Characterisation Studies of Ceramic Building Material from Rievaulx Abbey, North Yorkshire

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Excavations at Rievaulx Abbey, North Yorkshire, by Field Archaeology Specialists Ltd produced a group of flat roof tile with a visually distinctive fabric. Samples of these tiles were submitted to the author to determine whether or not they could be locally produced (App 1). Thin section and chemical analysis was carried out and the results of these studies confirm the published opinion of John Senior that the tile is likely to have been made a short distance to the north of the Abbey, where the River Rye cuts through Middle Jurassic strata.

Thin Section Analysis

All six samples had a similar appearance in the hand specimen and only one thin section was produced, by Steve Caldwell, University of Manchester. The following inclusion types were present:

- Subangular quartz. Abundant well-sorted grains, ranging from c.0.2mm to 1.0mm across. These grains typically have one or two flat faces, indicative of overgrowth, and in several instances the original grain boundary is visible in plane polarised light, as a result of the overgrowth having few inclusions.
- Sandstone. Moderate fragments of sandstone, up to 2.0mm across, composed mainly of quartz grains similar to those described above. Amorphous brown and opaque cements are present lining or filling pores whilst many of the grains are interlocking as a result of overgrowth.
- Ferruginous sandstone. Sparse angular fragments of sandstone containing abundant, well-sorted angular quartz, between 0.1mm and 0.2mm across, in a dark brown to opaque groundmass.

The groundmass consists of brown optically anisotropic baked clay minerals with abundant angular quartz grains and moderate muscovite laths up to 0.1mm long.

Chemical Analysis

Six samples were prepared for chemical analysis by Peter Hill and analysed at Royal Holloway College, London, under the supervision of Dr J N Walsh. A range of major elements were measured as percent oxides (App 2) and a range of minor elements was measured as parts per million (App 3). The silica content was not measured and was estimated by subtracting the total measured oxides from 100%. The tiles have a mean silica content of 68.69% with a standard deviation of 1.41%.

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The data was normalised to aluminium and then compared with other chemical data from North Yorkshire, selecting samples whose source area could be at least roughly determined. These comparative samples could be split into those from the North Yorkshire whiteware potteries (York glazed ware; Brandsby-type ware; Hambleton ware, Ruswarp Bank ware and Scarborough ware); and those from redware production sites in and around York and in the lower Vale of York (including samples from the Humberware/Walmgate ware production site at Fishergate, Eboracum ware, Anglo-Scandinavian handmade ware 1, Anglo-Scandinavian York D ware). Whitewares from West Yorkshire, produced using Carboniferous light-firing clays, were omitted from this analysis having been shown to be chemically distinct (for example in their very high Barium content).

Factor analysis of this dataset produced four factors, of which the first and third distinguished the Rievaulx tiles (Fig 2). Examination of the factor analysis results suggest that the main contributors to this separation were Zirconium and Chromium and a plot of zirconium against chromium values (Fig 1) confirms that the chromium levels alone would distinguish these tiles from the other two groups. The Zirconium levels are also high, but overlap with those of the North Yorkshire whiteware samples, especially samples of Brandsby-type ware and Scarborough ware.

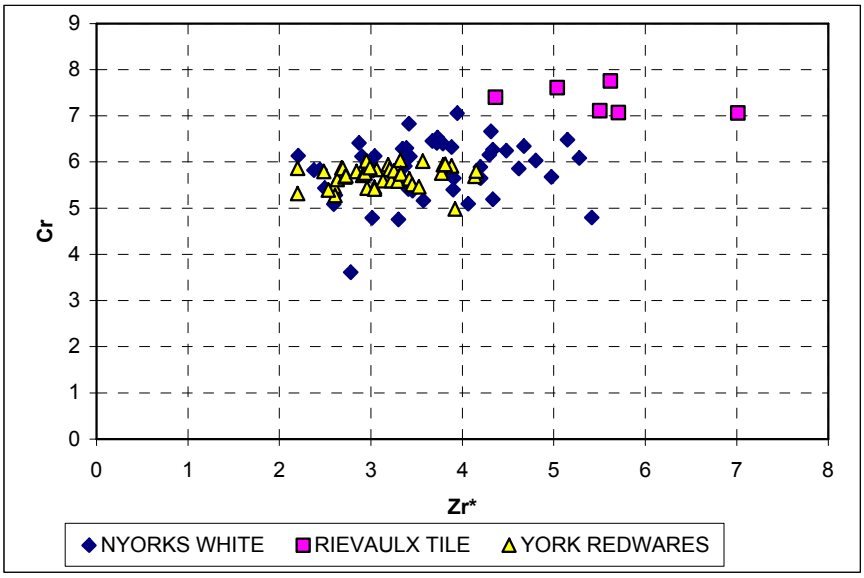

Figure 1

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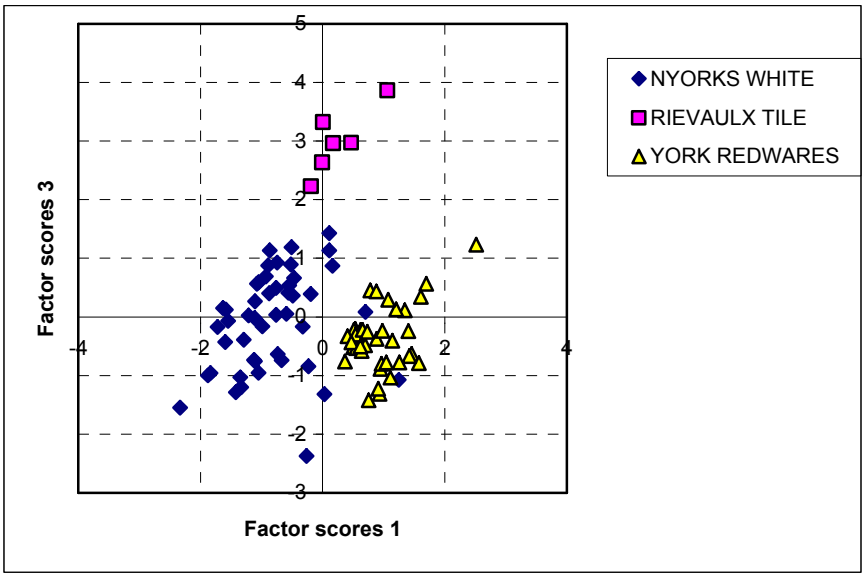

Figure 2

Discussion

The inclusions present in the fabric can be best interpreted as consisting of a quartzose sand derived from a well-sorted medium-grained sandstone with sparser inclusions of a finer-grained ferruginous sandstone, added to a coarse silty clay containing moderate quartz and muscovite silt and red-firing clay minerals. Lenses and streams of a white-firing clay were present in some of the samples but not in the thin sectioned example. Nevertheless, the presence of this light-firing clay indicates the proximity of Middle Jurassic mudstones to the parent clay outcrop used by the tilers.

In the immediate vicinity of the abbey the Rye is cutting through Upper Jurassic strata, mostly limestones (the Coralline Oolite formation) with Oxford Clay exposed at the base of the valley sides, but mostly obscured by alluvial silt. The clay and temper found in these tiles cannot therefore be from the immediate area of the abbey. However, Senior, in his study of building stone, suggests that the tiles were probably made from Middle Jurassic exposes further up the valley, the Wethercote quarries (Senior 1999). This same area produced sandstones of the Saltwick formation above which occur the Ingleby Ironstone.

The high Zirconium content of the tiles is consistent with a noted concentration of zirconium in stream sediments in the area of outcrop of the middle Jurassic sandstones (1996, 91). Similarly, high Chromium values occur in the same sediments (BGS 1996, 47) although they are highest in association with the Moor Grit sandstone, slightly higher in the geological sequence than the Saltwick formation. Both elements occur most commonly in heavy minerals (zircon and spinel) which were initially concentrated in the sandy and silty deltaic deposits of the middle Jurassic but which are then further concentrated in recent sediments.

The chemical data gives strong support to an upper Ryedale source but does not discount a source elsewhere in the north Yorkshire Moors where Middle Jurassic rocks outcrop (for example along the south and western edge of the Hambleton Hills, where pottery production seems to have started during the 12th century). The difference in composition between the tiles and the various pottery samples could simply be due to the greater frequency of sandstone and sandstone-derived quartz grains in the tiles although the estimated silica contents of the tiles and the various north Yorkshire whitewares are similar (the difference being due to a higher silt content in the whitewares).

Appendix 1

TSNO	Trench	Context	Cname	Form	class	Action	Part	REFNO
V3410	INT 3	1013	MTIL	FLAT	CBM	TS;ICPS	BS	SAMPLE 1
V3411	INT 3	1013	MTIL	FLAT	CBM	ICPS	BS	SAMPLE 2
V3412	INT 3	1013	MTIL	FLAT	CBM	ICPS	BS	SAMPLE 3
V3413	INT 3	1013	MTIL	FLAT	CBM	ICPS	BS	SAMPLE 4
V3414	INT 3	1009	MTIL	FLAT	CBM	ICPS	BS	SAMPLE 5
V3415	INT 3	1009	MTIL	FLAT	CBM	ICPS	BS	SAMPLE 6

Appendix 2

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V3410	19.10	5.96	0.87	0.57	0.34	2.53	1.52	0.09	0.028
V3411	20.53	5.65	0.98	0.51	0.28	2.79	1.68	0.09	0.064
V3412	19.68	5.84	0.93	0.51	0.29	2.65	1.63	0.08	0.032
V3413	17.27	5.95	0.85	0.46	0.32	2.24	1.45	0.07	0.029
V3414	19.72	5.62	0.95	0.54	0.27	2.69	1.75	0.09	0.026
V3415	18.66	7.66	0.96	0.39	0.34	2.63	1.52	0.09	0.068
mean	19.16	6.11	0.92	0.50	0.31	2.59	1.59	0.09	0.041
SD	1.12	0.77	0.05	0.06	0.03	0.19	0.11	0.01	0.019

Appendix 3

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V3410	461	135	35	54	38	19	108	170	26	109	54	100	55	8	2	4	2	96	321	33
V3411	483	146	35	62	38	22	114	200	28	113	62	117	63	10	2	5	3	59	109	29
V3412	463	139	35	56	40	22	112	198	31	138	61	119	62	9	2	5	3	60	82	30
V3413	441	134	32	45	36	19	102	158	24	97	54	107	54	8	2	4	2	48	76	25
V3414	476	146	31	54	38	21	113	205	20	86	61	116	61	9	2	4	2	44	76	25
V3415	503	142	30	56	45	20	99	180	25	94	55	98	56	8	2	4	2	54	70	28
mean	471	140	33	55	39	21	108	185	26	106	58	110	58	8	2	4	2	60	122	28
SD	21	5	2	6	3	1	6	19	4	18	4	9	4	1	0	1	0	19	98	3

Bibliography

BGS (1996) *Regional Geochemistry of North-East England*, British Geological Survey, Keyworth, Nottingham.

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