# Chemical analysis of pottery from the Broadgate Centre, Finsbury Avenue Square, City of London (FNB02)

## Alan Vince

In 2002 excavations by the Museum of London at the Broadgate Centres, Finsbury Avenue Square, City of London, revealed post-medieval pottery wasters. Five samples of post-medieval glazed red earthenware wasters and one tin-glazed ware waster were submitted for chemical analysis in order to establish their composition, to compare that composition with that of other post-medieval waste from the London area, specifically Moorfields, excavated by Pre-Construct Archaeology (Vince 2004), which is also located on the north side of the City of London outside the medieval city walls, and the Aldgate pottery, where a group of Antwerp potters established a maiolica factory on the site of Holy Trinity Priory in the late 16<sup>th</sup> century.

Samples were taken using the standard AVAC protocol, in which a fragment of pot was removed, all its surfaces mechanically abraded and the resulting lump was crushed to a fine powder using a porcelain pestle and mortar (Table 1). The powders were submitted to Royal Holloway College, London, where they were analysed using Inductively Coupled Plasma Spectroscopy. This method determines the percentage by weight of a range of major, minor and trace elements (listed in Appendix One).

The results indicate that the red earthenware samples were made from chemically-similar raw materials and that their composition distinguishes them from the nearby Moorfields waste. The tin-glazed ware sample has a composition which is similar to that of Antwerp maiolica rather than to either the Holy Trinity Priory waste or samples of probable London origin from consumer sites in the City.

## Glazed Red Earthenware

The five samples were examined at x20 magnification. This revealed two broad fabric groups: PMRE (samples C2339-41 and V2344) contains a fine subangular quartzose sand with a homogenous texture. Sparse rounded calcareous inclusions and fragments of battered, stained flint derived from Tertiary strata, both up to 4.0mm across, were present. PMR (sample V2343) is slightly coarser and has a poorly mixed texture, with lens of sand-rich and sand-free clay. The sample comes from the base of a large jar and has the stacking scar of a rim on the underside. The fabric of that vessel is also of Subfabric B. This suggests at least two batches of clay are present.

The frequency of silica in the samples was estimated by subtracting the sum of the major element values from 100%. The resulting value is mainly due to silica, but will also include chemically combined water, and incompletely burnt organic matter. For PMRE, the silica

#### AVAC Report 2004/121

estimate varies from 70.7% to 74.7% whilst that for PMR is 71.5%. Therefore, the two fabrics do not differ in their silica content (Fig 1 shows the range of silica values for various samples of Roman and later production waste from sites in the Thames basin).

Because of these variations in silica, which in some cases are the result of the deliberate tempering of the clay with quartzose sand, there will be a corresponding variation in the frequency of all other elements. To take account of this, the data from Finsbury, and that from these other Thames basin products, were all normalised to the frequency of Al2O3. The compositions of the two fabric groups from Finsbury were examined using this normalised date. The PMR sample has higher Fe2O3, CaO, P2O5, Sc, and V and lower K2O, and Ba than the PMRE samples. A factor analysis of the data shows the PMR sample separated by its F2 score, but also shows one of the PMRE samples, (V2341) separated by its high F1 score and one would need a larger number of samples to demonstrate a significant difference in composition between the two fabric groups (Fig 2).

Factor analysis was then carried out of the Finsbury data alongside that from other analysed production waste from the Thames basin. In order to try and understand the results of the analysis, three separate analyses were undertaken. The first (FA1) included data for the major elements alone, the second (FA2) included data for the minor and trace elements (excluding the rare earth elements) and the third (FA3) just included the rare earth elements.

FA1 indicated that there were two significant factors which between them accounted for 39% of the variability in the dataset. High Factor 1 scores have high weightings for MgO, CaO and MnO and negative weightings for Na2O. High Factor 2 scores have high weightings for TiO and Fe2O3 and no strong negative scores. Fig 3 shows a plot of F1 against F2 for this dataset. The Finsbury samples plot separately from most of the remainder as a result of their negative F2 scores. The contribution of Na2O and MgO to this separation is shown by Fig 4.

FA2 revealed three main factors. High F1 scores depend on strong weightings for Ni and Y and weak negative weightings for Sc and Cu. High F2 scores depend of strong weightings for Ba and Sr and strong negative weightings for Cr, V and Co. High F3 scores depend of high positive weightings for Sc and weak negative weightings for Ni.

A plot of F1 against F2 (Fig 5) shows a broad division into samples from northern Middlesex (Arkley, Pinner and Elstree), which have high F1 and negative F2 scores, and the remainder. The Finsbury samples are most similar to samples from the Fleet valley and Mill Green and have lower F2 values than the samples from Moorfields. The F3 scores for the Finsbury samples show that they are similar to the majority of the groups, with the exception of Copthall Close greyware, which has higher F3 scores, and Brockley Hill redwares, which have lower F3 scores (Fig 6).

#### AVAC Report 2004/121

Finally, FA3 showed that there was one main factor determining the variation in rare earth element compositions. This accounted for 70.5% of the variation in the dataset and depended on high positive weightings for all the elements, with the highest weightings being for La, Dy and Y and the lowest for Yb and Eu. The Finsbury samples have low F3 scores, as do those from Ingatestone (Fig 7). Fig 8 shows a plot of the two rare earth elements with the least similar weightings, Y and Yb. This shows that the ratios of these two elements fall into three groups: The first group consists of the samples from Elstree, Pinner, and Arkley. The second group consists of samples from Moorfields, Copthall Close, Sugar Loaf Court, and Brockley Hill and the third group consists of the Finsbury samples together with those from the Fleet Valley and Ingatestone.

## Discussion

Although the chemical data show strong similarities between the Finsbury samples and a range of sandy wares produced at different localities in the Thames Basin, within this dataset there are patterns. In particular, it is possible to distinguish the Finsbury samples from the Moorfields samples, which have a very similar visual appearance, using their major element compositions, their minor and trace element compositions and their rare earth element compositions. This therefore indicates that the Finsbury waste does come from a separate production centre.

The two visually distinct fabrics at Finsbury both share the same chemical characteristics.

There are probably underlying geological explanations for the various patterns seen here. For example there are chronological differences between the various exposures of London Clay, those from northern Middlesex being later than those exposed in the area of the City of London. The sands used as tempering in some of these groups come from different sources: the pre-glacial Proto-Thames, which ran to the north of the present river; the brickearth and lower terrace sands which occur in the vicinity of the City, and alluvial clays and silts found alongside the present river. However, these variations are best studied using thin sections and in any case are clearly complex and unlikely to be immediately useful in characterising the post-medieval pottery of the City. For this reason, we cannot use the chemical analyses to establish what the source of the clay used at Finsbury was.

## Tin-glazed ware

The sample of tin-glazed ware comes from an internally decorated bowl. The glaze has started to flow in the kiln, a fault often seen in tin-glazed waste from London. A major study of London tin-glazed ware was carried out at the British Museum in the 1990s using Neutron Activation Analysis (Hughes and Gaimster 1999). A small subset of the elements analysed by Hughes are also measured using ICPS and the feasibility of using these shared elements to characterise the various analysed wares has been demonstrated by Brown and Vince

#### AVAC Report 2004/121

(Vince and Brown 2002). Using the same procedure, the Finsbury sample was compared with those analysed for the Maiolica in the North project and various tin-glazed wares analysed using ICPS at the Royal Holloway College, London, for the author.

The results clearly distinguished the Norwich and Italian samples included in the BM dataset and these were therefore excluded and the analyse repeated. The result indicated a single factor, with high positive weightings for the rare earth elements La, Sm, Eu and Ce and for Fe2O3 and Sc. Applying these weightings the Finsbury sample has a score of -1.37. This lies outside the range for both the 20 Holy Trinity Priory samples and the 46 samples from consumer sites in the City which were thought to be London-made pieces (Figs 9 and 10). By contrast, the score falls within the range for Antwerp, and in particular for Antwerp Schoytestraat. It is therefore possible that the sherd is not a London tin-glazed waster but a import of second quality from Antwerp.

Figures



Figure 1 Silica content for Finsbury and other production waste from the Thames basin



Figure 2 Plot of Factors 1 and 2 for Finsbury Redware data











Figure 5















Figure 9



Figure 10

|--|

TSNO	Context	Cname	Subfabric	Form	Part	Description
V2339	1137	PMRE		JAR (SUGM?)	BS	
V2340	1137	PMRE		JAR COL	BS	
V2341	1137	PMRE		JAR COL	BS	
V2342	1206	TGW	TGW A	BOWL	BS	BLUE, LT BROWN, YELLOW DEC INT
V2343	1049	PMR			BS	
V2344	1137	PMRE		COL	BS	

TSNO	AI2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V2339	15.79	5.64	1.62	0.62	0.19	2.59	0.82	0.1	0.016
V2340	15.7	5.72	1.65	0.66	0.1805	2.59	0.81	0.12	0.016
V2341	16	7.1	1.95	0.38	0.1615	2.8	0.79	0.08	0.03
V2342	11.68	4.72	0.99	12.65	0.323	1.44	0.56	0.99	0.055
V2343	15.51	7.05	1.73	0.73	0.1805	2.39	0.78	0.14	0.024
V2344	14.25	5.75	1.42	0.51	0.1615	2.35	0.75	0.1	0.014

Appendix 1

TSNO	Ва	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Се	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Со
V2339	338	112	37	64	40	17	100	139	21	86	40	76	32	3.908	1.236	3.8	2.4	458.525	82	19
V2340	346	110	35	66	42	17	102	143	19	71	41	70	35	4.284	1.228	3.5	2.1	1100.75	79	18
V2341	368	122	28	86	62	17	81	160	26	64	43	137	48	6.27	1.69	5.2	2.7	356	94	40
V2342	437	77	38	42	39	12	361	77	22	76	28	49	64	3.284	0.928	3.6	1.9	2743.8	64	19
V2343	308	116	30	76	49	18	89	158	21	78	36	76	37	3.485	1.395	4.2	2.5	213.225	88	20
V2344	313	106	30	57	31	16	84	137	15	72	32	62	27	2.375	0.925	2.7	1.8	816.375	72	13

Appendix 2

## Bibliography

- Hughes, M. and Gaimster, D. (1999) "Neutron activation analysis of maiolica from London, Norwich, the Low Countries and Italy." in D. Gaimster, ed., *Maiolica in the North: the archaeology of tin-glazed earthenware in north-west Europe c.1500-1600*, British Museum Occasional Paper 122 British Museum Press, London, 57-90.
- Vince, A. and Brown, D. H. (2002) "Characterisation and identification of tin-glazed ceramics using inductively-coupled plasma spectroscopy." in J. Veekman, ed., *Majolica and Glass from Italy to Antwerp and beyond*, Antwerp, 465-474.