Petrological Analysis of Medieval Ceramic Building Material from Beaudesert, Henley in Arden, Warwickshire (Site BEAU01)

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In an assessment of the medieval ceramic building material from Beaudesert Castle, Henley in Arden it was recommended that scientific characterisation of the seven identified tile fabrics, MTILE1 to MTILE7 be carried out ({Vince 2002 #44573}). Accordingly, polished thin-sections and chemical analysis were undertaken (Table 1). The thin-sections were added to the AVAC thin-section collection under the codes V1282 to V1288. The chemical data is presented in Appendix One.

TSNO	Context	cname	Action
V1282	701	MTILE6	FTS;ICPS;PTS
V1283	301	MTILE2	FTS;ICPS;PTS
V1284	802	MTILE5	FTS;ICPS;PTS
V1285	503	MTILE7	DR;FTS;ICPS;PTS
V1286	304	MTILE3	FTS;ICPS;PTS
V1287	moat slope	MTILE4	FTS;ICPS;PTS
V1288	307	MTILE1	FTS;ICPS;PTS

The Petrology

MTILE1

In the hand specimen the fabric is almost invariably oxidised, although a few examples are found with a blue-grey core. The texture by eye is fairly homogenous but under x20 magnification lenses of untempered clay can be seen suggesting that the clay was mixed with sand before use.

The sand temper is mainly a well-sorted subangular quartzose sand, in which the grains are often coated with haematite. Thin lenses of haematite in the body are probably also derived from this sand, as is the sanding on the tile's underside and sides. The thin dusting of sand on the upper surface of the tiles is finer in texture, supporting the proposal made below that this is evidence for production in a dusty atmosphere. Rare rounded quartzite pebbles are present. These range up to 10mm across and sometimes erupt through the tile surface.

The haematite-coasted quartzose sand is visually similar to Triassic sandstones which outcrop in Warwickshire (and elsewhere in midland England) whilst the well-rounded quartzite pebbles are likely to be derived ultimately from the Sherwood Sandstone. These features support a local origin for the fabric but do not suggest that petrology can be used to pinpoint the source.

In thin-section (V1288), the fabric is seen to contain abundant well-sorted subangular and rounded silicious grains up to 0.3mm across, some of which have an opaque coating. Most of these grains are

quartz, but chert/altered lava and altered feldspar is present. There are also sparse angular siltstone or fine sandstone fragments up to 5.0mm across. The groundmass is variegated and contains moderate angular quartz up to 0.1mm across and sparse muscovite up to 0.1mm long.

MTILE2

In the hand specimen the fabric, which ranges in colour from pink to cream, is invariably oxidised. It contains abundant quartzose sand, with grains ranging up to 1.0mm across. The grains include white and red sandstone fragments as well as quartz.

In thin-section (V1283) the sample is seen to contain abundant rounded quartz grains, some of which are polycrystalline, up to 1.0mm across, sparse sandstone fragments, with iron-rich cement, up to 1.5mm across, sparse rounded chert fragments up to 1.5mm across and sparse rounded off-white clay pellets up to 0.5mm across. The groundmass consists of laminated, variegated anisotropic baked clay containing moderate angular quartz graoins up to 0.2mm across.

This fabric is an example of a Coal Measures Whiteware, the nearest sources for which would be the Nuneaton area (Chilvers Coton) and south Staffordshire.

MTILE3

In the hand specimen the tiles are all oxidised and differ from MTILE1 in fabric only in the character of the groundmass, which is variegated, with streaks of cream and pink-coloured clay. Some lenses contain noticeable quantities of muscovite but in the main the clay matrix is fine-textured. The range of colours, and the fact that the margins and surfaces are lighter/creamer in colour than the pinker cores, suggests that the clay may have been calcareous. The quartzose sand temper is identical to that of MTILE1.

In thin-section (V1286), the fabric contains abundant rounded quartz up to 0.5mm across and sparse heat-altered calcareous inclusions up to 1.0mm across. The groundmass is variegated and contains lenses of calcareous clay and some euhedral voids up to 0.2mm across which suggest that dolomite was originally present in the clay.

It is likely that MTILE3 was made using a Triassic clay, such as the Mercian Mudstone. However, unworked relict clay pellets, which are common in wares made from clays developed on the mudstone, are absent. MTILE3 probably represents the occasional use of this lighter clay source at the same tilery responsible for MTILE1.

MTILE4

In the hand speciment, the fabric appears to be lower-fired than MTILE1 and usually has a grey core with brown margins and surfaces. The fabric is tempered with a quartzose sand which includes rounded iron-rich nodules up to 2.0mm across and similar sized white sandstone fragments (with grains

c.0.2mm across). The majority of the grains are subangular quartz up to 1.0mm. In comparison with MTILE1 the sand is coarser in texture.

In thin-section (V1287) the fabric contains abundant rounded quartz up to 0.5mm across, sparse rounded siltstone/fine sandstone inclusions (similar to those in MTILE1) up to 3.0mm across, sparse rounded chert up to 0.5mm across and an isotropic groundmass with a grey core and oxidized margins containing moderate angular quartz up to 0.2mm across and sparce muscovite up to 0.2mm long.

MTILE5

In the hand specimen, the fabric had a grey core and light brown margins. The fabric is tempered with moderate quantities of quartzose sand, consisting mainly of subangular , often haematite-coated quartz grains up to 1.0mm across. Sparse larger fragments of rounded quartzite and sandstone occur, ranging up to 4.0mm. Angular voids suggest that calcareous inclusions have been leached out.

In thin-section (V1284), the sample contains abundant rounded quartz grains including polycrystalline examples, up to 0.5mm across, sparse rounded sandstone fragments up to 1.0mm across in which the grains range up to 0.3mm across, moderate altered dolomite and voids of similar size and shape up to 0.4mm across and sparse fine sandstone/siltstone up to 0.5mm across.

The presence of dolomite suggests that MTILE5 and MTILE3 share the same parent clay.

MTILE6

In the hand specimen, the fabric is tempered with abundant quartzose sand with grains up to 1.0mm across. The high firing temperature obscures further details of the sand. A single fragment of white sandstone up to 2.0mm across was noted. Sparse heat-altered calcareous inclusions were also present.

It is not clear visually whether MTILE6 is actually a separate fabric or an overfired version of MTILE4 or MTILE1.

In thin-section (V1282), the fabric contains abundant rounded quartz, including polycrystalline grains, up to 1.0mm across, sparse rounded chert and sandstone fragments, all up to 1.0mm across, in a vitrified matrix of isotropic baked clay minerals.

MTILE7

In the hand specimen, the fabric has a grey or dark brown core and light brown surfaces. The fabric is tempered with an illsorted quartzose sand composed of subangular quartz grains up to 1.0mm across, and rounded iron-rich inclusions and rounded white and red fine-grained sandstone fragments up to 2.0mm across. A single much larger sandstone fragment, 10mm across, was also recorded. The groundmass is fine-textured and contains moderate quantities of muscovite.

In thin-section (V1285) the fabric contains rounded quartz, including polycrystalline grains, up to 1.0mm across, sparse rounded chert fragments up to 0.5mm across, sparse sandstone fragments, moderate inclusionless clay or shale pellets, some of which are black and others light brown in colour, up to 1.0mm across, sparse rounded fine sandstone or siltstone up to 1.0mm across and a single large angular sandstone fragment over 5.0mm across. The groundmass is variegated and consists of lenses of light-coloured, inclusionless clay similar to that in the clay pellets mixed with a slightly darker version containing moderate angular quartz up to 0.2mm across.

Discussion of the petrological results

The analysis of the thin-sections confirms some of the conclusions reached through visual examination, refutes some of the visual conclusions and provides some information not available by eye.

There are four types of groundmass present and these can be divided into two groups.

- Red-firing, slightly silty clays
    - With dolomite: MTILE3 and MTILE5
    - Without dolomite: MTILE1, MTILE4, MTILE6 (in some cases the sample is vitrified and it may be that some of these also contained dolomite)
- Clays containing relict clay/shale pellets
    - Light firing: MTILE2
    - Red firing: MTILE7

The tempering is less easy to classify, since the inclusions are often so large in relation to the size of the thin-section that the presence or absence of an inclusion type may be fortuitious. The presence of clay or shale relicts in MTILE2 and MTILE7 is typical of Coal Measure clays and these ought to be treated as part of the groundmass rather than deliberately added inclusions. The black shale fragments in MTILE7 are probably low-grade coals or organic shales but the firing of the tiles has made it impossible to confirm this and it is possible that they were, instead, iron-rich shales.

The remaining inclusions can be divided into a detrital quartzose fraction, which includes quartz, polycrystalline quartz, chert and fine-grained sandstone, and a coarse gravel or pebble fraction which includes the fine sandstones/siltstones of MTILE1 and the angular sandstone fragment in MTILE7.

Rounded grains of the fine-grained sandstone found in MTILE1 occur in MTILE4, MTILE5 and MTILE7, thus linking together the Coal Measure and Triassic clay groups and with the exception of the finer texture of MTILE1 there appears to be little difference in the character of the detrital sand in the various fabrics.

Chemical analysis

Sub-samples of each of the seven fabrics were analysed using Inductively Coupled Plasma Spectroscopy (Appendix One). This technique measures the quantity of some major, minor and trace elements and was used here to test the grouping of fabrics based on their clay groundmass proposed above. The data were analysed using Principal Components Analysis which presents the similarity of samples to each other as points on a graph in which the axes are Principal Components, a set of weightings assigned to the various measured elements. Six components were calculated although it is usual to find that the first two or three account for most of the variation in the dataset and in this instance only the first two were analysed (Figures 1 and 2).

A plot of PC1 against PC2 (Figure 2) showed that the seven samples fell into three groups:

Group A: MTILE1, MTILE4, MTILE6 and MTILE7

Group B: MTILE3 and MTILE5

Group C: MTILE2

The elements which distinguish Group B are all associated with dolomite: Sr, CaO, MgO and Ba (Figure 1).

Those which distinguish Group C include Al2O3 and several Rare Earth Elements. These probably indicate that MTILE2 has a lower quantity of temper than the remaining fabrics. In addition, however, Zr and TiO distinguish this group. These normally occur in the sand fraction, as grains of Zircon and Rutile, for example. They indicate that the sand in MTILE2 is probably chemically different from that in the remaining samples.

Both Pb and Cu are extremely high in the MTILE7, indicating contamination of the sample by a lead glaze in which copper was deliberately added as a colourant.

Conclusions

The chemical analysis casts doubt on the identification of MTILE7 as a Coal Measure clay, since chemically it is clearly part of Group A, which consists of the non-dolomitic, probably Triassic clays. With that exception, both analytical techniques indicate that the fabrics are divisible into three groups: a Coal Measure whiteware (MTILE2), calcareous clays with dolomite inclusions (MTILE3 and MTILE5) and red-firing, slightly silty clays.

Acknowledgements

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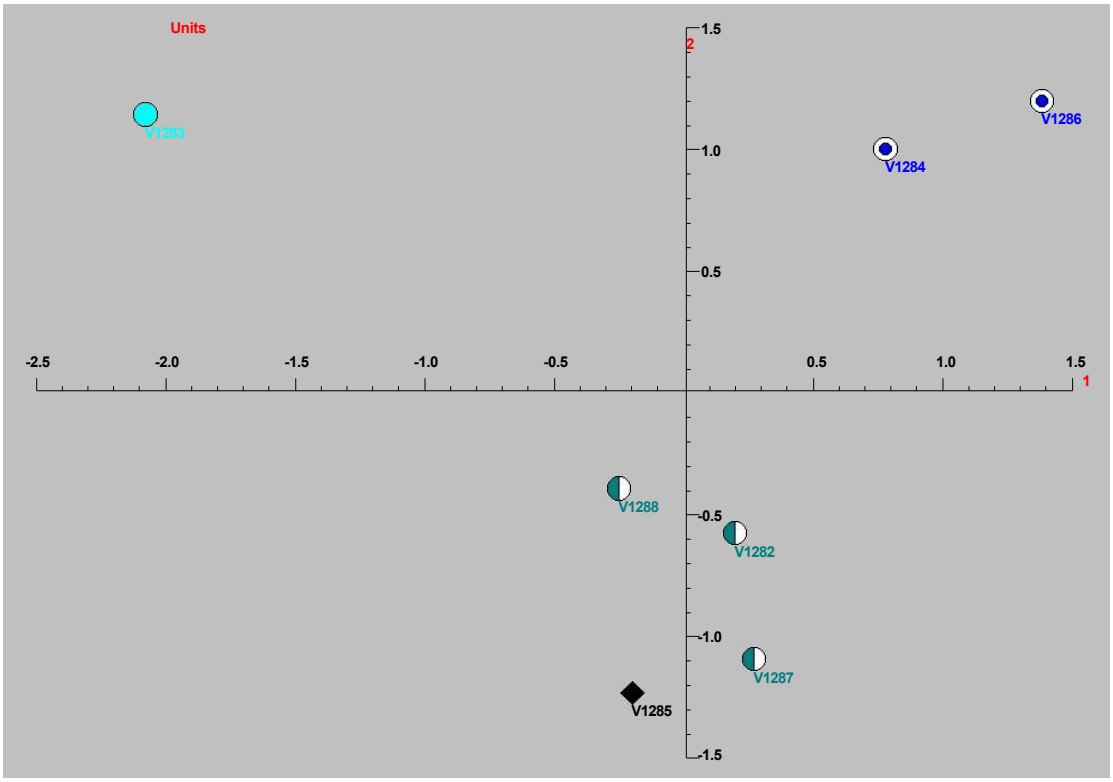

Figure 1

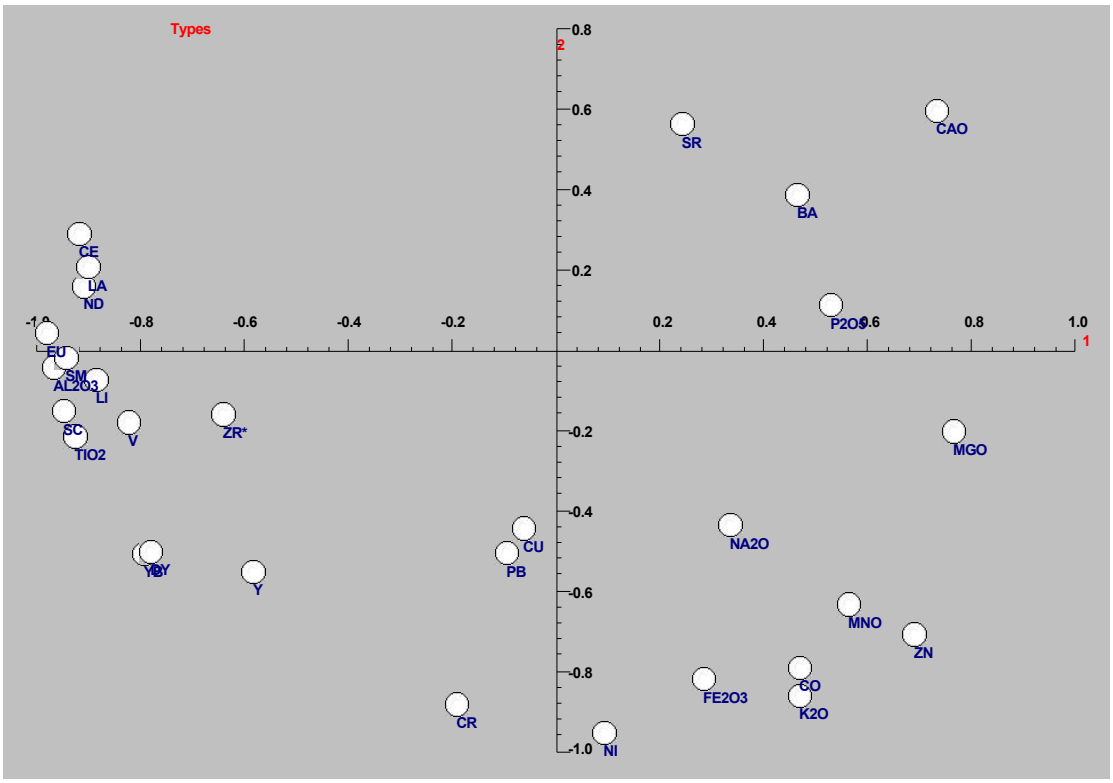

Figure 2

Appendix One

Major elements measured as Percentage Oxides

TSNO	AL2O3	FE2O3	MGO	CAO	NA2O	K2O	TIO2	P2O5	MNO
V1283	19.64	3.61	0.50	0.15	0.18	1.76	0.76	0.06	0.02
V1282	13.96	6.00	4.63	0.78	0.38	4.18	0.62	0.10	0.07
V1288	15.31	6.33	4.29	0.51	0.49	4.39	0.69	0.10	0.07
V1284	12.23	5.09	2.29	3.28	0.39	3.20	0.53	0.06	0.08
V1286	11.32	4.19	8.19	2.89	0.27	3.25	0.49	0.17	0.08
V1287	15.24	6.51	4.82	0.35	0.28	4.74	0.64	0.06	0.09
V1285	14.21	5.38	4.79	0.74	0.38	4.26	0.61	0.11	0.13

Minor and trace elements measured as parts per million

TSNO	BA	CO	CR	CU	LI	NI	SC	SR	V	Y	ZN	ZR*	LA	CE	ND	SM	EU	DY	YB	PB
V1283	391.00	8.00	87.00	38.00	189.00	34.00	22.00	79.00	129.00	19.00	44.00	63.00	43.00	84.00	44.27	7.70	1.61	4.10	2.00	112.46
V1282	550.00	19.00	109.00	18.00	119.00	68.00	15.00	55.00	106.00	18.00	84.00	61.00	30.00	59.00	31.49	5.20	1.12	3.50	1.90	78.64
V1288	461.00	15.00	94.00	20.00	97.00	52.00	14.00	60.00	84.00	19.00	84.00	65.00	37.00	70.00	38.54	6.14	1.19	4.00	1.80	86.19
V1284	727.00	15.00	79.00	25.00	69.00	38.00	11.00	228.00	96.00	17.00	71.00	60.00	29.00	61.00	30.36	3.86	0.99	3.30	1.60	104.27
V1286	470.00	12.00	69.00	63.00	80.00	35.00	9.00	72.00	53.00	15.00	83.00	38.00	30.00	55.00	31.21	3.51	0.96	3.20	1.20	69.38
V1287	379.00	20.00	122.00	18.00	131.00	80.00	16.00	43.00	94.00	17.00	90.00	49.00	29.00	55.00	30.83	3.95	1.08	3.80	1.80	54.16
V1285	401.00	16.00	102.00	434.00	116.00	66.00	15.00	52.00	107.00	22.00	90.00	57.00	34.00	64.00	35.91	5.71	1.27	4.20	1.90	2964.19