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Ancient Monuments Lab Report No 4183

THE ANALYSIS OF SOME MEDIEVAL RED GLASS

Excavations at Wharram Percy, Yorkshire produced two sherds of opaque red vessel glass (AM 791103-4), one from the church and the other from the northern boundary bank. The programme of analyses described below was carried out in an attempt to find other glass of a similar appearance and composition. It was hoped that this work might suggest a date and/or area of production for the sherds from Wharram as the glass was not from closely-dated contexts.

The analyses were carried out using energy dispersive x-fluorescence (XRF) with an evacuated sample chamber to allow the detection of some lighter elements. Because of the varying size, shape and surface texture of the pieces of glass, the absolute peak heights of the spectra obtained could not usefully be compared directly. In order to produce figures that were comparable, all the peak heights were normalised by dividing them by the corresponding silicon peak height. Silicon can be used in this way as it is present as a major element in all glass and, to a first approximation, the proportion of silicon in any glass is roughly constant. The results of the analyses are therefore presented as a series of normalised peak heights (see Table 2). It should be noted that different elements fluoresce more or less strongly so no direct comparisons can be made between the columns in Table 2; it is comparisons down the columns, ie between samples, that are useful. To allow comparison with other quantitative analyses the normalised figures given in Table 2 can be multiplied by the following factors to give very approximate percentage compositions: For manganese (Mn), iron (Fe), copper (Cu) and zinc (Zn) the factor is just under one while for tin (Sn) and antimony (Sb) it is two or a

little more. The lead cannot be calibrated in the same way but the levels seen here probably span the range from a fraction of a percent up to several percent.

Analytical results are not given for sodium (which was not detectable under the analytical conditions used), potassium or calcium. These alkali elements tend to leach out of glass so the analysis of a weathered surface, even if it looks in good condition, is unlikely to produce figures that bear much relation to the original glass composition. Some of the glass was in good condition but other pieces showed varying degrees of decay from slight iridescence (eg sample 7) or a matt surface to deep weathering and corresponding colour changes (eg samples 4 and 5). Analyses were made on three different areas on sample 5 which appeared red, pale green and buff respectively; these results are given in Table 3. Small differences are not significant and are more likely to be due to experimental variation than

Table 3 - Multiple analyses on sample 5

XRF Peak heights normalised to silicon

Glass Colour	Ti	Mn	Fe	Cu	Zn	Pb	Sn	Sb
Red	.05	.30	1.88	1.11	.12	.30	.04	-
Pale Green	.10	.19	4.45	1.12	.12	.43	.05	-
Buff	.06	.37	4.25	.71	.09	.68	.06	-

any real differences in composition. However, the most weathered (buff) glass shows higher iron and lead and lower copper levels than the least changed (red) glass. The extra iron will have been deposited in the decayed glass from the surrounding soil while the extra lead is not a real addition, rather a relative enrichment due to the depletion of other elements. Copper in its reduced form, cuprous oxide,

colours glass red. As the glass decays the copper ceases to be protected and is oxidised to the cupric form which is coloured green. It is no longer as strongly bound to the glass and so tends leach away, leading to lower copper levels in the glass. For these reasons the analytical results given in table 2 are all from the least weathered areas of the various samples and small differences are ignored when comparing individual samples.

In order to make the analytical results easier to compare they are plotted graphically in Figs 1-2. The vertical scales for the different elements are not all the same but have been adjusted so all the results can be fitted onto two pages. Similar patterns of histogram bars represent similar compositions while results that look very different are different in composition.

One immediately obvious difference is in the amount of lead the glass samples contain. The highest levels are in the middle Saxon glass from Hamwih with the opaque red glass (samples 8 and 9) containing more than the streaky, translucent glass (samples 10 and 11) which is red 'diluted' with colourless glass. These latter two samples are also unique in that they are the only glass analysed which contained detectable levels of antimony. Antimony can act either as an opacifying agent or as a decolouriser; the latter is more likely in this case though the glass contained manganese which also acts as a decolouriser. All four of these sherds were small and thin and came from fairly small vessels. The next group of glass (based on lead content) is samples 1-5 and the final, low lead group, samples 6-7 and 12-14.

The very low lead samples are not a coherent group. However, samples 12-14 are analytically fairly similar. They all contain no tin or antimony and only a trace (sample 12) or no zinc. Iron is the dominant element with insufficient manganese

to conteract its darkening effect on the red glass. All these glass samples are dark and have black streaks in the dull red glass. They are also all lumps of glass rather than vessel sherds; perhaps they were all discarded because of their poor colour. The Wealden glass (sample 12) is of 14th century date (Kenyon 1967, 161) while the Italian glass is 5th to 6th century. Their wide spatial and temporal separation should perhaps be taken as a warning against grouping analytical results without due regard to their archaeological provenance. The two other low lead red glasses are both translucent and are typified by low levels of all colouring elements. Both are thicker than the glass from Hamwih and are sherds from large vessels. Sample 6 contains zinc, which probably got into the glass when brass was added as a source of copper. Sample 7 contains no zinc but instead has some tin. The tin is probably present mainly in the marbled white core of the glass where it acts as an opacifier rather than in the transulcent red glass itself. Both these samples are well made from selected, relatively pure raw materials

The final group of samples are the medium lead opaque red vessel sherds (samples 1-5). The samples come from three sites and it can be seen that the duplicated samples (1 and 2, 4 and 5), which probably come from the same vessels, are closer to each other in composition than they are to any of the remaining samples. However, these five samples do all have a family likeness; they contain major amounts of both copper and iron (though the proportions vary) together with more minor amounts of manganese, zinc and tin. I would suggest that they were all made to the same recipe but come from different batches of glass. Whether they all come from one centre or the recipe was widely known cannot be said; further work might help to clarify this point. They do however agree roughly as to date. Sample 3 was

found in the fill of a cesspit with early 14th century finds, which was sealed by a 15th century wall while samples 4 and 5 are probably 13th century in date. The Wharram sample from the church is unlikely to be later than the early 14th century.

Opaque red glass vessels are widely though not commonly found throughout the medieval period. Charleston (1980) records examples from seven sites in the British Isles (including our sample 3) as well as further vessels decorated with opaque red threads; most seem to date to the 13th or 14th late centuries. He suggests they may have been made in England as red glass was found in a crucible at Chaleshurst (sample 12) though it has been shown here that these two samples at least are of rather different compositions.

Medieval red glass vessels are also known in Italy and from Corinth. Harden (1966) published some analyses carried out by Robert Brill on material from Salpi (Italy) and Corinth which are of very similar compositions. In some ways they are also similar to our samples 1-5 as they contain a few percent of iron and copper together with a lesser amount of manganese. The other elements however do not agree as well; the mediterranean glass contains only very low levels of tin and the lead levels are all under 0.1%.

Zinc was only detectable in one of five samples.

Arbman (1937, 252) too quotes the results of some analyses of coloured glasses. One of these samples was of opaque red glass from Anlier in Luxemburg. The glass-house here is probably 11th or 12th century but has been dated as late as the

13th century (Harden 1971, 89). The analysis does not cover the full range of elements determined in this study but the iron, manganese, copper levels are again comparable with those in samples 1-5 while the lead at 0.40% is closer to the values I would expect in these samples.

These other analyses do not really help to solve the problem of the source of the opaque red vessel glass like that from Wharram Percy. They should perhaps be taken as a caution in reading too much into similarities based on incomplete analyses; the most striking differences between the mediterranean glass and that from Luxemburg is not in fact in the colourants but in the alkalis it contains. The former are soda-lime glasses while the latter is a potash-lime glass with high levels of both lime and alumina. Perhaps fuller analyses would break up the groups suggested for the samples analysed here. They could not however associate the samples already shown to be of different compositions.

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David Andrews first raised the problem of the red glass from Wharram Percy and also supplied the Italian glass (samples 13 and 14). Donald Harden was most helpful in bringing to our notice other red glass, both published and unpublished, and in lending the glass from Dublin (samples 4 and 5) for analysis. Sample 3 was loaned by the Musuem of London, sample 6 by Clare Conybeare of the Salibury and South Wiltshire Musum, samples 7-11 by Mark Brisbane of Tudor House Musuem, Southampton and sample 12 by Matthew Alexander of Guildford Museum.

This report supercedes A.M.L Reports 3701 and 3938.

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Table 1 - Glass Samples Analysed

Sample No.	AM Lab No.	Site	Description
1	791103	Wharram Percy, Yorks	Opaque streaky dull red vessel sherd
2	791104	Wharram Percy, Yorks	Opaque streaky dull red rim sherd
3	-	Watling House (Site ER 190) City of London	Opaque red vessel sherd
4	-	Winetavern Street, Dublin	Opaque red vessel sherds thought to be from the same ?jug. Parts of the glass had weathered and appeared pale green and buff.
5	-	Winetavern Street, Dublin	
6	-	Old Sarum, Wilts	Translucent scarlet vessel sherd with a weathered surface which was translucent yellow.
7	830750	Southampton, Hants	Vessel sherd, transulcent orangey red on either side with a thin marbled opaque white central layer.
8	830746	Hamwih, Hants	Opaque dull red vessel sherd
9	830747	Hamwih, Hants	Opaque dull red bessel sherd with opaque yellow trail.
10	830748	Hamwih, Hants	Translucent streaky crimson vessel sherd
11	830749	Hamwih, Hants	Translucent streaky crimson vessel sherd with opaque yellow trail.
12	-	Chaleshurst lower furnace, Chidding old, Sussex	Dull streaky red-brown glass deposit in a crucible.
13	821640	S.Vincenzo, Molise, Italy	Dull liverish-red streaky glass lump.
14	821641	S.Vincenzo, Molise, Italy	Dull liverish-red streaky glass lump.

Table 2 - Analytical Results

XRF Peak heights normalised to silicon

Sample No	Ti	Mn	Fe	Cu	Zn	Pb	Sn	Sb
1	.04	.05	.53	3.38	?	.12	.08	-
2	.03	.02	.42	2.78	?	.08	.06	-
3	.04	.30	1.28	.94	.17	.34	.04	-
4	.06	.23	2.83	.71	.10	.34	.04	-
5	.05	.30	1.88	1.11	.12	.30	.04	-
6	.04	.24	.32	.43	.07	-	-	-
7	?	.11	.15	.02	-	.02	.04	-
8	.05	.23	1.01	.97	.16	1.91	.06	-
9	.13	.42	1.28	1.47	.35	2.59	.08	-
10	.03	.13	.47	.23	.04	.73	.03	.02
11	.03	.18	.49	.44	.05	.48	.03	.04
12	.03	.16	1.12	.56	.04	.04	-	-
13	.04	.28	2.28	.80	-	.04	-	-
14	.06	1.08	3.89	.83	-	.05?	-	-

Figure 1

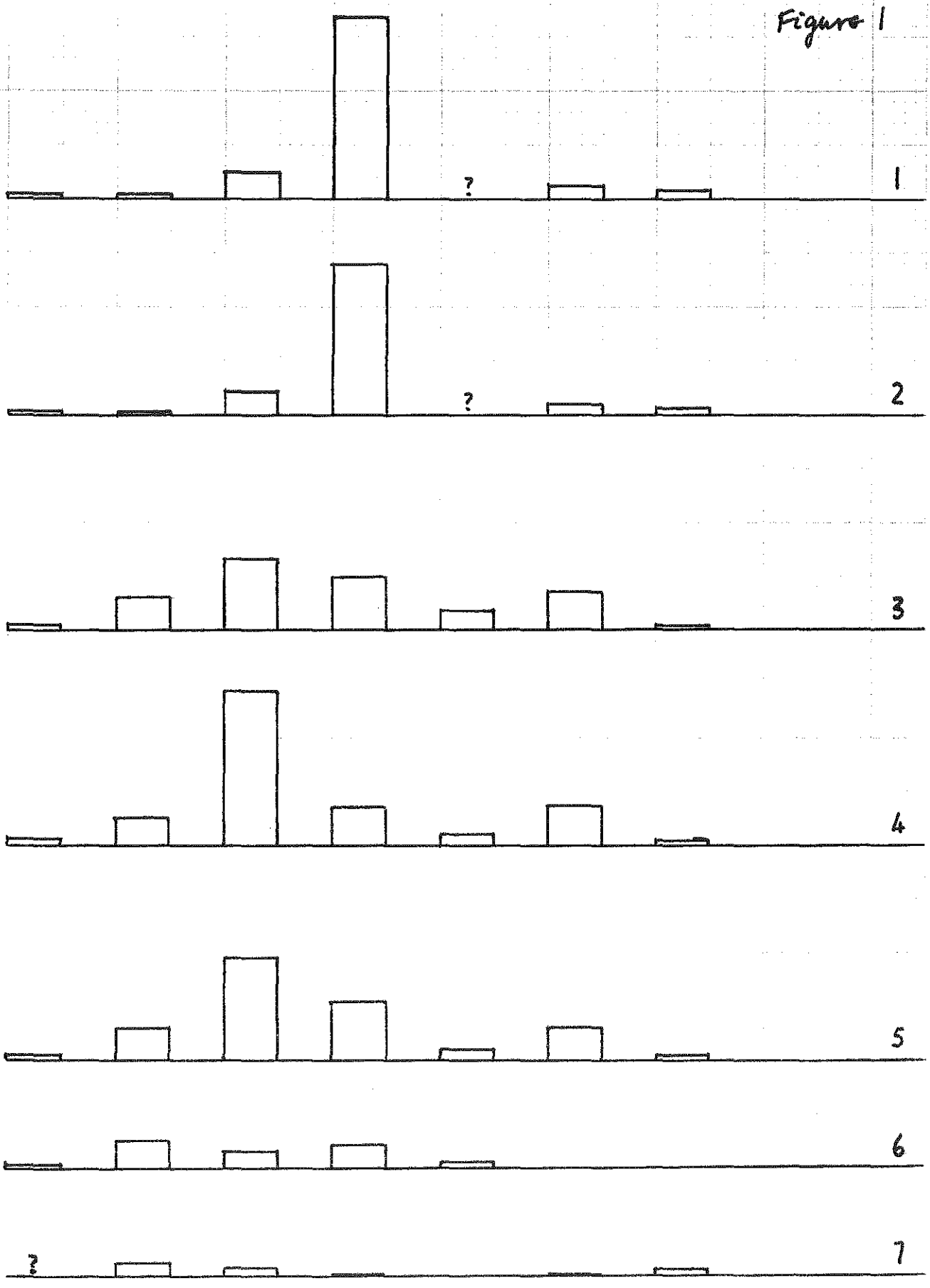

Figure 2