Characterisation of Fired Clay from Melton, East Yorkshire (OSA04 EX03)

Alan Vince

As part of a major study of the pottery and other ceramics used at Melton, East Yorkshire, a series of fired clay samples from the 2004 excavations undertaken by On-Site Archaeology were selected for analysis.

The purpose of selecting these samples was two-fold. Firstly, it was assumed that daub would not be made from non-local clays and that if these clays were characterised they would allow locally-made pottery to be identified. Secondly, it has been suggested by several specialists that prehistoric loom weights might not have been produced domestically but might, like pottery, be the products of specialists.

These aims therefore determined the selection process. Visual examination of the fabric of the fired clay established that there were three fabrics present: Fabric 1 was the most common fabric and had a sandy texture. Fabric 2 was next most common and was poorly mixed, with very little sand present and Fabric 3, which was rare, was a mixture of the two other fabrics, with sandy and sand-free lenses.

The loom weights were of two forms, cylindrical and pyramidal (triangular). Three samples of each type were analysed. All of the cylindrical weights were of fabric 1 whilst the triangular loom weight samples were of fabrics 2 and 3. In addition, one sample of fired clay probably came from a triangular loomweight although was not complete enough for a certain identification. All of the loomweight samples came from Iron Age pits apart from V4079, whose context might be Iron Age or Roman and V4069, which came from a Roman pit fill.

The daub samples, by contrast, all came from possible Roman or later contexts, although three contexts could have been Iron Age or Roman. Furthermore, none of the finds came from pits. Six samples came from a single large group of fragments found in the abandonment debris, 3952, from a late Roman kiln, 4374. All of the fired clay from this deposit was of Fabric 1, as was one other sample, V4080, which also came from a Roman context. Three samples of Fabric 2 daub were present, two from contexts which could be either Iron Age or Roman in date (V4082-3) and one from an early Anglo-Saxon context, V4084.

Table 1

DNo	context group	period code	trench	Context	Description	TSNO	Context	cname	Action
1	2565	IA	8	2564	pit fill	V4067	2564	FAB 2 TRI LOOM	ICPS
2	1528	IA	8	1527	pit fill	V4068	1527	FAB 1 CYL LOOM	ICPS
3	3503	ROM	20	3502	pit fill	V4069	3502	FAB 3 TRI LOOM	TS; ICPS
4	2013	IA	8	1961	pit fill	V4070	1961	FAB 3 TRI LOOM	TS; ICPS
5	1528	IA	8	1527	pit fill	V4071	1527	FAB 1 CYL LOOM	ICPS
6	1528	IA	8	1527	pit fill	V4072	1527	FAB 1 CYL LOOM	TS; ICPS
0	4374	ROM	4	3952	Kiln	V4073	3952	FAB 1 OVEN	TS;ICPS

0	4374	ROM	4	3952	Kiln	V4074	3952	FAB 1 OVEN	TS;ICPS
0	4374	ROM	4	3952	Kiln	V4075	3952	FAB 1 OVEN	ICPS
0	4374	ROM	4	3952	Kiln	V4076	3952	FAB 1 OVEN	ICPS
0	4374	ROM	4	3952	Kiln	V4077	3952	FAB 1 OVEN	ICPS
0	4374	ROM	4	3952	Kiln	V4078	3952	FAB 1 OVEN	ICPS
0	1605	LIA/RB	8	1602		V4079	1602	FAB 2 TRI LOOM	TS;ICPS
0	4036	ROM	4	3887	gully fill	V4080	3887	FAB 1 DAUB	TS;ICPS
0	5257	LIA/RB	5E	5069		V4081	5069	FAB 1 DAUB	ICPS
0	3385	LIA/RB	20	3384		V4082	3384	FAB 2 DAUB	ICPS
0	5253	LIA/RB	5E	5254	hearth fill	V4083	5254	FAB 2 DAUB	ICPS
0	3392	EMSAX	20	3374	ditch fill	V4084	3374	FAB 2 DAUB	ICPS

Petrological Analysis

In total, seven samples were thin-sectioned by Steve Caldwell, University of Manchester, and stained using Dickson's method (Dickson 1965). and study of these confirms the tripartite fabric classification.

Fabric 1

Four samples of Fabric 1 were thin-sectioned. All have a very similar texture although two contain no calcareous inclusions (V4074 and V4080), probably due to burial conditions. The quartz sand was common to all samples but other inclusions consisted of sparse examples, often present as a single fragment in a single section.

The following inclusion types were noted:

- Angular and subangular quartz. Moderate fragments up to 0.4mm across.
- Angular and subangular plagioclase feldspar. Sparse fragments up to 0..4mm across.
- Rounded quartz. Sparse well-rounded grains. The sphericity of some of the fragments suggests a Triassic origin rather than the Red Chalk.
- Muscovite. Sparse laths up to 0.2mm long.
- Flint. Rare rounded fragment in V4074.
- Organics. Moderate fragments in V4073.
- Limestone. Moderate rounded fragments up to 1.0mm across in V4072 and possibly V4073. These include a fragment of dolomitic limestone (i.e. unstained) with sparry infilling of fossil tests, none of which are identifiable and oolitic limestone with a ferroan calcite cement.
- Chalk. Moderate fragments in V4073 and sparse fragments in V4042 and V4080.
- Calcareous sandstone. Rare fragment 0.5mm across in V4042. The cement is ferroan calcite.
- Basic Igneous rock. Rare angular fragments up to 1.0mm across in V4042 and V4080.
- Biotite Sandstone. Rare angular fragment in V4042.
- Red Mudstone. Rare well-rounded pebble, 11mm long and 5mm wide in V4073.

The groundmass consists of optically isotropic baked clay minerals.

Fabric 2

A single sample of Fabric 2 was thin-sectioned. The groundmass is variegated and the quartz inclusions usually occur in laminae separating the different clay lenses. The following inclusion types were noted:

- Clay pellets. Moderate rounded pellets, mainly with opaque staining (?manganese?)
- Opaques. Sparse Angular fragments up to 0.5mm across.
- Angular and subangular quartz. Sparse fragments up to 0.4mm across.
- Rounded quartz. Sparse grains up to 0.5mm across.
- Ferroan Calcite. Sparse to moderate fragments ranging from 0.1mm up to 0.3mm across. None have clear tests but there are hints that they are microfossils.

The groundmass consists of optically anisotropic baked clay minerals with few visible inclusions.

Fabric 3

Two samples of Fabric 3 were thin-sectioned. Both have similar variegated textures but one of the samples is fired dark brown or black and contains charred organic inclusions (V4070) whilst the other is completely oxidized. It is uncertain whether the latter sample also originally contained organic inclusions. Both samples appear to be leached.

The samples appear to be a mixture of Fabrics 1 and 2. The following inclusion types were noted:

- Angular and subangular quartz.
- Rounded quartz.
- Flint.
- Organics (V4070 only)

Interpretation of Petrological data

Fabric 2 has the fine-textured groundmass typical of Jurassic clays in East Yorkshire and Lincolnshire. It is likely that the ferroan calcite inclusions are microfossils and that they were present in the parent clay, as were the black-stained clay pellets. The remaining inclusions are likely to be from contamination from clay of Fabric 1.

In the Melton area the only geological “solid” clay which might match these characteristics is of Upper Jurassic date although this is entirely obscured by boulder clay (except in dry valley sides and modern clay pits). The mostly likely identity of the clay, therefore, would be the upper part of the Oxfordshire stage of the Ancholme Clay Group (1992, 65 and Fig 26). In this case, the ferroan calcite inclusions might be either of biological origin or concretions, since concretionary limestone is noted by Gaunt *et* al within this deposit. However, it is also possible that the clay has been transported during the Ice Age and is a boulder clay. If so, its original identity is quite possibly Lower Jurassic.

Fabric 1, on the other hand, is clearly derived from a Quaternary deposit and includes erratics (the biotite sandstone and the basic igneous rock, as well as more locally-derived rock and mineral fragments (such as the rounded flint and chalk, the limestone and the calcareous sandstone). The angular and subangular quartz sand appears similar to that found in the Kellaways sand, which outcrops to the west of Melton and the most likely source of oolitic limestone is the Cave Oolite, also to the west. This suggests that the deposit is not actually a boulder clay, which in the Humber Gap is thought to be derived from ice flowing west, as shown both by the presence of Scandinavian erratics and the direction of ice flow indicated by the orientation of rocks in the till (1992, 109-127). Presumably, therefore, the deposit is associated with Lake Humber, a glacial lake formed by the blocking of the Humber gap by moraine.

Chemical Analysis

The samples for chemical analysis were prepared by cutting a block from the fired clay and removing all outer surfaces. The resulting block was then crushed to a fine powder and submitted to Royal Holloway College, London, Department of Geology, where Inductively-Coupled Plasma Spectroscopy was carried out under the supervision of Dr J N Walsh.

A range of major elements was measured and presented as percent oxides (App 1) and a range of minor and trace elements was measured and expressed as parts per million (App 2). Silica was not measured but was estimated by subtracting the total measured oxides from 100%. This estimate will include an unknown quantity of organic matter. Table 2 shows the mean and standard deviation of the silica contents by fabric group which confirms that each group is distinguishable by silica content alone.

Table 2

Fabric	N	Mean	Std.Dev.
FAB 2	5	60.61	2.452648609
FAB 3	2	68.01	0.237587878
FAB 1	11	75.02	2.14915017

The data were then normalized to aluminium, to allow the clay groundmass to be compared irrespective of sand content. The resulting data were then analysed using Factor Analysis. Five factors were found. A plot of the first two factors (Fig 1) indicates that the Fabric 2 samples have lower F2 scores than the remainder whilst the F1 scores distinguish the Fabric 1 oven samples from the fabric 1 cylindrical loom weights whilst the Fabric 1 daub samples have higher F2 scores than the remaining Fabric 1 samples. The Fabric 3 triangular loom weight samples have higher F2 scores than the Fabric 2 samples and lower F1 scores than the Fabric 1 samples. Therefore, each of these groups, apart from the Fabric 2 daub and triangular loom weights, is potentially made from chemically distinct clays. However, since all the groups, apart from the oven clay, contain very few samples one would have to sample further fragments to confirm this result.

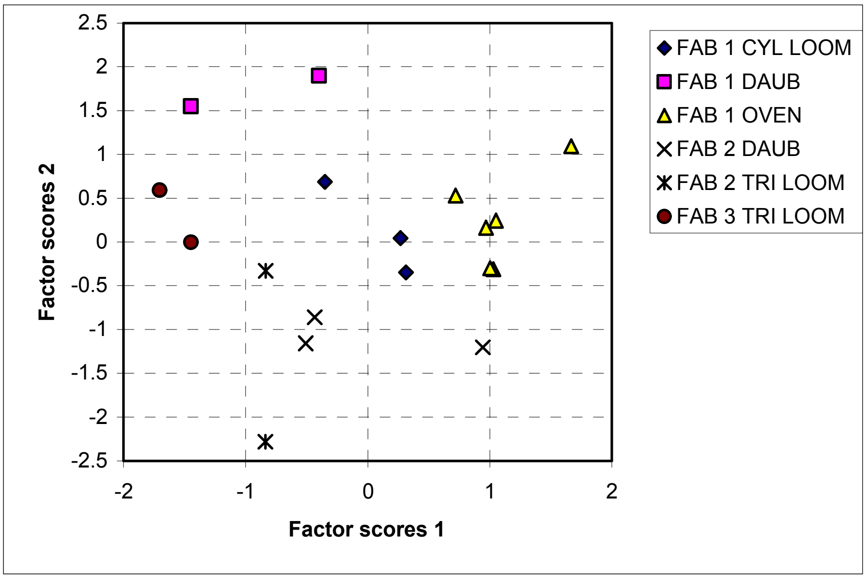

Figure 1

The remaining factors, F3 to F5, do not distinguish the different sample groups.

Factor 2, which distinguishes Fabric 2 from Fabrics 1 and 3, has high weightings for the rare earth elements (REEs) and lesser weightings for sodium and titanium. This means that Fabrics 1 and 3 have higher REE and higher sodium and titanium values. The latter are easily explained, since a small proportion of the quartzose sand will consist of resistate titanium-rich mineral grains and sodium-rich feldspar grains. However, the difference in REE content implies that the clay groundmass itself differs between the two, since REEs mainly bind to clay minerals and phosphates. A plot of phosphorous against cerium shows no correlation between the two and this therefore implies that it is indeed the clay fraction which contains the REEs.

The Melton fired clay data were then compared with fired clay and pottery data from other sites in East Yorkshire and Lincolnshire. The fabric 2 data compare well with samples made from Upper Jurassic in Lincolnshire, in particular with samples of daub of Iron Age date from Partney, made from Kellaways Sand (Vince 2006, DAUB2) and samples of a Dales-type shelly ware produced at an unknown source in the southern Lincolnshire Wolds (Vince 2006, DWSH GSQ). The Fabric 1 data were compared with samples of fired clay, and ceramic building material from Beverley, Wawne, Barton-upon-Humber and Grimsby. Factor analysis of this data shows that the Melton Fabric 1 fired clay is indistinguishable in chemical composition from the Barton-upon-Humber and Grimsby clays and from a samples of fired clay from Wawne. The medieval roof tiles produced at Beverley (kiln waste and Wawne fabrics 2 and 4) form a distinct group whilst the Melton 2 and 3 samples have scores which overlap with those of a group of medieval tiles from Wawne which do not match the sampled Beverley products (Wawne Fabrics 3, 5 and 6).

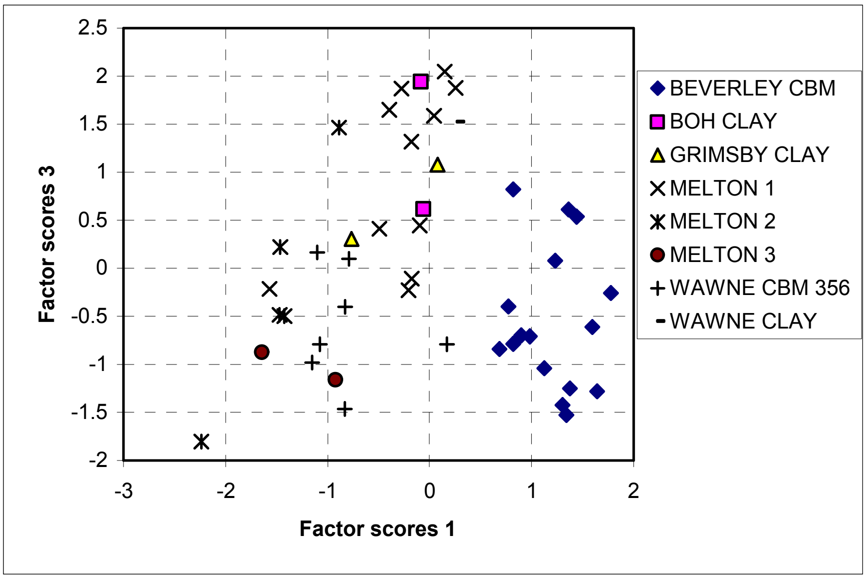

Figure 2

Conclusions

The thin section and chemical analysis indicates that the fired clay used at Melton could indeed be of local origin. It is probable that two clay sources were utilised, an Upper Jurassic weathered, slightly calcareous mudstone (Fabrics 2 and 3) and a Quaternary deposit, probably associated with Lake Humber. The similarity of Fabric 1 to samples of clay from Wawne, just south of Beverley, and to sites south of the Humber and north and east of the Wolds suggests that those deposits too are related to a Humber terrace rather than to ice moving north to south along the east coast whilst the dissimilarity of Fabric 1 to Beverley products indicates a different origin for the Beverley clay, all of which must be of Quaternary origin. The similarity of three of the Wawne ceramic building material fabrics to Fabrics 2 and 3 may indicate that those Wawne tiles were made from Upper Jurassic mudstone. However, if so then this may imply that some of the boulder clay in the Beverley area is redeposited Upper Jurassic clay or, less likely, it may imply that this group of Wawne tiles were not produced at the Beverley tilery, even though that tilery was located less than 3 miles from the site.

The chemical differences between the various groups of fired clay indicate that there are variations in composition in the local clays and that a different outcrop was exploited for each group. Unfortunately, there is a strong correlation between trench and the date of the samples and so it is difficult to be certain from this data whether the there was one source of clay used at any one time but that the sources changed through time or whether the clay exploited in any one area was that exposed on site by ditch and pit digging. However, if intensely local clays were being used then the lack of fabrics 2 and 3 from Trench 4 and the lack of Fabric 1 from Trench 20 should correlate with the underlying geology and its exposure during the prehistoric and Roman periods.

Appendix 1

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V4067	16.93	7.08	1.45	10.77	0.35	2.24	0.71	0.75	0.16
V4068	10.81	4.53	1	8.18	0.53	1.75	0.5	0.32	0.048
V4069	18.28	6.91	1.56	1.02	0.39	2.52	0.76	0.25	0.129
V4070	17.48	7.36	1.47	1.2	0.47	2.49	0.8	0.72	0.165
V4071	8.72	3.86	0.8	8.97	0.41	1.37	0.41	0.32	0.044
V4072	10.54	4.32	0.97	9.43	0.5	1.74	0.5	0.34	0.047
V4073	7.71	3.07	0.63	10.35	0.44	1.37	0.38	0.63	0.066
V4074	9.5	3.71	0.7	4.7	0.54	1.59	0.46	0.44	0.061
V4075	9.5	3.95	0.75	5.3	0.52	1.59	0.46	0.67	0.068
V4076	10.57	4.37	0.78	3.38	0.54	1.69	0.52	0.25	0.056
V4077	9.6	3.78	0.84	8.25	0.51	1.61	0.44	0.36	0.057
V4078	10.03	4.04	0.86	8.3	0.55	1.63	0.46	0.37	0.059
V4079	19.2	9.84	1.15	6.56	0.11	2.68	0.78	1.31	0.134
V4080	11.2	4.86	0.99	4.25	0.48	1.92	0.5	0.27	0.08
V4081	13.97	5.8	0.82	1.86	0.43	1.88	0.62	0.82	0.065
V4082	19.61	7.15	1.48	2.75	0.44	2.86	0.84	0.54	0.106
V4083	17.52	6.55	1.42	8.54	0.34	2.52	0.74	0.33	0.073
V4084	17.01	5.81	1.51	11.18	0.51	3.35	0.71	0.59	0.276

Appendix 2

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V4067	685	108	38	95	66	16	237	119	25	63	44	79	42	10	2	4	3	16	101	23
V4068	380	71	21	53	36	10	188	72	19	45	33	60	30	6	1	3	2	16	59	11
V4069	470	112	31	90	58	17	113	138	28	86	49	95	47	10	2	5	3	18	82	22
V4070	519	119	26	82	59	16	136	129	25	46	50	96	49	12	2	5	2	20	91	20
V4071	329	57	17	41	28	8	185	58	15	37	25	44	23	5	1	2	2	10	49	9
V4072	389	68	21	53	34	9	208	67	18	43	31	59	29	7	1	3	2	12	57	10
V4073	335	50	19	33	24	6	229	47	16	42	25	43	26	5	1	3	2	16	54	8
V4074	482	55	18	40	29	8	160	51	16	45	28	48	29	5	1	3	2	16	63	10
V4075	483	57	17	38	29	8	174	57	17	43	29	52	30	6	1	3	2	13	60	10
V4076	355	57	19	38	28	8	221	65	18	63	30	54	31	5	1	3	2	15	54	10
V4077	447	54	18	39	32	8	215	59	17	49	28	48	29	5	1	3	2	15	55	11
V4078	468	55	19	42	31	9	208	62	17	51	29	50	30	5	1	3	2	17	61	10
V4079	589	129	28	59	93	17	144	171	25	69	44	72	46	7	2	5	3	21	134	26
V4080	388	68	22	39	37	10	132	77	23	62	39	61	40	7	1	4	2	16	70	12
V4081	477	96	28	42	43	13	133	102	26	52	44	74	45	9	2	4	2	25	80	16

V4082	676	115	25	80	60	17	162	133	28	72	50	87	52	9	2	5	3	30	95	21
V4083	459	106	27	72	53	16	228	125	23	57	47	79	48	8	2	4	3	24	91	18
V4084	819	97	28	82	54	14	243	115	23	68	43	78	45	8	2	5	3	19	87	21

Bibliography

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

Gaunt, G. D., Fletcher, T. P., and Wood, C. J. (1992) *Geology of the Country around Kingston-upon-Hull and Brigg*,