Chemical analysis of Bronze Age Pottery from Washingborough, Lincolnshire (WPSE)

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Samples of eight Bronze Age vessels from Washingborough Pumping Station were submitted for thin section analysis by Carol Allen. This study showed that they could be grouped into several fabric groups (Table 1). The analysis suggested that the tempering material found in Fabrics 1a, 1b and 1c was the same, derived from a shelly limestone, interleaved with marl. However, the shell fragments found in fabric 1c were much larger than in the other two groups and Fabric 1b contained rounded opaque grains, and mudstone fragments, both of which were absent from Fabric 1a.

Fabric 2 contained angular flint fragments as well as inclusions typical of Lower Cretaceous deposits, but not found in the Washingborough area.

Fabric 3 contained fragments of a bioclastic limestone, parallels for which occur locally, in the Middle Jurassic Cornbrash which outcrops to the east of Washingborough, and in lower Jurassic limestones which outcrop in the Trent valley and the Humber gap.

Fabric 4 was so badly leached that it was not possible to identify the original calcareous inclusions with any certainty, although it was likely that this was a decalcified version of Fabric 1.

Since the chemical composition of vessels produced from weathered Lower Jurassic clays in northeast Lincolnshire and those produced from Middle Jurassic clays at various points along the dip slope of the Jurassic ridge differs, it was decided to analyse these samples using Inductively-coupled Plasma Spectroscopy to determine their chemical composition.

Table 1

TSNO	Fabric	Action	Context	REFNO	Form	Description
V3229	1a	TS	003	14319		
V3230	1a	TS	003	5339	JAR	GLOB BODY;BURNISHED INT AND EXT
V3231	1a	TS	003	5010		
V3232	2	TS	003	5208		
V3233	3	TS	011	5959		
V3234	4	TS	104	281	JAR	THIN WALLED;BURNISHED INT AND EXT
V3235	1c	TS	105	255		
V3254	1b	TS	424	8896		

Description

Samples of each sherd were prepared by Peter Hill and analysed at Royal Holloway College, London, under the supervision of Dr J N Walsh. The analysis included a number of major

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elements, determined as percent oxides (App.1) and minor elements, determined in parts per million (App.2).

Silica was not measured and can be estimated by subtracting the sum of measured oxides from 100%. This estimate will also include other elements, such as chemically-combined water and carbon. Fig 1 shows that there is a wide range in the estimated silica contents but that the range for Fabric 1c is wider than that of all the other fabrics, apart from Fabric 2 which is 71.90%.

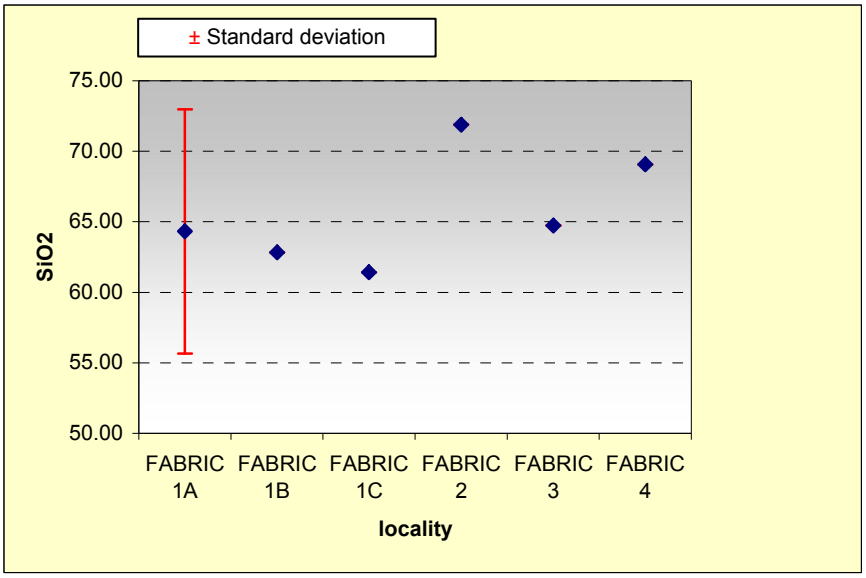

Figure 1 Estimated silica content for the Washingborough Pumping Station fabric groups

The data were normalised to Aluminium and then analysed using factor analysis. This indicated that there were no clear groupings within the data but that the fabric 1C sample is least similar to the remainder. In particular, there is no strong difference between Fabric 2 with the remainder.

The data were then compared with analyses of shell-tempered wares thought to have been made in specific localities:

a) Middle Jurassic clays, tempered with a shelly limestone similar to that found in Fabric 1 (Northern Maxey ware = MAX).

b) Lower Jurassic clays, tempered with Lower Jurassic limestones similar to that noted in Fabric 3 but in a siltier groundmass (Dales-type shelly ware, Subfabric S = DWSH S)

c) Lower Jurassic clays, tempered with Lower Jurassic limestones and some Cretaceous inclusions (Dales-type shelly ware, Subfabric C = DWSHC)

d) Upper Jurassic clays, tempered with shelly limestone of Middle Jurassic or Lower Cretaceous age and probably made somewhere immediately south or southwest of the Lincolnshire Wolds (Dales-type shelly ware, subfabric GSQ = DWSH GSQ)

e) Upper Jurassic clays, with various added tempering materials, from production sites at Market Rasen (MR)

f) Glacial tills of Devensian age from sites to the north and east of the Lincolnshire Wolds and vessels made from such tills (BEVO1T, BEVO2T and GR CLAY)

g) Upper Jurassic clays from the Southern part of the Yorkshire Wolds (QC).

For simplicity, these were then grouped according to their probably sources:

Ancholme Valley; East Lindsey; Humber Gap (DWSH C); Middle Jurassic; Northwest Lincolnshire (DWSH S), SE Lincs Wolds (DWSH GSQ) and South Yorks Wolds.

The data were then analysed using factor analysis and four main factors were found. A plot of Factor 1 against Factor 2 (Fig 1) shows that the Fabric 1b, 1c and 4 samples are distinct from all these groups, principally as a result of high weightings of some of the rare earth elements and low weightings for cobalt, nickel. The fabric 1c samples have similar compositions to the East Lindsey samples with one being more similar to the Middle Jurassic samples. The Fabric 2 sample plots in an area of the diagram occupied by Middle Jurassic, South Wolds and Humber gap samples overlap.

A plot of the third against the fourth factor (Fig 2) indicates that Fabrics 1a and 3 can be distinguished from all these comparanda, primarily by their low sodium and high zirconium contents. Fabric 2 is closest in this diagram to the Middle Jurassic clays. Fabrics 1b and 4 have similar F3 and F4 scores and plot on the edge of the Middle Jurassic and Ancholme groups. Finally, Fabric 1c plots with the Middle Jurassic group.

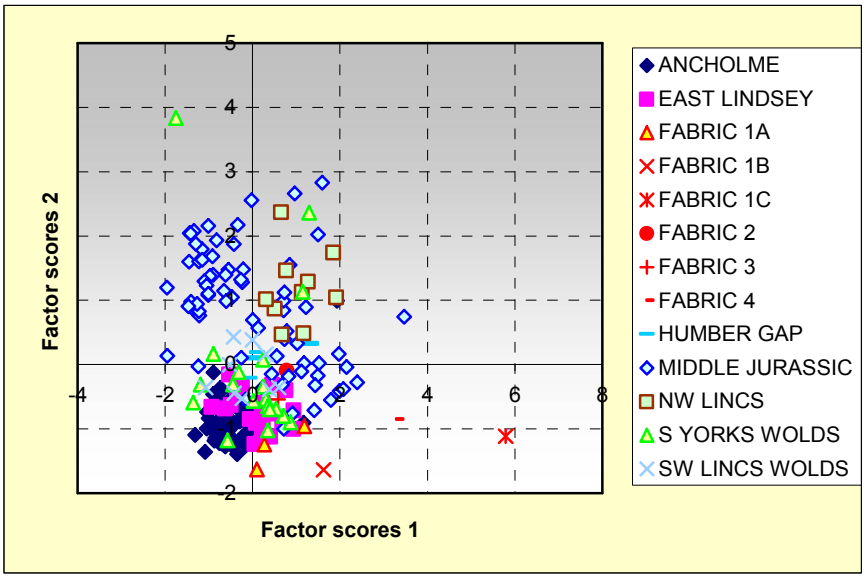

Figure 2 Bi-plot of the first two factors in factor analysis of Washingborough Pumping Station samples and comparanda

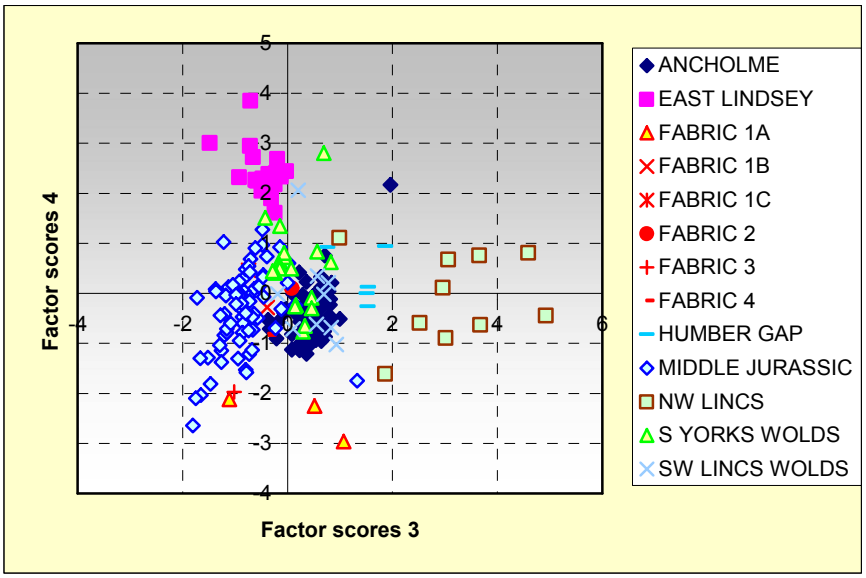

Figure 3 Bi-plot of the third and fourth factors in factor analysis of Washingborough Pumping Station samples and comparanda

Interpretation

The chemical composition of the eight samples from Washingborough firstly shows that the various fabrics recognised in thin section are also reflected in their chemical composition. The three Fabrics 1a samples group together in both Figs 1 and 2 whilst Fabric 3 is more similar to these than to the possible lower Jurassic clays, which thin section analysis suggested was the alternative origin of the inclusions present in the clay.. However, Fabrics 1b and 1c, which were interpreted on their thin section evidence as possibly being made from the same raw materials, are chemically different, as are Fabrics 2 and 4.

Comparing the samples with results from the study of material from various localities in Lincolnshire and east Yorkshire, most of which also has a fine-textured groundmass and are likely, ultimately, to have been made from Jurassic clays (sometimes redeposited as glacial till) shows that the main Washingborough group (fabrics 1a and 3) differs from any of the comparanda whilst the other samples differ from the remainder in at least one of the two plots. This evidence is summarised in Table 2. Only Fabric 2 has a composition which can be matched, and this fabric in thin section contains flint and polished quartz grains which do not outcrop in conjunction with Middle Jurassic clays. Therefore, on the one hand, the chemical analysis confirms the results of the thin section analysis but does not at present augment them but on the other this opens the possibility that the clay may be characterised subsequently and that there are differences in composition between different clay sources in Lincolnshire which can ultimately be used to determine the source of the Washingborough vessels more closely.

Table 2

Fabric	Factors 1 and 2 (Fig 1)	Factors 2 and 3 (Fig 2)	Conclusion
1a	Lower F2 scores than comparanda	Lower F4 scores than comparanda	Distinct composition
1b	Lower F2 scores than comparanda	Similar F4 scores to Middle Jurassic group	Distinct composition
1c	Higher F1 scores than comparanda	Similar F4 scores to Middle Jurassic group	Distinct composition
2	Similar to both Middle Jurassic and East Lindsey comparanda	Similar to Middle Jurassic, Ancholme and South Yorks Wolds group	Similar to Middle Jurassic group
3	Similar to all comparative groups except for NE Lincs	Similar to Fabric 1a	Distinct group
4	Higher F1 score than comparanda	Similar to Middle Jurassic and Ancholme	Distinct group

Appendix 1

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V3229	15.47	2.49	0.46	8.44	0.12	0.58	1.1	2.3	0.046
V3230	16.57	4.15	0.74	3.78	0.16	1.6	0.97	2.35	0.04
V3231	11.43	3.67	0.74	23.42	0.09	1.27	0.45	4.46	0.144
V3232	14.82	4.6	1.27	2.26	0.36	2.19	0.63	1.91	0.065
V3233	15.15	6.29	0.8	7.94	0.16	1.51	0.57	2.76	0.077
V3234	15.41	6	0.99	2.59	0.16	1.69	0.76	3.28	0.041
V3235	12.82	6.54	0.91	13.97	0.21	1.8	0.58	1.61	0.149
V3254	18.91	5.58	1.09	6.38	0.16	2.32	0.85	1.83	0.042

Appendix 2

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V3229	807	107	23	62	28	15	223	112	23	110	35	64	37	5	1	4	3	26	72	13
V3230	1164	116	31	33	36	17	211	132	23	97	40	71	42	6	1	4	3	22	112	14
V3231	1378	71	27	12	28	11	490	69	20	59	29	56	31	5	1	4	2	11	91	15
V3232	1092	107	27	49	59	15	169	119	24	71	41	77	43	7	1	4	3	29	193	17
V3233	1345	91	28	17	63	14	299	113	22	82	40	70	42	6	1	4	3	25	145	18

V3234	1277	99	44	19	57	16	237	105	39	98	57	114	60	11	2	7	3	28	133	21
V3235	1227	74	27	23	54	12	287	85	37	76	64	120	67	12	3	8	4	38	131	19
V3254	1,063	114	25	85	51	17	237	106	29	101	45	95	49	12	2	7	3	21	77	18