Characterisation of Late Medieval Reduced Ware from Heath and Reach and Grove Priory

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In a series of studies carried out since 2003, the Late Medieval Reduced wares of the Southeast Midlands have been characterised using a combination of thin section and chemical analysis (Vince 2003; Vince 2005a; Vince 2005b). A further production site has recently been discovered at Heath and Reach and samples from this site, clay from a series of deposits in the vicinity and a series of samples of Late Medieval Reduced Ware from a consumer site at Grove Priory have been taken with the aim of determining: a) whether the Heath and Reach fabric can be distinguished from other similar wares in Bedfordshire and surrounding counties, b) whether the sampled clays could have been used in its production, c) whether the Grove Priory samples could have been produced at either this site or other previously sampled production sites.

Thirteen samples were taken in total (Table 1). Each was thin-sectioned and a chemical composition analysis obtained, using Inductively-Coupled Plasma Spectroscopy.

TSNO	Sitecode	Context	cname	TSNO	subfabric	Form	Action	Description
V5020	HLR	103	LMRW	V5020			TS;ICPS	
V5021	HLR	104	LMRW	V5021			TS;ICPS	
V5063	HLR	103	LMRW	V5063		JAR	TS;ICPS	WT
V5064	HLR	103	LMRW	V5064			TS;ICPS	
V5065	grove	18/2	LMRW	V5065		-	TS;ICPS	WT
V5066	grove	13/105	LMRW	V5066		-	TS;ICPS	WT
V5067	grove	13/73	LMRW	V5067		JAR	TS;ICPS	WT
V5068	grove	7/714	LMRW	V5068		BOWL	TS;ICPS	WT
V5069	hrkw1	TILL	CLAY	V5069		SAMPLE	TS;ICPS	BRIQUETTE FIRED AT 1000 C BY A MACDONALD
V5070	hrkw2	TILL	CLAY	V5070		SAMPLE	TS;ICPS	BRIQUETTE FIRED AT 1000 C BY A MACDONALD
V5071	scp	TILL	CLAY	V5071		SAMPLE	TS;ICPS	BRIQUETTE FIRED AT 1000 C BY A MACDONALD
V5072	hrew1	TILL	CLAY	V5072		SAMPLE	TS;ICPS	BRIQUETTE FIRED AT 1000 C BY A MACDONALD
V5073	hrew2	TILL	CLAY	V5073		SAMPLE	TS;ICPS	BRIQUETTE FIRED AT 1000 C BY A MACDONALD

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http://www.postex.demon.co.uk/index.html
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http://www.avac.uklinux.net/potcat/pdfs/avac2008074.pdf

Thin Section Analysis

Each sample was thin-sectioned by Steve Caldwell, University of Manchester, and stained using Dickson's method (Dickson 1965). This staining distinguishes ferroan (blue stain) and non-ferroan (pink stain) calcite and distinguishes calcite from dolomite (unstained). A photomicrograph of each section, taken in reflected light is included here (each image is the same scale, with the horizontal width of view approx 3.4 mm, Figs 1 to 19).

Heath and Reach Kiln

Four samples of wasters from the Heath and Reach kiln were thin sectioned. They each have a similar range of inclusions but differ, unsurprisingly, in their firing conditions, giving the samples rather different appearances in thin section. Furthermore, one of the four has a finer texture than the remainder (Fig 2, V5021).

The following inclusion types were noted in thin section:

- Quartz. Moderate subangular grains up to 0.4mm across. Sparse well-rounded grains of Lower Cretaceous character up to 0.5mm across.
- Chert. Sparse rounded grains up to 1.0mm across.
- Voids. Sparse subrounded voids up to 0.5mm across containing altered calcareous material (re-crystallised microcrystalline non-ferroan calcite).
- Opaques. Sparse well-rounded grains up to 0.3mm across.
- Clay pellets. Rare rounded dark brown grains with a similar texture to the groundmass.
- Altered glauconite. Only recognisable in the two oxidized, less high-fired samples (V5063-4). Sparse subrounded grains up to 0.3mm across.

The groundmass consists in two cases of brown optically anisotropic baked clay minerals and in two cases of optically isotropic dark grey baked clay minerals. All four contain sparse angular quartz up to 0.1mm across, sparse sub-rounded altered glauconite grains up to 0.1mm across and rare muscovite laths up to 0.1mm long.

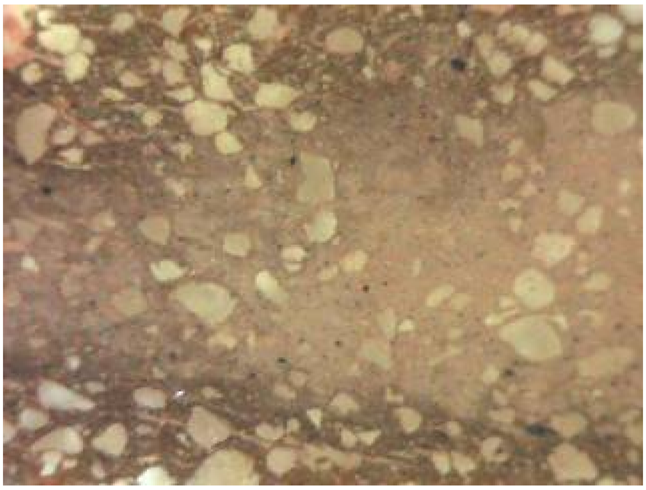

Figure 1 V5020

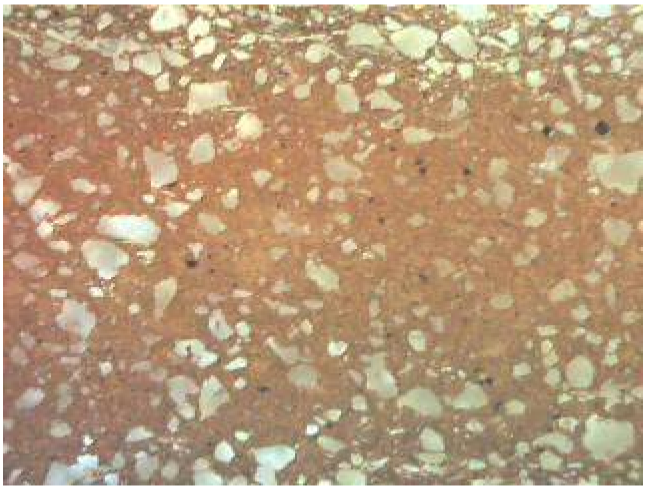

Figure 2 V5021

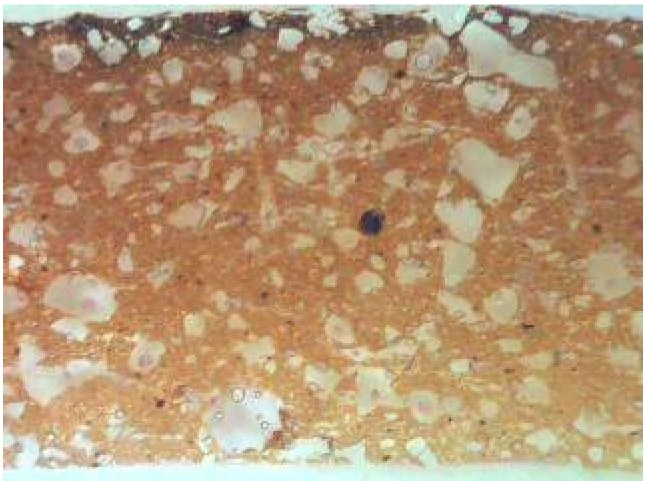

Figure 3 V5063

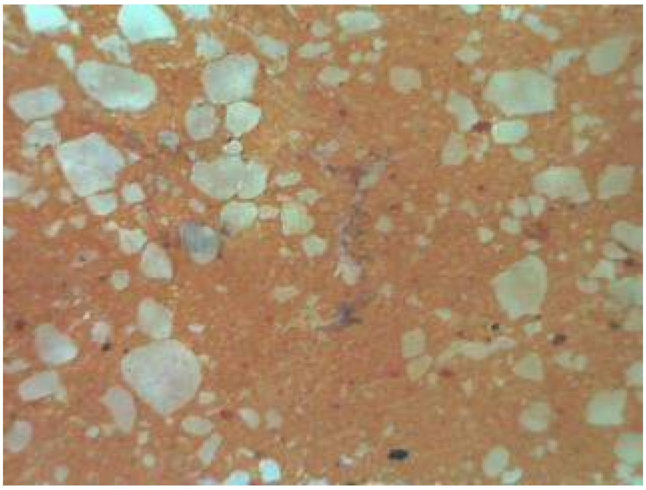

Figure 4 V5064

Clay Samples

The five clay samples were each worked up into a briquette and fired at 1000 degrees C by Andrew Macdonald. All have different appearances, textures and working properties. However, in thin section they can be grouped into three fabrics: Fabric 1 contains flint and chalk; Fabric 2 has a mixed quartzose sand and a variegated groundmass and Fabric 3 contains abundant fine quartz sand.

Sample 5 disintegrated after firing due to the alteration of the large calcareous inclusions to calcium hydroxide and sample 3 was extremely friable but by far the finest textured of the clays). Fabric 1, therefore, could not have been used to produce high-fired oxidized ceramics. Fabric 3, on the other hand, was so friable when worked into a briquette that it would have disintegrated under slight pressure and this too would have made it unsuitable as a potting clay. Fabric 2 is the only one which could have been used as a potting clay, but it differs in several details from the Heath and Reach fabric.

Therefore, none of these five clays could have been the source of the Heath and Reach potting clay and only one could have been used for the production of high-fired ceramics of the Late Medieval Reduced ware type.

Fabric 1 (Samples 2, 4 and 5)

The following inclusion types were noted in thin section:

- Quartz. Sparse subangular grains up to 1.0mm across. Some of these have one or more straight faces and are therefore probably overgrown. Sparse well-rounded grains of Lower Cretaceous character up to 1.0mm across. Sparse well-rounded grains (including cracked well-rounded grains) of Triassic character up to 0.5mm across. Abundant subangular grains up to 0.2mm across.
- Chalk. Sparse rounded fragments of non-ferroan micrite up to 1.5mm across.

- Flint. Moderate angular fragments of unstained flint up to 1.5mm across.
- Clay pellets. Sparse rounded dark brown clay pellets up to 0.5mm across. Some have an opaque coating c.0.1mm thick.
- Opaques. Sparse rounded grains, mainly up to 0.3mm across but including one 5.0mm across.

The groundmass is similar to that of Sample 1 with lenses and laminae of light grey isotropic clay interspersed with brown anisotropic clay.

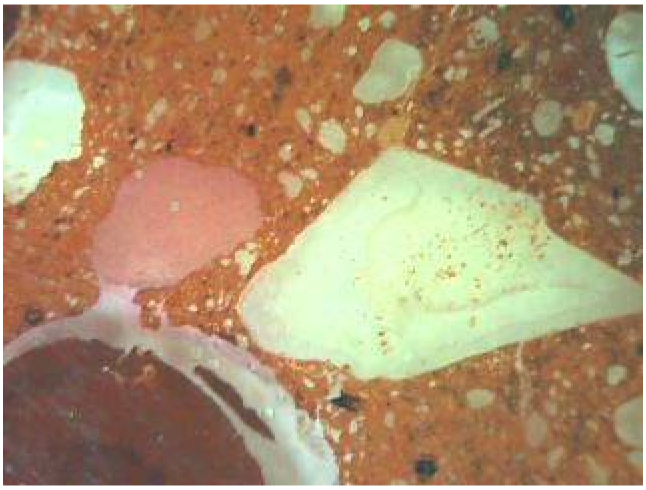

Figure 5 V5069

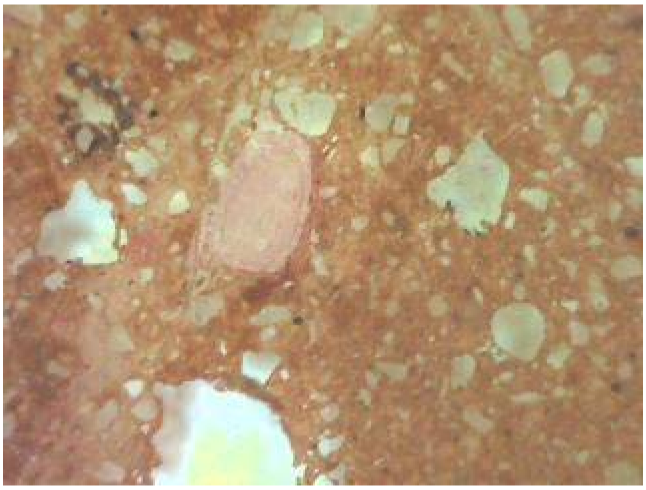

Figure 6 V5072

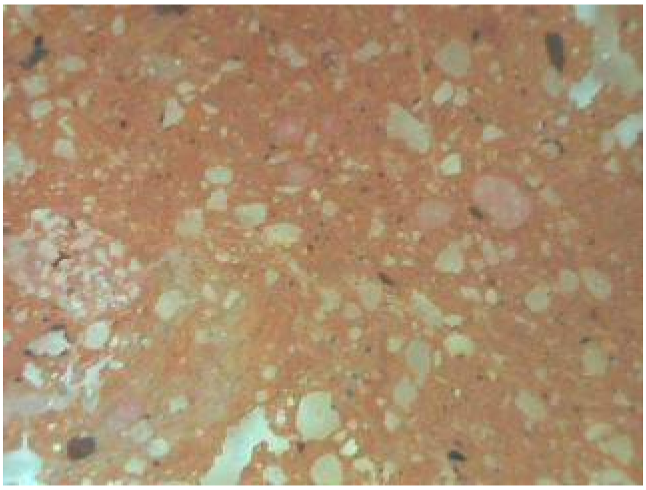

Figure 7 V5073

Fabric 2 (Sample 1)

The following inclusions were noted in thin section:

- Quartz. Rare well-rounded grains of Lower Cretaceous appearance up to 0.5mm across and moderate well-rounded grains of Triassic appearance up to 0.5mm across. The latter includes some polycrystalline strained grains of metamorphic origin. Moderate subangular quartz up to 0.3mm across.
- Chert. Sparse well-rounded grains up to 1.5mm across.
- Microcline. Rare subangular grains up to 0.3mm across.
- Altered glauconite. Sparse rounded grains up to 0.3mm across. Most almost opaque.
- Opaques. Sparse rounded fragments up to 1.0mm across

The groundmass is variegated and consists of lenses of light grey, optically isotropic clay and very dark red clay almost opaque in plane polarised light, mixed with brown optically isotropic baked clay with moderate angular quartz up to 0.1mm across and sparse muscovite laths up to 0.1mm long.

The isotropic, light-coloured clay was probably highly calcareous. Similar calcareous lenses were noted in samples of fired clay from Linslade and presumably originated in a Jurassic clay outcropping further north.

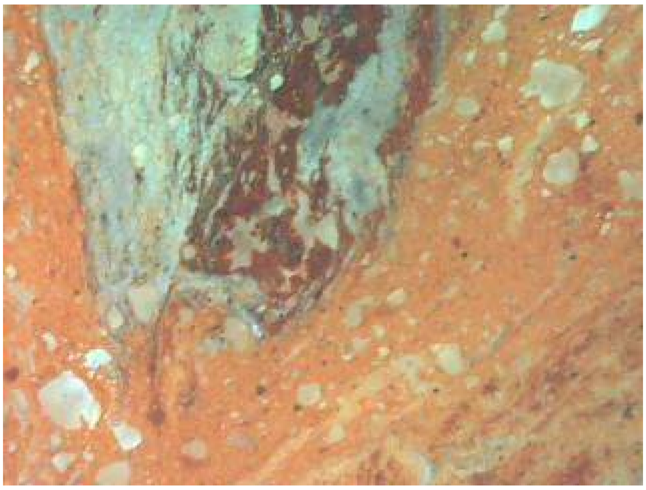

Figure 8 V5070

Fabric 3 (Sample 3)

The following inclusion types were noted in thin section:

- Quartz. Moderate well-rounded grains of Lower Cretaceous character, some of which have either an opaque coating or opaque veins, up to 0.5mm across. Abundant subangular grains up to 0.3mm across.
- Opaques. Sparse well-rounded grains up to 0.5mm across.
- Sandstone. Sparse rounded fragments up to 0.1mm across containing similar quartz to that described above in an opaque matrix. Also rounded fragments with a finer texture including muscovite laths.

The groundmass consists of optically anisotropic baked clay minerals, abundant angular quartz grains up to 0.1mm across, sparse muscovite laths up to 0.1mm long and sparse subangular opaque grains up to 0.1mm across.

This sample appears to be derived from Lower Cretaceous sand deposits such as the Woburn Sands.

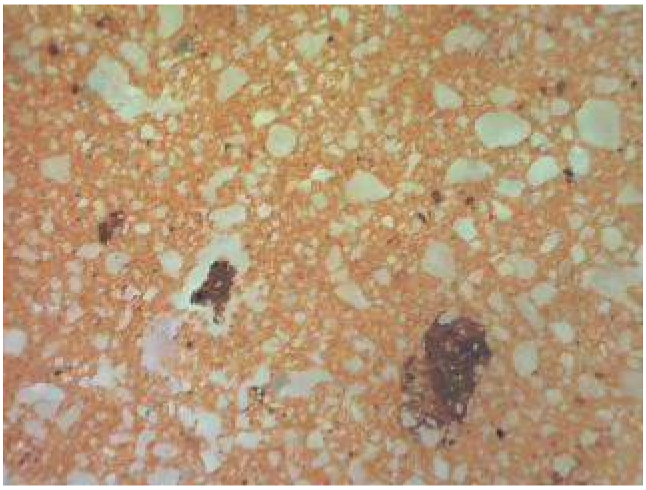

Figure 9 V5071

Grove Priory LMRW

The four samples have similar characteristics in thin section.

The following inclusion types were noted in thin section:

- Quartz. Moderate subangular grains, some coated with opaque material or with opaque veins, up to 0.4mm across. Also sparse rounded grains of Lower Cretaceous character up to 1.0mm across.
- Opaques. Sparse, well-rounded grains up to 0.3mm across.
- Altered glauconite. Sparse subrounded grains up to 0.3mm across.

The groundmass consists of optically anisotropic baked clay minerals, sparse angular quartz, altered glauconite and opaque grains up to 0.1mm across and sparse muscovite laths up to 0.1mm long.

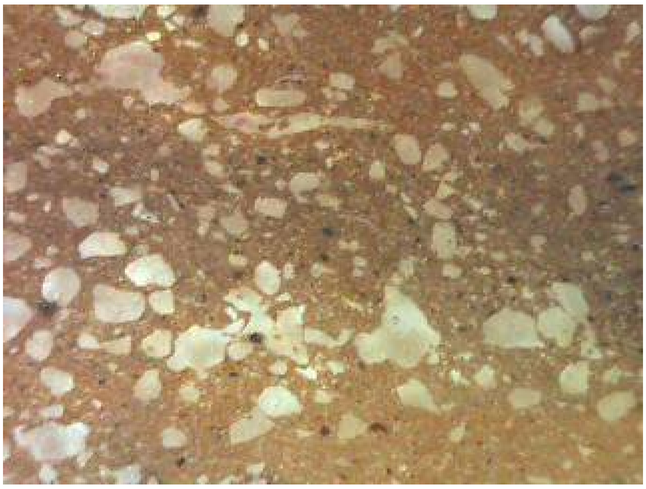

Figure 10 V5065

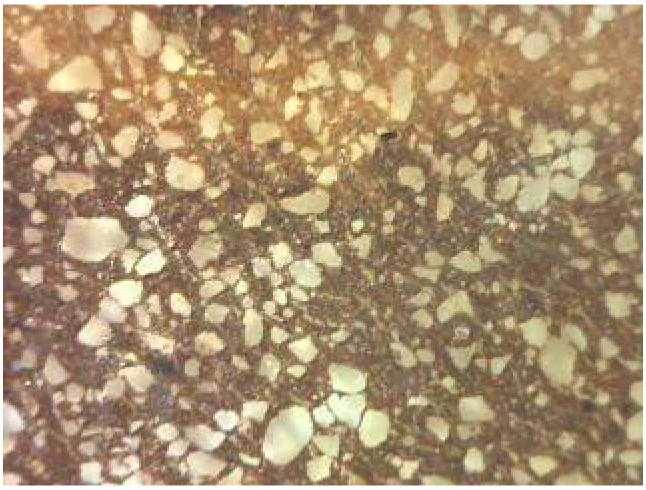

Figure 11 V5066

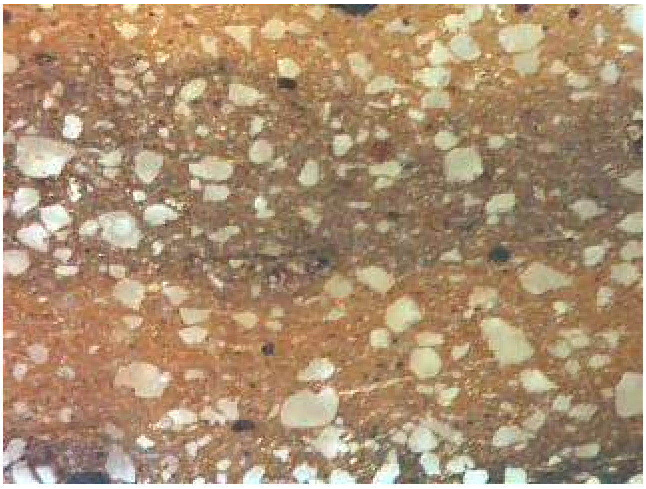

Figure 12 V5067

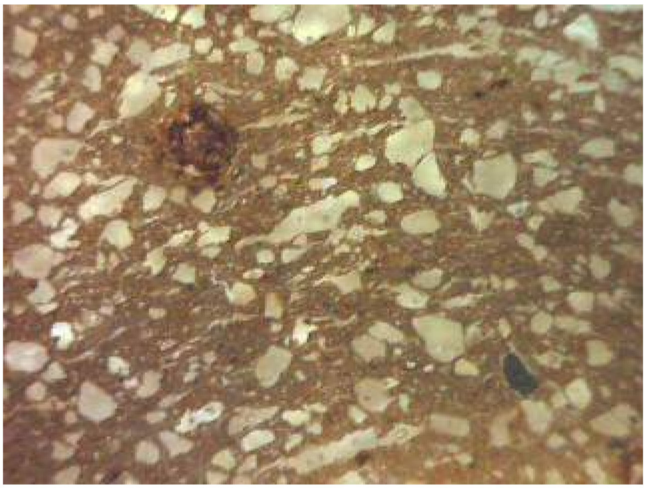

Figure 13 V5068

Interpretation of Thin Section Data

The samples all contain quartzose sand and on its basis they can be divided into wares in which the sand is of mixed origin, including Triassic material, chert, fine-grained sandstone and euhedral Carboniferous sand grains as well as Lower Cretaceous grains, and those which are probably derived mainly from Lower Cretaceous sands with opaque, iron-rich cement. Other distinctive features are the presence/absence of calcareous inclusions, glauconite and the character of the groundmass (summarised in Table 1). Using these traits it can be shown that no group precisely matches the Heath & Reach kiln waste. Despite its similar origin, the Clay Fabric 3 sample is actually distinguishable from the Grove Priory samples by its higher frequency of sand and the present of iron-cemented sandstone fragments.

Table 1

Ware	Sand	Calcareous inclusions	Glauconite	Groundmass
Heath & Reach kiln	Mixed	Burnt out?	Present	Slight micaceous silt
Clay Fabric 1	Mixed	Chalk	Absent	Mixed calcareous
Clay Fabric 2	Mixed	None	Present	Mixed calcareous
Clay Fabric 3	Lower Cretaceous with high iron content	None	Absent	Slight micaceous silt
Grove Priory LMRW	Lower Cretaceous	None	Present	Slight micaceous silt

Chemical Analysis

Sub-samples of each sample were cut and all exterior surfaces removed to a depth of 0.5 to 1.0mm to minimise post-burial contamination and leaching. The analyses were carried out at Royal Holloway College, London, under the supervision of Dr J N Walsh, using Inductively-Coupled Plasma Spectroscopy (ICP-AES).

A range of major elements was measured as percent oxides (App 1) and a range of minor elements was measured in parts per million (App 2). Silica was not measured but was estimated by subtracting the total measured oxides from 100%. Fig 14 shows the mean values for estimated silica by fabric group. This indicates that most of the pottery samples have similar silica contents but that two of the clay fabrics and the third clay fabric, Fabric 3, has a higher estimated silica content than any of the pottery.

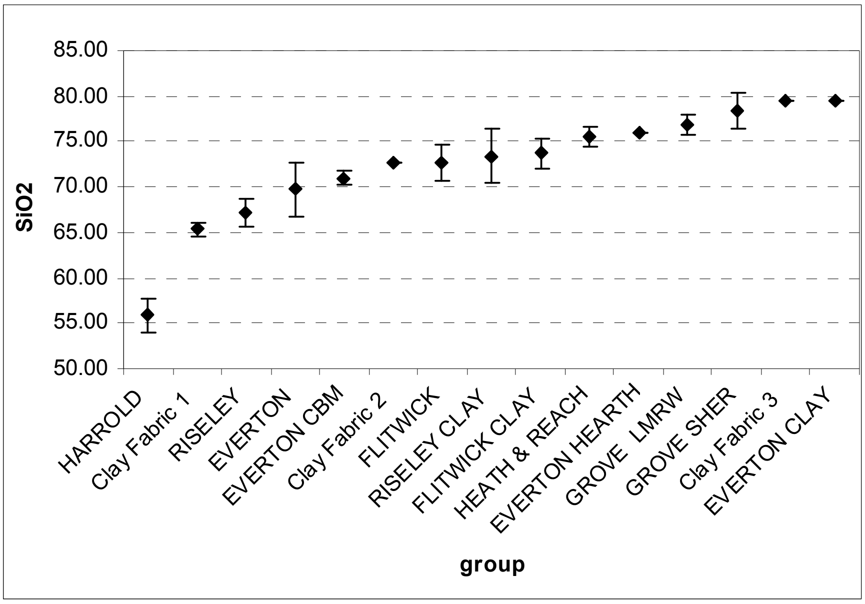

Figure 14

The data were normalised to Aluminium and then analysed using factor analysis (using the factor analysis option in WinSTAT for Excel ™, Fitch 2002). Factor analysis is a multivariate statistical technique for reducing a high number of variables to a lower number, whilst expressing the degree to which these new factors account for variation in the dataset. For each new factor, the contribution of each original variable (in this case element frequency values) is given as a weighting and these weightings themselves can provide useful information on the structure of the dataset.

Because of the effect of burial (leaching and contamination) and firing (decomposition of calcite and its subsequent leaching or incorporation into the surrounding fabric), several elements were omitted from the factor analysis. These consist of calcite, phosphorus and strontium. Barium also sometimes replaces calcium but showed no correlation in this data.

In addition to the samples submitted for this analysis, data from the analysis of six Hertfordshire Reduced Ware samples from Grove Priory were also included (GROVE SHER).

Four significant factors were determined for this reduced dataset, accounting in total for 83.23% of the variability. A bi-plot of the first two factor scores (Fig 15) indicates that Factor 2 (F2) separates the clay samples from the pottery and that the F1 scores distinguish the Grove SHER samples from the Heath and Reach and Grove LMRW samples. The high F2 scores are due to iron and vanadium values. The main determinant of F1 scores is variation in magnesium, lithium, barium and chromium (higher in samples with negative F1 scores).

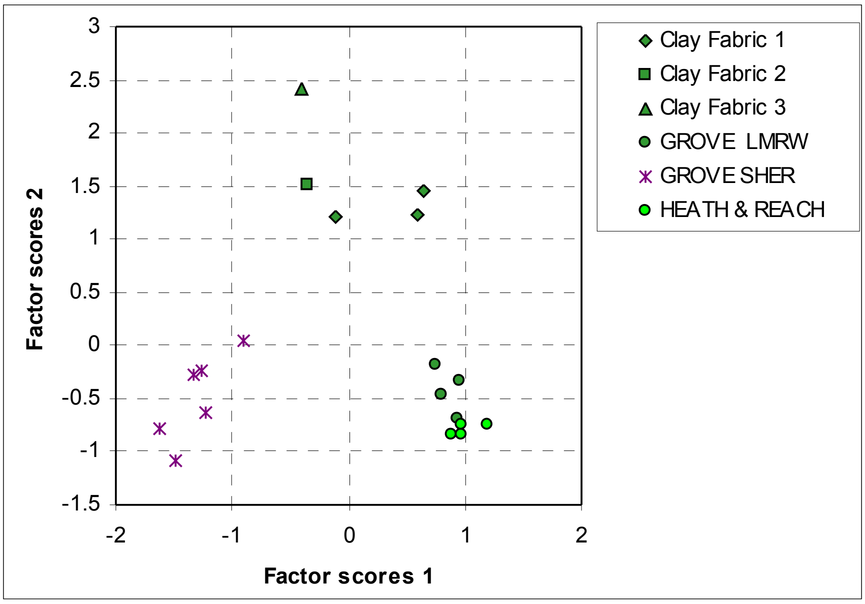

Figure 15

A bi-plot of F3 against F4 scores (Fig 16) shows little interpretable patterning, although the Grove SHER samples are distinguished by their F4 scores, three of which are higher than the remainder and three lower.

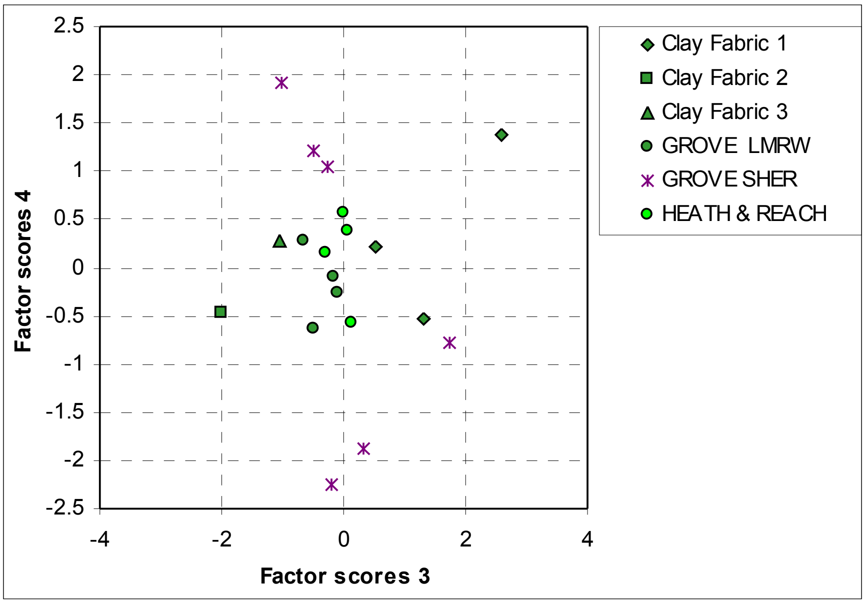

Figure 16

This analysis seems to indicate that the sampled clays are all rather different from the pottery in chemical composition and that the Grove LMRW samples are much closer in composition to the Heath and Reach wasters than are the SHER samples from the sample site.

The data were then compared with that from other LMRW production sites in Bedfordshire: Flitwick, Everton and Riseley and with samples from the shelly-ware production site at Harrold Middle School.

A bi-plot of the F1 and F2 scores for this dataset (Fig 17) separated two of the clay fabrics from the remainder (Fabrics 1 and 3) and within the main cluster the Grove SHER and Harrold samples form a discrete sub-group.

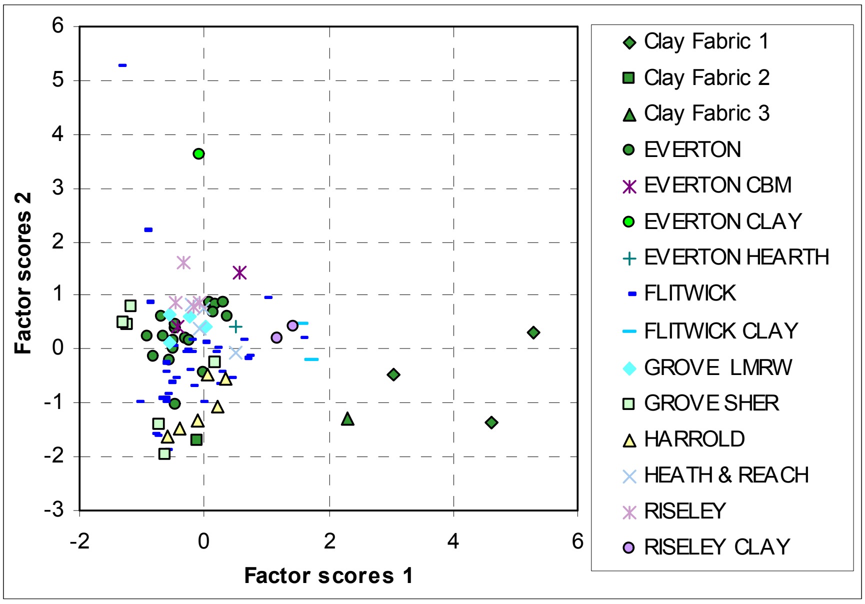

Figure 17

A bi-plot of the F3 and F4 scores (Fig 18) clearly distinguishes the Harrold samples from the remainder. Within the main cluster, the Heath and Reach and Grove LMRW samples form discrete groups but are more similar to each other than to the Everton, Flitwick or Riseley samples. The clay Fabric 3 sample, has a higher F4 score than any of the other samples whilst the Fabric 1 and 2 clay samples are similar in composition to the Everton, Flitwick and Riseley samples rather than to the Heath and Reach and Grove LMRW samples.

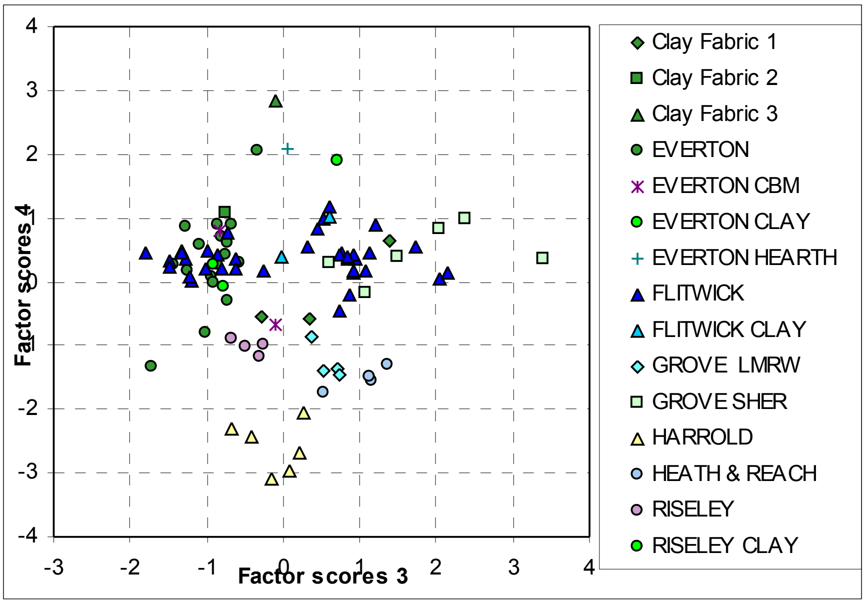

Figure 18

Conclusions

The Heath and Reach kiln produced pottery using a clay which could have been obtained from the local boulder clay, but probably only after cleaning of the clay to remove the coarser inclusions. Certainly, none of the five submitted clay samples provides a good match for the clay either in petrology or chemical composition.

The Heath and Reach pottery has a chemical composition which distinguishes it from other sampled Bedfordshire sand-tempered wares. It is closest in composition to the Grove Priory LMRW samples but these can be distinguished in thin section and are certainly not Heath and Reach products (nor the products of any of the sampled Bedfordshire production sites). Nevertheless, it is very likely that the Grove Priory LMRW samples originated in the general area.

Bibliography

Fitch, Robert K (2002) *WinSTAT(r) for Excel: User's Manual*. R. Fitch Software

Vince, Alan (2003) *Characterisation Studies of Iron Age and Late Medieval Pottery from Southeast Bedfordshire (WIS01)*. AVAC Reports 2003/118 Lincoln,

Vince, Alan (2005a) *Characterisation Studies of Late Medieval Reduced Wares: 1. Brickhill, Everton and Flitwick*. AVAC Reports 2005/62 Lincoln,

Vince, Alan (2005b) *Characterisation Studies of Late Medieval Reduced Wares: 2. Flitwick, Higham Ferrers and Riseley*

. AVAC Reports 2005/104 Lincoln,

Appendix 1

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V5020	13.95	5.89	1.42	1.17	0.22	2.14	0.71	0.12	0.028
V5021	13.14	5.81	1.46	1.12	0.21	1.91	0.68	0.12	0.030
V5063	12.97	5.11	1.31	1.68	0.22	2.13	0.63	0.62	0.014
V5064	12.43	5.15	1.29	0.92	0.20	1.74	0.59	0.70	0.018
V5065	13.62	5.11	1.30	1.19	0.22	1.78	0.68	0.42	0.019
V5066	11.40	4.61	1.08	1.73	0.20	1.55	0.57	0.45	0.015
V5067	12.49	5.18	1.21	1.84	0.19	1.60	0.59	0.64	0.024
V5068	11.63	4.92	1.22	2.20	0.20	1.60	0.57	0.50	0.028
V5069	13.57	13.11	1.08	3.27	0.32	2.19	0.62	0.33	0.136
V5070	14.88	7.53	1.02	0.24	0.44	2.42	0.76	0.05	0.034
V5071	8.60	8.61	0.54	0.13	0.32	1.59	0.48	0.15	0.042
V5072	11.94	7.09	1.31	11.61	0.50	2.11	0.57	0.12	0.157
V5073	11.29	7.24	1.14	11.11	0.38	2.10	0.52	0.17	0.083

Appendix 2

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V5020	271	69	23	89	86	13	76	116	21	121	37	92	38	8	1	3	2	24	79	19
V5021	277	64	21	98	87	13	77	111	19	102	35	91	36	6	1	3	2	23	73	28
V5063	370	64	19	63	69	12	102	100	21	109	31	84	32	6	1	3	2	18	82	15

V5064	370	63	22	67	68	12	88	102	18	128	28	75	29	5	1	3	2	18	132	15
V5065	386	80	22	85	78	12	112	106	18	134	36	90	37	6	1	3	2	15	74	15
V5066	303	74	21	58	58	11	113	95	16	106	29	75	30	5	1	3	2	17	62	11
V5067	359	83	20	62	84	12	115	104	15	82	28	68	29	5	1	3	2	16	64	17
V5068	323	72	23	64	65	11	143	97	16	96	29	72	30	5	1	3	2	21	66	17
V5069	299	100	39	64	91	15	108	155	35	65	47	84	51	12	2	7	3	57	246	21
V5070	329	101	17	78	29	14	74	138	12	64	34	60	34	6	1	2	2	33	102	13
V5071	287	76	19	39	37	8	56	101	11	55	25	56	25	4	1	2	1	240	93	10
V5072	343	76	24	62	47	12	182	123	23	69	33	66	37	7	1	6	2	21	85	20
V5073	286	68	25	59	46	11	179	116	20	56	33	66	35	7	1	4	2	101	104	15