2355

Ancient Monuments Laboratory
Report 77/93

ASSESSMENT OF POTENTIAL FOR TECHNOLOGICAL ANALYSIS OF GLASSWORKING DEBRIS FROM LITTLE BIRCHES, WOLSELEY (STAFFORDSHIRE), 1991

Catherine Mortimer BTech DPhil

Ancient Monuments Laboratory Report 77/93

ASSESSMENT OF POTENTIAL FOR TECHNOLOGICAL ANALYSIS OF GLASSWORKING DEBRIS FROM LITTLE BIRCHES, WOLSELEY (STAFFORDSHIRE), 1991

Catherine Mortimer BTech DPhil

Summary

Twenty samples of glass and glassmaking waste were analysed quantitatively. The majority of the material dates to the 16th century, but glass from a crucible fragment associated with a 14th century furnace was also investigated. All the glass analysed is potash glass with a high magnesia content. Directions of future research are outlined.

Author's address :-

Catherine Mortimer BTech DPhil

Ancient Monuments Laboratory
English Heritage
23 Savile Row
London
W1X 1AB

Assessment of potential for technological analysis of glassworking debris from Little Birches, Wolseley (Staffordshire), 1991

Catherine Mortimer

Excavation in advance of gravel extraction, revealed two glassworking furnaces, one dated to the first half of the 14th century and the other to the mid-16th century (dates by archaeomagnetic dating and typological study of the pottery are in general agreement). Large quantities of glass waste were recovered from around these furnaces, from four large waste tips, from a 'kiln' structure (which may be connected with annealing) and from scatters in the topsoil. The material includes fragments of glassworking crucibles (*c.* 60kg) as well as irregularly-shaped glass waste (*c.*180kg), droplets (*c.* 700g), pieces of prepared glass (window crowns, flat glass *etc. c.* 14kg), some of which may be cullet. Two important contexts, 101 and 90 (near the later furnace), contained nearly 23kg of glass which has not been divided into material types.

Evidence for medieval glassworking is rare outside the Wealden area, until the 16th century. Staffordshire is one of a very small number of areas which are known to have glassmakers during the 14th and 15th centuries (Godfrey 1975,10). Sites contemporary with the earliest phase of glassworking at Little Birches are those in the Chiddingfold area of Surrey, some of which have been investigated by documentary research and site survey (*eg* Blunden's Wood, Hambledon (Wood 1965) and those mentioned in Kenyon 1967).

Staffordshire became an important area for glassworking in the late 16th and 17th centuries, which was a period of resurgence for glassmaking in this country. Sites contemporary with the later phase at Little Birches include the nearby Bagot's Park and Bishop's Wood which have been excavated and reported upon (Crossley 1967; Kenyon 1967, 68-71). Glass from Bagot's Park crucibles was analysed chemically and proved to be potash or 'forest' glass (Crossley 1967; 72), although some coloured glass fragments were richer in soda than in potash.

The existence of two phases of occupation on the site is of interest and research will be carried out by other team members to establish whether these episodes are recorded in the documentary records of the period. Analysis of the structural remains may also suggest dated parallels. Chemical analysis of the glass and glass waste at the site will establish which types of glass were being worked at the site. This information can be compared with evidence from other medieval glass material and may also help determine whether there were significant changes in technique or resource use.

Groups of glass artefacts and of glassworking debris from the site were submitted for examination to allow proper assessment of the glass industry at the site. Two further samples from Cattail Pool glass furnace (one mile east of Little Birches) were also submitted for comparative purposes; documentary evidence suggests that this site was a glasshouse *c.* 1452. The Little Birches samples were from a variety of locations and have various visual characteristics (see sample listing). Only a small amount of material was recovered from the early part of the site, and hence only one early sample (a crucible sherd) was included in the assessment. The appearance of excavated glass is often misleading and chemical analysis is the only sure way of establishing their type.

Method

The samples were mounted in a clear resin, ground and polished to 1 micron. After carbon coating, the glasses were analysed using the energy-dispersive X-ray analysis (EDAX) facility of a Cambridge Stereoscan scanning electron microscope (SEM). At least three areas were analysed from each polished fragment and the average value is quoted here (Table 1).

Results

Nearly all the glass analysed in this assessment was potash glass (also known as forest glass), with a narrow composition range (Table 1). The major oxide contents are similar to those of some contemporary potash glass found elsewhere, for instance at Bagot's Park (Crossley 1967), Blunden's Wood (Wood 1965) and in some vessels used in post-medieval London (Mortimer 1991, Table 5).

The consistently high magnesia contents are significant and, for this reason, the Little Birches collection is particularly comparable with material from Bagot's Park and Blunden's Wood. Other post-medieval potash glasses have lower magnesia levels (*eg* 'late' Wealden, Kenyon 1967, 39). Differences in magnesia content may reflect different types of plant ash or silica (*ie* sand or pebbles) were being used.

Groups of glass fragments from individual deposits at the site (*eg* the eastern and western tips) are generally similar in composition, as a consideration of their major oxide contents demonstrates (Fig 1). However, such groups are not particularly distinctive analytically, when compared with material from elsewhere at the site. This means, for example, that there is no evidence to suggest the tips were used at different times or for different types of glass.

A group of glass fragments said to be **cullet** (Sample 9, C1-C5 in Fig 1 and 'Cullet' in Fig 2) was found near Furnace 1. Most of these have compositions which are very similar to the glass from elsewhere on the site; if the nature of this deposit has been correctly identified, then it seems that the glassworkers recycled glass which they had produced themselves at the site, or glass which was produced in a very similar production tradition.

One piece of glass (Sample 9,3 (C3 on Fig 1)) within the 'cullet' grouping is distinctive - it is lower in magnesia, potash and manganese oxide and higher in alumina and lime than the others. The hand sample is noticeably well-preserved, without substantial corrosion but with a 'sealing-wax red' coloured outer layer on one side. This appearance and chemical composition is not repeated elsewhere in the sample and may indicate a different source for this piece of glass. The composition can be seen as mid-way between true potash glass and high-lime, low-alkali glass.

Glass adhering to the sides of a **crucible found near the early furnace** was analysed (Sample 12). The glass was badly deteriorated and easily crumbled away from the crucible, but an internal area of solid glass was found for analysis. This glass has a composition similar to the general (*ie* mostly 16th century) potash glass 'recipe' at the site (Figs 3 and 4). This single early sample is inadequate for any serious comparison with the later material, but the results do suggest that the glass type produced in the 14th century was similar to that produced in the 16th century.

The unusual compositional characteristics of the glass attached to a **crucible found near the later furnace** (Sample 11) included high alumina and iron oxide contents and low phosphorous pentoxide and potash contents ('Cruc 2' in Fig 3; 'Late crucible' in Fig 4). These results may prove to be outliers when further glass from crucibles is analysed. Analysis of such samples can be misleading because they reflect the composition of glass that remained in the crucible, and was not used, possibly because it was not suitable.

Two pieces of roughly shaped **glass waste**, which incorporated quartz pebbles and vitrified clay were analysed (Samples 13 and 17; Waste 1 and Waste 2 on Fig 3). The results show their compositions are largely comparable with the other potash glass at the site. A further piece of clear glass waste was tentatively identified as cullet (Sample 15; 'Cullet?' on Fig 3) and the composition of this too conforms with that of the majority of the glass at the site.

The exceptions to this general compositional picture are the two pieces of glass from **Cattail Pool**, which have low potash levels (2.8% and 3.1%) and moderate amounts of soda (4.9% and 5.4%), giving total-alkali levels which are significantly lower than those of glass fragments from Little Birches (7.7% and 8.5% *cf* 9.4%-17.7%). These pieces also have less magnesia, more lime and perhaps somewhat more chlorine[1] than the Little Birches material (Table 1; Fig 5). In appearance, they are better preserved than much of the Little Birches material, with less surface deterioration. These observations are said to be typical of the material from this site.

These analyses suggest that the glassworkers at these two sites used different raw material sources. Two samples are too few on which to base much supposition, but possible reasons for the difference in composition may include the use, at the Cattail Pool furnace, of plant ash which was richer in soda than in potash or of a proportion of soda-rich cullet. The Cattail Pool compositions are comparable to the glass compositions found at Clavell's early seventeenth century glasshouse at Kimmeridge (Crossley 1987, Table 3) and are also similar to some of the high-lime, low-alkali glasses found in post-medieval London (Fig 5; data from Mortimer 1991, Table 5).

Conclusions

Analysis shows that the Little Birches glass and glassworking debris are all made of potash glass. This type of glass was relatively common during the post-medieval period, being used for windows and many types of domestic ware. The Little Birches artefact and waste material is extremely uniform and is notable for it's distinctive high magnesia levels. One possible cullet fragment from the site was made of a different type of potash glass, with lower potash levels and higher lime levels. The 'comparative' material from Cattail Pool has quite a different chemical character, being high-lime, low-alkali glass.

All these glasses can be classified under the general heading of 'forest glass' since they are most probably the products of a glass production system that used plant or tree ash.

Assessment

Some aspects of the analytical results indicate that further research could be usefully carried out.

1. The chemical homogeneity of the glass fragments suggests that further analysis of this type of material would not be rewarding. However, analysis of cullet and deliberately-deposited material, especially within large groups (*eg* from contexts 101 and 90) could give useful information about manufacture and reuse of glass at the site. Analysis so far suggests this would require rather a large sampling programme to reveal any patterning (perhaps *c.* 50 samples), and should be proposed only where visual examination of the material shows marked and significant groupings within each context. 50 samples would take four weeks to analyse and report on.

2. Analysis of some of the more unusual types of glass at the site (*ie* the small numbers of coloured glass, painted glass and other diagnostic material) also has potential for determining the types of glass production system with which the Little Birches glassworkers were in contact. Analysis of glass fragments from the early part of the site is essential for a complete understanding of the industry. There may be some curatorial reluctance to allow sampling of such material. Once typological study has been completed, such objections will be largely removed and the chemical information will become even more worthwhile. The poor survival prognosis for this type of glass means that analysis (typological and chemical) should be carried out as soon as possible.

As this material represents only a small proportion of the total weight of glass at the site, this work has a lower priority than that on the crucible glass (see below). Preparing a report on the analysis of *c.* 20 sherds would take c. 2 weeks, if the material proved straight-forward.

3. Work on glass from crucibles appears to be of greater importance. Given the unusual composition of the only 'late' crucible to be analysed, further examples should be investigated to see whether this result is anomalous within a larger database. It is also important that the effects of high-temperature interaction between glass and crucible are evaluated, as these may have caused such an unusual composition. The most direct way of examining such effects is through SEM-EDAX analysis of sections of glass from crucibles to see how element concentrations vary with distance from the crucible/glass interface. Compositional changes with distance from the base of the crucible should also be evaluated.

This type of work will take longer to complete than the simple compositional analysis of glass fragments. Six samples of glass from crucibles should suffice and preparing a report would take about 4 weeks.

Notes

1. Analyses of trace elements or oxides are likely to have poorer accuracy and precision than those of major elements or oxides, for example, 0.4% should perhaps be quoted as 0.4% ± 0.2. Analysis using an alternative method (inductively-coupled plasma spectroscopy, ICP) will be carried out on material from this site. The results of analyses from the two methods will then be compared to evaluate the accuracy and precision.

References

Crossley D 1967 'Glassmaking at Bagots Park, Staffordshire in the sixteenth century' *Post-Medieval Archaeology 1*; 44-83.

Crossley D 1987 'Sir William Clavell's Glasshouse at Kimmeridge, Dorset: The Excavations of 1980-81' *Archaeological Journal 144*; 340-382.

Godfrey E S 1975 'The development of English glassmaking 1560-1640'

Kenyon G H 1967 'The glass industry of the Weald'

Mortimer C 1991 'Analysis of medieval and post-medieval glass from the City of London' *Ancient Monuments Laboratory report 135/91.*

Wood E S 1965 'A medieval glasshouse at Blunden's Wood, Hambledon, Surrey' *Surrey Archaeological Collections 62*; 54-79.

Sample listing

Sample	Context no, description of context	Sample number, description	
1	45, West tip	1.1	Pale. Surface pitting
		1.2	Ditto, with irridescence on one side
		1.3	Ditto
2	-, East tip	2.1	Strong, clear colour. Slight pitting. Relatively thin
		2.2	Darker. Less pitting. Slightly thicker
		2.3	Pale green in section. Pitting. Thick.
3	11, South tip	Three pieces, well-preserved, only light corrosion. Mossy green. One piece thinner than the others. *Not analysed.*	
4	1, Topsoil	Two pieces, pale moss green, one piece frosted, the other slightly darker green. *Not analysed.*	
5	1, Topsoil	One piece, dark mossy green. *Not analysed.*	
6	18, Topsoil, nr Kiln	One piece, pale. Not very heavily pitted.	
7	18, Topsoil, nr East tip	Pale,some pitting	
8	90, Deliberate deposit	8.1	Pale green, large pits.
		8.2	Ditto
9	101, Cullet deposit?	9.1	Pale green, some pitting
		9.2	Ditto, curved piece - vessel?
		9.3	Rim/edge? Flashed red on one side, otherwise clear green.
		9.4	Very pale, irridescence and flaking
		9.5	Green, but heavily corroded. Oval section rod.
11	01, Upper site	Crucible with glass deposits inside and out.	
12	-, lower (=northern=older) site	Crucible with glass deposit inside, poorly preserved, very crumbly	
13	01, Upper site	Crucible with glass deposit outside.	
14	42, West tip	'Dross', Light black and porous. *Not analysed.*	
15	101, Upper furnace	Clear - cullet? Large irregular pieces. Dark green	
16	-, East tip	Waste? Clear dark green. Lots of bubbles. *Not analysed.*	
17	-, East tip	Waste, including white pebble. Dark green, clear with some big bubbles.	
Cattail Pool			
10	Surface finds	10.1	Strongly coloured. Irregular shape
		10.2	Pale mossy green.

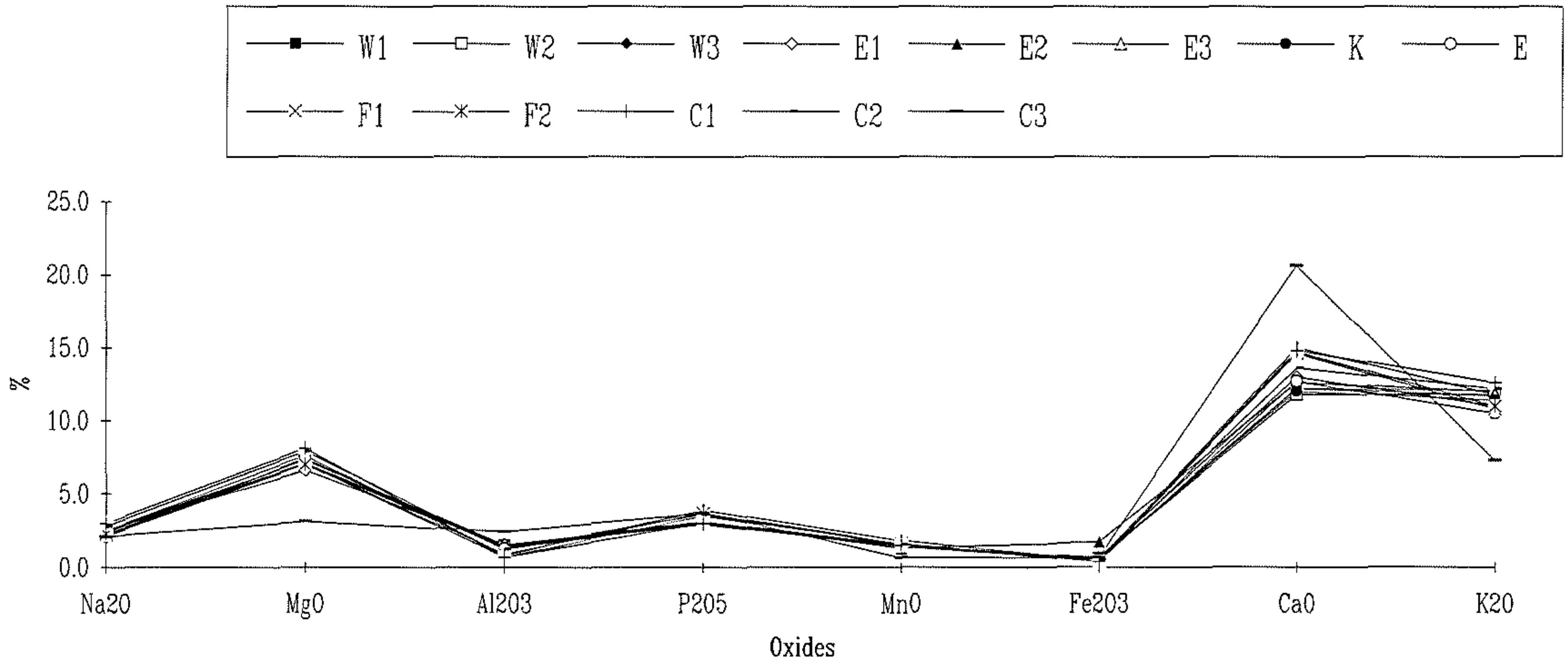
All glass samples are green and transparent in section, except were noted. The forms represented are probably all window glass fragments.

The crucible fragments examined are not large enough to determine their original forms, see other assessments for comments on the forms at the site.

Table 1: Chemical compositions

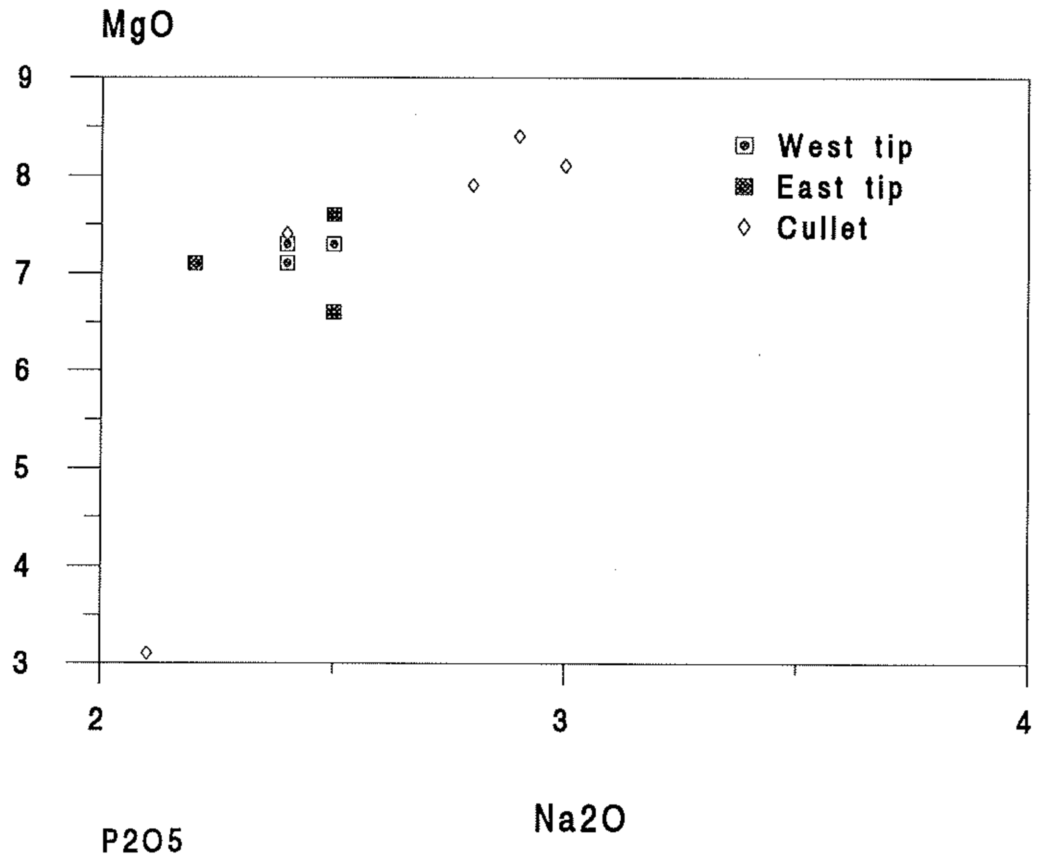
		Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	S	Cl	CaO	K_2O	TiO_2	Cr_2O_3	MnO	Fe_2O_3	CuO	SnO_2	PbO	Total
Glass fragments																		
Sample 1,1	West tip	2.5	7.3	1.5	57.3	2.9	0.1	0.1	12.2	12.1	0.2	0.1	1.4	0.5	0.1	nd	nd	98.3
Sample 1,2	West tip	2.4	7.3	1.4	58.5	3.1	0.1	0.1	11.8	11.8	0.2	0.1	1.5	0.6	nd	nd	nd	98.9
Sample 1,3	West tip	2.4	7.1	1.5	59.1	3.1	nd	0.1	12.2	11.7	0.1	nd	1.4	0.6	nd	nd	nd	99.3
Sample 2,1	East tip	2.5	6.6	1.5	58.7	2.9	nd	0.1	13.0	11.0	0.1	0.1	1.4	0.7	nd	nd	nd	98.6
Sample 2,2	East tip	2.2	7.1	1.4	58.0	3.0	0.1	0.1	12.6	12.0	0.2	0.1	1.3	1.7	nd	nd	nd	99.8
Sample 2,3	East tip	2.5	7.6	0.8	55.4	3.9	0.1	0.2	15.0	11.8	0.1	0.1	1.8	0.5	nd	nd	nd	99.8
Sample 6	Kiln	2.1	7.0	1.3	58.9	2.9	nd	0.1	12.0	11.4	0.2	nd	1.4	0.7	nd	nd	0.1	98.1
Sample 7	nr East	2.1	7.4	1.2	61.0	3.1	nd	nd	12.7	10.5	nd	nd	1.5	0.4	0.1	nd	nd	100.0
Sample 8,1	Furn 1	2.2	7.0	0.7	56.8	3.5	0.1	0.2	14.6	10.8	0.1	0.1	1.6	0.4	nd	nd	nd	98.1
Sample 8,2	Furn 1	2.3	7.0	0.9	58.9	3.7	0.1	0.2	14.7	11.0	nd	nd	1.6	0.4	0.3	nd	nd	101.1
Sample 9,1	Cullet?	3.0	8.1	0.7	54.5	3.0	nd	0.1	14.8	12.6	0.1	nd	1.5	0.4	nd	nd	nd	98.8
Sample 9,2	Cullet?	2.8	7.9	1.2	55.1	3.6	0.1	0.1	13.6	12.2	0.2	0.1	1.5	0.5	nd	nd	nd	98.9
Sample 9,3	Cullet?	2.1	3.1	2.4	55.6	3.7	nd	0.2	20.6	7.3	0.2	nd	0.7	0.7	nd	nd	nd	96.6
Sample 9,4	Cullet?	2.4	7.4	1.2	60.0	3.2	nd	0.1	13.3	10.3	0.1	0.1	1.5	0.5	nd	0.4	nd	100.5
Sample 9,5	Cullet?	2.9	8.4	1.1	55.5	3.6	0.1	0.1	13.2	12.4	0.3	0.1	1.6	0.4	nd	nd	nd	99.7
Glass waste and crucible fragments																		
Sample 11	Cruc 2	1.7	6.0	4.7	62.8	2.3	nd	nd	9.7	8.0	0.3	0.1	1.4	1.3	0.1	nd	nd	98.4
Sample 12	Cruc 1	1.8	6.9	1.8	52.2	4.5	0.1	0.1	16.6	12.9	0.2	0.1	1.6	0.7	nd	nd	0.3	99.8
Sample 13	Waste 1	3.4	7.3	1.3	52.8	4.3	0.1	0.1	12.6	14.3	0.1	0.1	1.9	0.5	0.1	nd	nd	98.9
Sample 15	Cullet?	3.3	8.3	1.9	57.8	3.9	0.1	0.2	13.9	11.7	0.1	nd	1.3	0.5	nd	nd	nd	103.0
Sample 17	Waste 2	3.1	7.8	0.9	60.3	4.1	0.1	0.2	16.5	14.5	0.1	0.1	1.9	0.5	0.1	nd	nd	110.2
Glass from Cattail Pool																		
Sample 10,1	Glass	4.9	3.7	3.2	61.0	2.7	nd	0.4	17.5	2.8	0.3	nd	0.6	0.9	nd	nd	0.1	98.1
Sample 10,2	Glass	5.4	4.2	3.7	57.8	3.3	nd	0.4	21.5	3.1	0.3	0.1	0.6	1.0	nd	nd	0.1	101.5

Fig 1: Glass from the west and east tips, and from other contexts



Codes: W= west tip, E= east tip, K = kiln, C = cullet

Fig 2: Oxide contents of some glass from the west and east tips, and cullet



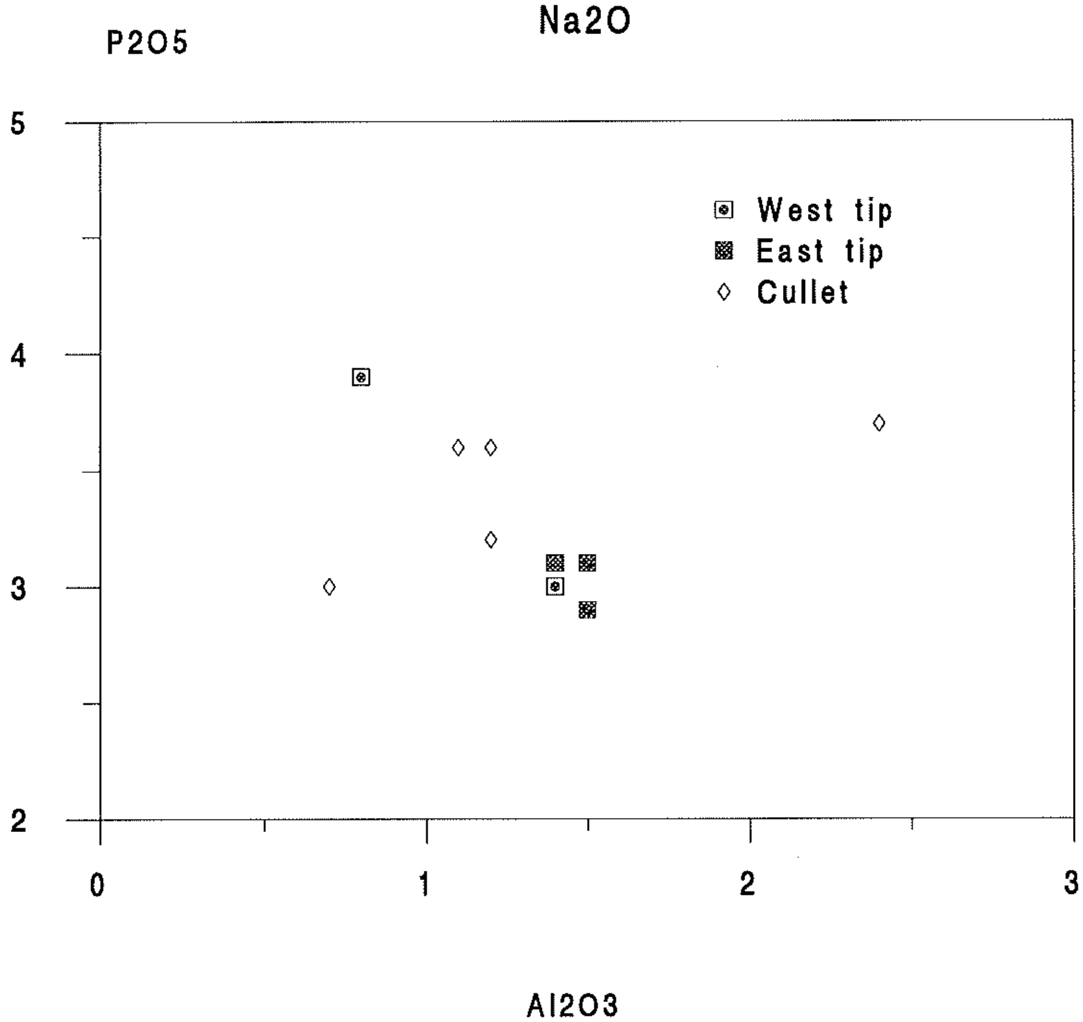
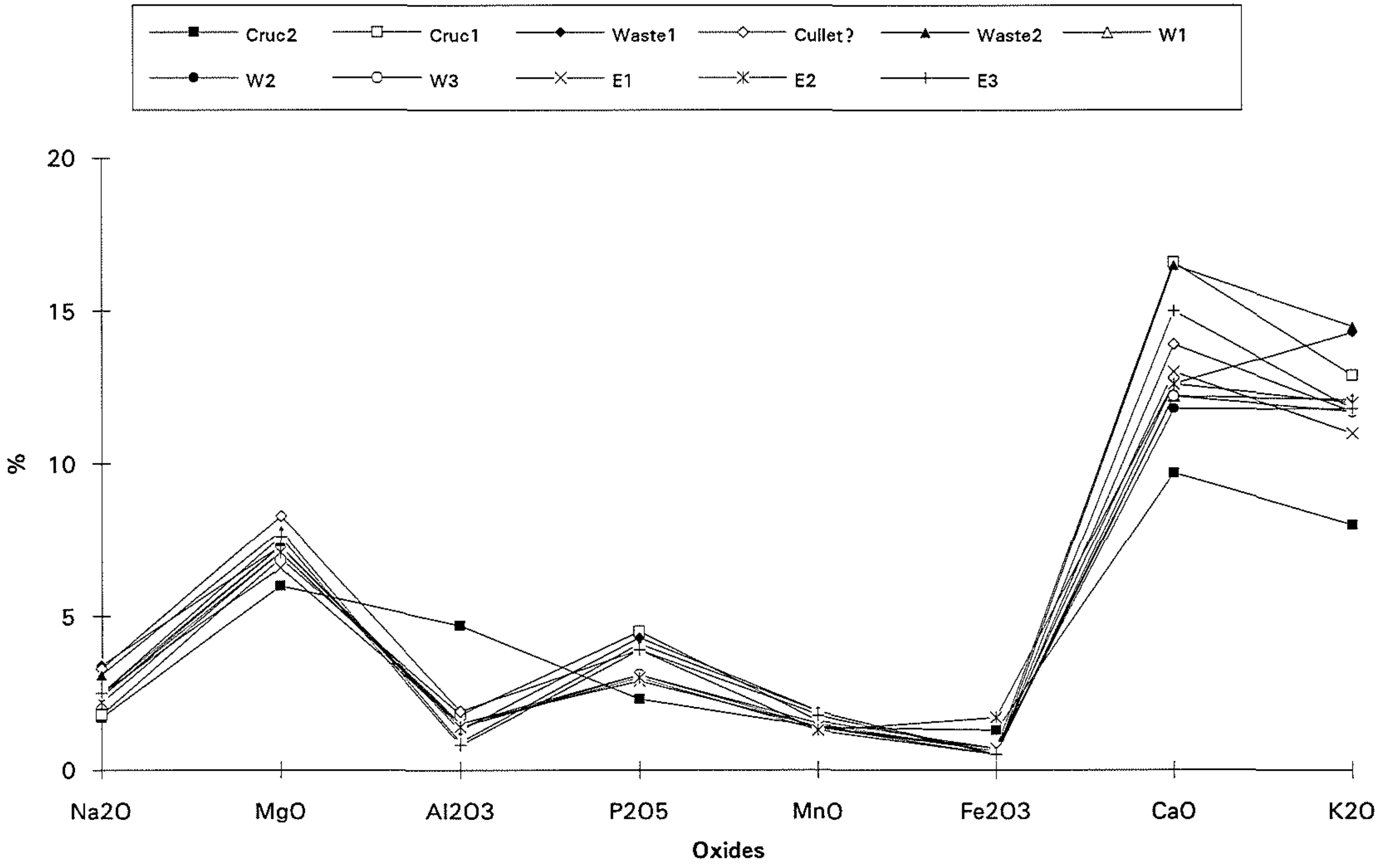


Fig 3: Glass from crucibles and glass waste, compared with other glass



Codes: Cruc 1 = early, Cruc 2 = late, W = west tip, E = east tip

Fig 4: Crucibles, waste, cullet and other glass

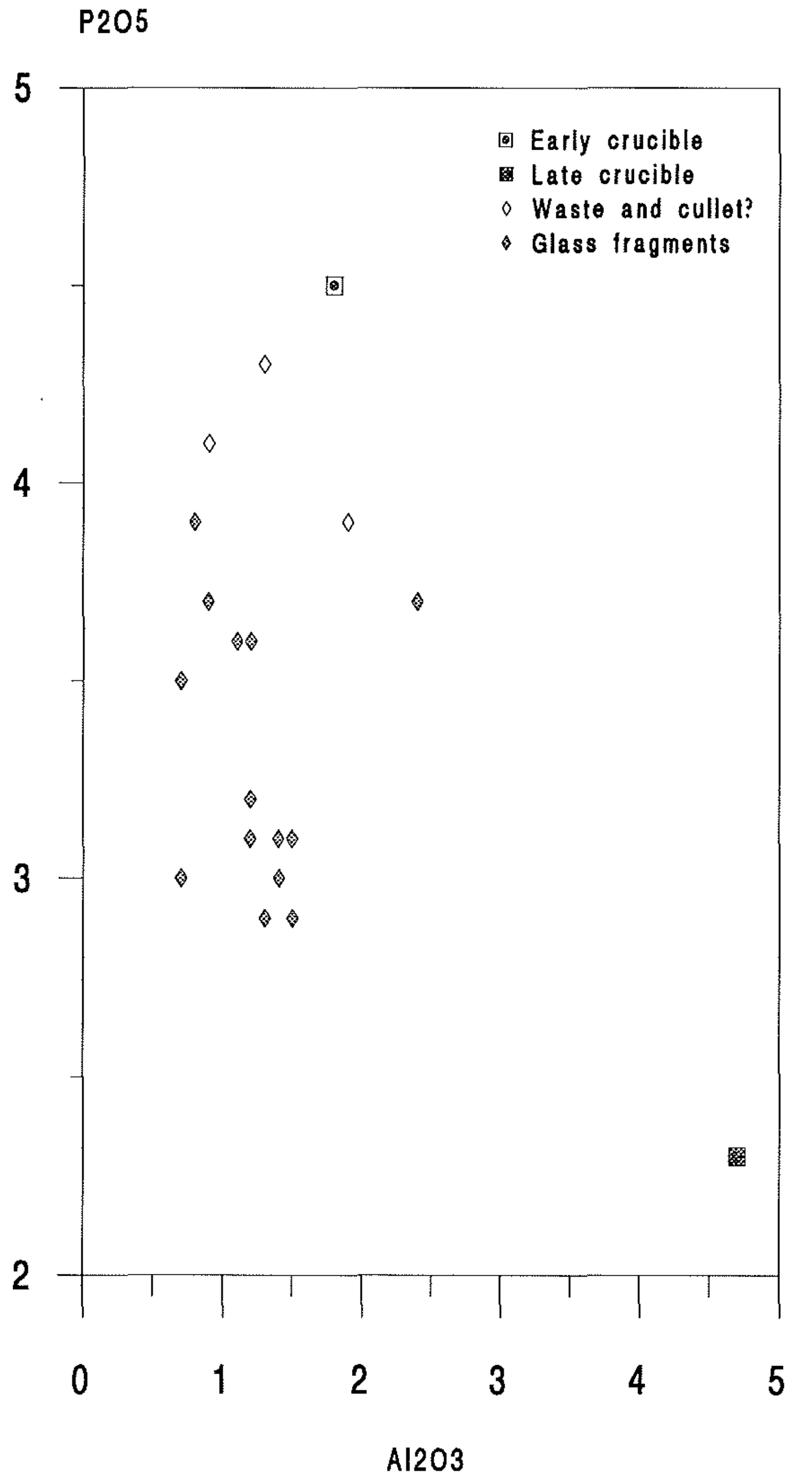


Fig 5: Post-medieval glass compositions