Characterisation Studies of Anglo-Scandinavian Pottery Waste from Danesgate, Lincoln

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Excavations in advance of construction of The Collection, in Danesgate, Lincoln, produced evidence for the production of pottery in the 10th century. Wasters of three wares were recovered; LKT, LSLS and SNLS. LKT is a shell-filled ware whereas the remaining two wares are sandy.

The same site had previously, in the 1940s, produced waste from the production of late 9th/early 10th-century wares, LG and LSLS (Coppack 1973).

Further down the hill, at Silver Street, waste and kilns from the production of 10th-century shell-filled ware, LKT, were excavated in 1973 (Young 1989; Miles and Wacher 1989; Woods 1989).

Samples of the Silver Street and 1945-7 Danesgate waste have been sampled for chemical analysis as part of the Northumbrian Kingdom Anglo-Saxon Pottery Project, supported by a grant from English Heritage and samples of the 2003 Danesgate waste were analysed for comparison.

The analysis was intended to address three questions: firstly, were the sandy and shelly clays made from the same parent clay but with different tempering material added and, secondly, is it possible to see any trend in chemical composition between the different groups of waste. Finally, is it possible to distinguish the products of the different productions?

The 2003 Danesgate samples included six samples of shelly ware; five samples of sandy ware of late 10th/11th-century date (SNLS); one sample which might be either of late 10th/11th or 9th/10th-century date (LS/SNLS) and one sample of kiln furniture. The latter was examined to see whether it was made from the same clay as the pottery (Table 1). One of the LKT samples came from a vessel with a splashed lead glaze.

Table 1

TSNO	Context	REFNO	cname	Form	Action	Description
V4016	0458	DR13	SNLS	JAR	TS;ICPS	
V4017	0454		KFURN	KILN PROP	TS;ICPS	
V4018	0072		SNLS	BOWL	ICPS	
V4019	0038		SNLS	JAR	ICPS	
V4020	0821		SNLS	JAR	ICPS	
V4021	1238		SNLS	JAR	ICPS	

V4022	0811		LS/SNLS	JAR	ICPS	
V4023	0794		LKT	JAR	ICPS	
V4024	0454		LKT	JAR	ICPS	
V4025	0794		LKT	JAR	ICPS	
V4026	0794		LKT	JAR	ICPS	
V4027	0454		LKT	JAR	ICPS	
V4028	0454	VESS1	LKT	JAR	TS;ICPS	GLAZE SPOTS

Thin Section Analysis

Samples of the kiln furniture, a sandy sherd and a shell-filled sherd were taken and thin sections produced by Steve Caldwell, University of Manchester. The samples were stained using Dickson's method (Dickson 1965). This staining distinguishes non-ferroan and non-ferroan calcite from each other and from dolomite, each of which is otherwise difficult to differentiate in thin section.

LKT (V4028)

The following inclusion types were noted:

- Bivalve shell. Moderate angular fragments of non-ferroan nacreous bivalve shell up to 1.5mm long and 1.0mm wide. Some of the grains have a coating of fine-grained sparry ferroan calcite and laminae and boreholes filled with a mixture of sparry ferroan calcite and brown clay.
- Clay/iron. An oolitic concretion 1.0mm across consisting of clay of the same colour and texture with roughly concentric layers of darker clay/iron.
- Quartz. Sparse subangular quartz grains up to 0.3mm across and rarer rounded grains up to 0.4mm across.
- Chert. Rare rounded grains up to 0.4mm across.

The groundmass consists of optically anisotropic baked clay minerals, moderate rounded dark brown clay/iron grains and sparse angular quartz up to 0.1mm across. It is a dark grey/brown colour with oxidized margins.

The groundmass is typical of Jurassic marine clays, with a very low quartz content and containing dark brown clay/iron grains which are either concretions precipitated from solution or produced by iron bacteria.

The shell fragments are of oyster-like species as shown by the shell structure and the laminae. The ferroan calcite concretion may indicate that the shells come from a cemented limestone but might be a contemporary coating of biological origin (e.g. serpulid worm casts). The sharp edges indicates that the shell fragments are not detrital and were either crushed and added as temper or the parent clay contained whole fossil shells.

The quartz and chert sand is unlikely to be a natural constituent of the parent clay but neither is it present in sufficient quantities to be interpreted as a deliberate temper. Most likely, it is present as a contaminant from the sand used to temper the sandy ware and kiln furniture.

SNLS (V4016)

The following inclusion types were noted:

- Quartz. Abundant subangular grains up to 0.3mm across and sparse rounded grains up to 0.4mm across.
- Chert. Sparse rounded, highly spherical grains up to 0.8mm across.
- Opaques. Sparse subangular grains up to 1.0mm across.
- Mudstone. Sparse rounded grains of similar colour to the groundmass up to 1.0mm across. Those in the reduced core are darker than the groundmass suggesting that they may have an organic content.
- Limestone. Sparse rounded, heat altered grains up to 0.4mm across.
- Ferruginous sandstone. Sparse subangular fragments up to 0.4mm across containing abundant well-sorted angular quartz c.0.1-0.2mm across in an opaque groundmass.

The groundmass is similar to that of the LKT sample, apart from being reduced with an oxidized external margin.

Kiln Furniture (V4028)

The following inclusion types were noted:

- Quartz. Abundant grains similar in size and character to those in the SNLS sample.
- Mudstone. Moderate angular fragments of laminated mudstone up to 2.0mm across. Some are similar in colour and texture to the groundmass but most have a lighter colour and fewer dark brown inclusions. Some of the fragments contain no dark brown grains at all. One fragment is brown iron-stained at one end of the fragment, indicating the presence of iron-rich veins or staining along joints.
- Chert. Sparse grains similar to those in the SNLS sample.
- Ferruginous sandstone. A single large subangular fragment 5.0mm long. Similar to those seen in the SNLS sample but also containing sparse muscovite laths.

The groundmass is similar to that of the LKT and SNLS samples.

The light-coloured mudstone fragments are probably derived from the lower estuarine beds, the Grantham Formation (Kent 1980, 47-8). This is also the probable source of the ferruginous sandstone. With this exception, the fabric is very similar to that of the SNLS sample.

Chemical Analysis

Offcuts were taken from each sample and the outer surfaces removed mechanically. The resulting block, about 1-2gm, was then crushed to a fine powder and submitted to Royal Holloway College, London, where the powders were analysed using Inductively-Coupled Plasma Spectroscopy under the supervision of Dr J N Walsh.

A range of major elements was measured and the results expressed as percent oxides (App 1) and a range of minor and trace elements were measured and expressed as parts per million (App 2). Silica was not measured but an estimate of silica content was obtained by subtraction of the total measured oxides from 100%.

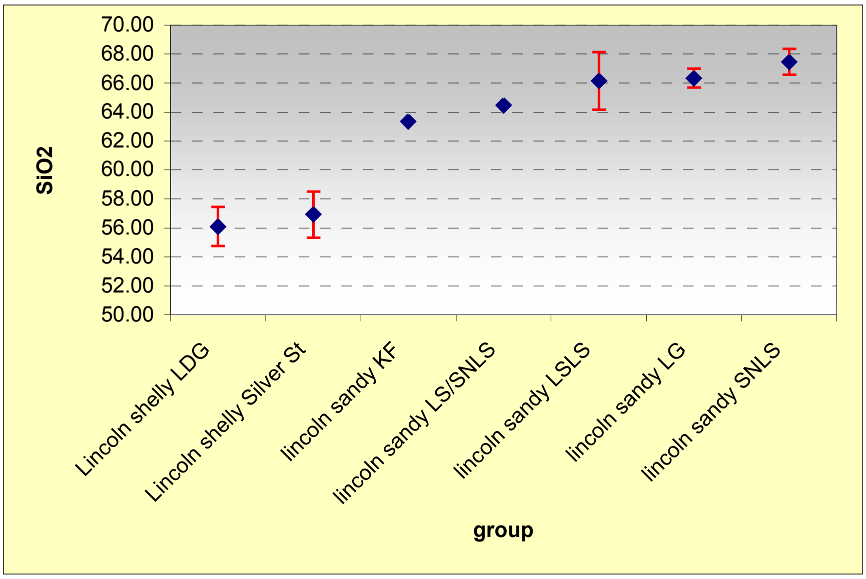

Figure 1

Fig 1 shows the mean estimated silica content for the various groups of wasters. The two shell-filled wares have comparable silica contents which are lower than those of the sandy wares whilst the kiln furniture (KF in Fig 1) has a lower estimated silica content than the sandy wares but a higher content than the shell-filled wares.

Lead was measured and showed enhancement in one of the samples, an SNLS jar which also had a high barium content, suggesting that in this case the lead was naturally present as a detrital lead ore grain rather than through the presence of lead glaze.

The data were normalised to aluminium. This normalised data shows differences between the three groups of samples (LKT, SNLS and Kiln furniture, Table 2). A group of elements are higher in the shelly ware and the kiln furniture, and lower in the sandy ware. These include four rare earth elements, which are normally found in the clay fraction together with sodium and potassium. A second group of elements were higher in the shelly ware, lower in the sandy ware and intermediate in the kiln furniture. A third group of elements was higher in the shelly ware and lower in the sandy ware and kiln furniture. This group includes calcium and strontium, present in the shell, but also manganese, copper, cobalt and lead. A single element, scandium, is highest in the kiln furniture, lowest in the sandy ware and intermediate in the shelly ware. Iron and titanium are higher in the sandy ware and kiln furniture than in the shelly ware. Silica is highest in the sandy ware, lowest in the shelly ware and intermediate in the kiln furniture whilst lithium is the only element to be higher in the sandy ware than in either the shelly ware or the kiln furniture.

Table 2

Element	LKT	SNLS	Kiln Furniture
Sodium	Higher	Lower	Higher
Potassium	Higher	Lower	Higher
Cerium	Higher	Lower	Higher
Samarium	Higher	Lower	Higher
Europium	Higher	Lower	Higher
Dysprosium	Higher	Lower	Higher
Phosphorous	Higher	Lower	Intermediate
Nickel	Higher	Lower	Intermediate
Neodymium	Higher	Lower	Intermediate
Zinc	Higher	Lower	Intermediate
Calcium	Higher	Lower	Lower
Manganese	Higher	Lower	Lower
Copper	Higher	Lower	Lower
Strontium	Higher	Lower	Lower
Cobalt	Higher	Lower	Lower
Lead	Higher	Lower	Lower
Scandium	Intermediate	Lower	Higher
Iron	Lower	Higher	Higher

Titanium	Lower	Higher	Higher
Silica	Lower	Higher	Intermediate
Lithium	Lower	Higher	Lower

In a few instances these differences can be explained as being due to the tempering materials used and the composition of the kiln furniture is based on a single sample. To investigate further, the differences were explored using factor analysis. Calcium, Phosphorous and linked elements were omitted, because of the possibility of leaching and post-burial phosphate concretions within the voids left by the shell.

Three factors were found with eigenvalues greater than 1.0. A plot of F1 against F2 (Fig 2) shows a difference between the shelly and sandy wares but no clear difference between the different chronological and spatial groups within each of these ware groups. The F3 scores show no apparent correlation with either major ware type or chronological/spatial group.

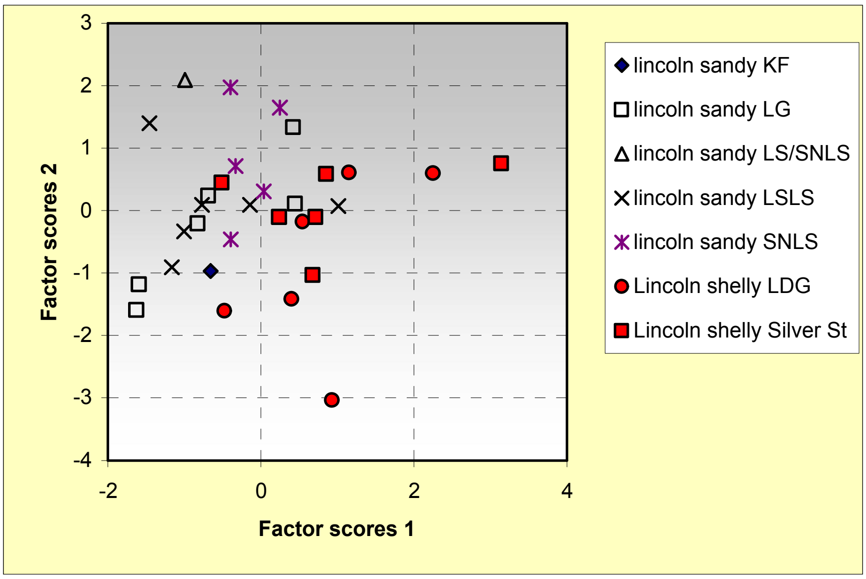

Figure 2

Examination of the data indicates that the shell-filled ware has higher copper, cobalt, manganese, zinc and nickel than the sandy ware, which has more titanium, chromium, lithium, vanadium, and zirconium. The titanium, vanadium and zirconium are presumably present in the quartzose sand in detrital heavy mineral grains. There are slight signs of a correlation of calcium with manganese and zinc content but little sign of a correlation between cobalt and nickel and calcium and these, therefore, are probably present in the clay fraction. A factor analysis was therefore carried out omitting those elements which might be linked with either the shell or quartzose sand. Four factors were found and a plot of F1 against F2 shows no sign of a distinction between the shell and quartzose sand filled wares (Fig 3).

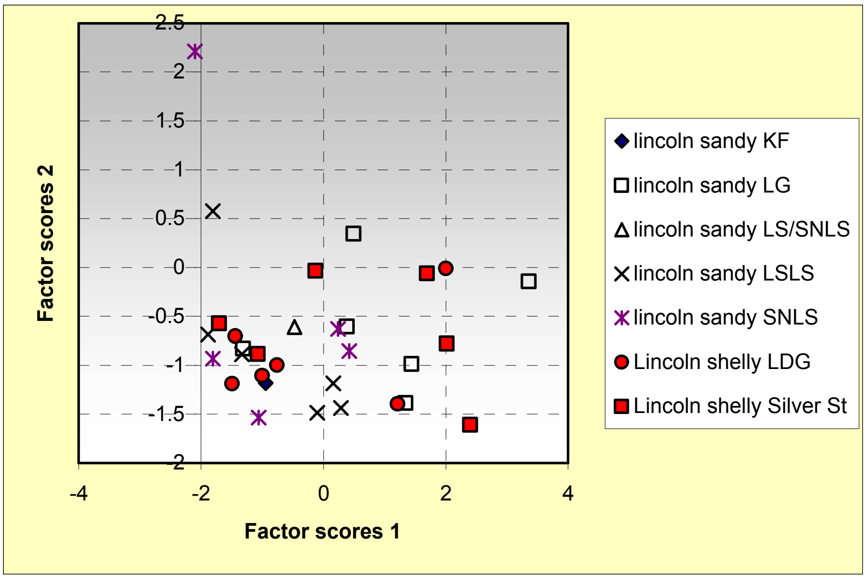

Figure 3

Conclusions

The thin section and chemical analysis of pottery waste from the Danesgate site indicates that the waste falls into two groups, a sand-tempered group and a shell-tempered group and that most of the chemical differences between these two groups can be explained as being due to the differences in temper. There is no difference in composition between the shell-tempered ware from Danesgate and that from Silver Street and this indicates that the same raw materials were used in both places. Finally, there is also no difference between the various sandy ware fabrics (LSLS, LS/SNLS and SNLS) and the gritty ware fabric (LG). All of these groups were therefore also made from the same clay.

The source of the clay is probably the Upper Lias, which in the Lincoln area consists of mudstones and paper shales (Kent 1980, 44) but with mudstone and sandstone from the overlying Grantham formation mixed with the Upper Lias clay in the kiln furniture. The slightly lower silica content of the kiln furniture, compared with the sandy pottery, is probably due to this added mudstone. It is possible that the kiln furniture was made from a head deposit present on the site itself whilst the potting clay appears to have been organic when dug and probably came from a quarry cutting into the weathered, but *in situ* Upper Lias clay.

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Appendix 1

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V4016	18.68	5.37	1.13	2.04	0.24	2.78	0.79	0.29	0.048
V4017	21.17	7.54	1.41	1.12	0.51	3.64	0.89	0.34	0.026
V4018	19.65	6.25	1.35	0.73	0.22	2.8	0.83	0.17	0.024
V4019	22.71	5.17	1.01	0.12	0.35	2.87	0.99	0.08	0.02
V4020	20.34	5.64	1.42	0.74	0.23	2.98	0.88	0.22	0.023
V4021	21.04	6.22	1.3	0.82	0.21	2.83	0.88	0.18	0.018
V4022	23.13	5.52	1.29	1.36	0.17	2.99	0.96	0.11	0.013
V4023	14.33	4.95	0.96	16.84	0.39	2.67	0.52	1.64	0.059
V4024	18.33	6.79	1.14	11.75	0.31	2.67	0.75	1.12	0.041
V4025	18.76	6.16	1.42	14.25	0.63	3.15	0.76	0.61	0.046
V4026	18.13	5.66	1.38	14.09	0.27	2.82	0.75	0.68	0.057
V4027	17	5.7	1.11	15.71	0.21	2.46	0.7	0.4	0.043
V4028	19.19	8.15	1.33	12.52	0.22	2.61	0.8	0.35	0.045

Appendix 2

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V4016	388	137	22	143	45	15	156	104	35	132	39	68	42	7	1	4	3	17	84	13
V4017	367	160	22	140	56	20	110	120	25	103	49	85	51	8	1	5	3	20	105	15
V4018	377	149	29	140	50	18	162	108	25	98	43	71	45	7	1	4	3	16	91	15
V4019	1,063	165	28	262	43	21	99	176	32	133	54	89	54	7	1	4	3	416	67	13
V4020	398	163	34	111	48	19	120	113	18	123	40	62	36	6	1	3	3	18	95	15
V4021	349	104	23	159	53	16	121	115	23	105	41	65	44	6	1	4	3	20	80	14
V4022	363	111	24	187	38	19	134	127	21	107	48	79	47	7	1	4	2	20	66	13
V4023	312	75	33	35	34	13	317	80	19	79	33	55	33	5	1	3	2	25	107	12
V4024	379	106	31	59	31	17	278	100	23	98	41	72	46	7	1	4	2	20	117	13
V4025	334	106	28	79	52	17	291	105	18	101	40	67	41	5	1	3	2	22	120	16
V4026	348	93	29	107	69	17	272	92	34	101	44	80	54	9	2	6	3	20	135	17
V4027	292	84	29	74	43	15	289	94	17	85	36	57	35	5	1	3	2	21	109	13
V4028	318	103	30	128	57	18	295	108	26	103	46	84	49	8	1	5	3	17	101	16