Characterisation studies of the post-medieval brick from Northgate, Pontefract (PNG'04)

Alan Vince

Excavations at Northgate, Pontefract, by Field Archaeology Specialists revealed the remains of two brick kilns, built into the backfill of a Civil War ditch and associated with mid/late 17th-century finds. The bricks were made using the slop moulding technique and because of their unusual manufacturing technique and the close date it was determined that the source of the clay and the nature of any preparation techniques used should be investigated.

Samples of two bricks and two samples of the underlying subsoil, which it was surmised might have been used as the raw materials, were submitted for study. The clay was examined at x20 magnification and then worked into a briquette which was fired at a temperature of 950 degrees C by Andrew Macdonald (Table 1).

Table 1

TSNO	Sitecode	Context	cname	Form	Action	Description
V2432	png'04	1094	PMTIL	BRICK	TS;ICPS	
V2433	png'04	1091	PMTIL	BRICK	TS;ICPS	
V2434	png'04	CLAY	CLAY	SAMPLE	TS;ICPS	FIRED AT 950 DEGREES C
V2435	png'04	CLAY	CLAY	SAMPLE	TS;ICPS	FIRED AT 950 DEGREES C

Thin sections of each of the bricks and of each of the briquettes were prepared and chemical analyses of each of the four samples were prepared by Peter Hill and submitted for Inductively-Coupled Plasma Spectroscopy (ICP-AES) at Royal Holloway College, London.

Petrological analysis

The Northgate site lies on an outcrop of Coal Measure mudstone and this is clearly the main origin of the subsoil, which contains abundant illsorted angular fragments of mudstone, of similar colour to the groundmass. However, in the hand specimen, in addition, the subsoil samples contain fragments of sandstones and quartz sand. These suggest that the subsoil is not derived immediately from the *in situ* weathering of the mudstone but is either a colluvial deposit or boulder clay.

Clay samples

In thin section, one of the clay samples included no large quartzose or sandstone inclusions at all and the other contains quartz-sand-rich lenses in a fine-textured groundmass (V2434).

The groundmass in both cases consisted of optically anisotropic baked clay with few inclusions larger than 0.1mm across. One of the samples (V2434) contains numerous large angular relict clay pellets of varying colour. The groundmass in this instance varies in colour, from being a light brown to a darker redder brown, and contains little visible silt. The other sample has a more uniform groundmass, with a light brown colour. This sample contains sparse to moderate quartz and muscovite silt and abundant rounded dark brown inclusions, less than 0.05mm across.

The differences between the two samples is probably due to slight variations in thickness of the two samples, indicating that the inclusions in the groundmass are close in size to the thickness of the section (c.0.03mm) so that slight variations in section thickness or texture give rise to an apparent large difference in composition.

The sections are both typical of Coal Measure mudstone-derived clays, which vary in thickness but typically contain little quartz silt and include bands of light-coloured clay, due to their being paleosols developed in tropical swampy conditions. The abundant dark brown inclusions noted in V2435 are probably biological in origin, either being colonies of bacteria or faecal pellets.

The inclusions in V2434 include a fragment of sandstone containing subangular grains of quartz (mainly monocrystalline, including vein quartz with abundant inclusions, with lesser quantities of polycrystalline quartz with sutured boundaries and strain), chert and altered feldspar. The cement is a mixture of non-ferroan calcite, haematite, and kaolinite. The remaining sand-grade inclusions are likely to be derived from a similar sandstone.

Bricks

The two brick samples have similar fabrics, although one, V2433, is partially vitrified, leading to the formation of an isotropic dark grey groundmass.

Both samples contain abundant quartzose sand, ranging in size from c.0.2mm to 0.5mm. Most of these grains have similar characteristics to those seen in V2434, with the addition of sparse grains of plagioclase and microcline feldspar and grains of inclusionless monocrystalline and strained polycrystalline quartz with a higher sphericity and roundness. These grains may be derived from a Permo-Triassic sand. There were no sandstone fragments in either sample. Sparse rounded, dark red mudstone inclusions were present as were rounded concretions with a higher quartz sand content than the groundmass.

The groundmass was similar to that of the clay samples, although in both sections it contained a higher quartz content, possibly as a result of the added sand having a silt-grade component but possibly indicating a higher silt content in the parent clay.

The thin sections, therefore, indicate that the bricks contain substantially more quartz sand than the clay samples and that the differences between the two groups are possibly due to the tempering of the local subsoil with a quartz sand. This sand may contain material of Permo-Triassic origin in addition to material derived from Coal Measure sandstone such as those seen in one of the clay samples.

Chemical analysis

The chemical analysis was based on a finely-ground sample of the brick or briquette from which any potentially contaminated material had been mechanically removed. Because of the heterogeneous nature of the sample a large amount of sample was ground up, to minimise the effect of sampling a single inclusion of mudstone or sandstone.

The resulting data include values for a range of major elements, measured as oxides and of minor and trace elements, measured in parts per million (Appendices 1 and 2).

An estimate of the amount of silica present in the samples was made by subtracting the sum of the major oxides from 100%. The clay samples have a slightly lower silica content than the bricks (61-62% as opposed to 67-68%) a result of the silica, in the form of quartz sand and sandstone, added to the clay.

A factor analysis of the data was carried out, including other examples of West and South Yorkshire-made ceramics for comparison.

This factor analysis revealed six significant factors, of which the first, F1, accounted for over 44% of the variation in the data. A plot of F1 against F2 shows that the Pontefract brick and clay samples are similar to each other, and to other West and South Yorkshire ceramics, in particular to a group of Rawmarsh-type coal measure whitewares from Rotherham (sampled as part of the West and South Yorkshire Medieval Pottery Fabric Series). One of the clay samples, however, is more similar to samples of Doncaster wares, having a higher F1 score than the remainder.

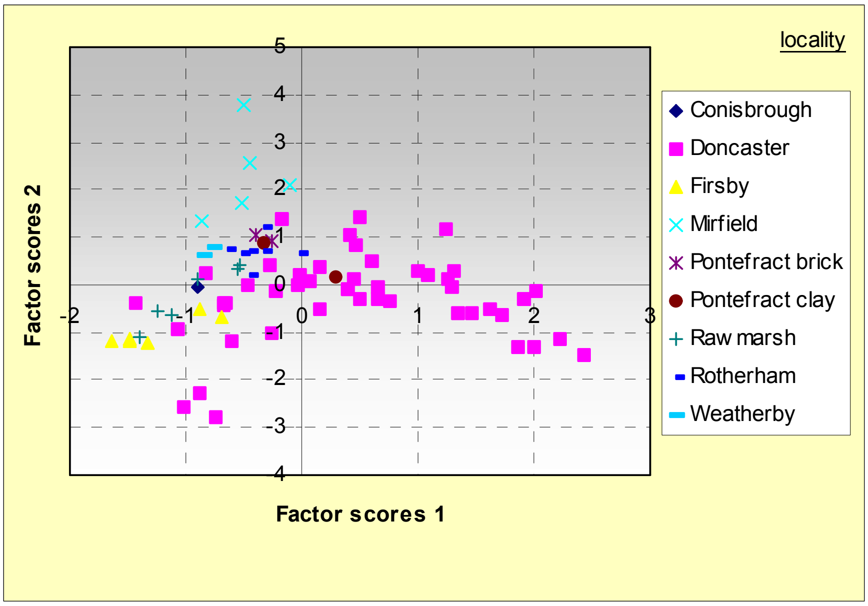

Figure 1

A plot of F3 against F4, however, separates the Pontefract brick and clay samples from the remainder. The clay samples, in particular, have a higher F4 score than the bricks or the comparanda. High F4 scores in this analysis are the result of high weightings for magnesium (MgO) and potassium (K2O). It is interesting to note that the Pontefract samples also have high F3 scores, a characteristic shared only, within the comparative data, with Rawmarsh wares.

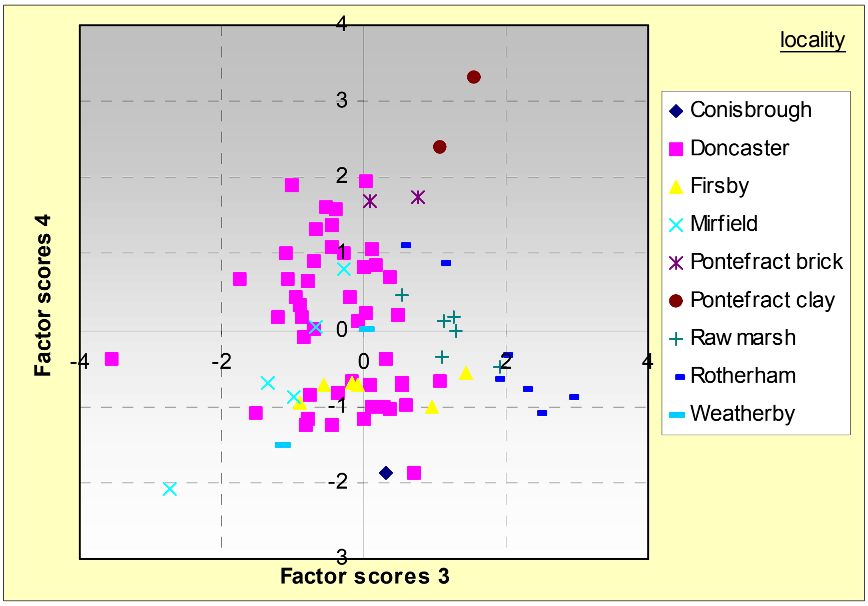

Figure 2

Finally, a plot of F5 against F6 again shows a difference in composition between the bricks and clay samples, in both their F5 and F6 scores, although both are within the range of the comparative samples (Fig 3).

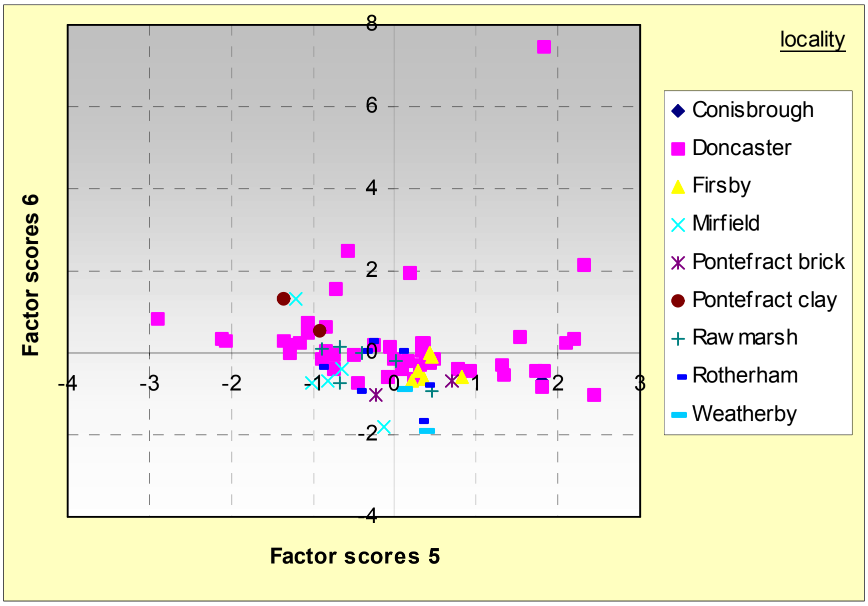

Figure 3

Conclusions

The chemical analyses show that whilst the brick and clay samples have very similar compositions there are differences between them. Having normalised the data to aluminium, the bricks have a higher iron, sodium, titanium, manganese, chromium and cobalt content, and a lower magnesium, potassium, lithium, nickel, strontium, vanadium, yttrium, samarium, europium, and dysprosium content. With so few samples, it is impossible to be certain that these differences are not due to random variations but are consist with the dark concretions noted in the bricks but not the clay samples The elements which are enriched in the bricks could therefore easily be present in the added sand fraction, but it is difficult to see how the process of brickmaking could have led to a lowering of the original magnesium and potassium contents, for example.

Nevertheless, the overall similarity in composition does make it likely that, if not the actual clay available on site then a very similar Coal Measures mudstone-derived clay was used in the manufacture of the bricks, having been mixed with a detrital sand composed mainly material derived from Coal Measure sandstones with some Permo-Triassic sand.

Appendix 1

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V2432	18.44	7.06	1.41	0.43	0.28	3.12	0.83	0.18	0.113
V2433	19.15	7.71	1.39	0.41	0.28	3.32	0.9	0.09	0.061

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V2434	22.76	6.67	2.23	0.79	0.23	4.73	0.91	0.14	0.042
V2435	23.6	5.35	2.1	0.36	0.23	4.79	0.98	0.17	0.036

Appendix 2

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V2432	576	111	18	41	51	17	81	121	13	44	43	100	43.428	6.582	1.2352	3.2	1.5	126.028	87	18
V2433	532	111	16	47	46	18	86	131	16	69	43	92	43.24	5.387	1.0832	3	2.1	89.105	79	20
V2434	643	107	54	60	86	27	117	162	27	56	52	116	53.486	9.999	1.8664	4.9	2.6	74.412	104	17
V2435	600	116	11	65	76	21	117	173	21	63	55	123	55.836	9.695	1.672	4.4	2.1	78.32	81	17