

APPENDIX 3

Analytical data

The following pages contain the original data (compositions in weight % of oxides and reported weight % errors, ± 1 sigma) obtained from SEM-EDS analysis of glass and paint samples:

- (a) Samples from Sherborne Abbey w1 panel 2d
- (b) Samples from All Saints Church Emscote n7 tracery panel
- (c) Various unfired paint and flux samples.

The data were obtained using an FEI Sirion XL-30 Scanning Electron Microscope (SEM) equipped with a Thermo Noran Ultra-Dry Energy Dispersive X-Ray Spectrometer (EDS) and NSS Spectral Analysis System v.2.3 (Thermo Fisher Scientific). Imaging and analysis were carried out at an accelerating voltage of 20 kV with standardless quantification.

Samples from Sherborne Abbey w1 2d

Sample_no.	Material	F	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₂ O ₅	SO ₃	Cl	K ₂ O	CaO	Fe ₂ O ₃	ZnO	Cu ₂ O	MoO ₃	PbO	Total
Sample1(1)_pt2	Paint	2.04			2.64	13.51		5.31	0.17		0.81	44.30	0.92			30.31	100.0
Sample1(2)_pt1	Paint	3.25			1.95	14.22		2.00	0.13	0.09	0.69	49.90	1.06			26.73	100.0
Sample1(5)_pt1	Paint				1.78	16.09		1.05	0.08		0.64	53.30		0.58		26.49	100.0
Sample4(3)_pt1	Paint	0.99			1.66	24.38			0.28	0.21	1.08	44.40			3.13	23.86	100.0
Sample4(5)_pt1	Paint	1.34		0.13	0.9	24.57	0.76		0.17	0.35	0.75	56.63			0.38	14.02	100.0
Sample5(2)_pt1	Paint	0.85	1.49		1.08	24.46		0.30	0.33		1.69	42.38				27.42	100.0
Sample5(5)_pt1	Paint	1.54	0.53		1.21	19.68		0.62	0.17		0.81	53.15				22.29	100.0
Sample5(7)_pt1	Paint (edge)	1.47	0.36	0.15	1.11	17.9			0.34		0.83	56.45				21.4	100.0
Sample5(8)_pt1	Paint	1.26	1.69		1.36	22.22			0.24		2.27	40.36				30.59	100.0
Sample9(5)_pt1	Paint	1.44	2.54		0.80	15.53		0.02	0.18	3.13		45.13				31.24	100.0
	Average	1.42	1.32	0.14	1.45	19.26		1.33	0.21	0.95	1.06	48.60				25.44	101.2
Reported errors	O	F	Na	Mg	Al	Si	P	S	Cl	K	Ca	Fe	Zn	Cu	Mo	Pb	
Sample1(1)_pt2	±0.25	±0.21			±0.05	±0.07		±0.15	±0.06		±0.06	±0.25	±0.13				±0.94
Sample1(2)_pt1	±0.21	±0.26			±0.06	±0.07		±0.15	±0.05	±0.03	±0.06	±0.27	±0.16				±1.08
Sample1(5)_pt1	±0.24	±0.00			±0.06	±0.07		±0.13	±0.05		±0.03	±0.27		±0.12			±1.04
Sample4(3)_pt1	±0.30	±0.22			±0.03	±0.08			±0.05	±0.03	±0.06	±0.28				±0.35	±1.89
Sample4(5)_pt1	±0.27	±0.20		±0.03	±0.03	±0.08	±0.03	±0.03	±0.02	±0.05		±0.28				±0.28	±0.91
Sample5(2)_pt1	±0.24	±0.22	±0.07		±0.03	±0.08		±0.14	±0.05		±0.06	±0.25					±1.66
Sample5(5)_pt1	±0.23	±0.21	±0.04		±0.05	±0.07		±0.13	±0.05		±0.03	±0.26					±1.61
Sample5(7)_pt1	±0.24	±0.20	±0.04	±0.03	±0.05	±0.07		±0.00	±0.04		±0.05	±0.27					±0.94
Sample5(8)_pt1	±0.24	±0.21	±0.07		±0.05	±0.08			±0.04		±0.06	±0.25					±1.06
Sample9(5)_pt1	±0.22	±0.22	±0.08		±0.05	±0.07		±0.14	±0.05	±0.07		±0.26					±1.80
Average	±0.24	±0.20	±0.06	±0.03	±0.05	±0.07	±0.03	±0.11	±0.05	±0.05	±0.05	±0.26	±0.15	±0.12	±0.32		±1.29

Sample	Material	F	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	Cl	K ₂ O	CaO	TiO ₂	MnO	Fe ₂ O ₃	MoO ₃	Total
Sample1(1)_pt3	Glass clear		11.05	1.13	2.66	68.71	0.15	0.65	14.05		0.31	1.29		100.0
Sample1(2)_pt2	Glass clear		9.60	1.02	2.67	68.85	0.2	0.66	15.22	0.21		1.56		100.0
Sample1(5)_pt2	Glass clear	0.03	9.52	1.03	2.70	68.83	0.21	0.73	15.11		0.31	1.54		100.0
Sample5(2)_pt2	Glass clear		9.39	0.91	2.5	69.04	0.18	0.69	15.48		0.34	1.48		100.0
Sample5(5)_pt2	Glass clear		9.49	0.87	2.54	68.73	0.22	0.64	15.46	0.18	0.39	1.28	0.21	100.0
	Average		9.81	0.99	2.61	68.83	0.19	0.67	15.06	0.20	0.34	1.43		100.1
Reported errors	O	F	Na	Mg	Al	Si	Cl	K	Ca	Ti	Mn	Fe	Mo	
Sample1(1)_pt3	±0.28		±0.07	±0.03	±0.05	±0.13	±0.02	±0.02	±0.08		±0.04	±0.05		
Sample1(2)_pt2	±0.31		±0.07	±0.03	±0.05	±0.13	±0.02	±0.02	±0.09	±0.02		±0.06		
Sample1(5)_pt2	±0.34	±0.14	±0.07	±0.03	±0.05	±0.13	±0.02	±0.02	±0.09		±0.05	±0.06		
Sample5(2)_pt2	±0.30		±0.07	±0.03	±0.05	±0.13	±0.02	±0.02	±0.09		±0.05	±0.10		
Sample5(5)_pt2	±0.46		±0.07	±0.03	±0.05	±0.13	±0.03	±0.02	±0.09	±0.03	±0.05	±0.10	±0.04	
Average	±0.34	±0.14	±0.07	±0.03	±0.05	±0.13	±0.02	±0.02	±0.09	±0.03	±0.05	±0.07	±0.04	

Sample	Material	F	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	SO ₃	Cl	K ₂ O	MnO	Fe ₂ O ₃	PbO	Total
Sample4(2)_pt1	Glass yellow	1.40	1.21		1.00	47.77	0.07	0.21	9.53	2.17	7.82	28.83	100.0
Sample4(2)_pt2	Glass yellow	2.42	1.21		1.06	50.62		0.19	9.88	2.48	6.91	25.22	100.0
Sample4(3)_pt3	Glass yellow	2.67	2.63		0.94	53.27	0.05	0.21	8.33	2.17	6.64	23.08	100.0
Sample4(5)_pt2	Glass yellow	2.68	2.39	0.17	1.01	53.45		0.19	8.77	1.92	6.75	22.67	100.0
Sample9(5)_pt2	Glass yellow	1.06	2.32		0.98	52.76	0.41	0.24	8.59	2.26	6.96	24.43	100.0
	Average	2.05	1.95		1.00	51.57		0.21	9.02	2.20	7.02	24.85	99.9

Reported errors	O	F	Na	Mg	Al	Si	S	Cl	K	Mn	Fe	Pb
Sample4(2)_pt1	±0.24	±0.22	±0.05		±0.03	±0.11	±0.13	±0.05	±0.09	±0.15	±0.19	±1.04
Sample4(2)_pt2	±0.24	±0.13	±0.05		±0.04	±0.10		±0.04	±0.09	±0.07	±0.16	±0.96
Sample4(3)_pt3	±0.23	±0.12	±0.05		±0.04	±0.11	±0.12	±0.04	±0.08	±0.13	±0.15	±0.90
Sample4(5)_pt2	±0.24	±0.13	±0.05	±0.03	±0.04	±0.11	±0.04	±0.08		±0.13	±0.16	±1.47
Sample9(5)_pt2	±0.24	±0.20	±0.05		±0.04	±0.11	±0.12	±0.05	±0.08	±0.13	±0.16	±1.53
Average	±0.24	±0.16	±0.05	±0.03	±0.04	±0.11	±0.10	±0.05	±0.09	±0.12	±0.16	±1.18

Sample	Material	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	SO ₃	Cl	K ₂ O	CaO	Cu ₂ O	PbO	Total
Sample6(1)_pt2	Base clear under flash	12.9	0.66	1.24	71.14	0.79	0.1	1.32	11.84			100.0
Sample6(1)_pt1	Red flash	2.65		0.9	57.97	0.08	0.14	12.11	8.84	1.91	15.39	100.0

Reported errors	O	Na	Mg	Al	Si	S	Cl	K	Ca	Cu	Pb
Sample6(1)_pt2	±0.31	±0.08	±0.03	±0.03	±0.13	±0.03	±0.02	±0.03	±0.08		
Sample6(1)_pt1	±0.30	±0.07		±0.04	±0.12	±0.11	±0.04	±0.11	±0.10	±0.22	±0.86

Samples from All Saints' Church Emscote n7 tracery

Sample	Material	Na ₂ O	Al ₂ O ₃	SiO ₂	CaO	Fe ₂ O ₃	CoO	PbO	Total
Sample 1(1)_pt2	Paint	2.59		24.74	0.7	30.03	3.79	38.14	100.0
Sample 1(2)_pt1	Paint	2.72		20.88	1.56	43.2	8.22	23.42	100.0
Sample 1(4)_pt1	Paint	2.66	0.55	27.3	1.2	25.1	3.42	39.77	100.0
	Average	2.66		24.31	1.15	32.78	5.14	33.78	99.8

Reported errors	O	Na	Al	Si	Ca	Fe	Co	Pb
Sample 1(1)_pt2	±0.40	±0.08		±0.12	±0.05	±0.40	±0.36	±1.82
Sample 1(2)_pt1	±0.38	±0.08		±0.11	±0.10	±0.41	±1.65	
Sample 1(4)_pt1	±0.39	±0.13	±0.05	±0.13	±0.06	±0.39	±0.20	±1.95
Average	±0.39	±0.10	±0.05	±0.12	±0.07	±0.40	±0.74	±1.89

Sample	Material	F	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	SO ₃	Cl	K ₂ O	CaO	MnO	Fe ₂ O ₃	MoO ₃	Total
Sample 1(1)_pt3	Glass	1.41	10.44		1.33	67.24		0.24	0.61	12.41	0.75	2.46	3.11	100.0
Sample 1(2)_pt2	Glass	0.32	10.91		1.3	68.66	1.82	0.23	0.73	13.29		2.75		100.0
Sample 1(4)_pt2	Glass		11.69	0.17	1.16	68.17		0.32	0.69	12.17	0.72	2.48	2.42	100.0
	Average	0.87	11.01		1.26	68.02		0.26	0.68	12.62	0.74	2.56	2.77	100.8

Reported errors	O	F	Na	Mg	Al	Si	S	Cl	K	Ca	Mn	Fe	Mo
Sample 1(1)_pt3	±0.40	±0.23	±0.11		±0.04	±0.17		±0.04	±0.04	±0.14	±0.09	±0.20	±0.15
Sample 1(2)_pt2	±0.51	±0.27	±0.11		±0.04	±0.17	±0.07	±0.04	±0.04	±0.15	±0.12		
Sample 1(4)_pt2	±0.44		±0.12	±0.05	±0.04	±0.17		±0.04	±0.04	±0.14	±0.09	±0.20	±0.15
Average	±0.45	±0.25	±0.11	±0.05	±0.04	±0.17	±0.07	±0.04	±0.04	±0.14	±0.10	±0.20	±0.15

Unfired paint and flux samples

Samples analysed:

JP Emery Ltd Strong Black No D 7430 (sample dating to 1940s, acquired from Harper and Hendra Studios, Harpenden, now defunct)

JP Emery Ltd Soft Black No D 7085 (sample dating to 1940s, acquired from Harper and Hendra Studios, Harpenden, now defunct)

Hancock's Glass Shading Brown H986 (sample dated 1939, acquired from Harper and Hendra Studios, Harpenden, now defunct)

Rockingham Tracing Brown 3980 (modern sample)

Heatons Flux No I (sample dating to 1940s, acquired from Harper and Hendra Studios, Harpenden, now defunct)

JC Ground Flux (sample acquired from Jonathan Cooke)

BAM Flux No 1 (sample acquired from Dr Manfred Torge, BAM; known composition, see below)

BAM Flux No 2 (sample acquired from Dr Manfred Torge, BAM; known composition, see below)

BAM Flux No 5 (sample acquired from Dr Manfred Torge, BAM; known composition, see below)

Published composition of BAM Fluxes:¹

	B₂O₃	Na₂O	SiO₂	PbO	Total
BAM Flux 1			25	75	100.0
BAM Flux 2	7.7	3.4	22.2	66.6	99.9
BAM Flux 5	46.2	20.4	22.2	11.1	99.9

¹ Müller et al, 1997: 82.

	F	Na ₂ O	Al ₂ O ₃	SiO ₂	P ₂ O ₅	SO ₃	K ₂ O	TiO ₂	Cr ₂ O ₃	MnO	Fe ₂ O ₃	CdO	CoO	ZnO	As ₂ O ₃	Sb ₂ O ₃	MoO ₃	PbO
Emery D7430(1)_pt1			0.71	6.64							10.82		9.63					72.2
Emery D7430(3)_pt1			0.43	7.2							10.4		9.21					72.75
Emery D7430(5)_pt1			1.09	6.54							10.58		9.89	2.12				69.78
Average			0.74	6.79							10.60		9.58	2.12				71.58
Emery D7085(2)_pt1				5.59		1.17					6.3		5.7	3.58				77.67
Emery D7085(3)_pt1			0.33	5.42							5.46		6.92	3.64				78.22
Average			0.33	5.51		1.17					5.88		6.31	3.61				77.95
Hancock H986(1)_pt1	2.78		3.06	39.37			1.38		3.71	4.58	8.03			12.64		6.69		17.78
Hancock H986(2)_pt1			2.93	41.16			1.42		3.62	4.64	7.34			11.79	3.04	6.92		17.14
Average	2.78		3.00	40.27			1.40		3.67	4.61	7.69			12.22	3.04	6.81		17.46
Rock'ham 3980(2)_pt1	1.7	2.39	2.6	26.87	0.97		0.33	1			24.17	3.4						36.57
Rock'ham 3980(3)_pt1	1.16	2.67	2.02	23.3	0.88		0.26	1.05			27.35							41.33
Average	1.43	2.53	2.31	25.09	0.93		0.30	1.03			25.76	3.40						38.95
Heatons Flux(1)_pt1		1.53	1.3	33.58			5.87				6.27							51.44
Heatons Flux(2)_pt1		1.61	1.2	32.52			5.7				6.52							52.45
Average		1.57	1.25	33.05			5.79				6.40							51.95
JC Ground Flux(1)_pt1			0.56	30.53	1.05			0.93						3.3				63.63
JC Ground Flux(2)_pt1			0.41	29.91	1.44			0.82						3.25				64.18
Average			0.49	30.22	1.25			0.88						3.28				63.91

	F	Na ₂ O	Al ₂ O ₃	SiO ₂	P ₂ O ₅	SO ₃	K ₂ O	TiO ₂	Cr ₂ O ₃	MnO	Fe ₂ O ₃	CdO	CoO	ZnO	As ₂ O ₃	Sb ₂ O ₃	MoO ₃	PbO	
BAM Flux 1(1)_pt1				18.3														81.7	
BAM Flux 1(2)_pt1				20.05														79.95	
Average				19.18														80.83	
BAM Flux 2(1)_pt1		2.25	1.12	18.67														77.97	
BAM Flux 2(2)_pt1		1.97	1.06	18.55														78.42	
BAM Flux 2rpt(1)_pt1		1.91	0.88	18.26														78.95	
BAM Flux 2rpt(2)_pt1		1.99	0.9	17.37														79.74	
Average		2.03	0.99	18.21														78.77	
BAM Flux 5(1)_pt1		23.1	1.01	44.86		0.22	0.33											30.49	
BAM Flux 5(2)_pt1		22.73	0.51	45.17			0.41										1.9	29.28	
Average		22.92	0.76	45.02		0.22	0.37										1.90	29.89	
Reported errors	O	F	Na	Al	Si	P	S	K	Ti	Cr	Mn	Fe	Cd	Co	Zn	As	Sb	Mo	Pb
Emery D7430(1)_pt1	±0.26			±0.06	±0.11							±0.41		±0.49					±2.65
Emery D7430(3)_pt1	±0.28			±0.06	±0.11							±0.41		±0.50					±2.73
Emery D7430(5)_pt1	±0.28			±0.09	±0.10							±0.38		±0.46	±0.33				±2.54
Average	±0.27			±0.07	±0.11							±0.40		±0.48	±0.33				±2.64
Emery D7085(2)_pt1	±0.27				±0.11		±0.29					±0.21		±0.45	±0.35				±2.76
Emery D7085(3)_pt1	±0.26			±0.06	±0.10							±0.37		±0.25	±0.35				±4.25
Average	±0.27			±0.06	±0.11		±0.29					±0.29		±0.35	±0.35				±3.51
Hancock H986(1)_pt1	±0.45	±0.51		±0.06	±0.17			±0.06		±0.12	±0.33	±0.36			±0.72		±0.53		±1.95
Hancock H986(2)_pt1	±0.41			±0.07	±0.18			±0.07		±0.23	±0.34	±0.37			±0.73	±1.46	±0.55		±3.63
Average	±0.43	±0.51		±0.07	±0.18			±0.07		±0.18	±0.34	±0.37			±0.73	±1.46	±0.54		±2.79

Reported errors	O	F	Na	Al	Si	P	S	K	Ti	Cr	Mn	Fe	Cd	Co	Zn	As	Sb	Mo	Pb
Rock'ham 3980(2)_pt1	±0.40	±0.44	±0.08	±0.06	±0.14	±0.06		±0.07	±0.08			±0.43	±0.44						±3.52
Rock'ham 3980(3)_pt1	±0.41	±0.42	±0.13	±0.10	±0.14	±0.06		±0.06	±0.08			±0.46							±2.26
Average	±0.41	±0.43	±0.11	±0.08	±0.14	±0.06		±0.07	±0.08			±0.45	±0.44						±2.89
Heatons Flux(1)_pt1	±0.42		±0.07	±0.05	±0.15			±0.16				±0.35							±2.44
Heatons Flux(2)_pt1	±0.41		±0.11	±0.09	±0.15			±0.16				±0.35							±2.38
Average	±0.42		±0.09	±0.07	±0.15			±0.16				±0.35							±2.41
JC Ground Flux(1)_pt1	±0.36			±0.05	±0.14	±0.06			±0.09						±0.33				±2.59
JC Ground Flux(2)_pt1	±0.31			±0.05	±0.14	±0.12			±0.07						±0.29				±2.23
Average	±0.34			±0.05	±0.14	±0.09			±0.08						±0.31				±2.41
BAM Flux 1(1)_pt1	±0.21				±0.07														±2.36
BAM Flux 1(2)_pt1	±0.20				±0.07														±2.21
Average	±0.21				±0.07														±2.29
BAM Flux 2(1)_pt1	±0.30		±0.11	±0.08	±0.11														±3.95
BAM Flux 2(2)_pt1	±0.31		±0.12	±0.10	±0.14														±4.19
BAM Flux 2rpt(1)_pt1	±0.19		±0.06	±0.05	±0.07														±2.31
BAM Flux 2rpt(2)_pt1	±0.19		±0.06	±0.05	±0.07														±2.19
Average	±0.19		±0.06	±0.05	±0.07														±2.25
BAM Flux 5(1)_pt1	±0.22		±0.15	±0.07	±0.14		±0.17	±0.05											±1.77
BAM Flux 5(2)_pt1	±0.22		±0.15	±0.04	±0.14			±0.05										±0.33	±1.76
Average	±0.22		±0.15	±0.06	±0.14		±0.17	±0.05										±0.33	±1.77