

GLASS: ANALYSIS OF SAMPLES FROM THE SANCTUARY PAVEMENT

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Samples of the opaque glasses were analyzed by Ian Freestone in 1989,¹ and the translucent glasses by Colleen Stapleton in 1997.² The published analyses of glass from the Westminster Retable (altarpiece) are also pertinent.³ The results of the 1989 and 1997 analyses are given in **Tables 1 and 2.**⁴

Opaque Glass

The opaque glasses on the tomb-cover on the south side of the pavement (panel 55) are all soda-lime-silica glass (**Table 1**). They are of a type known as *high-potash high-magnesia*, or *soda-ash* glass, where the source of the soda and lime is believed to have been plant ash.

The white and blue glasses were rendered opaque by the inclusion of tin oxide, and lead is present at levels typically associated with tin-opacified glass. Two types of blue glass are present: turquoise blue, coloured by copper oxide, and a deep blue containing low amounts of copper and cobalt. The analyser was unable to detect cobalt at the levels likely to cause the colouration (c. 0.2%) but it is assumed to be present on the basis of comparisons with other, similar glasses.

Tin-opacified, soda-ash glass is typical of production in southern Europe, the Mediterranean and the Near East during the medieval period. On the basis of the somewhat limited information available, it is possible to make some tentative distinctions between tin-opacified glasses from different regions on the basis of their tin and lead contents (**Fig. 7/###**). It is observed that early (12th century) and late (12th–14th century) Islamic glasses are distinguished from early (13th–14th century ‘Aldrevandin’) and late (16th century) Venetian glasses. Interestingly, opaque glass in the pavement is identical in composition to opaque glasses used to enamel metalwork in Limoges at about the same time. However, though there is no suggestion of a French origin for the opaque glass on the pavement, it is not out of the question that opaque glass for enamelling was being made in Limoges at this time. It is likely that the glass used in the Pavement and the enamels was imported from the South or East.

Table 1 Composition of opaque glasses in the sanctuary pavement

	32839	32840	32841	32842
	Red	Blue	Turquoise	White
SiO ₂	59.3	49.3	51.5	49.7
Al ₂ O ₃	1.8	1.3	1.4	1.6
FeO	3.7	0.8	0.6	0.5
MnO	0.3	0.2	0.4	1.0
MgO	3.6	3.3	2.4	2.7
CaO	9.5	7.4	5.9	5.6

Na ₂ O	17.2	14.5	13.9	12.9
K ₂ O	2.0	2.0	1.4	1.4
P ₂ O ₅	0.5	0.6	0.3	0.3
Cl	1.1	0.9	1.1	0.9
SO ₂	0.2	0.3	0.3	0.3
CuO	0.8	0.5	1.8	0.5
PbO	0.3	13.1	13.1	17.4
SnO ₂	0.5	6.4	6.3	7.4
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Total	100.0	99.6	100.1	101.4

Note the inclusion of tin oxide (SnO₂) as an opacifier, which is not present in translucent glass.

Analyses in weight percent, by energy dispersive X-ray analysis in the scanning electron microscope. Relative accuracies are around 2% for SiO₂, 5% for CaO and Na₂O and 10% for components above 1 wt%.

Translucent glass

Table 2 shows that the compositions of translucent glasses in the Cosmati pavement are very different from those of the opaque glasses. They are potash-lime-silica glasses having a fairly low soda (Na₂O), but high potash (K₂O), content. There is no evidence for the production of high quality coloured glass in England at this time;⁵ the glass is typical of medieval *forest* glasses produced in Northern Europe. There are essentially two different sub-types of *forest glass* present in the pavement. The strongly coloured amber, red, dark blue and green glasses contain broadly similar amounts of potash and lime, while a single example of green-blue glass has about twice as much lime as potash. The colours are due to the inclusion of copper (red and green), cobalt (blue) and iron (amber) in the molten glass batch. These glasses are so similar in composition to those decorating the Westminster Retable, that it is thought the glass was made in the same workshop, representing one or more different batches of base glass, to which colouring agents were added. It is not impossible that the Retable and Pavement translucent glasses were part of a single consignment. Analysis of the green-blue glass shows it is a single example of high-lime glass with very low silica. It is a very different product, made with different raw materials from an unknown source. Work soon to be submitted for publication by Laura Adlington and co-workers⁶ indicates that the typical Retable and Pavement translucent glasses are likely to have been made in northwestern France. The origin of the high-lime green-blue glass is less clear-cut, although it resembles Rhenish compositions more than it does those from Normandy.

TABLE 2. Composition of translucent glasses in the sanctuary pavement

	Amber	Red	Dark blue	Green	Green-blue
SiO ₂	57.8	53.6	54.5	55.2	45.1
Al ₂ O ₃	1.11	1.18	1.20	1.14	2.42
FeO	0.65	0.70	1.03	0.67	0.67
MnO	1.83	1.51	1.94	1.50	1.29
MgO	7.17	6.58	6.87	6.22	4.83
CaO	11.46	13.25	13.81	12.63	27.59
Na ₂ O	3.63	2.72	2.60	2.81	1.26
K ₂ O	12.98	14.22	13.17	11.86	13.66
CoO	<0.05	<0.05	0.13	<0.05	0.07
CuO	<0.06	0.82	0.30	2.98	0.13
ZnO	<0.1	0.17	0.33	0.46	0.19
PbO	<0.1	<0.1	0.15	<0.1	0.26
P ₂ O ₅	3.72	4.15	3.89	3.51	1.56
Total	100.37	98.86	99.88	99.02	99.04

Analyses in weight percent, by energy dispersive X-ray analysis in the scanning electron microscope. Relative accuracies are around 1% for oxides above 10 wt%, better than 10% for remaining oxides, except Na₂O at better than 30%.

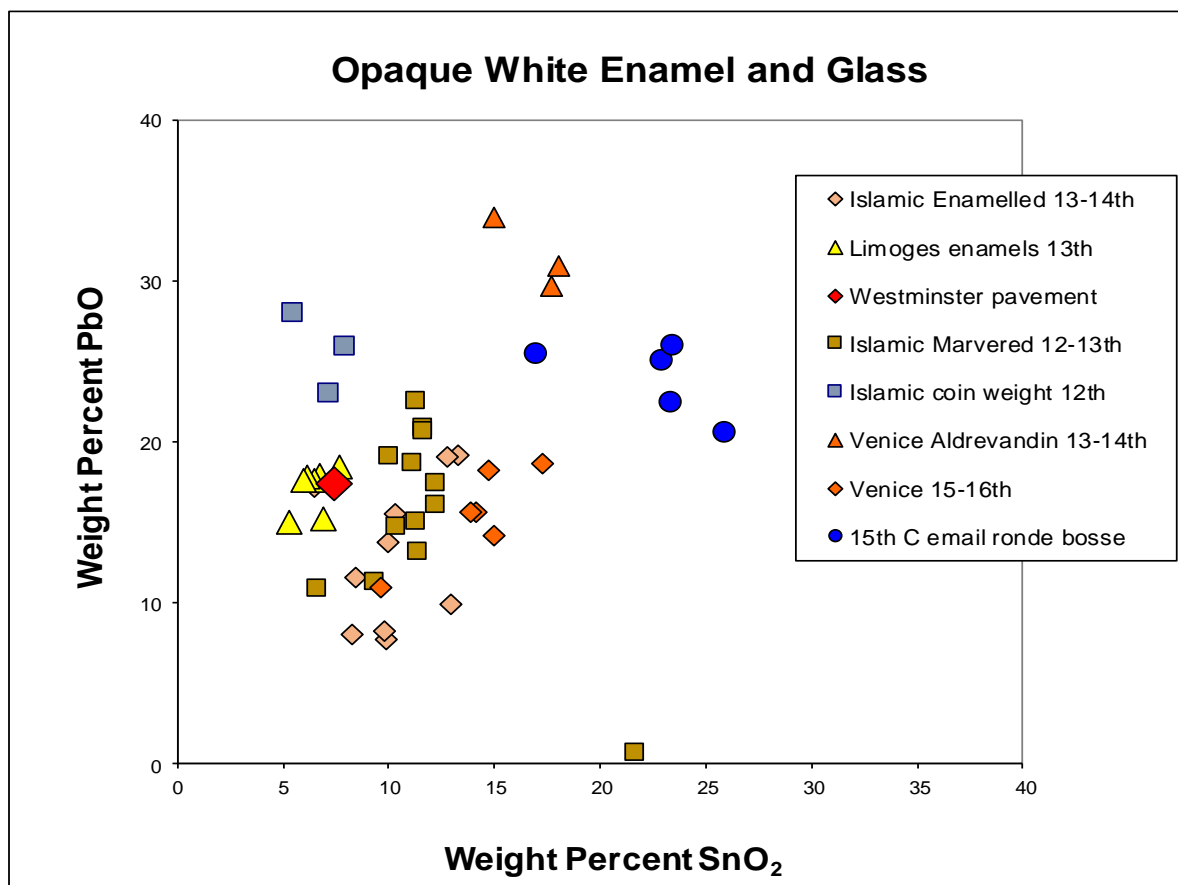


Fig. 7/#####. Dated tin-opacified glass from different regions, grouped on the basis of their lead and tin oxide contents

¹ I. Freestone, British Museum Department of Scientific Research: Project Report 5831, 19 June 1989.

² C. Stapleton, British Museum Department of Scientific Research: Project Report 6952, 25 June 1997.

³ Binski and Freestone 1995; Davison 2009.

⁴ See also Foster 2002, 59-63.

⁵ Binski and Freestone 1995.

⁶ Adlington L W, Freestone I C, Kunicki-Goldfinger, J J and Ayers T (2018 manuscript to be submitted for publication) Regional patterns in medieval European glass composition as a provenance tool.