	20.00	102.00	38.00	75.00	15.00	111.00	107.00	172.00	88.00	45.00	78.00	47.47	6.68	1.66	5.50	2.90	36.76	81.00	29.00
V1141	407.00	15.00	77.00	35.00	62.00	12.00	179.00	94.00	224.00	93.00	58.00	110.00	59.41	8.99	1.94	5.20	3.00	36.05	25.00	25.00
V1142	431.00	12.00	63.00	31.00	36.00	11.00	131.00	75.00	215.00	90.00	50.00	101.00	51.70	9.63	1.89	5.00	2.50	37.16	25.00	23.00
V1143	442.00	13.00	78.00	31.00	46.00	12.00	102.00	87.00	184.00	96.00	77.00	162.00	80.65	16.05	3.29	8.80	3.80	39.54	31.00	42.00
V1144	472.00	13.00	79.00	55.00	48.00	13.00	349.00	86.00	320.00	109.00	85.00	179.00	88.64	16.81	3.40	9.30	4.00	31.13	24.00	46.00
V1145	514.00	11.00	73.00	32.00	34.00	11.00	100.00	88.00	174.00	74.00	31.00	52.00	31.96	3.45	0.93	3.00	1.80	59.54	71.00	16.00
V1146	464.00	14.00	72.00	35.00	46.00	12.00	251.00	78.00	305.00	92.00	59.00	111.00	60.82	10.42	2.06	5.70	2.80	41.27	24.00	27.00
V1147	331.00	6.00	76.00	37.00	22.00	11.00	88.00	91.00	111.00	91.00	28.00	45.00	28.76	2.69	0.74	2.60	1.60	35.26	39.00	13.00
V1148	450.00	14.00	110.00	34.00	48.00	15.00	125.00	151.00	151.00	98.00	38.00	73.00	39.76	5.33	1.37	4.30	2.80	38.96	71.00	23.00
V1149	505.00	4.00	76.00	27.00	20.00	10.00	150.00	95.00	116.00	102.00	32.00	51.00	32.15	2.64	0.65	2.20	1.60	33.16	37.00	12.00