

Supplementary Materials for:

Influence of the painting medium on the alteration process of smalt in oil paintings using combined K and Co K-edge XANES analyses.

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1. About mock-ups

1.1. Mock-ups preparation

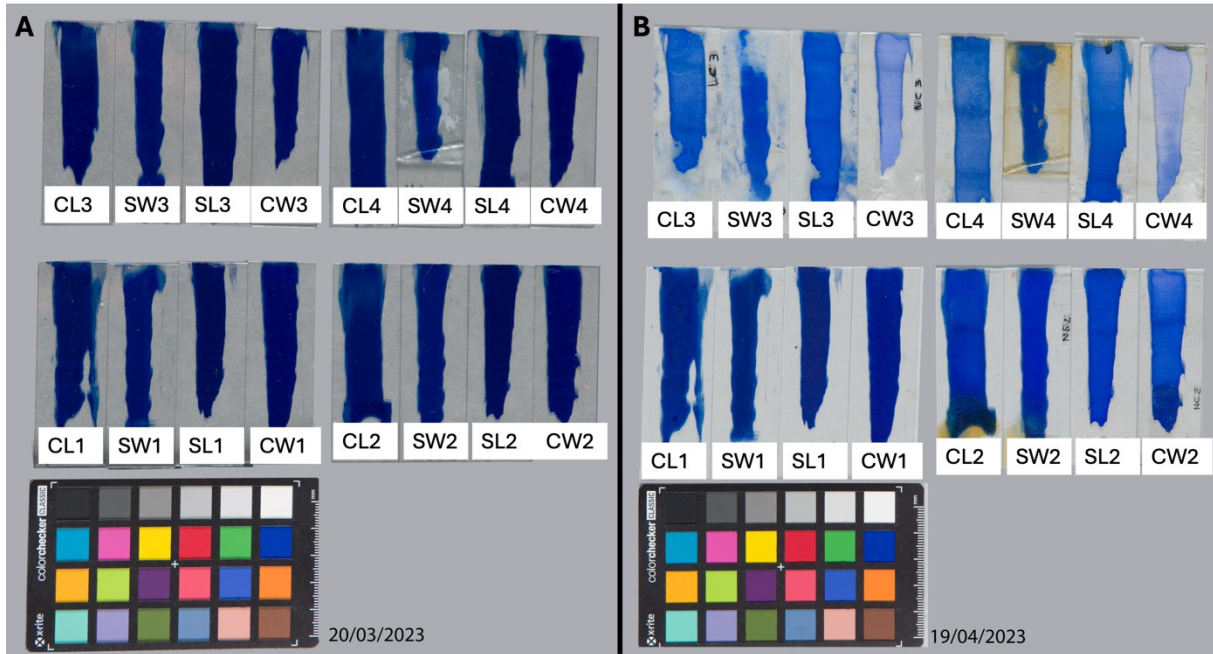


Figure 1: Images of the mock-up samples. A: Before aging. B: After aging

Table 1: Evolution of the thermostatic conditions during the aging

	Day 0	Day 1 to 2	Day 3	Day 4 to 7	Day 8 to 9	Day 10	Days 11 to 13	Day 14	Day 15 to the end
Temperature (°C)	70	Unknown	70	70	Unknown	20	70	70	70
Humidity (%)	97	Unknown	3	97	Unknown	50	97	50	97

1.2. Mock-ups analyses

1.2.1. SEM-EDX

1.2.1.1. CLO

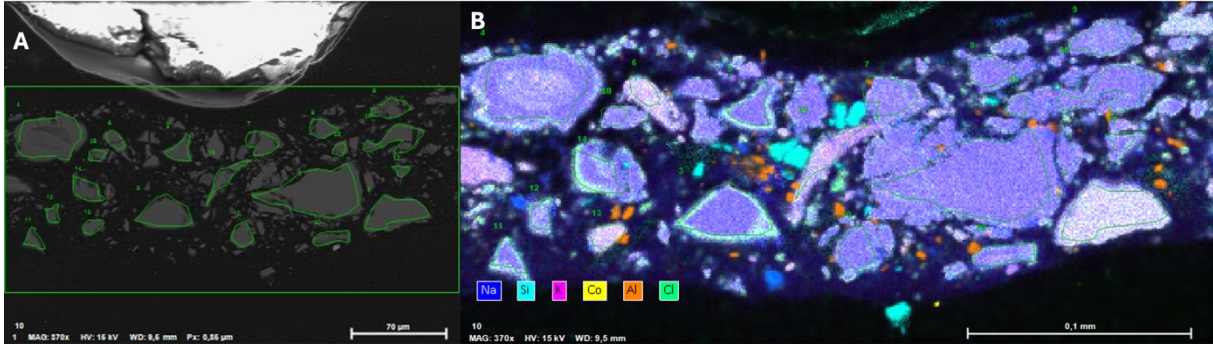


Figure 2: SEM-EDX images of CLO sample. A: Backscattered electron image with analyzed areas. B: Elemental maps

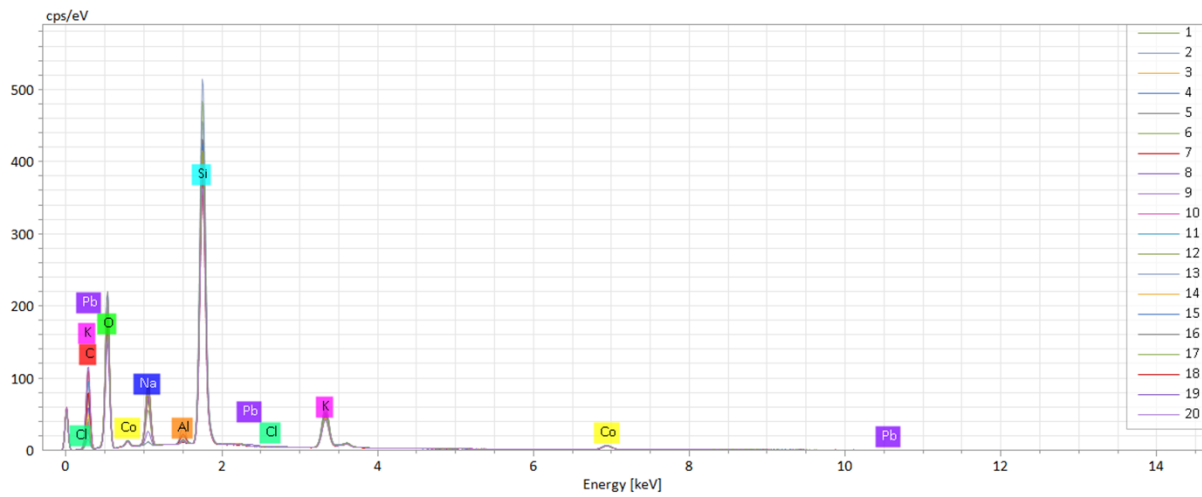


Figure 3: EDX spectra of analyzed areas shown on Figure 2

Table 2: Semi quantitative results of the EDX analyses

Spectrum	ClO ₂	CoO	PbO	Na ₂ O	Al ₂ O ₃	SiO ₂	K ₂ O
1	0.02	6.91	0.66	15.40	0.62	63.96	12.44
2	0.00	7.74	1.07	1.17	0.44	75.00	14.59
3	0.05	7.00	0.72	14.60	0.66	65.37	11.61
4	0.03	7.09	0.76	13.67	0.53	65.92	12.00
5	0.07	7.02	0.72	14.80	0.51	64.86	12.01
6	0.00	7.55	1.05	1.18	0.69	74.45	15.07
7	0.00	7.29	0.61	12.63	2.39	64.99	12.08
8	0.00	6.86	0.79	15.49	0.57	64.22	12.07
9	0.08	6.79	0.66	13.64	0.65	65.81	12.36

10	0.03	7.09	0.76	16.11	0.69	63.13	12.18
11	0.00	7.97	0.00	12.58	0.54	67.90	11.01
12	0.05	8.39	0.73	9.35	0.48	69.84	11.16
13	0.00	7.51	0.63	0.99	4.00	71.90	14.96
14	0.22	7.50	0.80	11.15	0.60	68.14	11.58
16	0.03	7.10	0.35	14.89	0.85	64.46	12.32
17	0.00	6.55	0.77	12.38	0.58	69.69	10.02
18	0.12	6.86	0.87	12.61	0.47	65.67	13.40
19	0.19	7.22	1.48	4.42	1.07	68.71	16.91
20	0.23	6.99	0.61	14.09	0.81	65.08	12.21
Mean	0.06	7.23	0.74	11.11	0.90	67.32	12.63
Sigma	0.08	0.45	0.29	5.17	0.87	3.49	1.66
SigmaMean	0.02	0.10	0.07	1.19	0.20	0.80	0.38

1.2.1.2. CL4

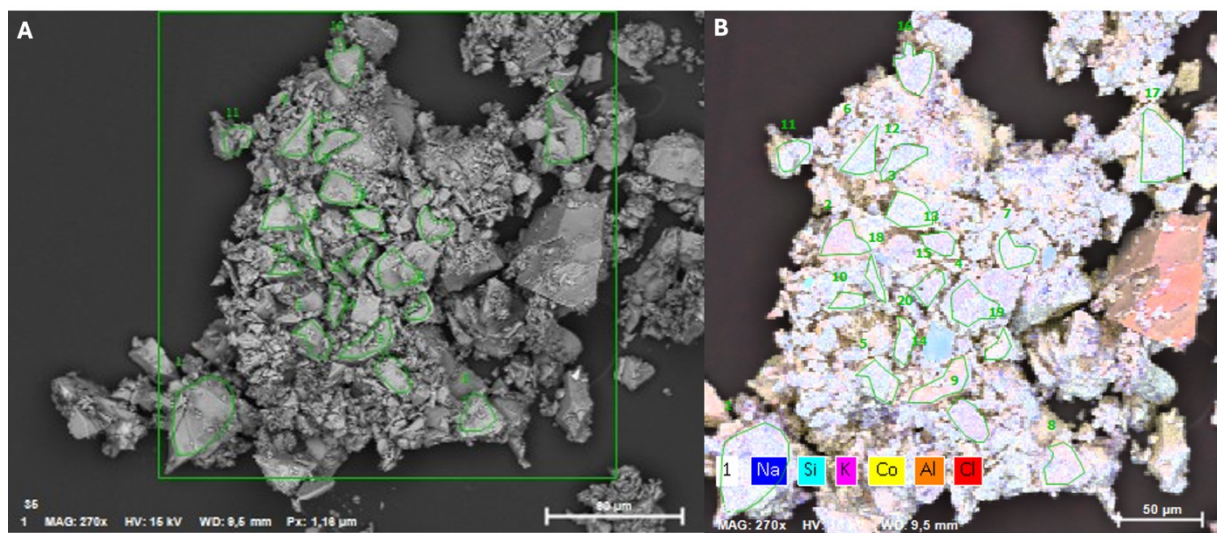


Figure 4: SEM-EDX images of CL4 sample. A: Backscattered electron image with analyzed areas. B: Elemental maps

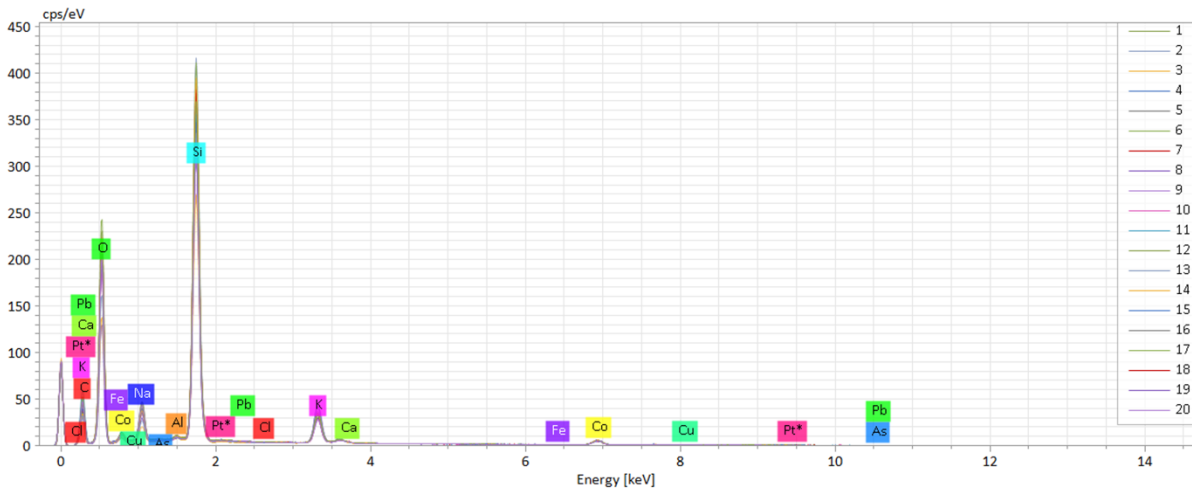


Figure 5: EDX spectra of analyzed areas shown on Figure 4

Table 3: Semi quantitative results of the EDX analyses

Spectrum	ClO ₂	CoO	PbO	Na ₂ O	Al ₂ O ₃	SiO ₂	K ₂ O
1	0.05	7.51	0.95	10.23	0.39	68.55	12.31
2	0.08	7.85	1.01	7.21	0.32	67.88	15.65
3	0.04	8.17	1.17	8.14	0.49	70.05	11.93
4	0.00	6.98	1.18	7.94	0.43	71.00	12.47
5	0.04	8.09	0.88	8.83	0.40	70.81	10.94
6	0.13	7.53	0.92	8.66	0.31	70.96	11.51
7	0.01	7.86	1.32	8.52	0.31	70.48	11.49
8	0.01	8.31	0.88	7.74	0.43	68.29	14.34
9	0.01	7.76	1.47	7.32	0.29	68.45	14.70
10	0.14	7.32	0.94	9.86	0.82	69.62	11.29
11	0.03	7.97	1.08	8.67	0.40	70.69	11.16
12	0.08	7.15	0.00	9.81	0.51	71.21	11.24
13	0.00	8.55	0.88	7.18	0.34	69.24	13.81
14	0.11	7.94	1.20	6.73	0.80	68.47	14.75
15	0.00	7.00	0.92	8.24	0.34	71.60	11.91
16	0.19	7.20	0.70	10.16	0.29	68.03	13.43
17	0.04	7.58	0.93	8.46	0.74	70.77	11.48
18	0.20	8.54	0.59	10.34	0.36	68.44	11.52
19	0.00	7.83	1.24	9.30	0.25	70.99	10.38
20	0.36	7.37	0.73	10.87	0.59	68.09	11.98
Mean	0.08	7.73	0.95	8.71	0.44	69.68	12.41
Sigma	0.09	0.47	0.31	1.20	0.17	1.29	1.49
SigmaMean	0.02	0.11	0.07	0.27	0.04	0.29	0.33

1.2.1.3. SLO

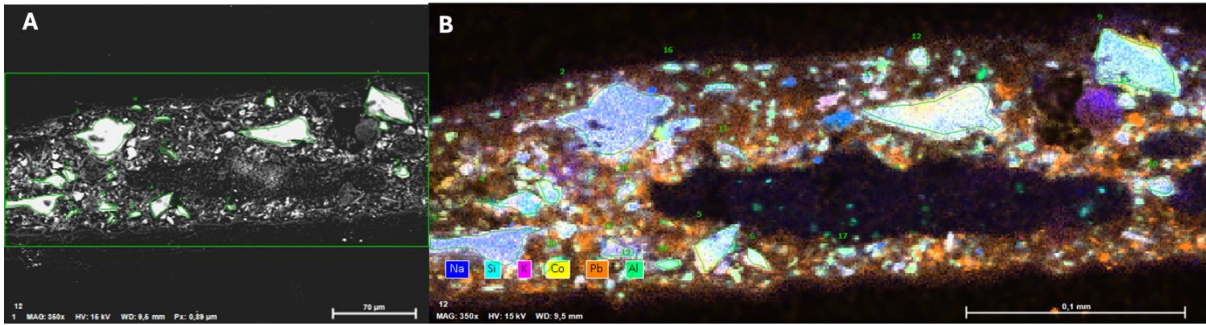


Figure 6: SEM-EDX images of SLO sample. A: Backscattered electron image with analyzed areas. B: Elemental maps

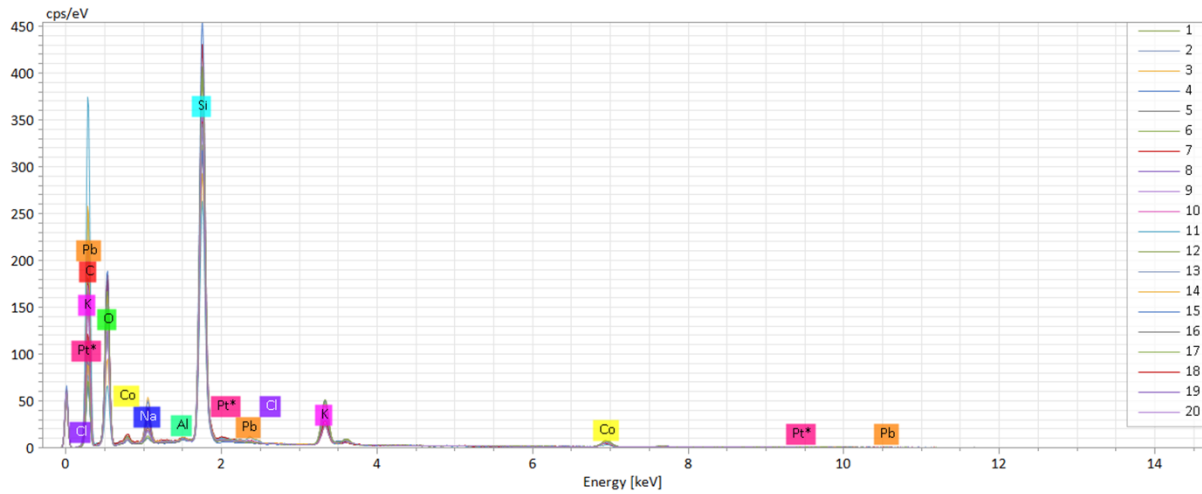


Figure 7: EDX spectra of analyzed areas shown on Figure 6

Table 4: Semi quantitative results of the EDX analyses

Spectrum	ClO ₂	CoO	PbO	Na ₂ O	Al ₂ O ₃	SiO ₂	K ₂ O
1	0.00	8.62	1.29	1.79	0.34	73.23	14.74
2	0.00	7.99	0.81	10.62	0.55	68.11	11.93
3	0.00	7.85	0.78	10.26	0.66	67.89	12.57
4	0.14	6.71	0.92	0.92	0.60	75.20	15.51
5	0.08	7.89	1.57	5.23	0.63	73.00	11.59
6	0.55	7.39	1.04	2.10	0.23	72.57	16.12
7	0.00	9.72	1.15	8.98	0.78	69.57	9.80
8	0.00	8.30	0.94	6.26	0.50	75.27	8.73
9	0.02	8.98	0.81	6.31	0.53	73.34	10.02
10	0.20	8.69	1.63	7.20	0.57	71.54	10.17
11	0.00	5.25	2.60	7.72	0.25	73.23	10.95
12	0.00	9.19	0.82	1.07	0.31	73.66	14.94
13	0.00	8.93	1.17	2.84	0.53	71.16	15.38
14	0.14	7.25	3.51	6.90	0.69	70.54	10.98

15	0.12	6.84	1.32	11.94	0.33	65.98	13.47
16	0.22	9.75	0.18	6.52	0.39	74.13	8.81
17	0.15	7.37	0.82	6.13	0.20	77.49	7.85
18	0.26	8.60	0.57	3.59	0.56	80.40	6.04
19	0.00	12.76	1.10	3.98	0.29	65.70	16.17
20	0.04	7.54	1.89	4.03	0.07	79.05	7.37
Mean	0.10	8.28	1.25	5.72	0.45	72.55	11.66
Sigma	0.14	1.52	0.74	3.20	0.19	3.94	3.11
SigmaMean	0.03	0.34	0.17	0.72	0.04	0.88	0.70

1.2.1.4. SL4

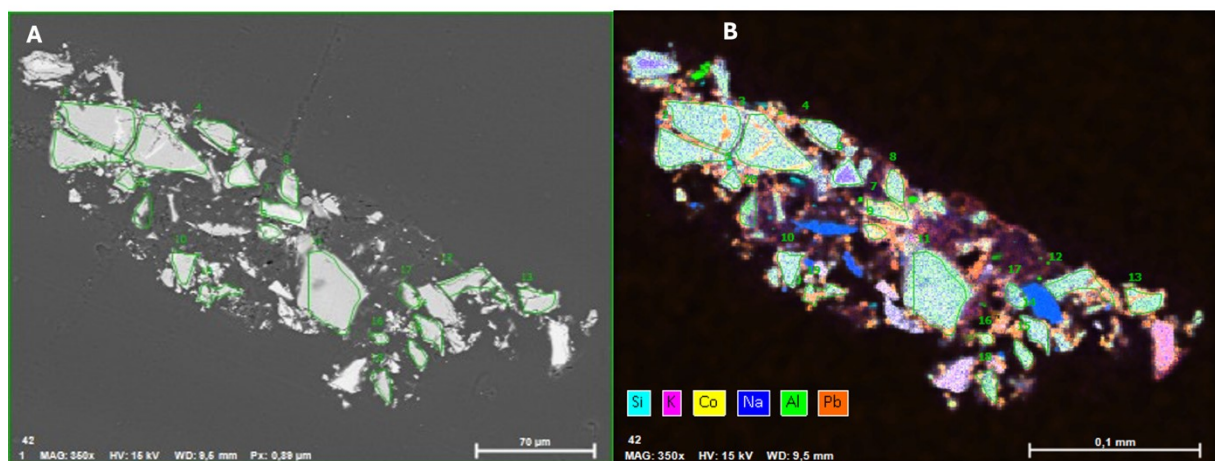


Figure 8: SEM-EDX images of SL4 sample. A: Backscattered electron image with analyzed areas. B: Elemental maps

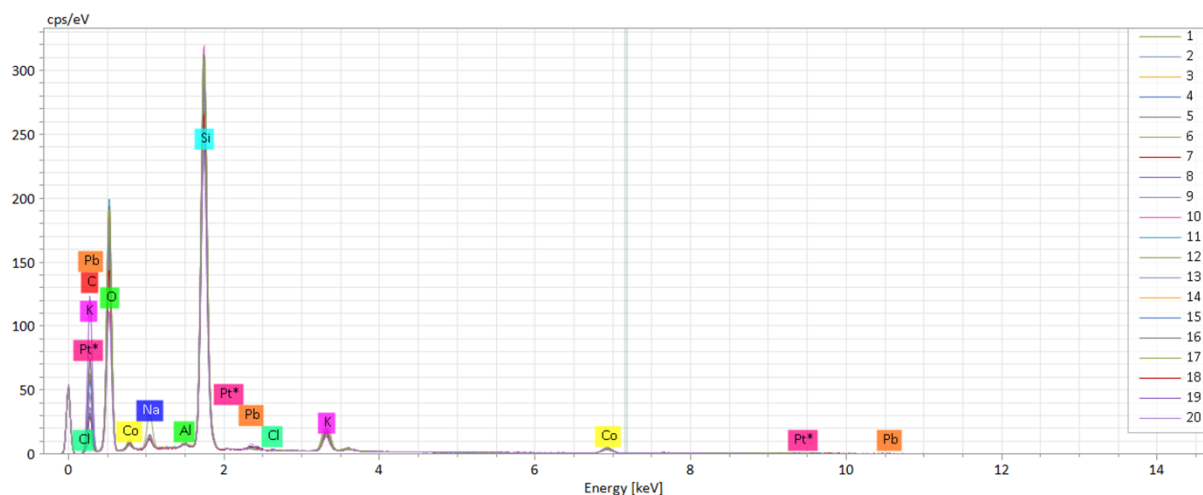


Figure 9: EDX spectra of analyzed areas shown on Figure 8

Table 5: Semi quantitative results of the EDX analyses

Spectrum	ClO ₂	CoO	PbO	Na ₂ O	Al ₂ O ₃	SiO ₂	K ₂ O
1	0.06	9.63	1.66	4.02	0.54	74.97	9.11
2	0.08	9.57	1.63	4.02	0.50	74.64	9.55
3	0.05	10.31	1.91	3.81	0.53	74.26	9.14
4	0.13	10.09	1.51	3.51	0.60	74.59	9.57
5	0.00	10.05	1.90	3.67	0.66	74.93	8.79
6	0.07	9.13	0.81	9.52	0.45	67.06	12.97
7	0.00	9.04	3.02	3.54	0.65	76.14	7.61
8	0.00	9.24	1.72	3.82	0.85	76.11	8.26
9	0.00	9.76	3.55	3.94	0.51	73.58	8.66
10	0.00	9.02	1.65	3.28	0.15	77.02	8.88
11	0.06	10.14	1.45	3.13	0.48	75.29	9.45
12	0.00	9.39	2.30	4.08	0.47	75.90	7.87
13	0.00	9.31	2.55	3.64	0.54	77.11	6.84
14	0.00	9.03	1.32	3.14	0.51	77.56	8.46
15	0.11	9.03	1.20	2.59	0.65	79.81	6.63
16	0.00	9.63	2.65	3.83	1.88	73.93	8.07
17	0.00	8.75	1.68	2.73	0.48	78.87	7.49
18	0.19	8.93	1.89	2.86	0.59	78.30	7.24
19	0.17	8.67	3.77	4.29	0.66	74.76	7.68
20	0.00	9.39	1.96	4.75	0.41	77.26	6.24
Mean	0.05	9.40	2.01	3.91	0.60	75.60	8.42
Sigma	0.06	0.48	0.76	1.43	0.33	2.64	1.45
SigmaMean	0.01	0.11	0.17	0.32	0.07	0.59	0.32

1.2.1.5. CWO

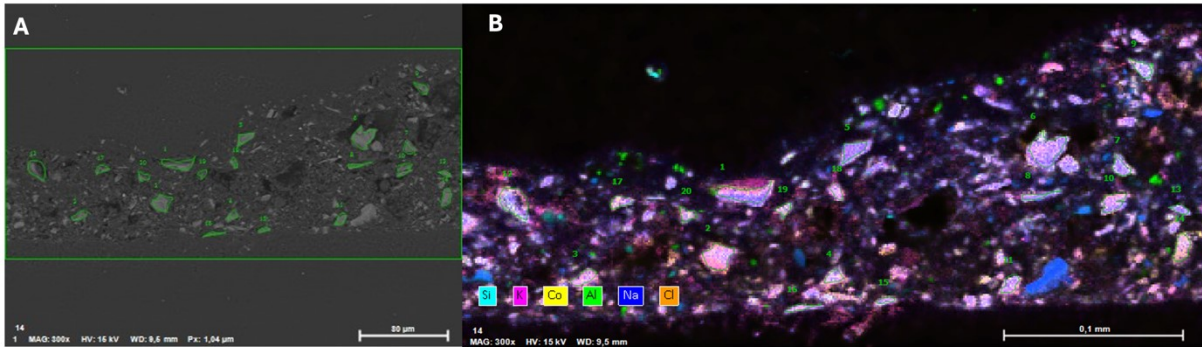


Figure 10: SEM-EDX images of CWO sample. A: Backscattered electron image with analyzed areas. B: Elemental maps

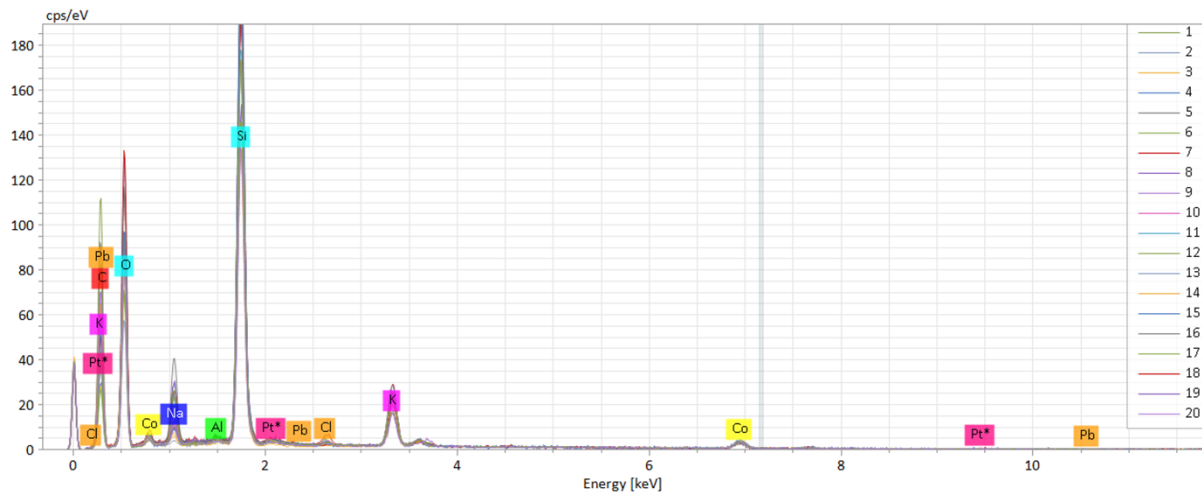


Figure 11: EDX spectra of analyzed areas shown on Figure 10

Table 6: Semi quantitative results of the EDX analyses

Spectrum	ClO ₂	CoO	PbO	Na ₂ O	Al ₂ O ₃	SiO ₂	K ₂ O
1	0.37	6.89	0.00	10.46	0.74	69.14	12.39
2	0.45	8.68	0.82	1.14	0.78	71.35	16.80
3	0.30	6.78	0.05	1.36	0.20	77.58	13.73
4	0.17	10.27	0.06	3.18	0.54	70.66	15.11
5	0.62	6.75	0.00	11.03	0.45	67.62	13.54
6	0.43	6.96	0.05	9.20	0.32	69.90	13.15
7	0.00	6.81	0.00	8.00	0.51	73.84	10.84
8	0.26	8.67	0.09	11.60	1.09	64.08	14.21
9	0.53	9.48	0.03	7.98	0.68	67.48	13.83
10	0.12	7.17	0.00	4.56	0.23	74.36	13.57
11	0.52	8.07	0.31	8.45	0.50	68.51	13.63
12	1.18	6.68	0.00	6.75	0.83	73.81	10.75
13	0.33	6.94	0.05	9.71	0.27	69.32	13.38
14	0.04	8.14	0.00	3.23	0.59	77.55	10.44

15	1.74	7.40	0.00	7.37	0.58	67.53	15.38
16	0.96	8.33	0.20	2.13	0.67	74.74	12.97
17	1.31	12.53	0.08	5.95	0.36	65.26	14.51
18	1.56	7.89	0.00	2.13	0.07	71.31	17.04
19	0.18	7.26	0.18	3.62	0.98	79.12	8.66
20	0.23	9.33	0.00	4.12	0.01	77.76	8.55
Mean	0.57	8.05	0.10	6.10	0.52	71.55	13.12
Sigma	0.51	1.49	0.19	3.39	0.29	4.38	2.32
SigmaMean	0.11	0.33	0.04	0.76	0.06	0.98	0.52

1.2.1.6. CW4

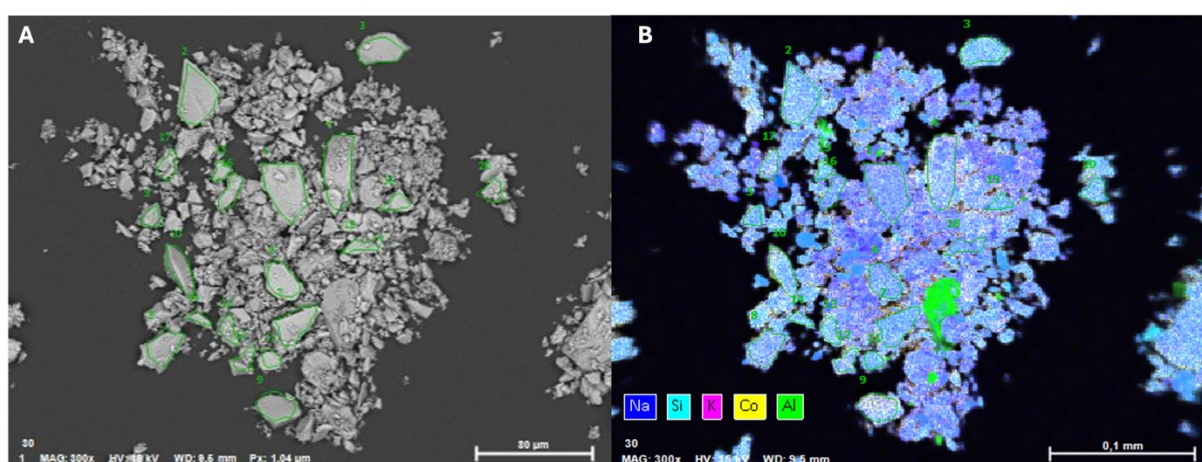


Figure 12: SEM-EDX images of CW4 sample. A: Backscattered electron image with analyzed areas. B: Elemental maps

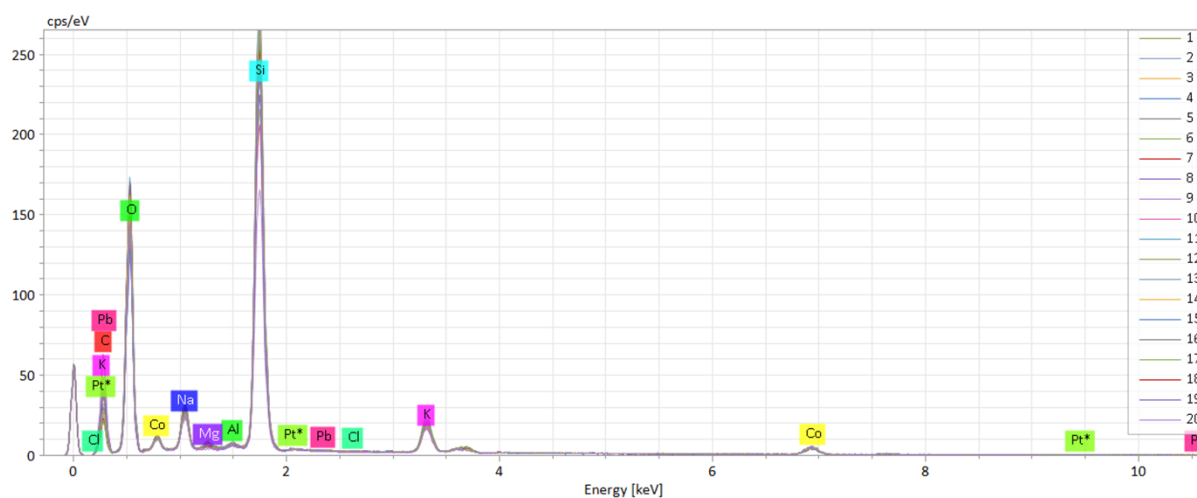


Figure 13: EDX spectra of analyzed areas shown on Figure 12

Table 7: Semi quantitative results of the EDX analyses

Spectrum	ClO ₂	CoO	PbO	Na ₂ O	Al ₂ O ₃	SiO ₂	K ₂ O
1	0.00	9.50	1.28	9.18	0.48	68.17	11.39
2	0.11	10.12	1.43	8.66	0.63	68.71	10.33
3	0.00	10.18	0.86	8.82	0.58	71.13	8.43
4	0.06	10.31	1.12	9.21	0.42	67.07	11.81
5	0.03	13.23	0.28	9.18	0.33	67.78	9.17
6	0.02	9.66	0.85	9.46	0.79	69.63	9.60
7	0.06	9.93	1.36	9.39	0.76	69.17	9.34
8	0.00	11.39	1.06	9.51	0.78	67.98	9.29
9	0.01	13.43	1.31	11.44	0.57	61.99	11.25
10	0.06	11.89	1.11	9.60	0.36	67.74	9.25
11	0.04	8.43	0.93	7.57	0.27	73.23	9.53
12	0.00	15.48	0.23	9.63	0.90	66.39	7.38
13	0.00	10.87	0.16	9.78	0.04	71.62	7.52
14	0.00	9.23	0.08	9.80	0.95	72.63	7.31
15	0.00	7.96	0.98	7.88	0.66	76.06	6.46
16	0.00	7.14	1.35	10.09	0.34	70.67	10.41
17	0.00	14.39	0.82	10.03	1.07	65.46	8.24
18	0.05	9.61	1.42	10.75	1.04	66.74	10.38
19	0.03	8.64	0.00	8.37	0.34	75.16	7.45
20	0.04	10.86	0.25	9.70	0.66	70.60	7.88
Mean	0.03	10.61	0.84	9.40	0.60	69.40	9.12
Sigma	0.03	2.16	0.49	0.89	0.28	3.36	1.52
SigmaMean	0.01	0.48	0.11	0.20	0.06	0.75	0.34

1.2.1.7. SWO

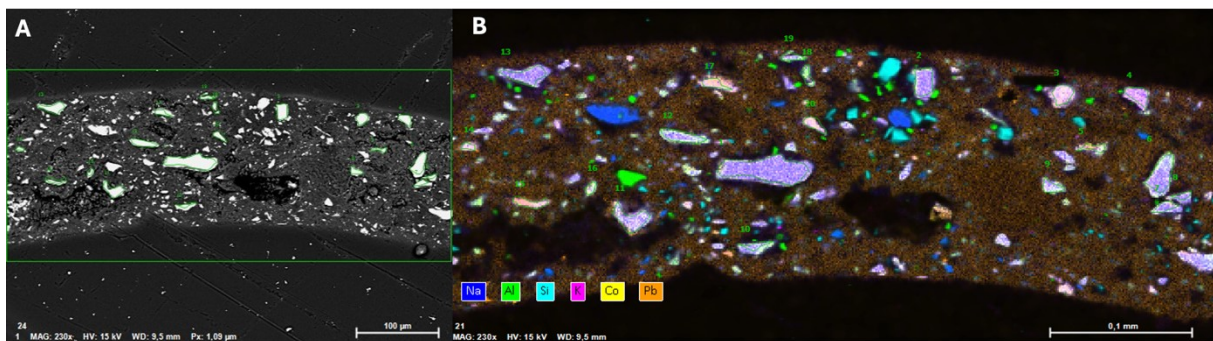


Figure 14: SEM-EDX images of SWO sample. A: Backscattered electron image with analyzed areas. B: Elemental maps

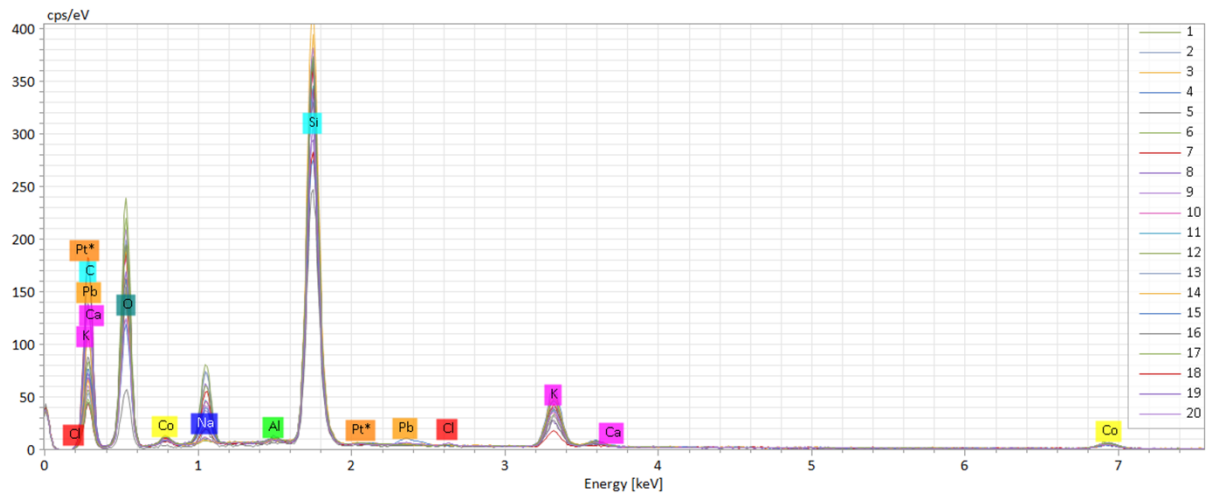


Figure 15: EDX spectra of analyzed areas shown on Figure 14

Table 8: Semi quantitative results of the EDX analyses

Spectrum	ClO ₂	CoO	PbO	Na ₂ O	Al ₂ O ₃	SiO ₂	K ₂ O
1	0.07	7.41	0.76	15.99	0.54	61.16	14.06
2	0.08	8.78	0.47	13.94	0.51	62.27	13.94
3	0.11	7.49	0.00	0.72	0.08	73.95	17.65
4	0.23	7.29	0.79	8.10	0.57	63.30	19.71
5	0.00	9.63	0.37	6.78	0.48	73.14	9.60
6	0.00	7.82	0.42	13.07	0.20	65.57	12.92
7	0.00	7.01	0.88	11.95	0.40	66.46	13.30
8	0.00	9.84	0.00	13.00	0.95	63.87	12.34
9	0.00	8.33	1.23	8.92	0.32	70.87	10.33
10	0.18	10.32	0.21	10.91	0.41	65.67	12.30
11	0.16	7.99	0.34	10.14	0.58	67.28	13.50
12	0.03	8.82	0.78	9.54	0.41	69.29	11.14
13	0.04	6.94	0.74	15.57	0.53	62.07	14.11
14	0.00	6.48	0.17	1.23	0.15	80.14	11.83
15	0.08	6.94	4.14	1.70	0.51	71.62	15.00
16	0.00	10.48	1.33	5.74	0.27	74.39	7.79
17	0.02	10.58	0.00	0.99	0.23	71.27	16.92
18	0.04	10.13	0.00	5.08	1.12	76.36	7.26
19	0.04	7.81	0.49	9.52	1.01	72.54	8.59
20	0.35	8.33	1.65	1.90	0.42	71.37	15.97
Mean	0.07	8.42	0.74	8.24	0.49	69.13	12.91
Sigma	0.09	1.33	0.93	5.03	0.27	5.27	3.26
SigmaMean	0.02	0.30	0.21	1.12	0.06	1.18	0.73

1.2.1.8. SW4

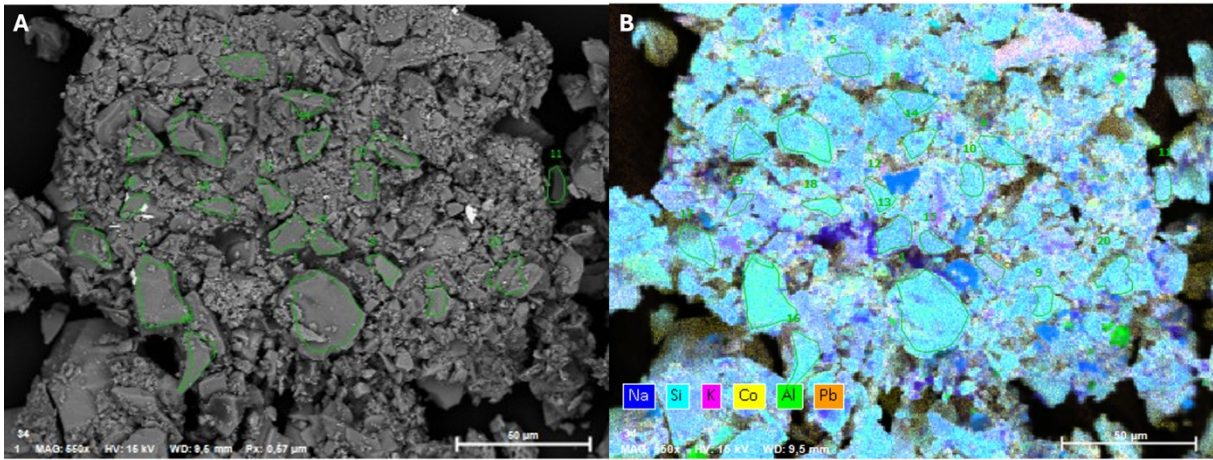


Figure 16: SEM-EDX images of SW4 sample. A: Backscattered electron image with analyzed areas. B: Elemental maps

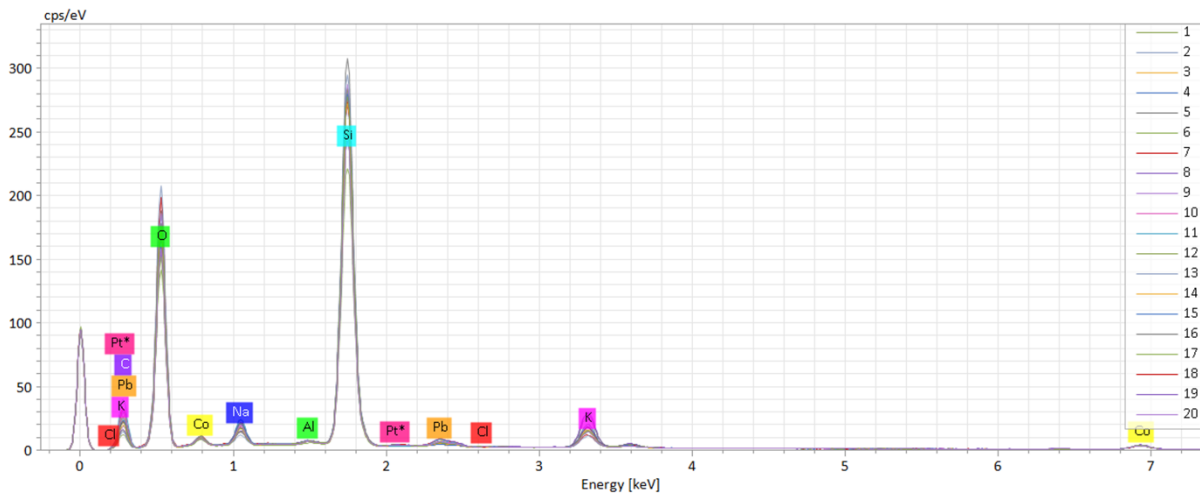


Figure 17: EDX spectra of analyzed areas shown on Figure 16

Table 9: Semi quantitative results of the EDX analyses

Spectrum	ClO ₂	CoO	PbO	Na ₂ O	Al ₂ O ₃	SiO ₂	K ₂ O
1	0.00	8.37	3.16	5.04	0.43	75.33	7.66
2	0.02	8.67	3.54	2.96	0.47	78.89	5.45
3	0.00	7.94	3.07	5.29	0.45	75.83	7.42
4	0.00	8.44	2.72	6.35	0.50	73.33	8.65
5	0.03	8.00	1.92	5.03	0.25	72.39	12.37
6	0.00	7.84	4.00	6.94	0.58	73.01	7.62
7	0.00	7.23	2.49	6.63	0.39	74.35	8.90
8	0.00	6.70	4.64	3.95	0.48	70.12	14.11
9	0.00	9.22	3.50	4.64	0.50	75.49	6.66

10	0.00	8.75	3.68	5.55	0.44	73.87	7.72
11	0.00	7.25	4.63	8.08	0.61	71.55	7.88
12	0.05	8.00	3.00	4.43	0.29	75.55	8.69
13	0.00	7.14	3.02	6.54	0.41	73.19	9.70
14	0.00	7.47	3.85	6.67	0.75	73.36	7.90
15	0.00	7.56	3.18	7.24	0.22	72.44	9.36
16	0.00	8.29	3.40	5.02	0.44	75.53	7.32
17	0.00	8.35	4.15	5.53	0.35	73.65	7.98
18	0.07	8.52	4.80	4.78	0.61	75.27	5.94
19	0.04	8.00	2.36	4.07	0.07	71.16	14.29
20	0.00	7.56	3.93	6.29	0.52	74.41	7.29
Mean	0.01	7.97	3.45	5.55	0.44	73.94	8.65
Sigma	0.02	0.63	0.78	1.27	0.15	1.98	2.39
SigmaMean	0.00	0.14	0.17	0.28	0.03	0.44	0.53

1.2.2. XANES at the Co K-edge

1.2.2.1. CLO

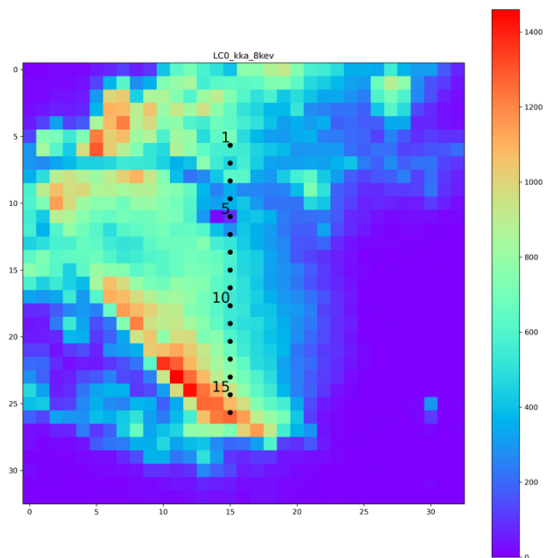


Figure 18: XRF elemental map of Co with location of XANES points.

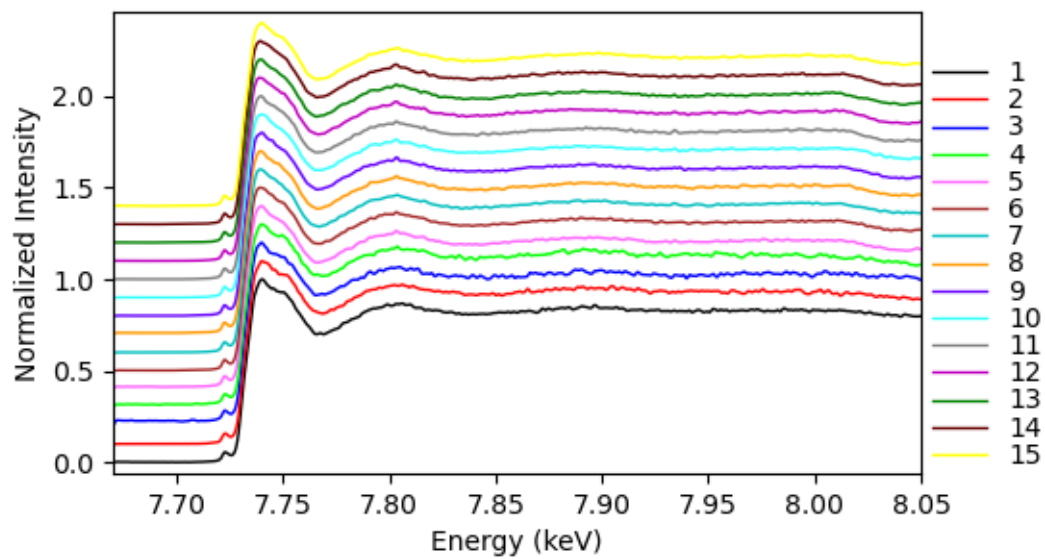


Figure 19 : XANES spectra at the Co K-edge measured on the locations shown on figure 18.

1.2.2.2. CL3

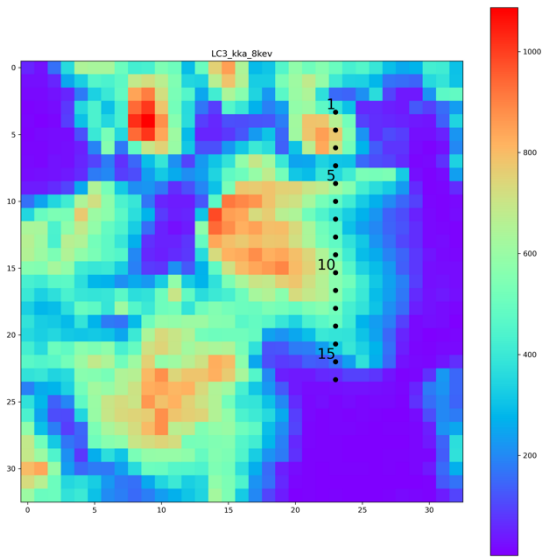


Figure 20: XRF elemental map of Co with location of XANES points.

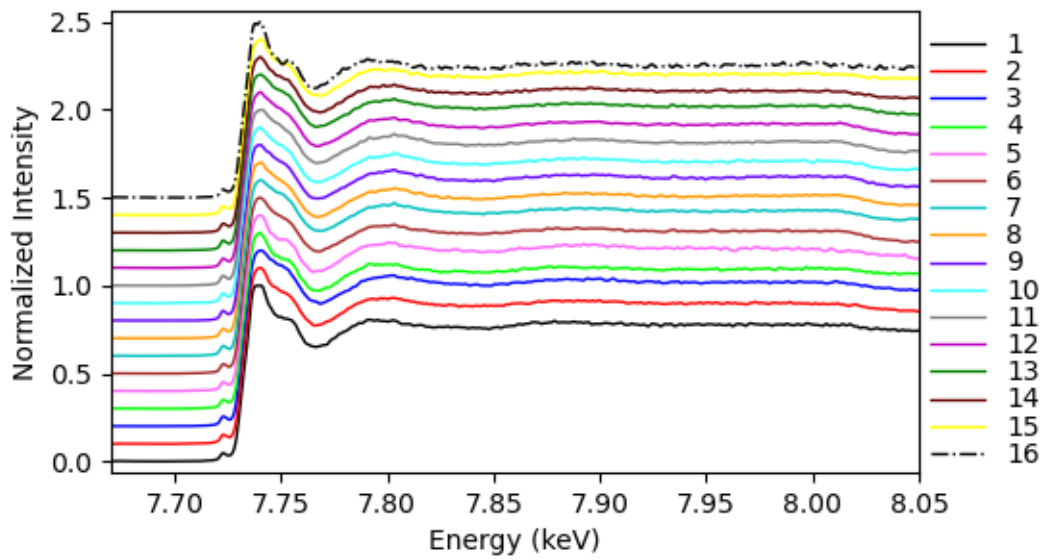


Figure 21: XANES spectra at the Co K-edge measured on the locations shown on figure 20.

1.2.2.3. CL4

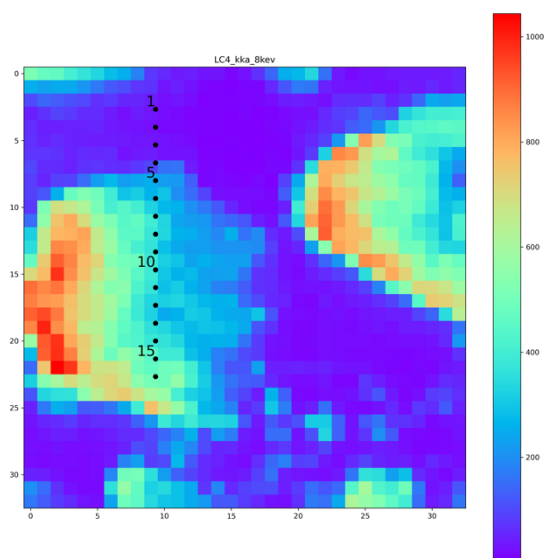


Figure 22: XRF elemental map of Co with location of XANES points.

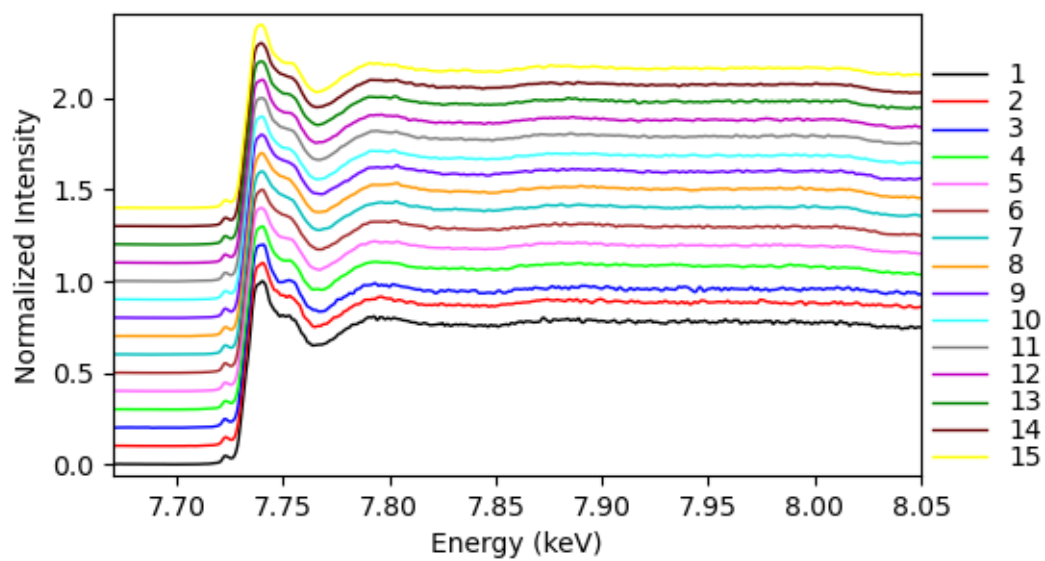


Figure 23: XANES spectra at the Co K-edge measured on the locations shown on figure 22.

1.2.2.4. SLO

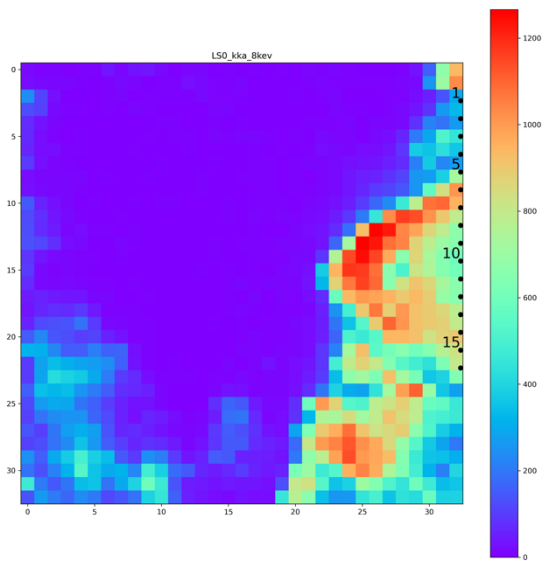


Figure 24: XRF elemental map of Co with location of XANES points.

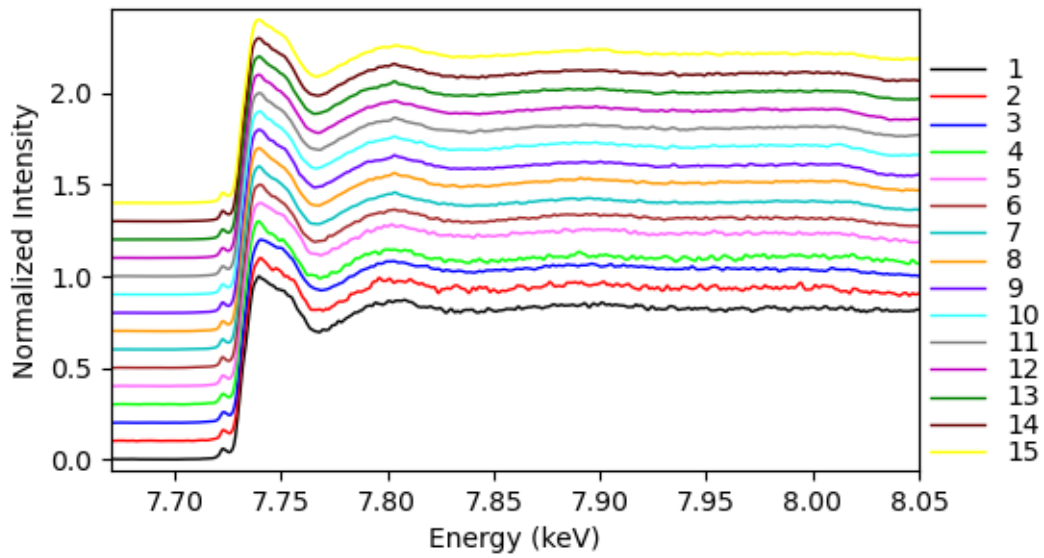


Figure 25: XANES spectra at the Co K-edge measured on the locations shown on figure 24.

1.2.2.5. SL3

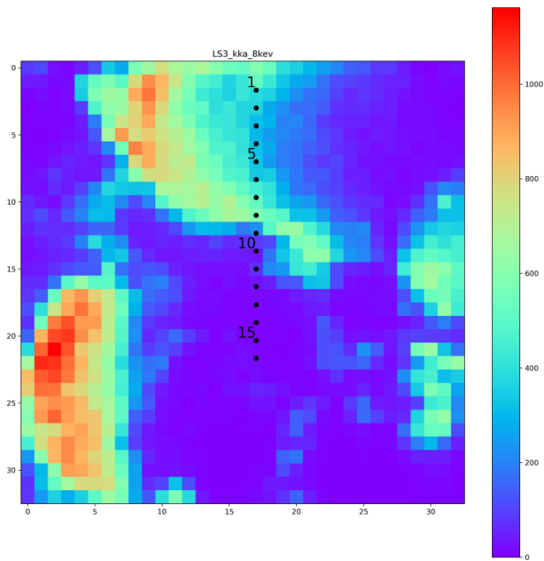


Figure 26: XRF elemental map of Co with location of XANES points.

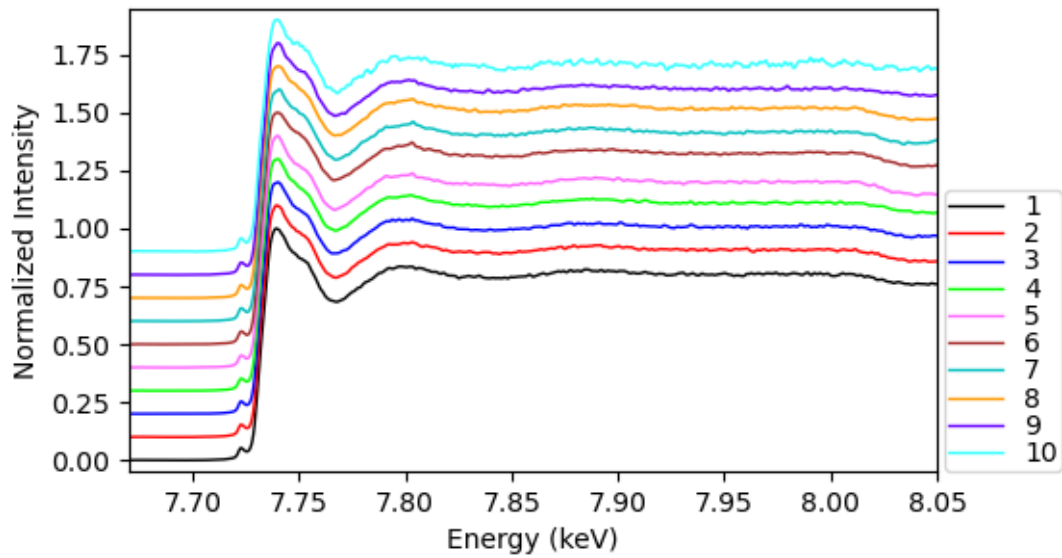


Figure 27: XANES spectra at the Co K-edge measured on the locations shown on figure 26.

1.2.2.6. SL4

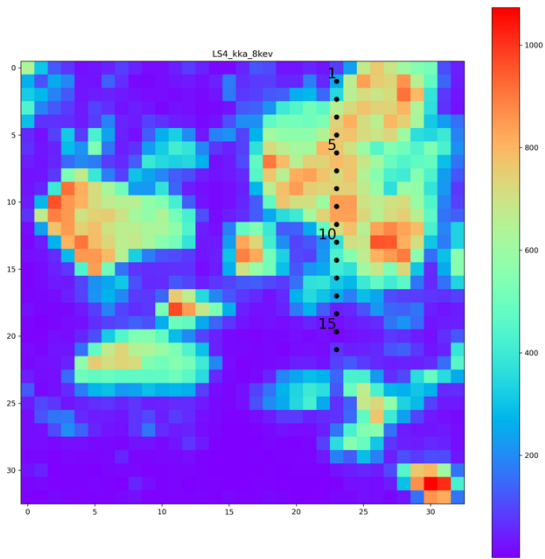


Figure 28: XRF elemental map of Co with location of XANES points.

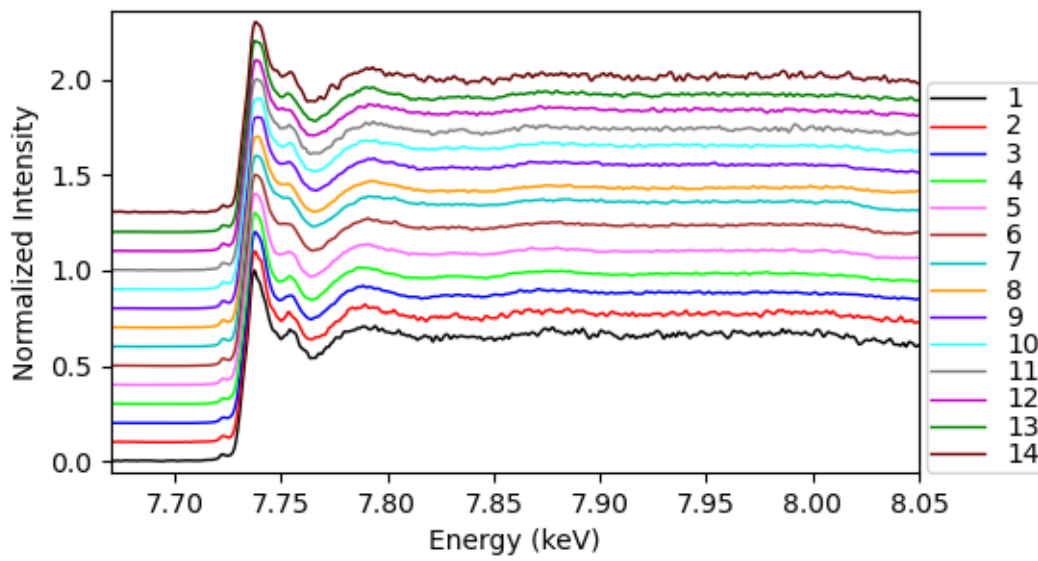


Figure 29: XANES spectra at the Co K-edge measured on the locations shown on figure 28.

1.2.2.7. CW0

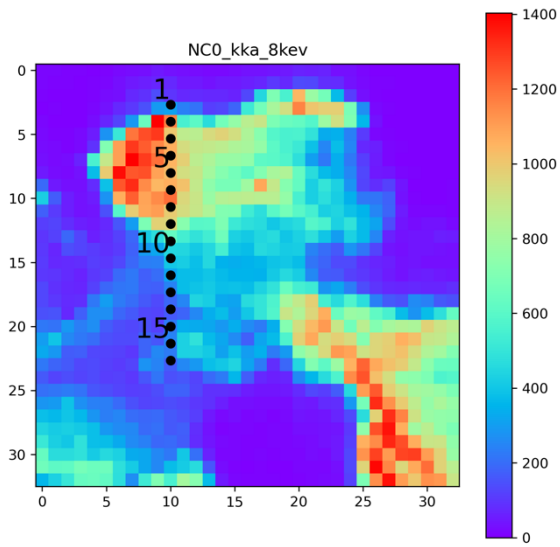


Figure 30: XRF elemental map of Co with location of XANES points.

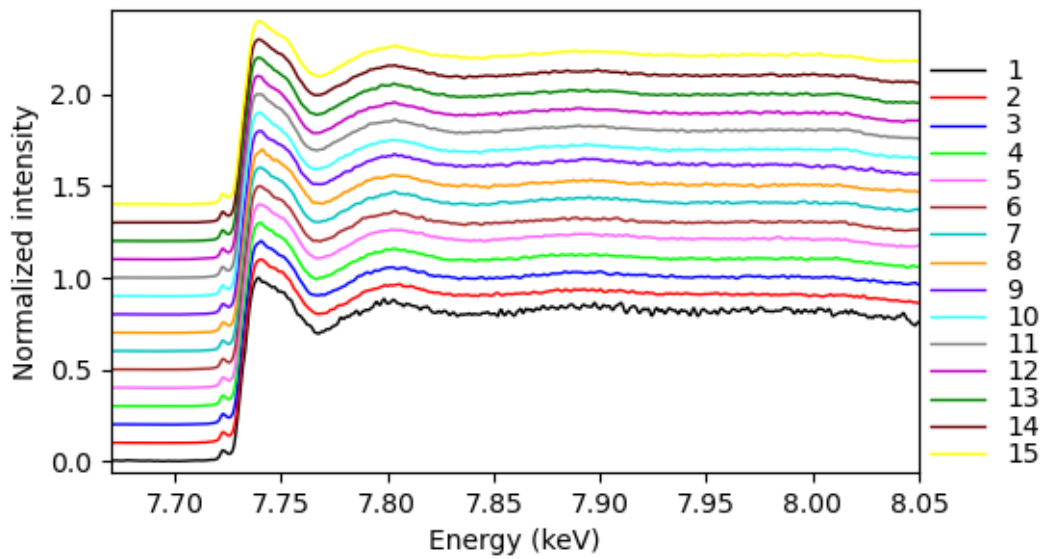


Figure 31: XANES spectra at the Co K-edge measured on the locations shown on figure 30.

1.2.2.8. CW3

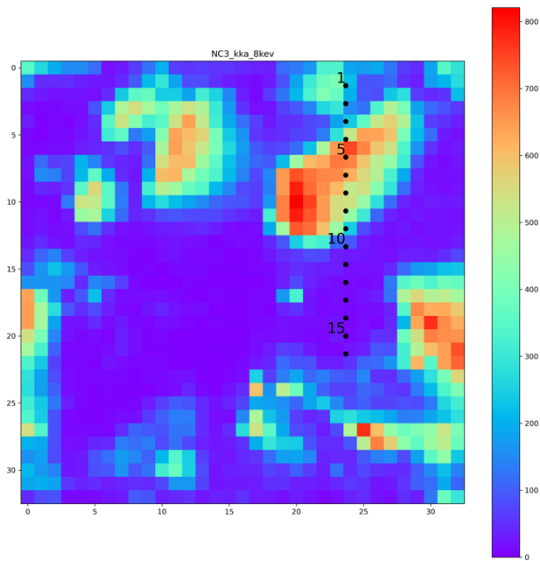


Figure 32: XRF elemental map of Co with location of XANES points.

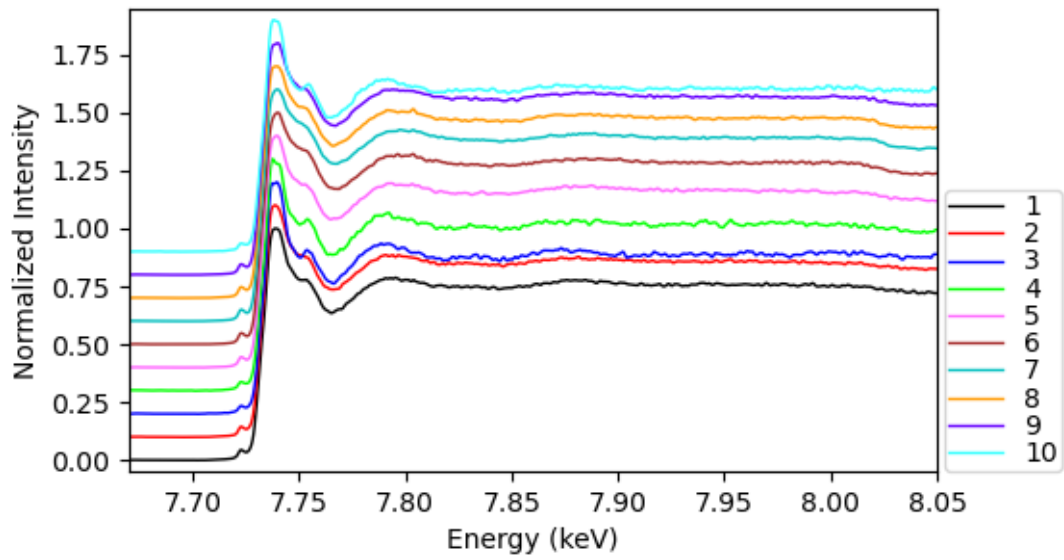


Figure 33: XANES spectra at the Co K-edge measured on the locations shown on figure 32.

1.2.2.9. CW4

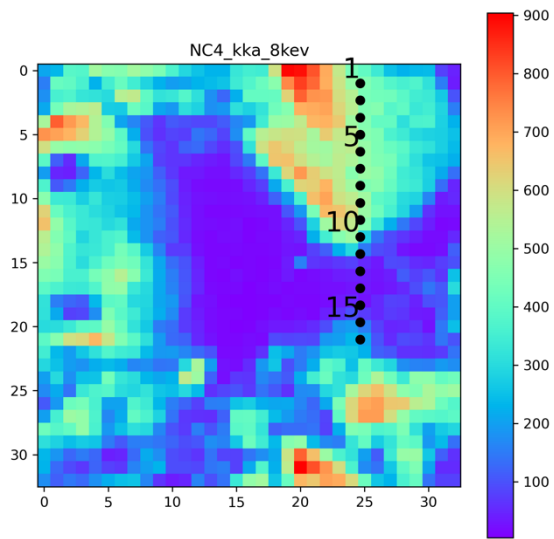


Figure 34: XRF elemental map of Co with location of XANES points.

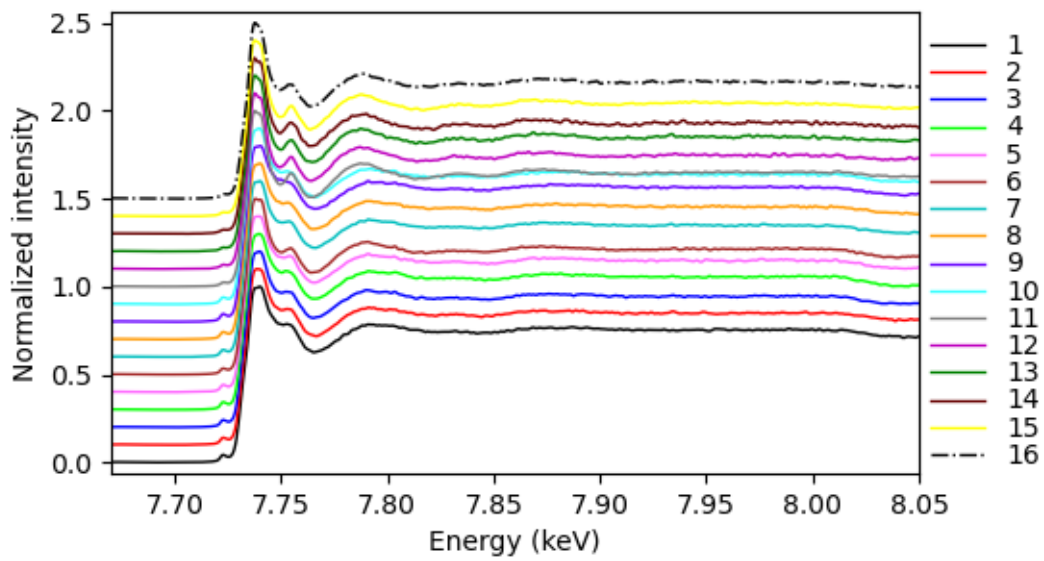


Figure 35: XANES spectra at the Co K-edge measured on the locations shown on figure 34.

1.2.2.10. SW0

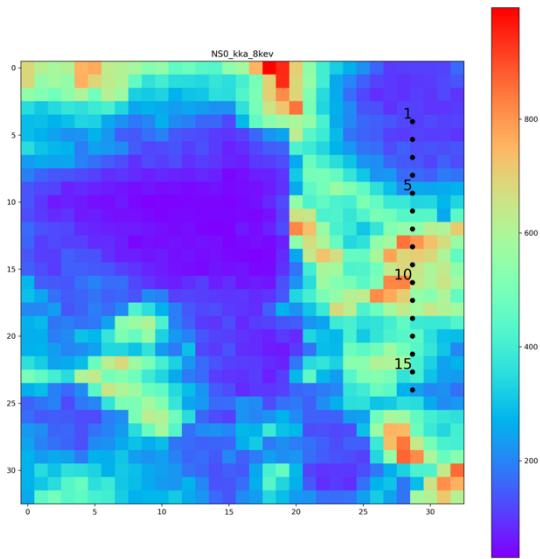


Figure 36: XRF elemental map of Co with location of XANES points.

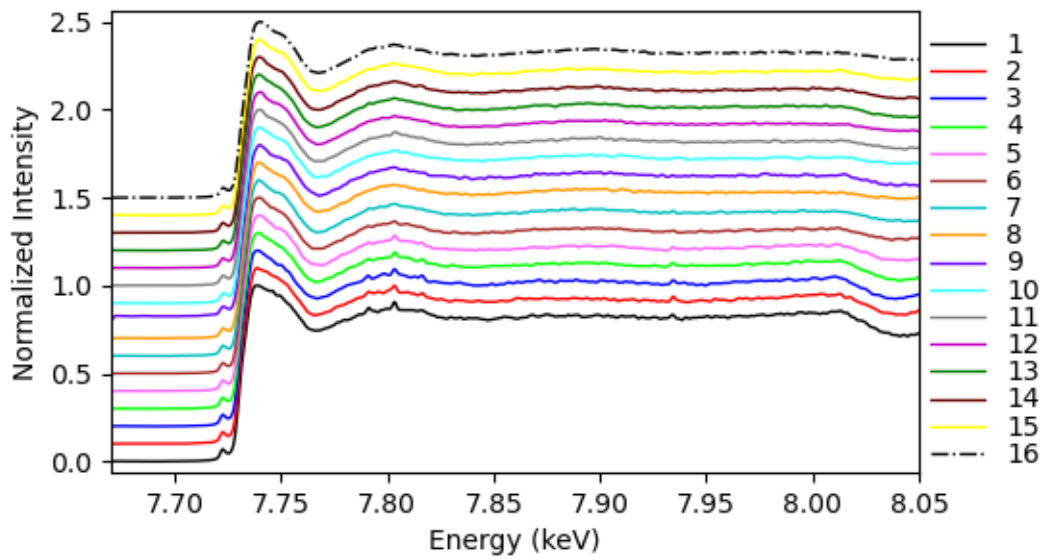


Figure 37: XANES spectra at the Co K-edge measured on the locations shown on figure 36.

1.2.2.11. SW3

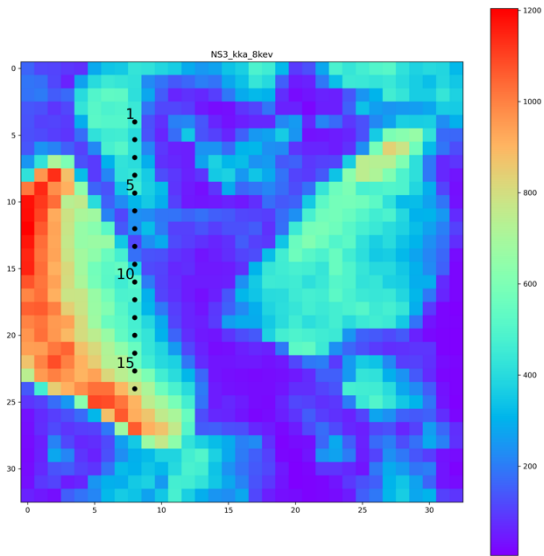


Figure 38: XRF elemental map of Co with location of XANES points.

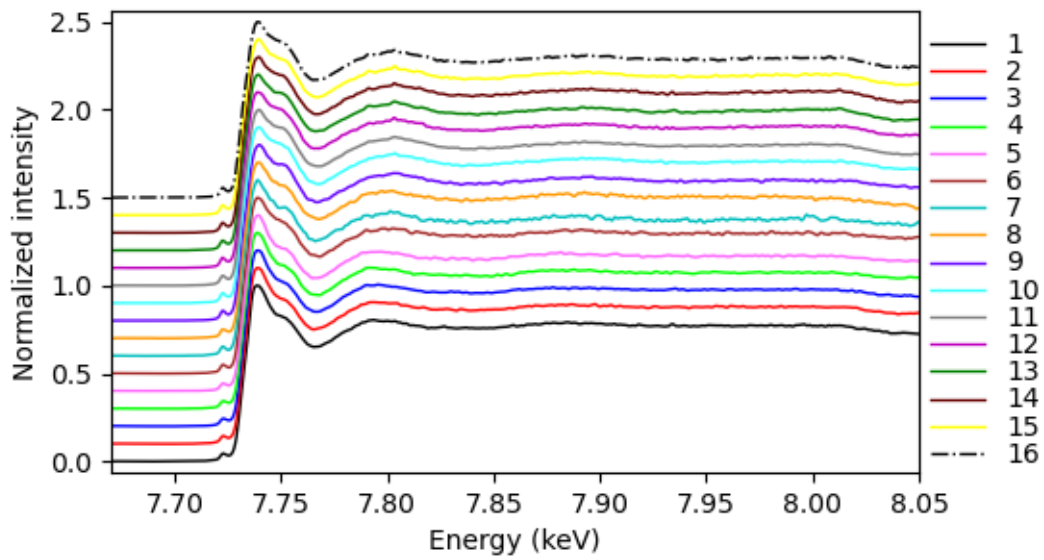


Figure 39: XANES spectra at the Co K-edge measured on the locations shown on figure 38.

1.2.2.12. SW4

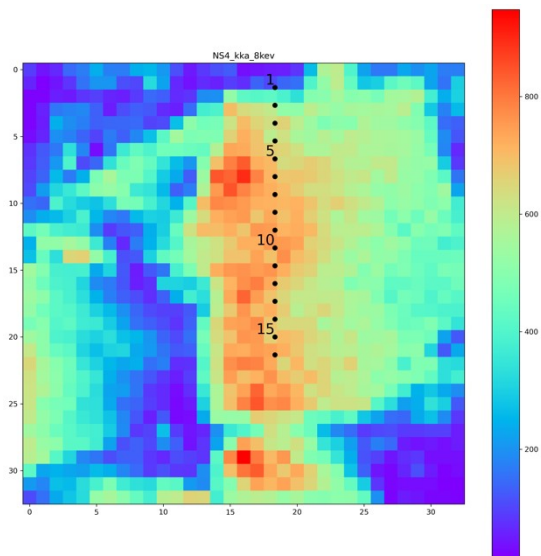


Figure 40: XRF elemental map of Co with location of XANES points.

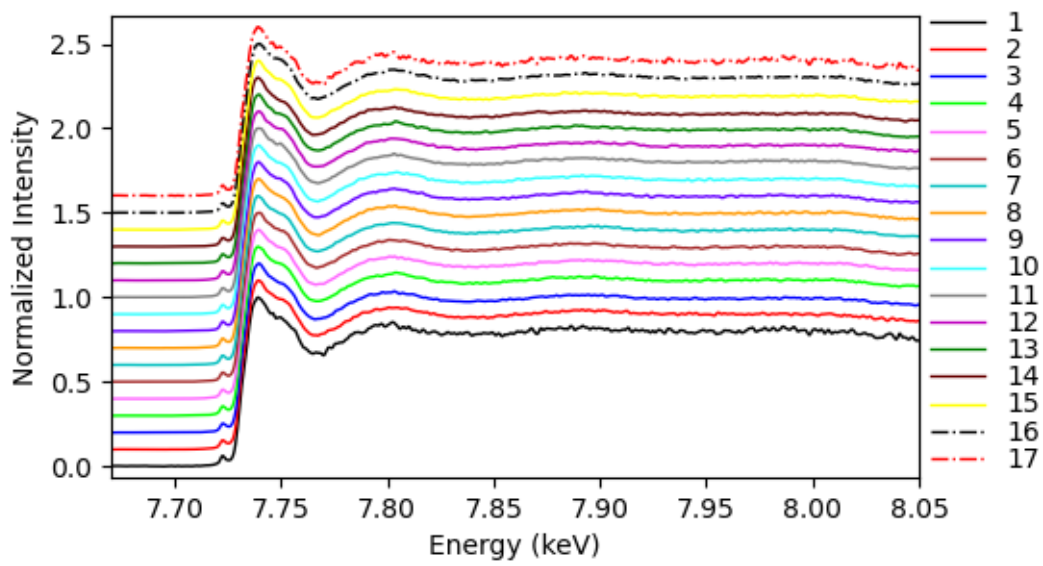


Figure 41: XANES spectra at the Co K-edge measured on the locations shown on figure 40.

1.2.3. XANES at the K K-edge

1.2.3.1. CL0

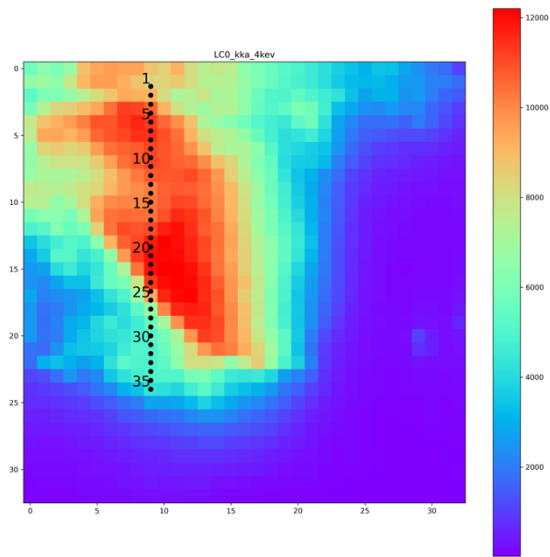


Figure 42: XRF elemental map of K with location of XANES points.

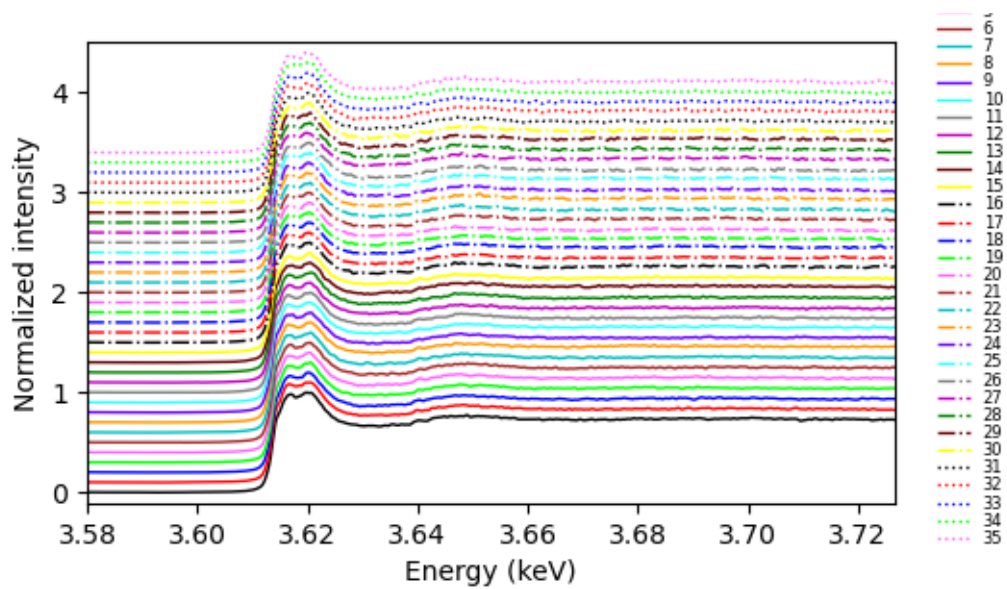


Figure 43: XANES spectra at the Co K-edge measured on the locations shown on figure 42.

CL3

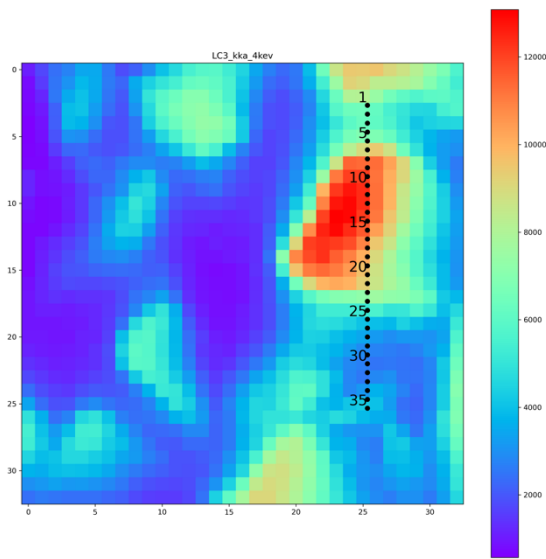


Figure 44: XRF elemental map of K with location of XANES points.

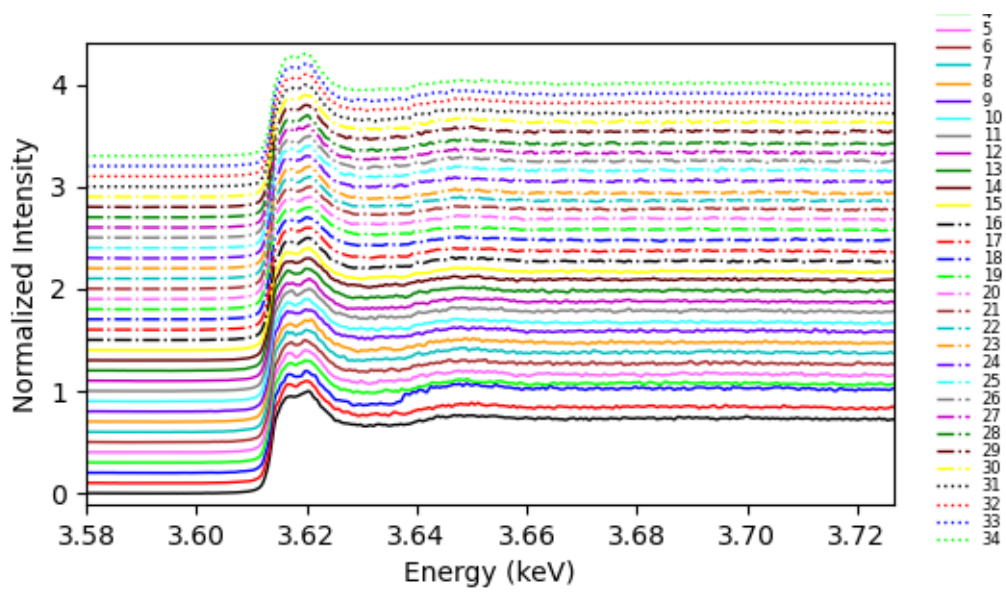


Figure 45: XANES spectra at the Co K-edge measured on the locations shown on figure 44.

1.2.3.2. CL4

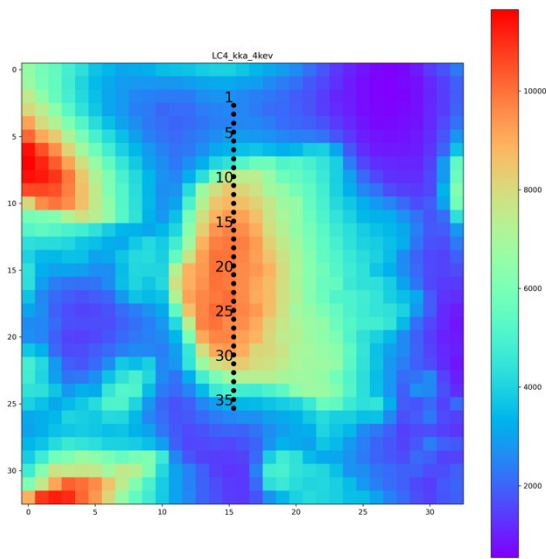


Figure 46: XRF elemental map of K with location of XANES points.

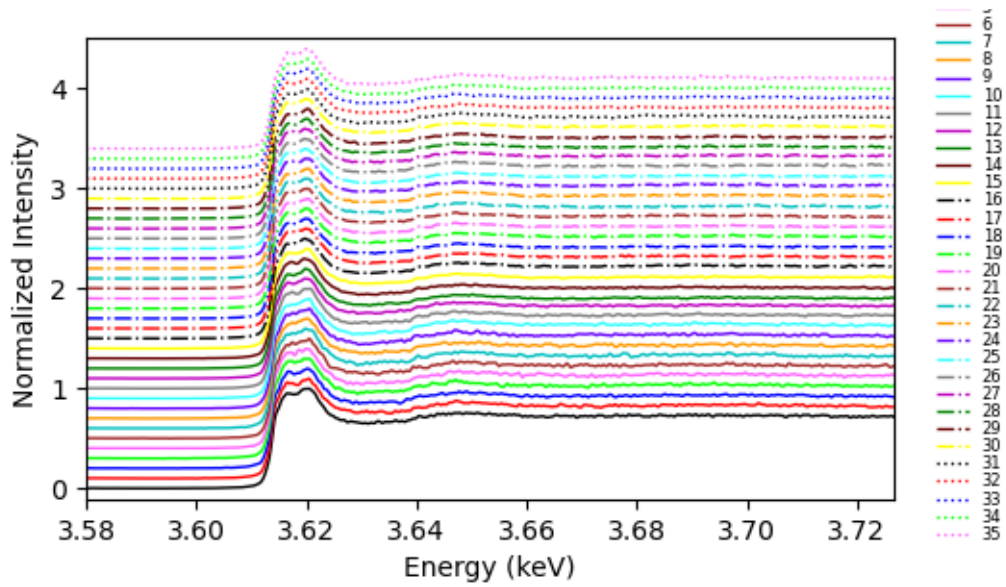


Figure 47: XANES spectra at the Co K-edge measured on the locations shown on figure 46.

1.2.3.3. SLO

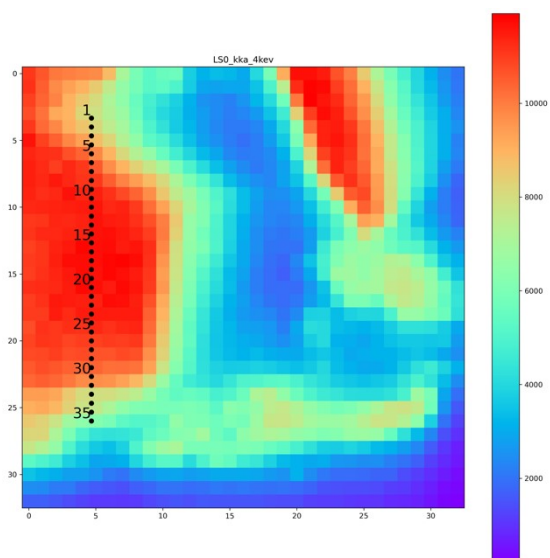


Figure 48: XRF elemental map of K with location of XANES points.

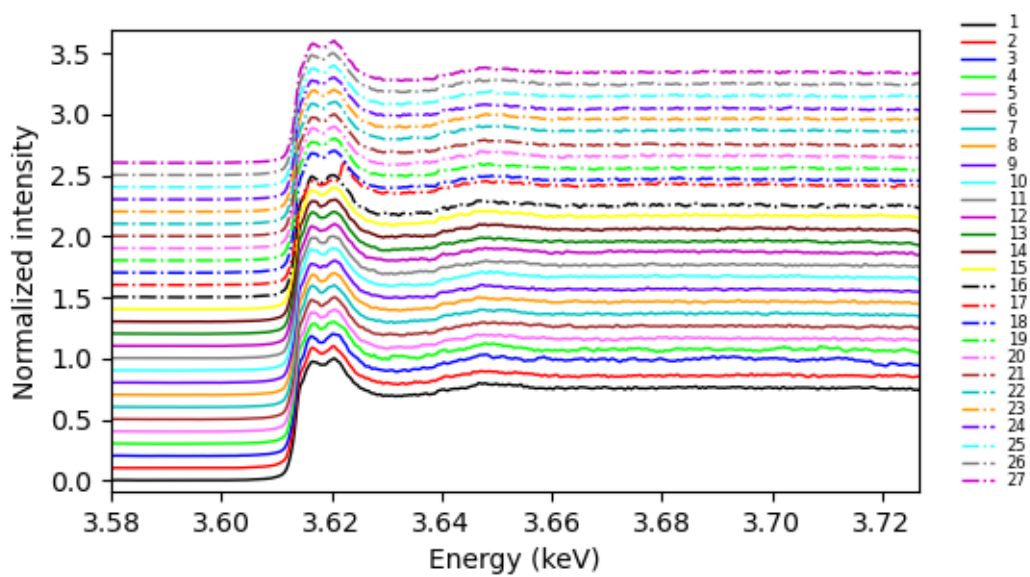


Figure 49: XANES spectra at the Co K-edge measured on the locations shown on figure 48.

1.2.3.4. SL3

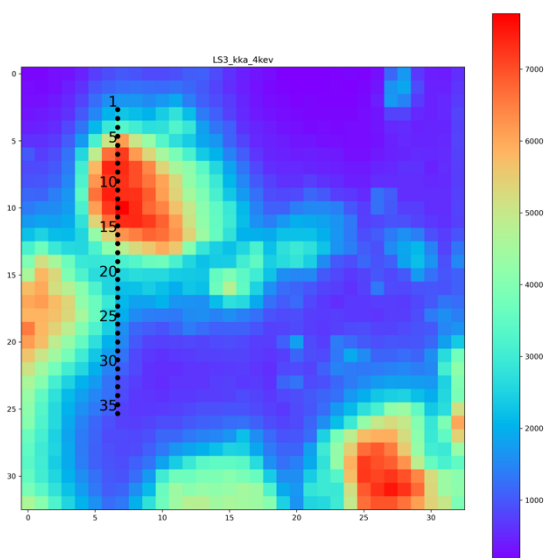


Figure 50: XRF elemental map of K with location of XANES points.

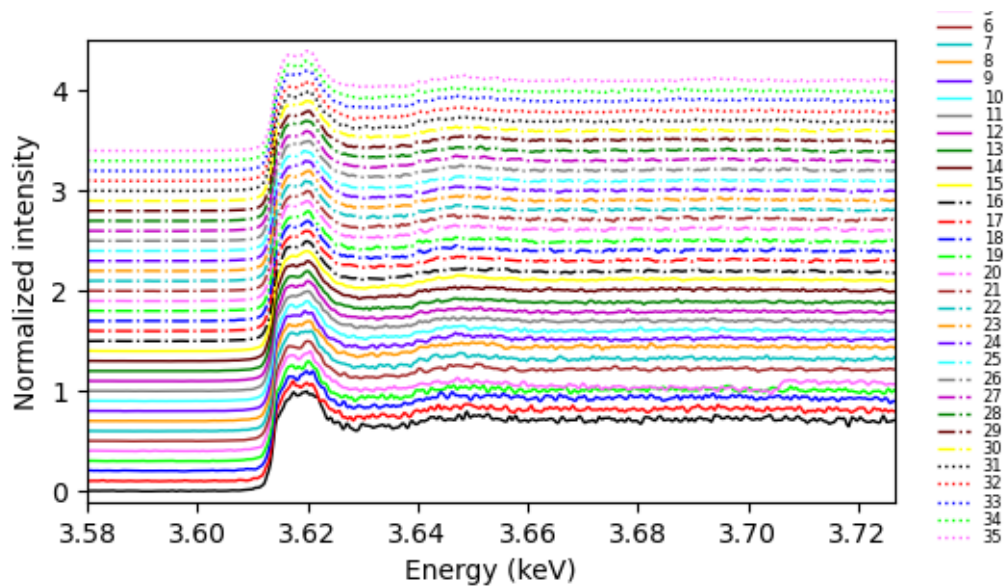


Figure 51: XANES spectra at the Co K-edge measured on the locations shown on figure 50.

1.2.3.5. SL4

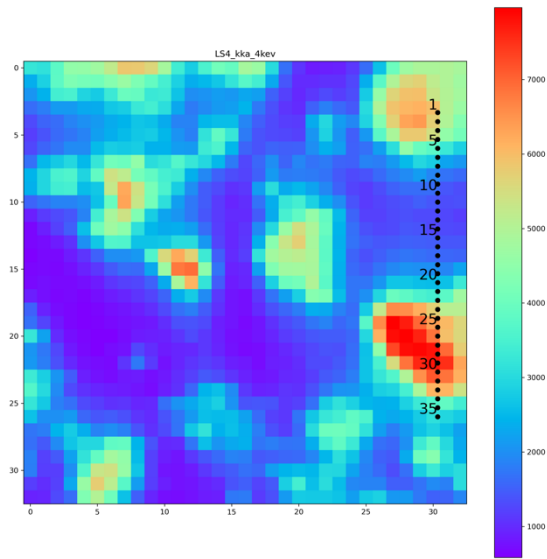


Figure 52: XRF elemental map of K with location of XANES points.

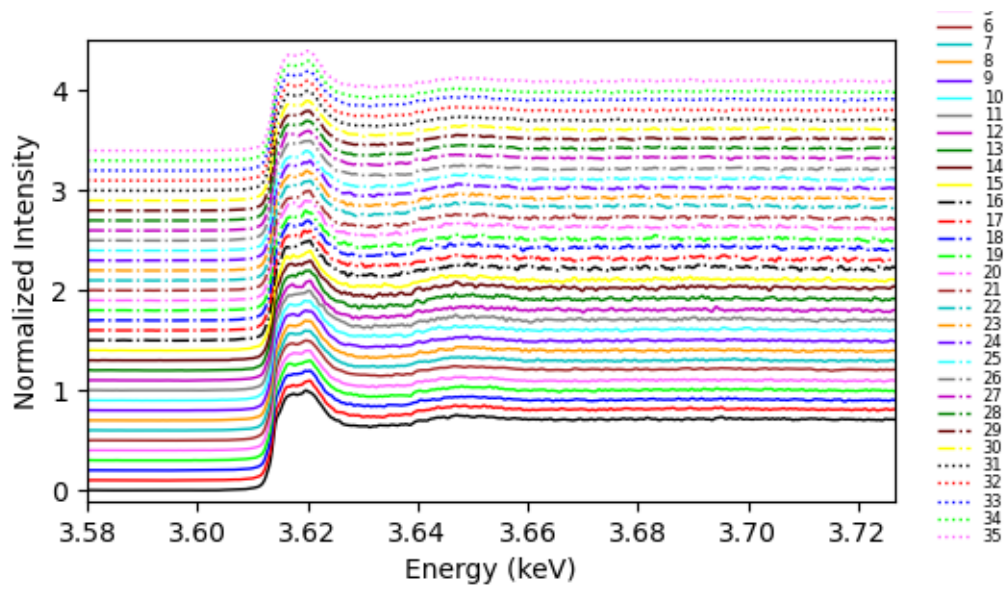


Figure 53: XANES spectra at the Co K-edge measured on the locations shown on figure 52.

1.2.3.6. CW0

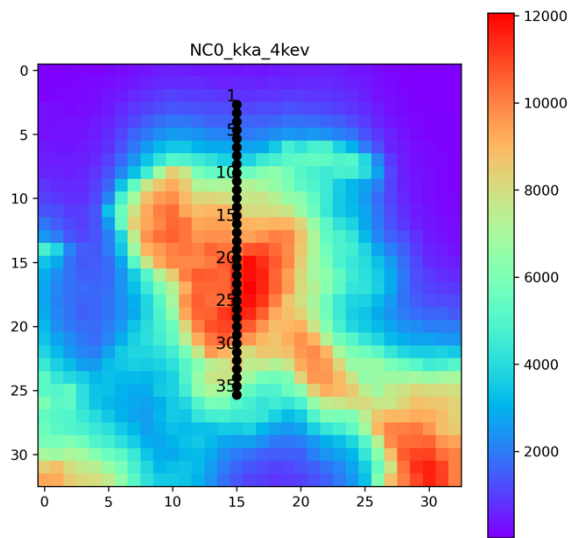


Figure 54: XRF elemental map of K with location of XANES points.

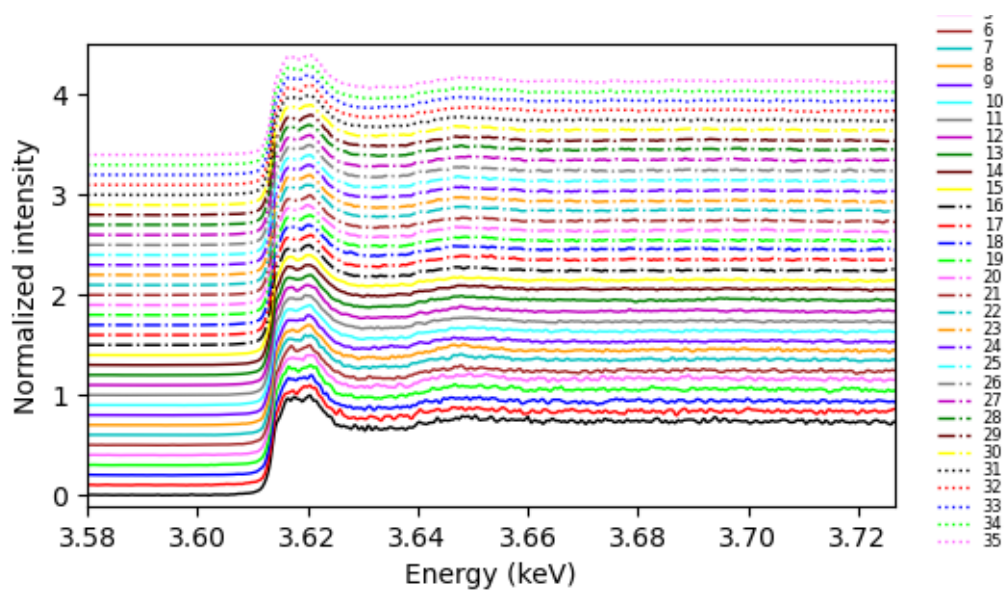


Figure 55: XANES spectra at the Co K-edge measured on the locations shown on figure 54.

1.2.3.7. CW3

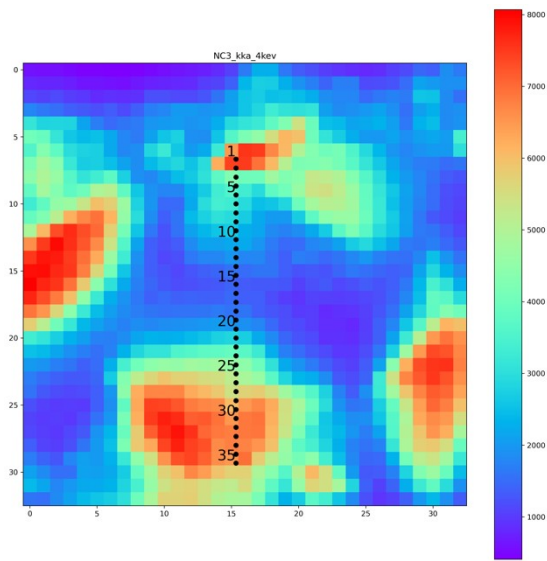


Figure 56: XRF elemental map of K with location of XANES points.

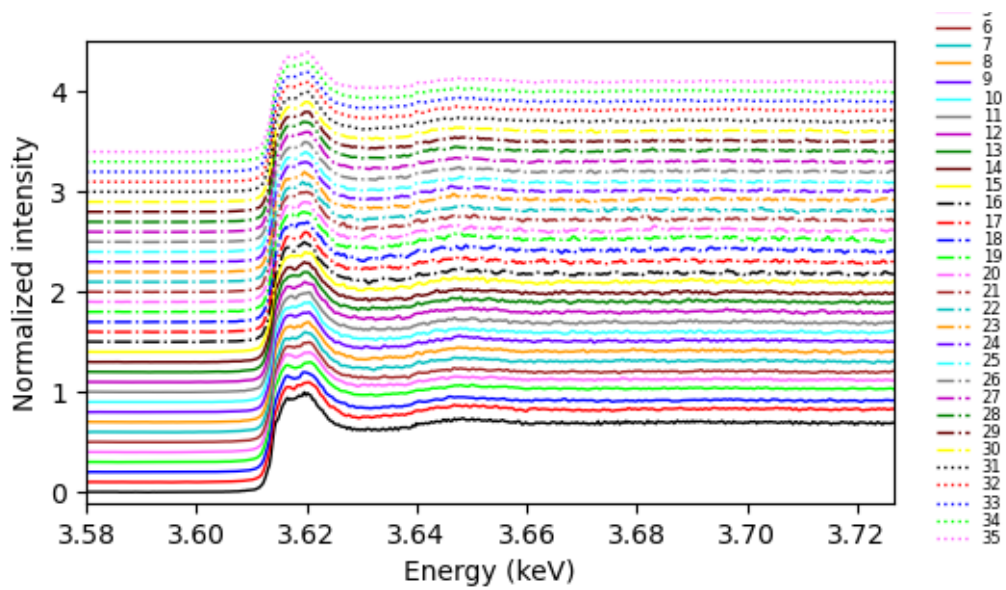


Figure 57: XANES spectra at the Co K-edge measured on the locations shown on figure 56.

1.2.3.8. CW4

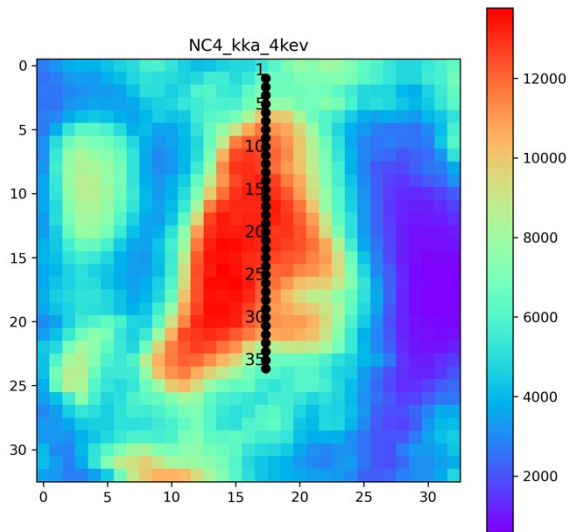


Figure 58: XRF elemental map of K with location of XANES points.

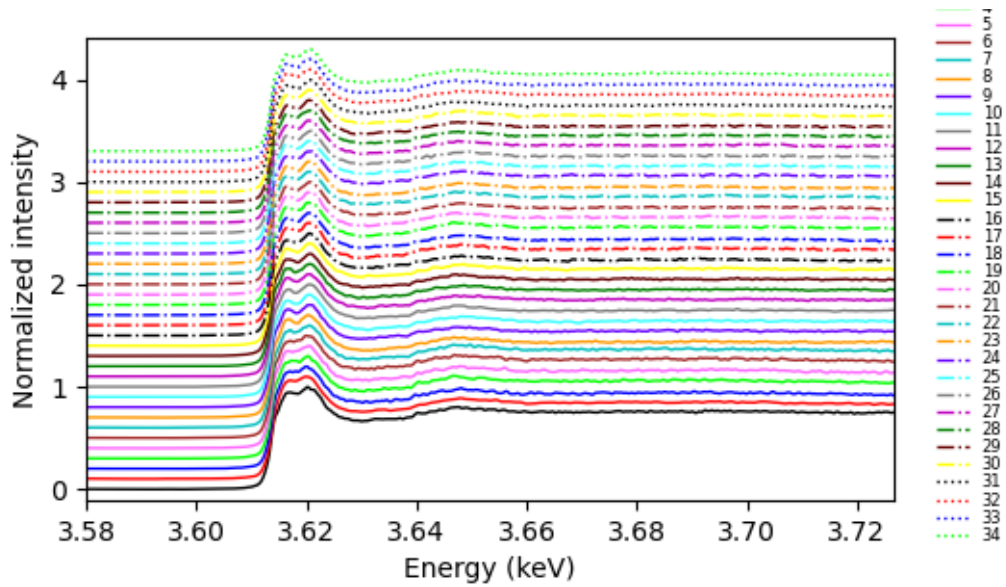


Figure 59: XANES spectra at the Co K-edge measured on the locations shown on figure 58.

1.2.3.9. SW0

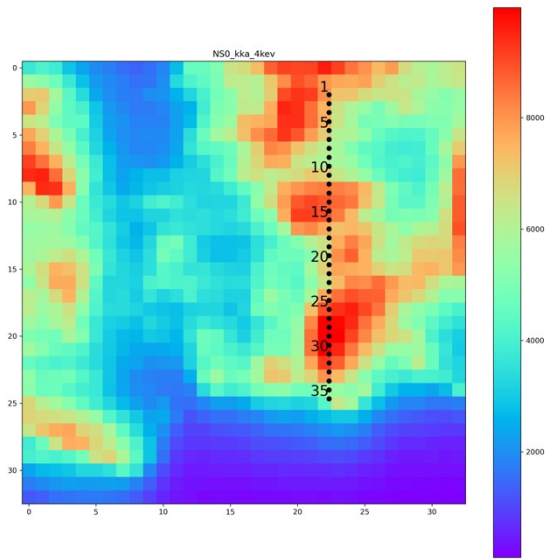


Figure 60: XRF elemental map of K with location of XANES points.

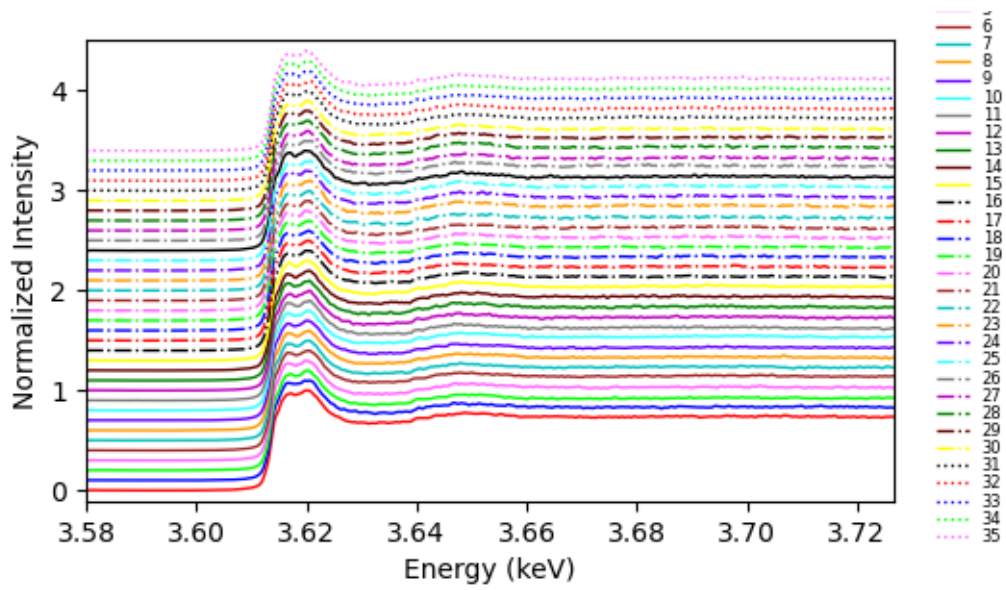


Figure 61: XANES spectra at the Co K-edge measured on the locations shown on figure 60.

1.2.3.10. SW3

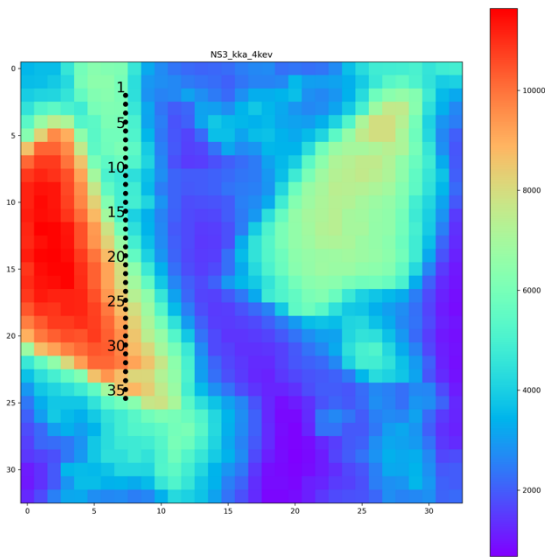


Figure 62: XRF elemental map of K with location of XANES points.

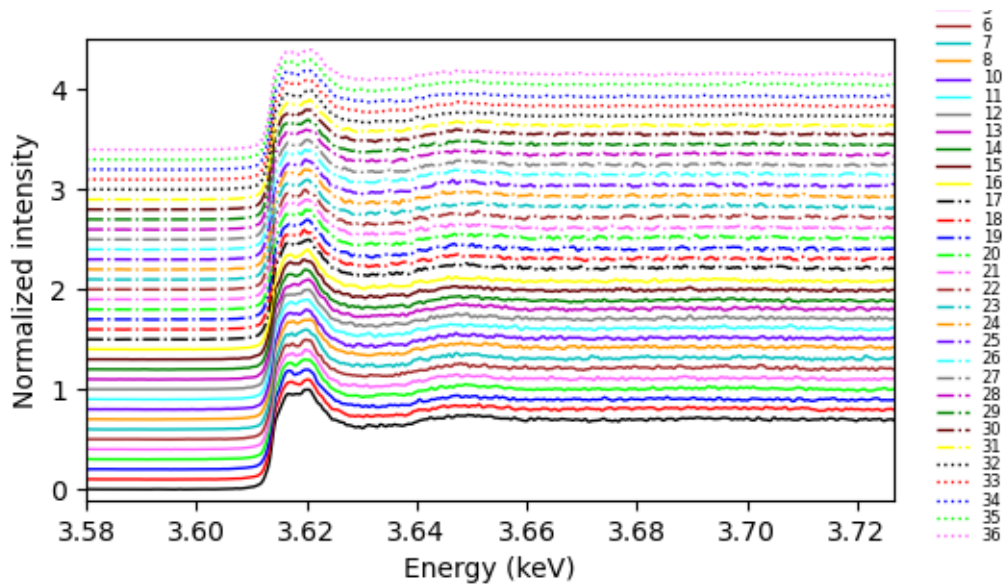


Figure 63: XANES spectra at the Co K-edge measured on the locations shown on figure 62.

1.2.3.11. SW4

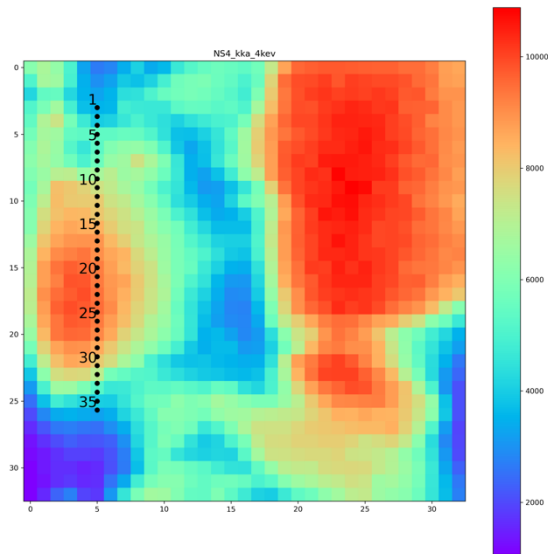


Figure 64: XRF elemental map of K with location of XANES points.

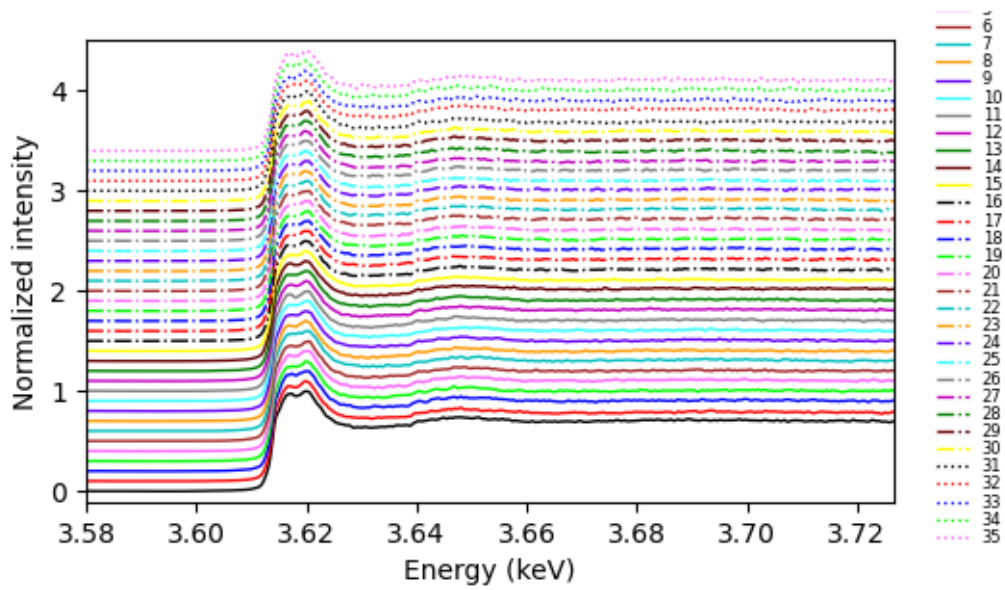


Figure 65: XANES spectra at the Co K-edge measured on the locations shown on figure 64.

2. About historical cross-section

2.1. *The Annunciation* by Giorgio VASARI

2.1.1. Information about the painting

Table 10: Information about the painting

Name	Painter	Date	Type	Museum	Cross-section n°
The Annunciation	Giorgio Vasari	1512 - 1574	Oil on canvas	Louvre museum	2719



Figure 66: Image of the painting with the location of the cross section. *The Annunciation*, 1567. Louvre Museum. @1987 RMN-Grand Palais / Arnaudet / Schormans

2.1.2. Images of the cross-section 2719

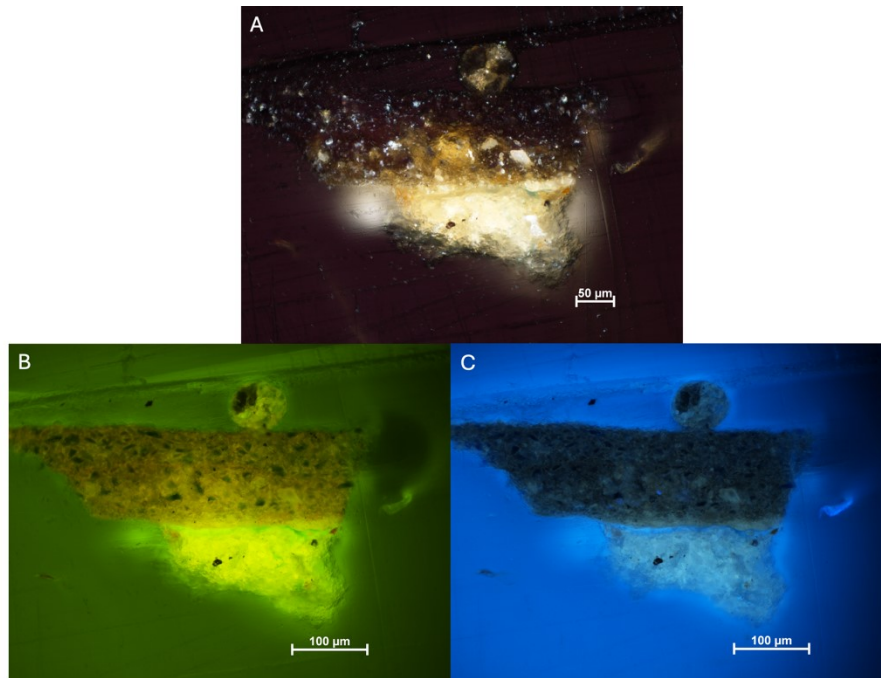


Figure 67: micrographs of cross-section 2719. A: under white lite. B: under near UV light. C: under UV light

2.1.3. μ -XRF and XANES analysis of the cross-section

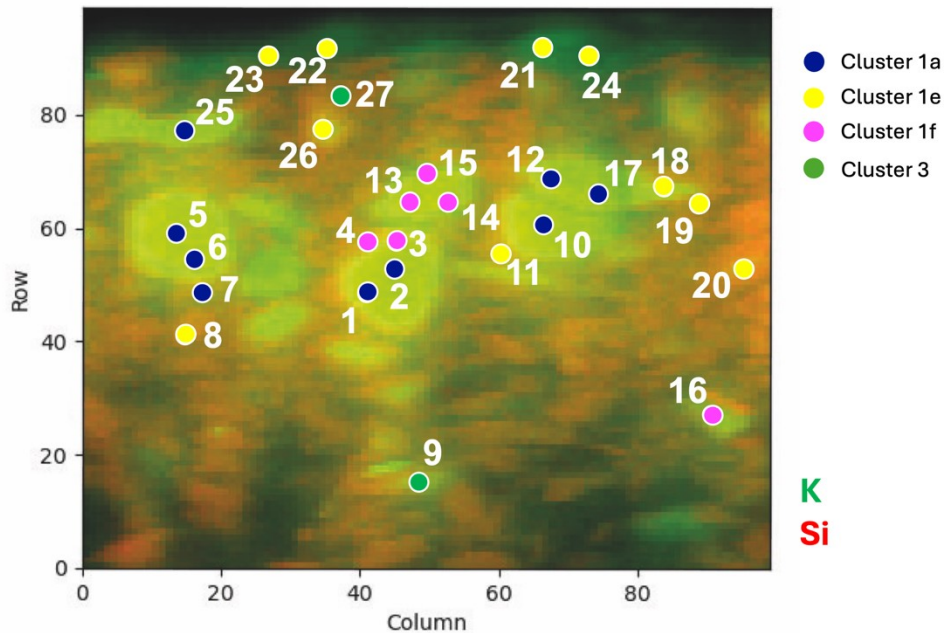


Figure 68: K and Si elemental maps obtained by μ -XRF at 3.7 keV with locations of XANES at the K K-edge points colored by function of their clusters.

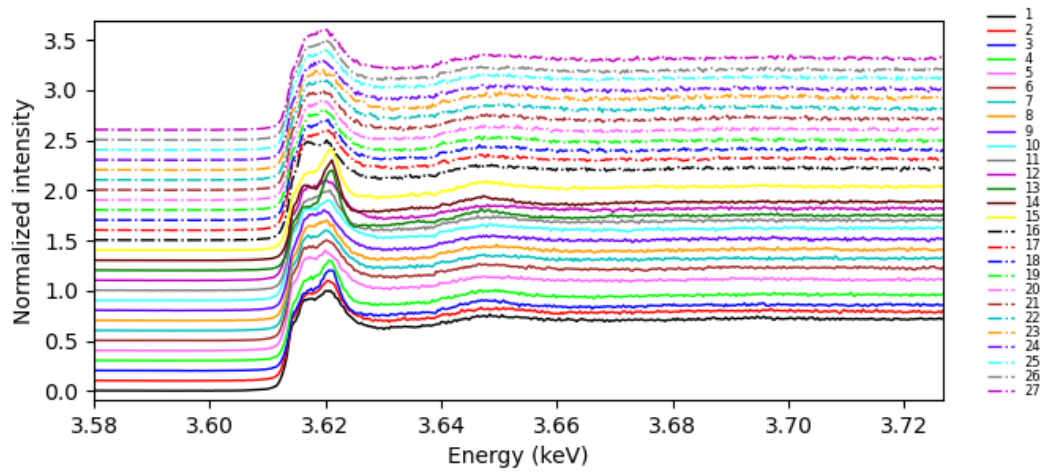


Figure 69: XANES spectra at the K K-edge measured on cross-section 2719.

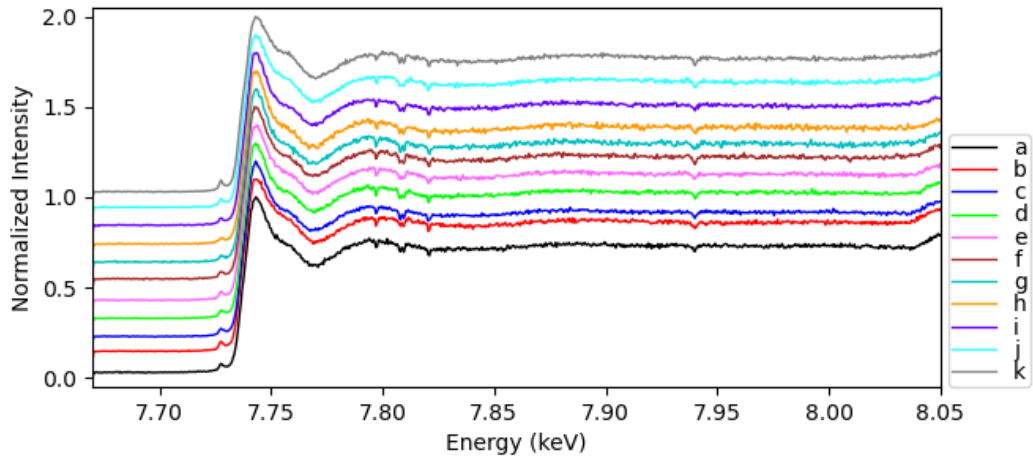


Figure 70: XANES Spectra at the Co K-edge measured on small grains from cross-section 2719.

2.2. Wedding at Cana by Paolo VERONESE

2.2.1. Information about the painting

Table 11: Information about the painting

Name	Painter	Date	Type	Museum	Cross-section n°
Wedding at Cana	Paolo VERONESE	1562-1563	Oil on canvas	Louvre museum	6757



Figure 71: Image of the painting with location of the cross-section. Wedding at Cana, Paolo VERONESE, 1562-1563, Louvre Museum.
© 2021 RMN-Grand Palais (musée du Louvre) / Arnaudet / Schormans

2.2.2. Images of the cross-sections

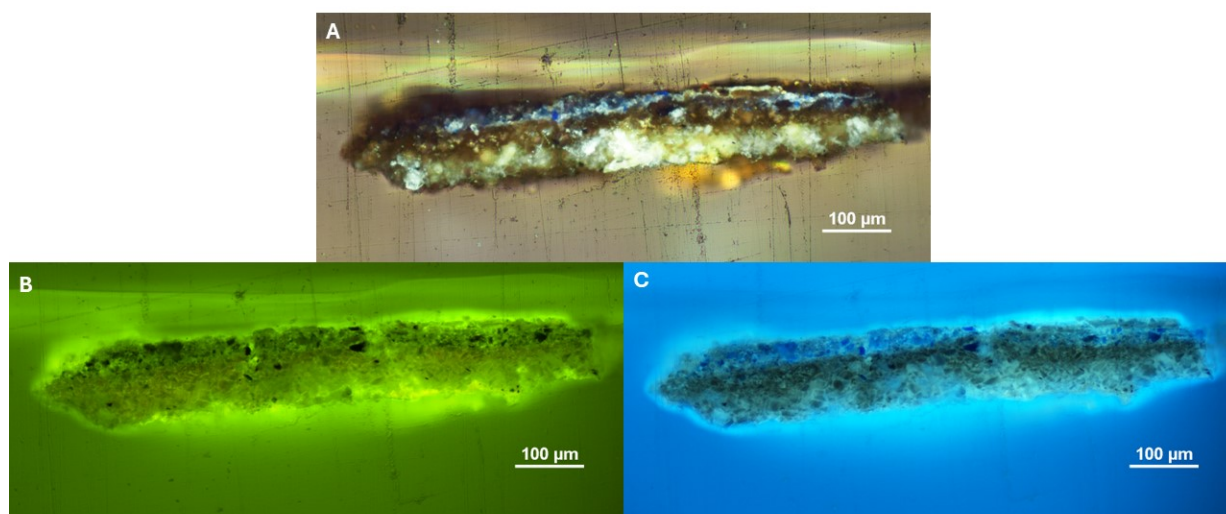


Figure 72: Micrographs of the 6757 cross-section. A: under white light. B: under near UV light. C: under UV light

2.2.3. μ -XRF and XANES analysis of cross-section 6757

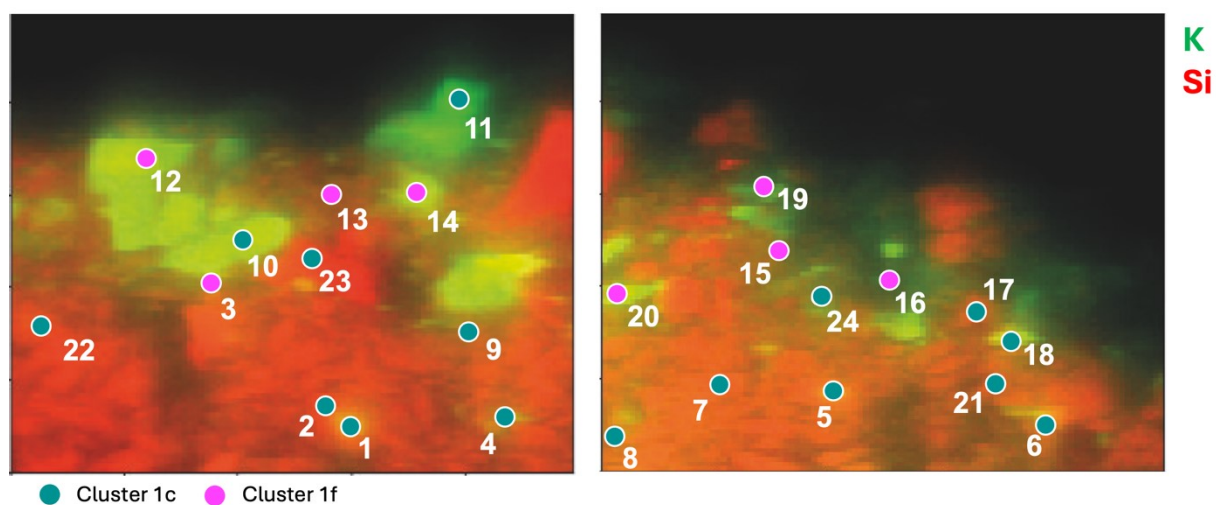


Figure 73: K and Si elemental maps obtained by μ -XRF at 3.7 keV with locations of XANES at the K K-edge points colored by function of their clusters.

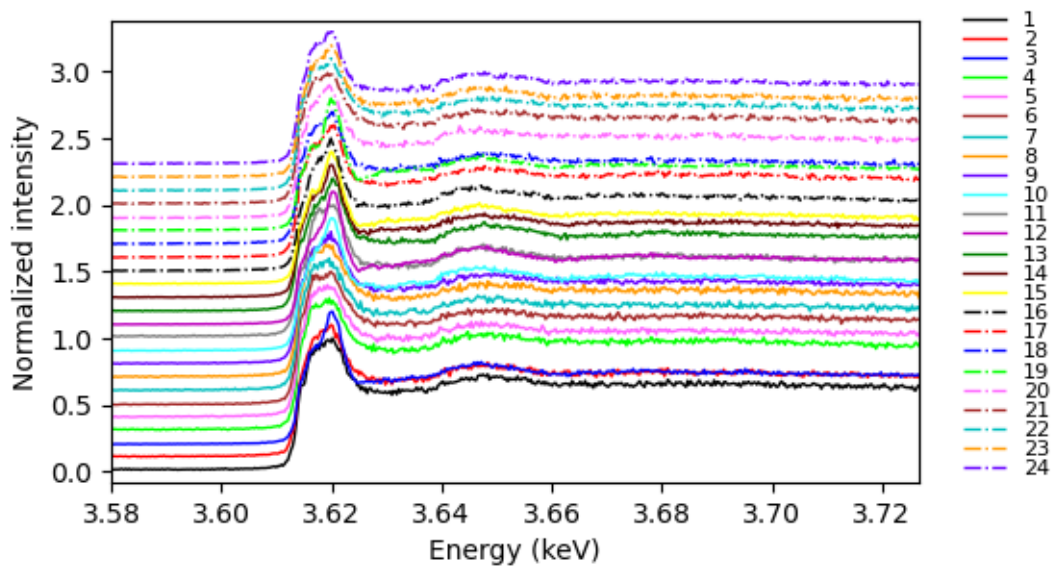


Figure 74: XANES spectra at the K K-edge measured on cross-section 6757.

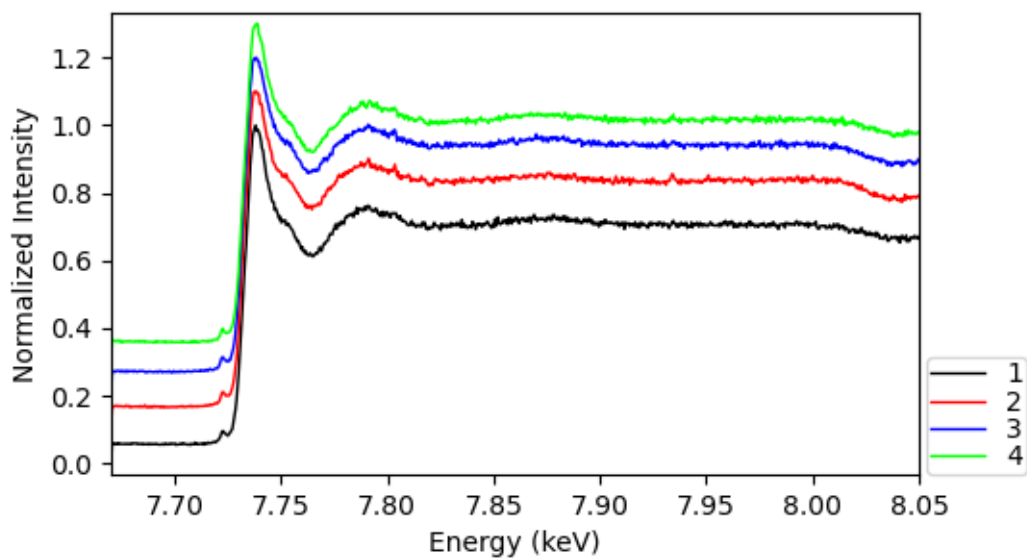


Figure 75: XANES Spectra at the Co K-edge measured on small grains from cross-section 6757.

2.2.4. SEM-EDX analyses of cross-section 6757

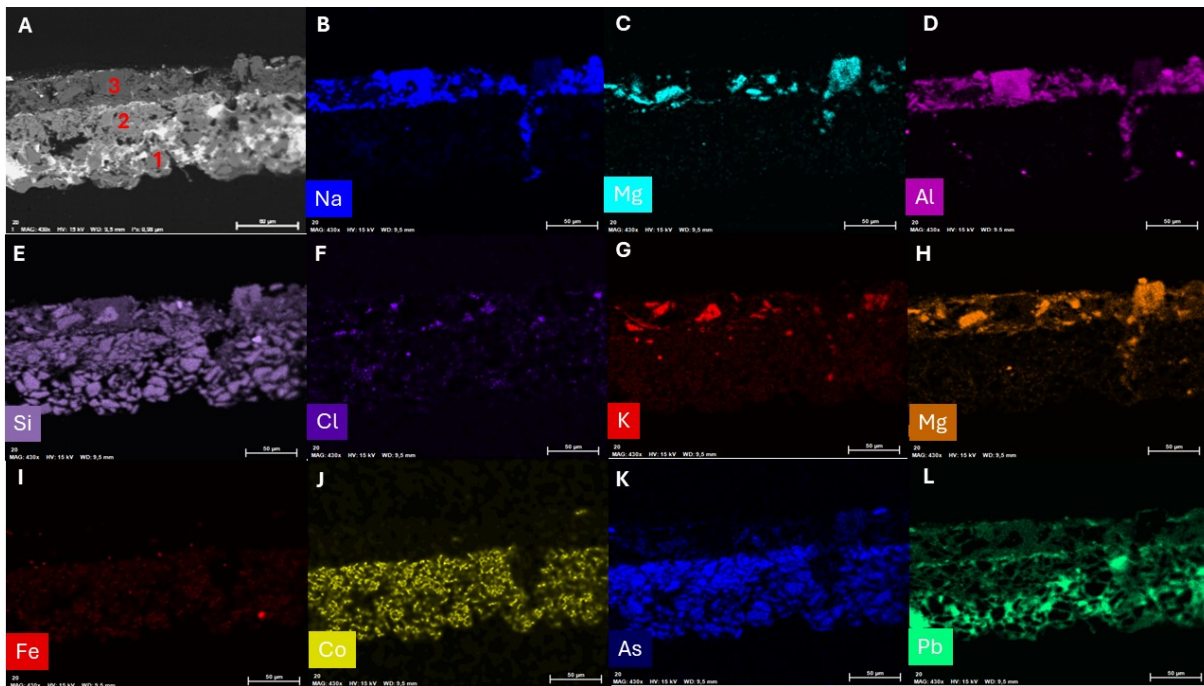


figure 76: SEM-EDX analysis of cross-section 6757. A: Backscattered electron image of a part of the cross-section with paint layers numbers. B: Na Elemental map. C: Mg elemental map. D: Al elemental map. E: Si elemental map. F: Ca elemental map. G: K elemental map. H: Mg elemental map. I: Fe elemental map. J: Co elemental map. K: As elemental map. L: Pb elemental map

Table 12: SEM-EDX results on cross-section 6757. Main elements are written in bold and traces in italic.

Layer	Elements	Interpretation
1	Si, Pb , As, Co, Fe, Ca, K, Al, <i>Na, Cl</i>	Smalt and lead white
2	Si, Pb , As, Co, Fe, K, Ca, Cl, Ni, <i>Al</i>	Smalt and lead white
3	Si, Pb, Al, Ca , Na, S, K, Mg, Cl, <i>Pb, Co</i>	Lapis lazuli and lead white

2.3. Adoration of the Kings by Pieter BRUEGEL II

2.3.1. Information about the painting

Table 13: Information about the painting

Name	Painter	Date	Type	Museum	Cross-section n°
Adoration of the Kings	Pieter BRUEGEL II	1564-1638	Oil on panel	Museum of Technology of Salins-les-Bains	12575



Figure 77: Image of the painting with location of the cross-section. Adoration of the Kings, Pieter BRUEGEL II, 1564-1638, Museum of technology of Salins-les-Bains. ©C2RMF / Joël Requilé

2.3.2. Images of the cross-section

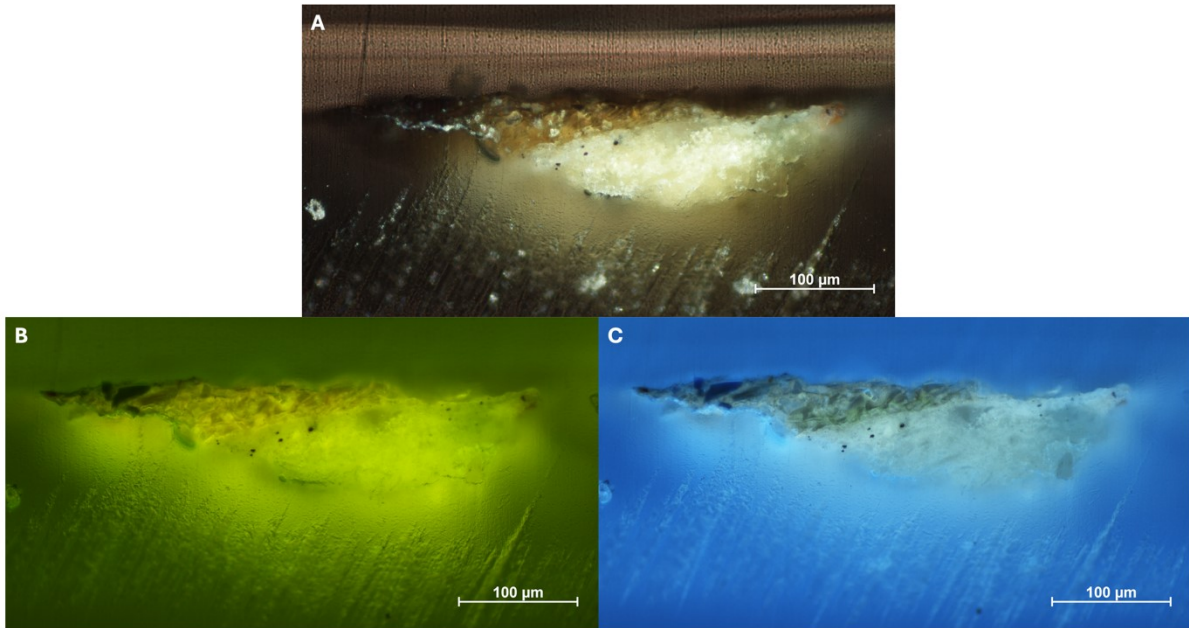


Figure 78: Micrographs of the cross-section 12575. A: under white light. B: Under near UV light. C: Under UV light.

2.3.3. μ -XRF an XANES analysis of the cross-section

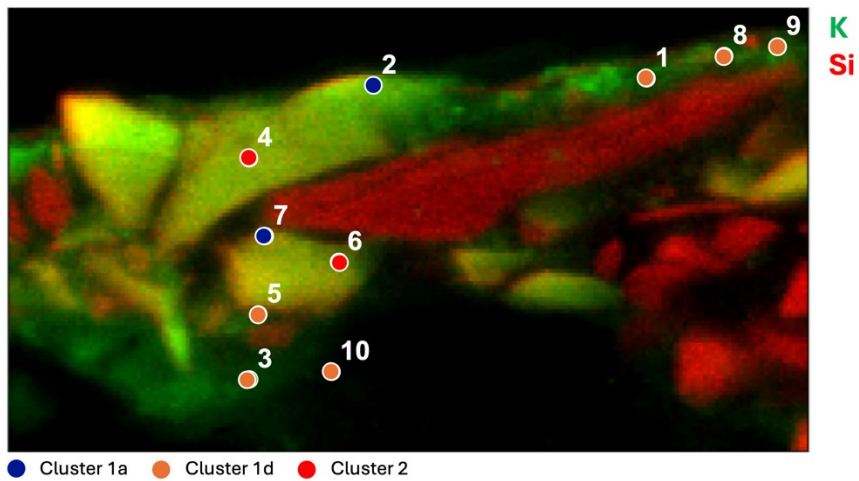


Figure 79: K and Si elemental maps obtained by μ -XRF at 3.7 keV with locations of XANES at the K K-edge points colored by function of their clusters.

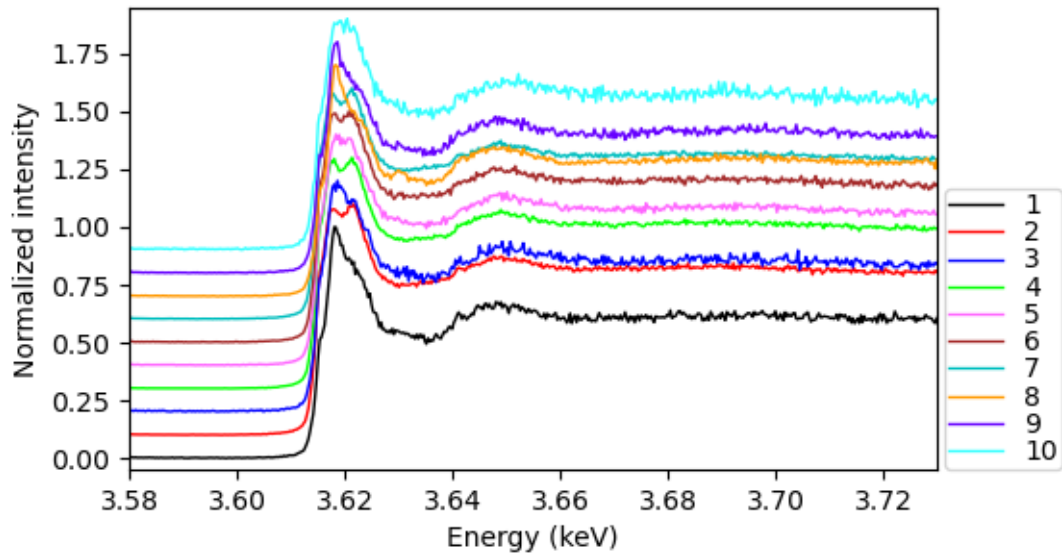


Figure 80: XANES spectra at the K K-edge measured on cross-section 12575.

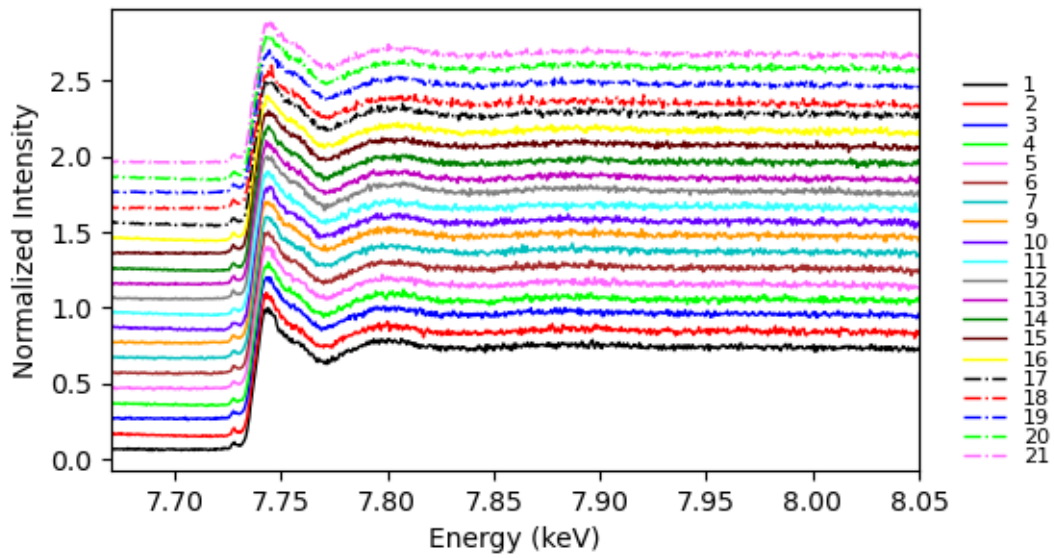


Figure 81: XANES Spectra at the Co K-edge measured on small grains from cross-section 12575.

2.4. *Departure of an Oriental Entourage* by Jan-Baptist WEENIX

2.4.1. Information about the painting

Table 14: Information about the painting

Name	Painter	Date	Type	Museum	Cross-section n°
<i>Departure of an Oriental Entourage</i>	Jan-Baptist WEENIX	1621-1660	Oil on canvas	Louvre Museum	2177



Figure 82: Image of the painting with location of the cross-section. *Departure of an Oriental Entourage*, Jan-Baptist WEENIX, 1564-1660, Louvre Museum. © 2016 RMN Grand Palais / Tony Querrec

2.4.2. Images of the cross-section

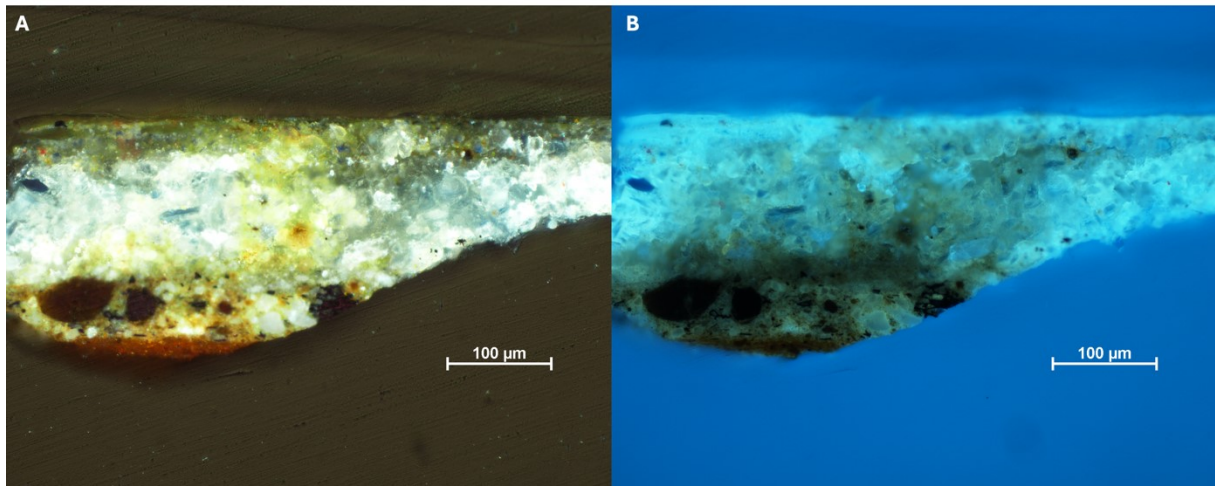


Figure 83: Micrograph of the 2177 cross-section. A: under white light. B: under UV light

2.4.3. μ -XRF and XANES analysis of the cross-section

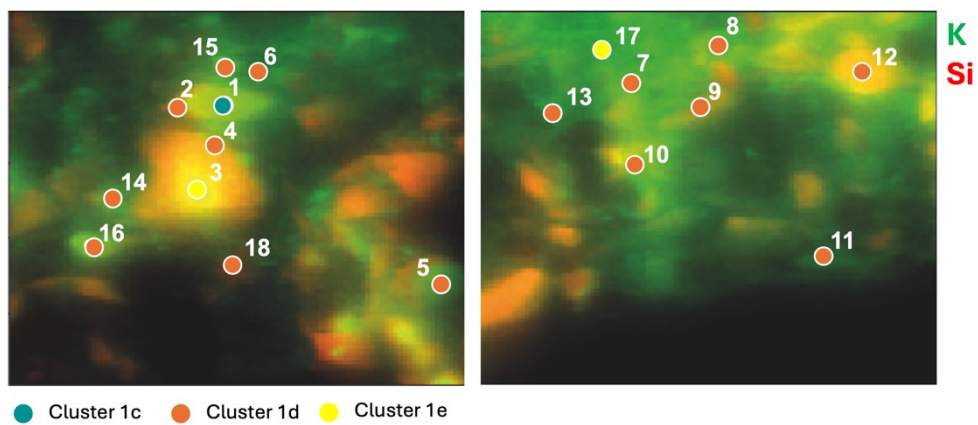


Figure 84: K and Si elemental maps obtained by μ -XRF at 3.7 keV with locations of XANES at the K K-edge points colored by function of their clusters.

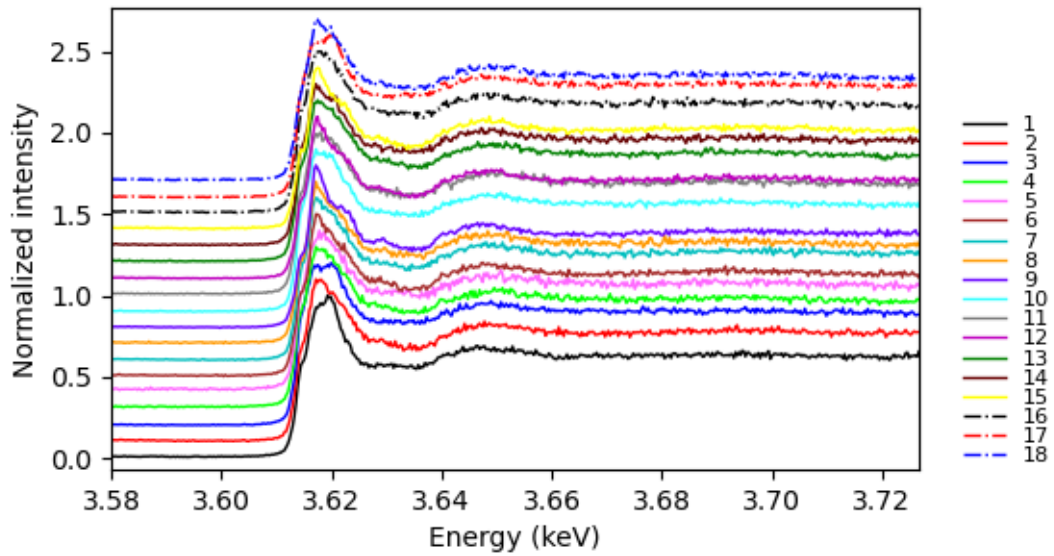


Figure 85: XANES spectra at the K K-edge measured on cross-section 2177.

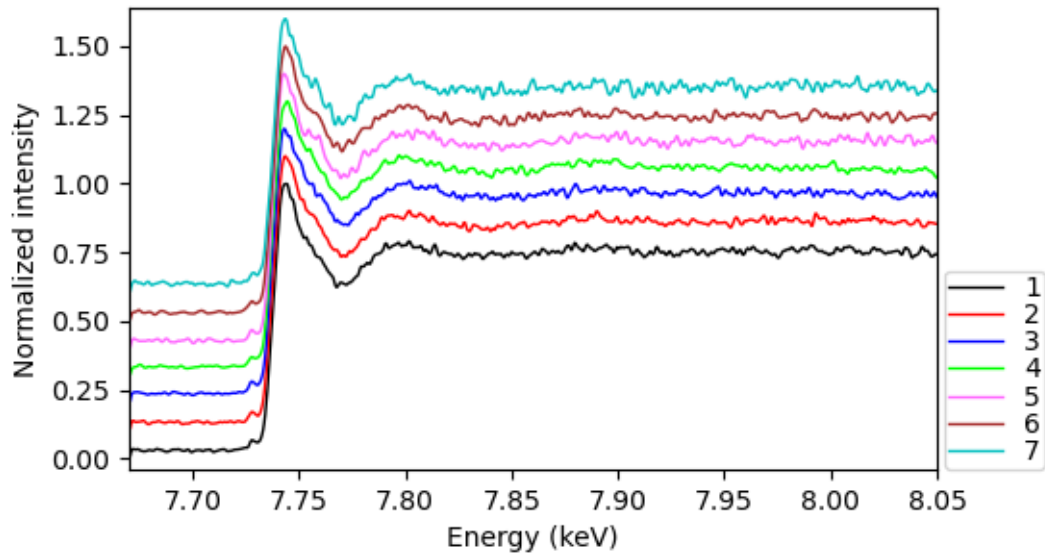


Figure 86: XANES Spectra at the Co K-edge measured on small grains from cross-section 2177.

2.5. *Wheat Field* by Jacob van RUISDAEL

2.5.1. Information about the painting

Table 15: Information about the painting

Name	Painter	Date	Type	Museum	Cross-section n°
<i>Wheat Field</i>	Jacob van RUISDAEL	~ 1660	Oil on canvas	Lille Fine arts Museum	7850



Figure 87: Image of the painting with location of the cross-section. *Wheat Field*, Jacob van RUISDAEL, ~1660, Lille Museum of Fine arts. ©C2RMF / J.M. Routhier

2.5.2. Images of the cross-section

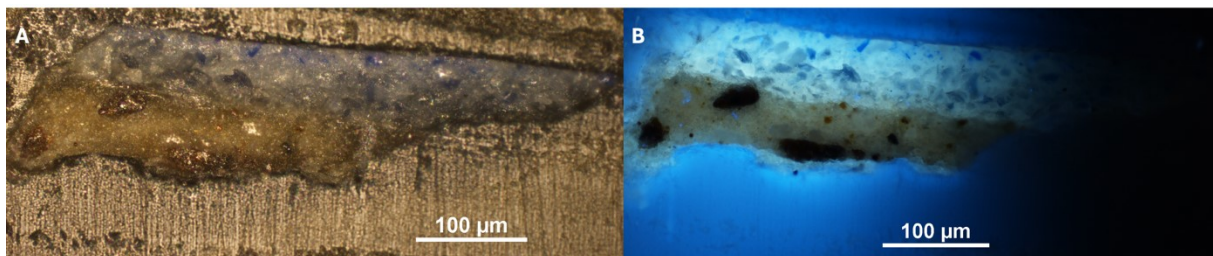


Figure 88: Micrographs of the cross-section 7850. A: Under white light. B: under UV light.

2.5.3. μ -XRF and XANES analysis

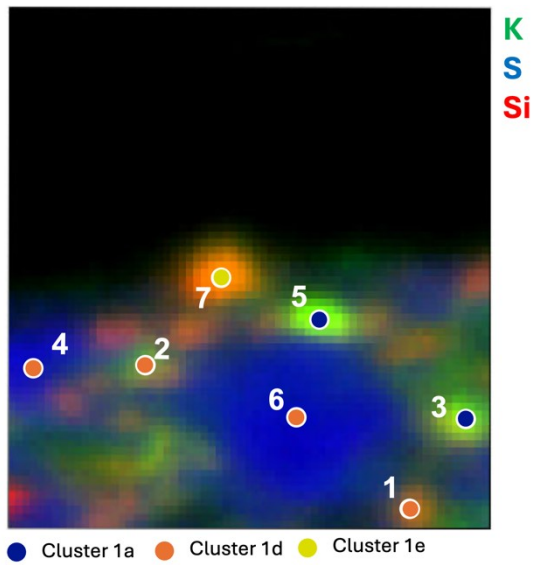


Figure 89: K, S and Si elemental maps obtained by μ -XRF at 3.7 keV with locations of XANES at the K K-edge points colored by function of their clusters.

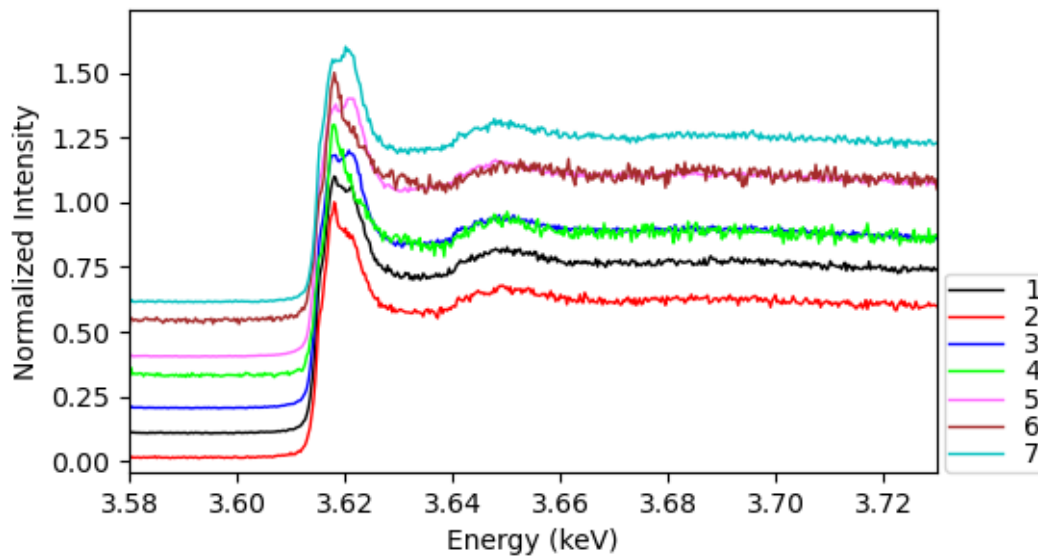


Figure 90: XANES spectra at the K K-edge measured on cross-section 7850.

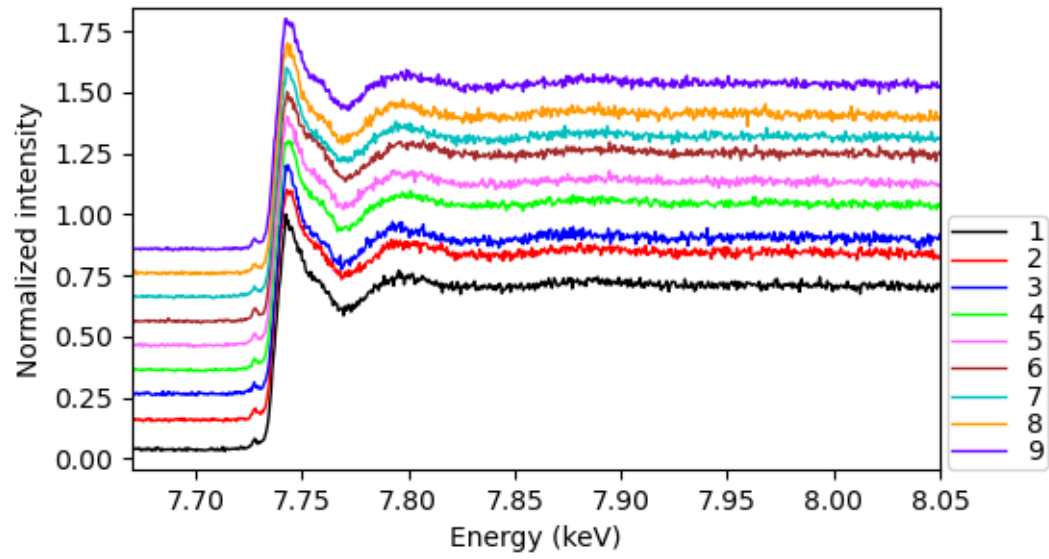


Figure 91: XANES Spectra at the Co K-edge measured on small grains from cross-section 7850.

2.6. Christ Risen from the dead by Salvator ROSA

2.6.1. Information about the painting

Table 16: Information about the painting

Name	Painter	Date	Type	Museum	Cross-section n°
Christ Risen from the dead	Salvator ROSA	1660 – 1662	Oil on canvas	Conde Museum	6732

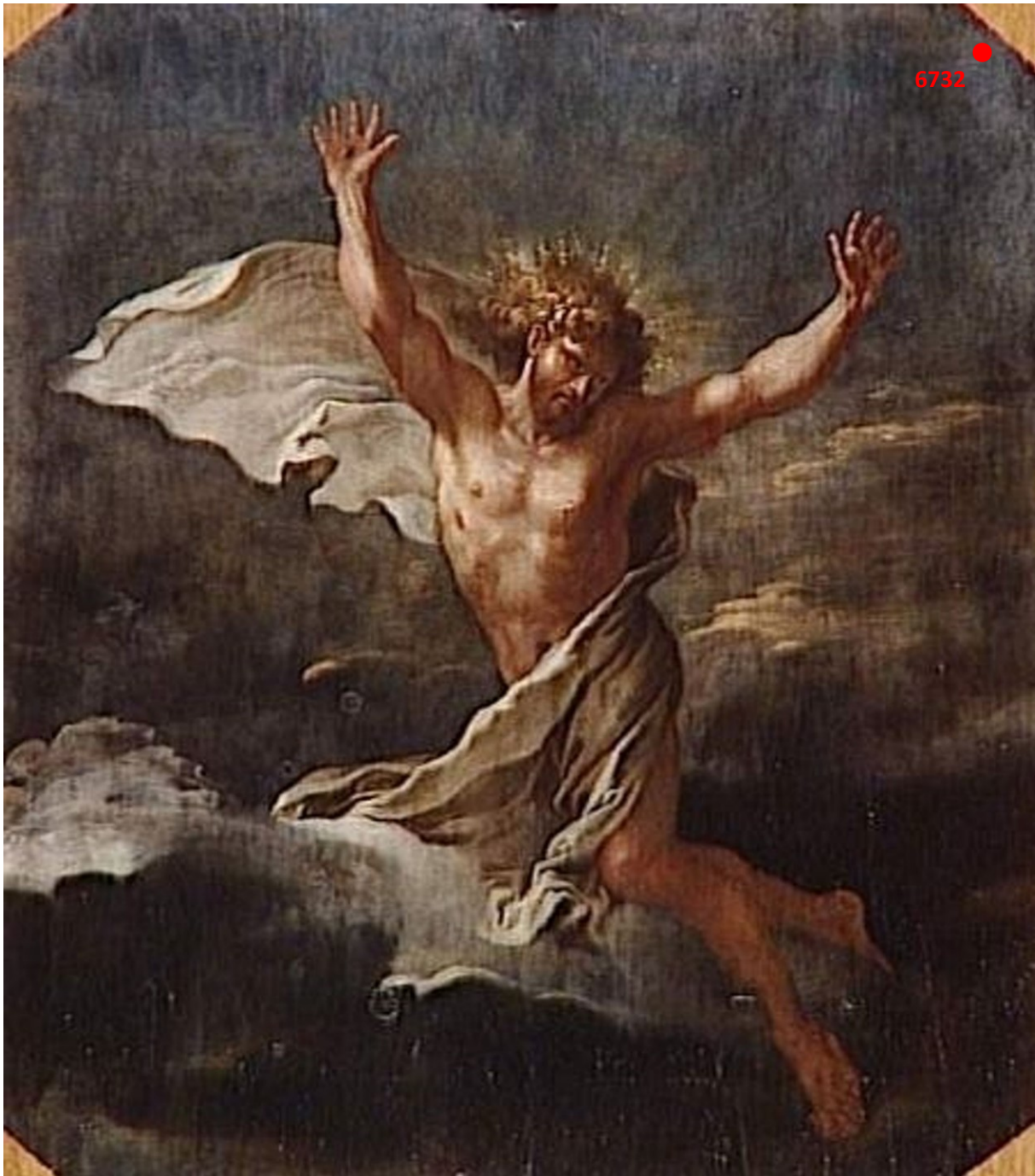


Figure 92: Image of the painting with location of the cross-section. Christ Risen from the dead, Salvator ROSA, 1660-1662, Conde Museum. © C2RMF / Joël Requilé

2.6.2. Images of the cross-section

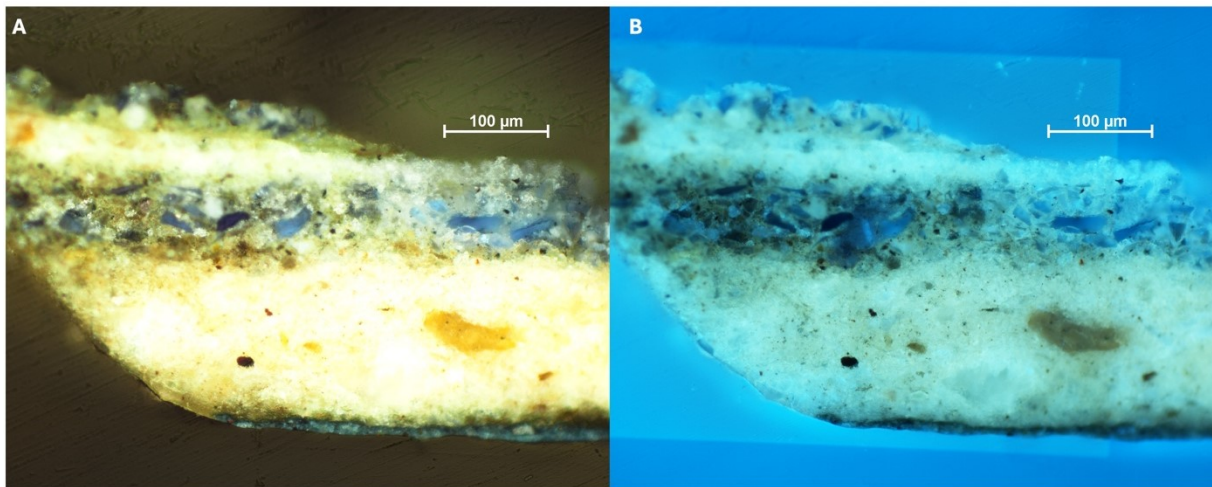


Figure 93 : Micrographs of the cross-section 6732. A: under white light. B: under UV light

2.6.3. μ -XRF and XANES analysis of the cross-section

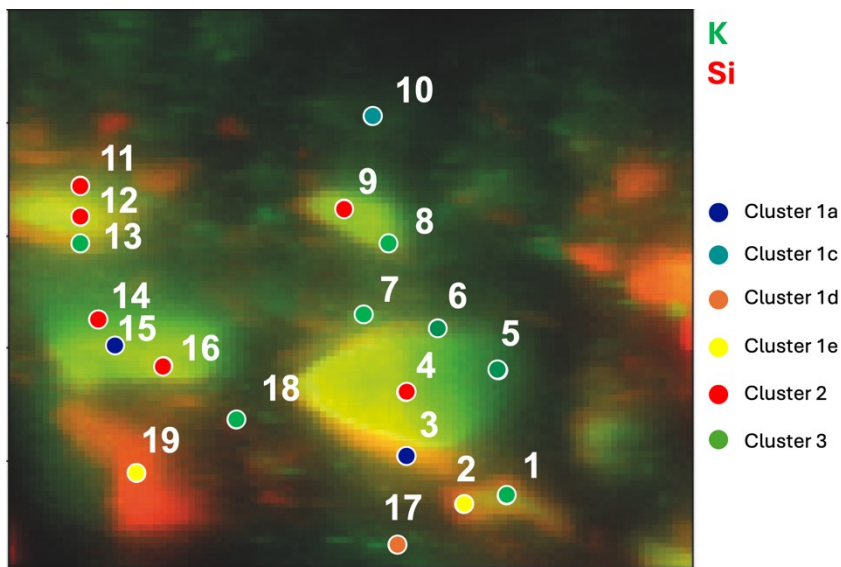


Figure 94: K and Si elemental maps obtained by μ -XRF at 3.7 keV with locations of XANES at the K K-edge points colored by function of their clusters.

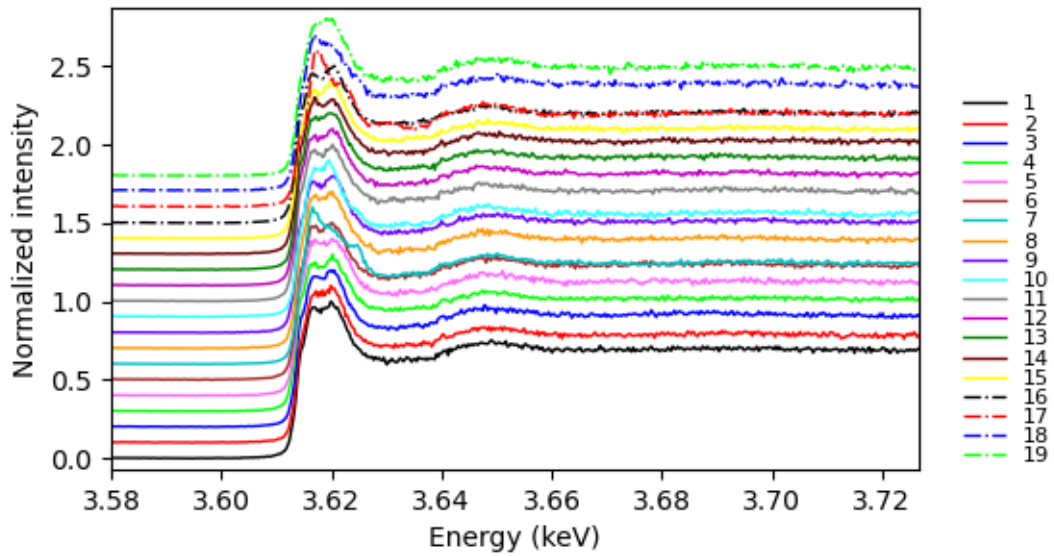


Figure 95: XANES spectra at the K K-edge measured on cross-section 6732.

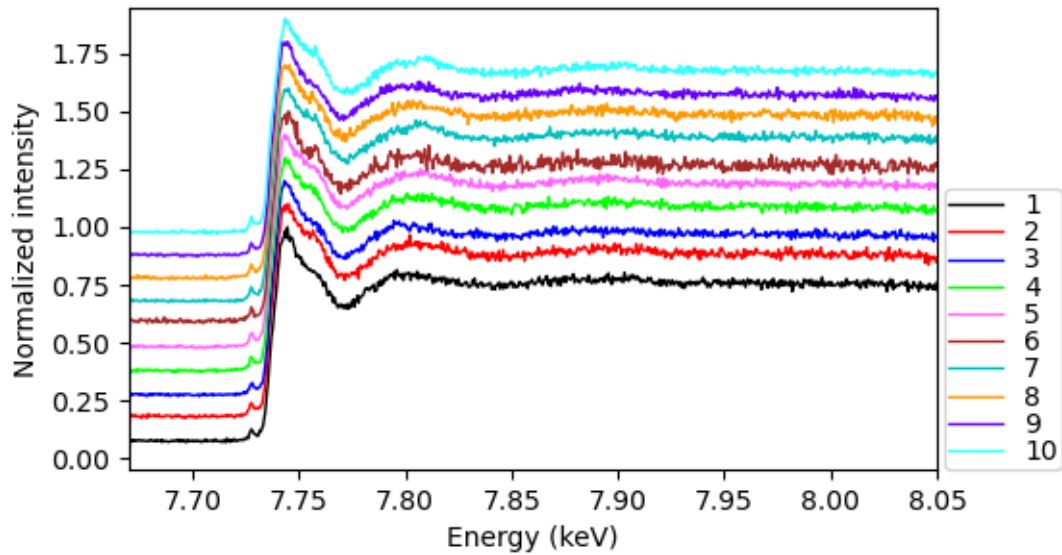


Figure 96: XANES Spectra at the Co K-edge measured on small grains from cross-section 6732.

2.7. Jesus on the way to Calvary by Pierre Mignard

2.7.1. Information about the painting

Table 17: Information about the painting

Name	Painter	Date	Type	Museum	Cross-section n°
Jesus on the way to Calvary	Pierre Mignard	1684	Oil on canvas	Louvre Museum	4150



Figure 97: Image of the painting with location of the cross-section. Jesus on the way to Calvary, Pierre MIGNARD, 1687, Louvre Museum. © 2009 RMN Grand Palais (musée du Louvre) / Jean-Gilles Berizzi

2.7.2. Images of the cross-section

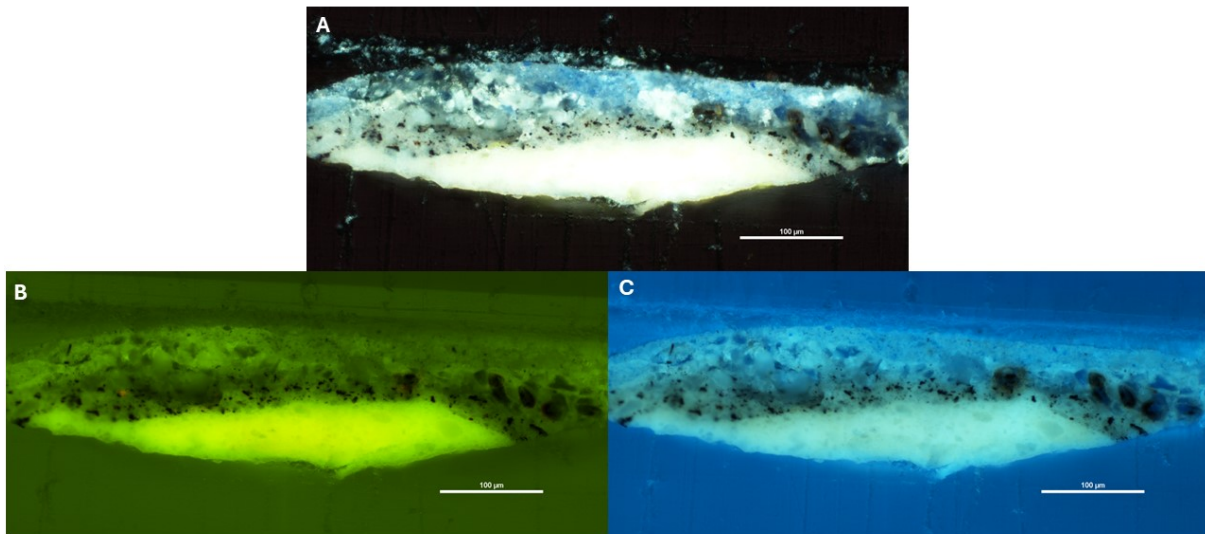


figure 98: Micrographs of cross-section 4150. A: Under white light. B: under near UV light. C: Under UV light

2.7.3. μ -XRF and XANES analysis of the cross-section

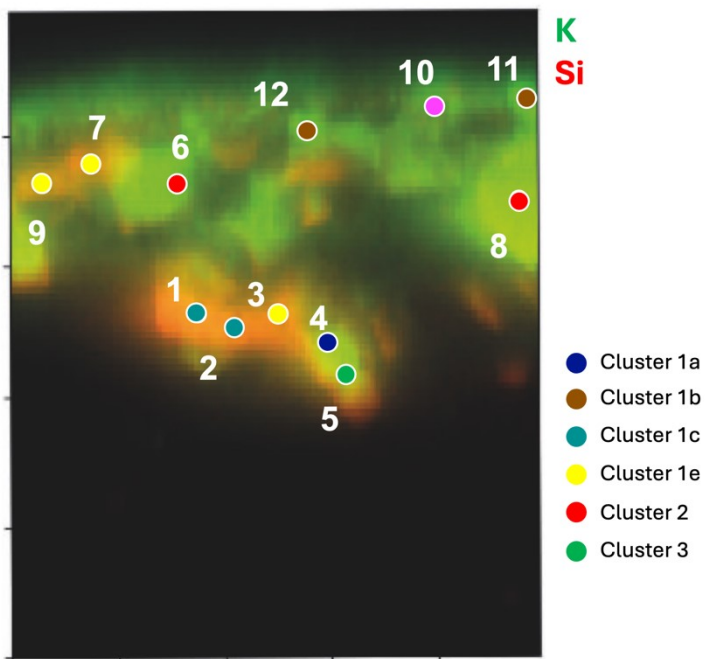


Figure 99: K and Si elemental maps obtained by μ -XRF at 3.7 keV with locations of XANES at the K K-edge points colored by function of their clusters.

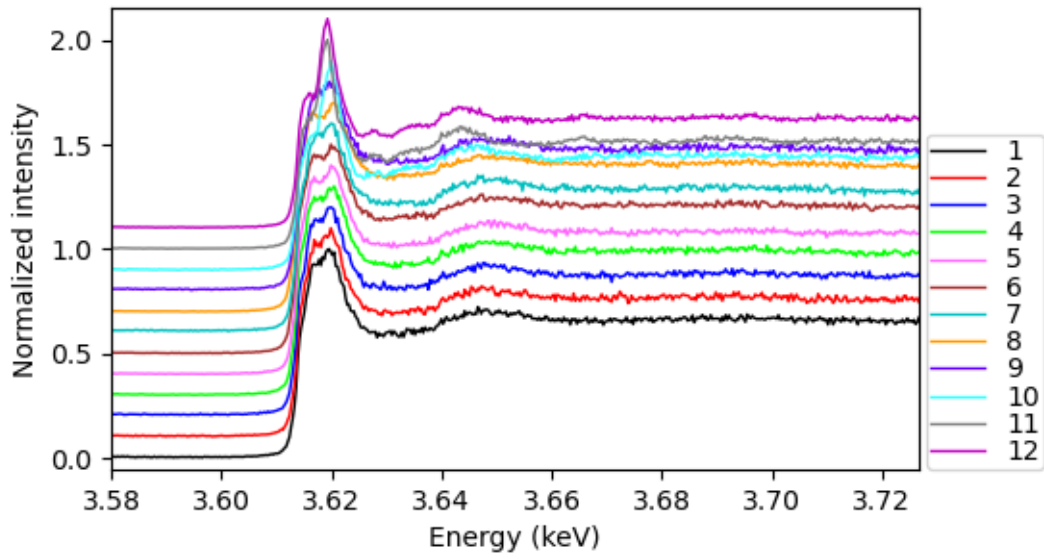


Figure 100: XANES spectra at the K K-edge measured on cross-section 4150.

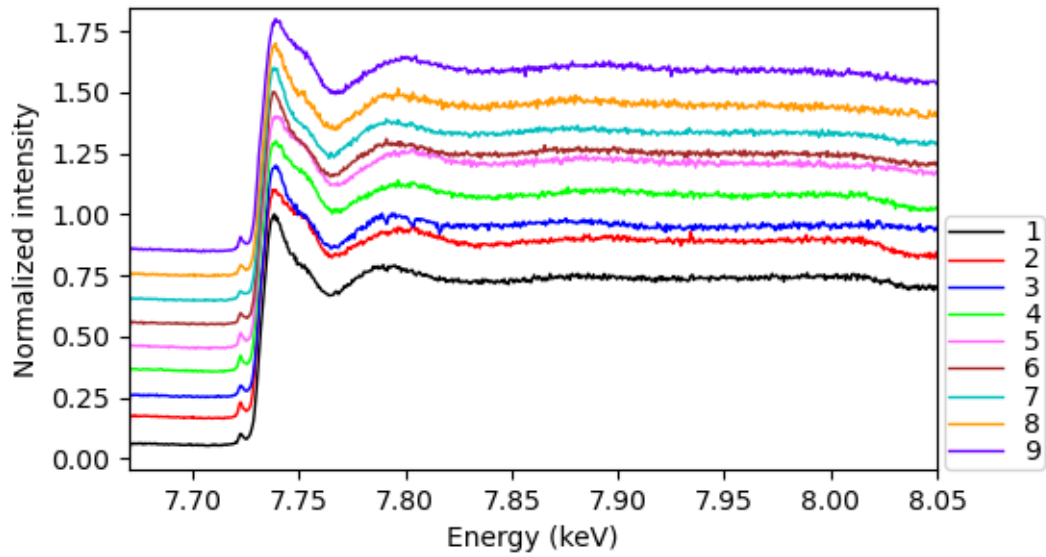


Figure 101: XANES Spectra at the Co K-edge measured on small grains from cross-section 4150.

2.8. *Abbaye among Oak Trees* by Caspar David FRIEDRICH

2.8.1. Information about the painting

Table 18: Information about the painting

Name	Painter	Date	Type	Museum	Cross-section n°
Abbey among Oak Trees	Caspar David FRIEDRICH	1808 - 1810	Oil on canvas	Alte Nationalgalerie Museen zu Berlin	P15a



Figure 102: Image of the painting with location of the cross-section. *Abbey among Oak Trees*, Caspar David FRIEDRICH, 1808-1810, Alte Nationalgalerie Museen zu Berlin. © Staatliche Museen zu Berlin, Nationalgalerie / Foto : Kristina Mösl, Francesca Schneide.

2.8.2. Images of the cross-section

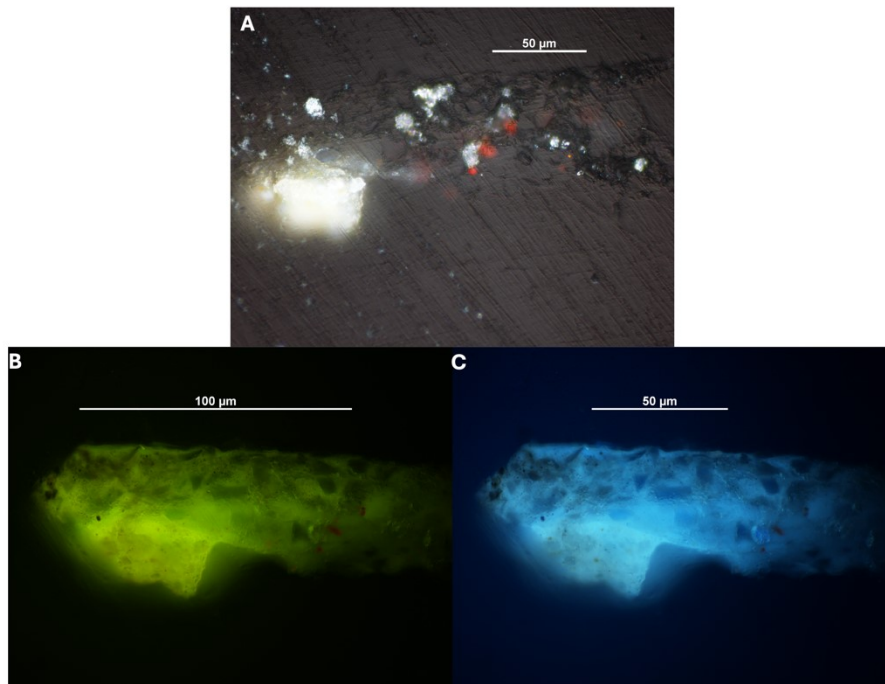


Figure 103: Micrographs of the cross-section P15a. A: under white light. B: Under near UV light. C: under UV light

2.8.3. μ -XRF and XANES analysis of the cross-section

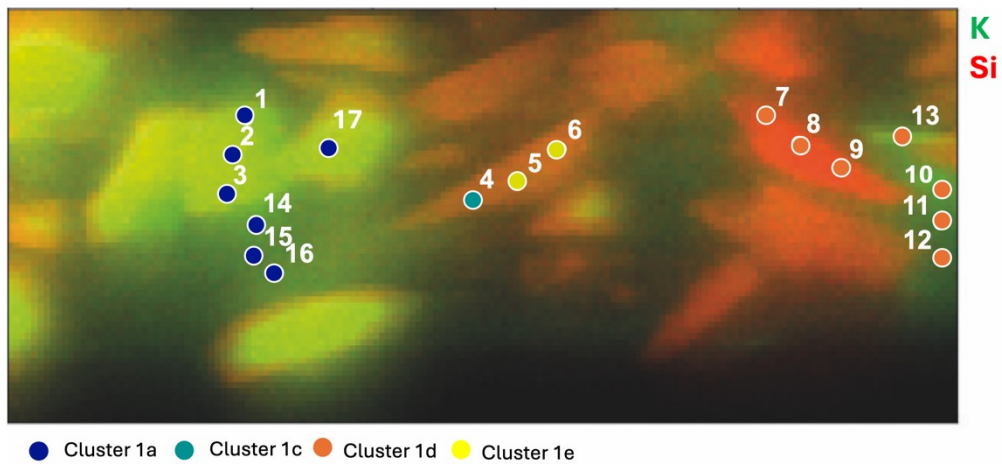


Figure 104: K and Si elemental maps obtained by μ -XRF at 3.7 keV with locations of XANES at the K K-edge points colored by function of their clusters.

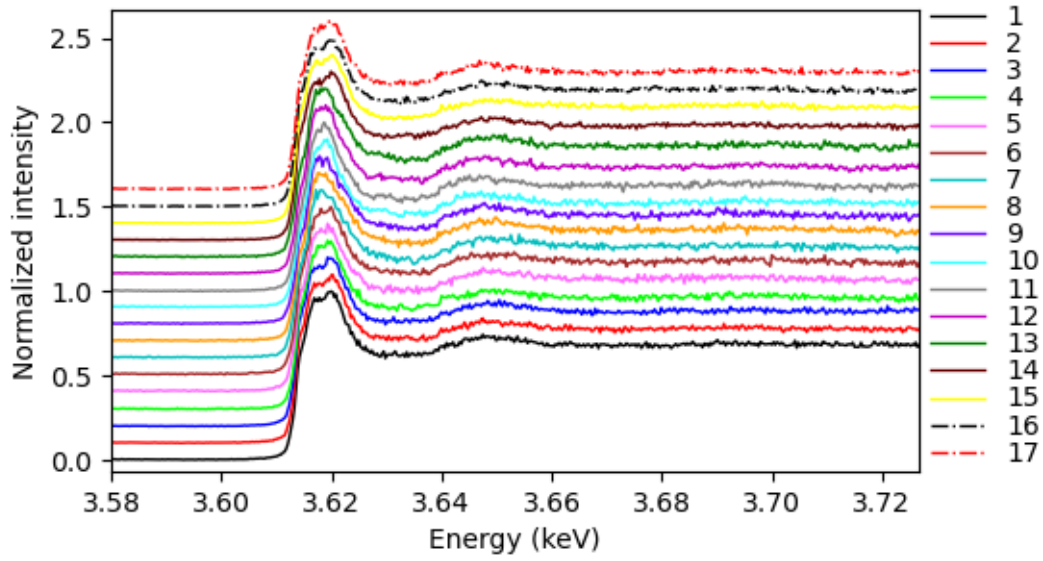


Figure 105: XANES spectra at the K K-edge measured on cross-section P15a

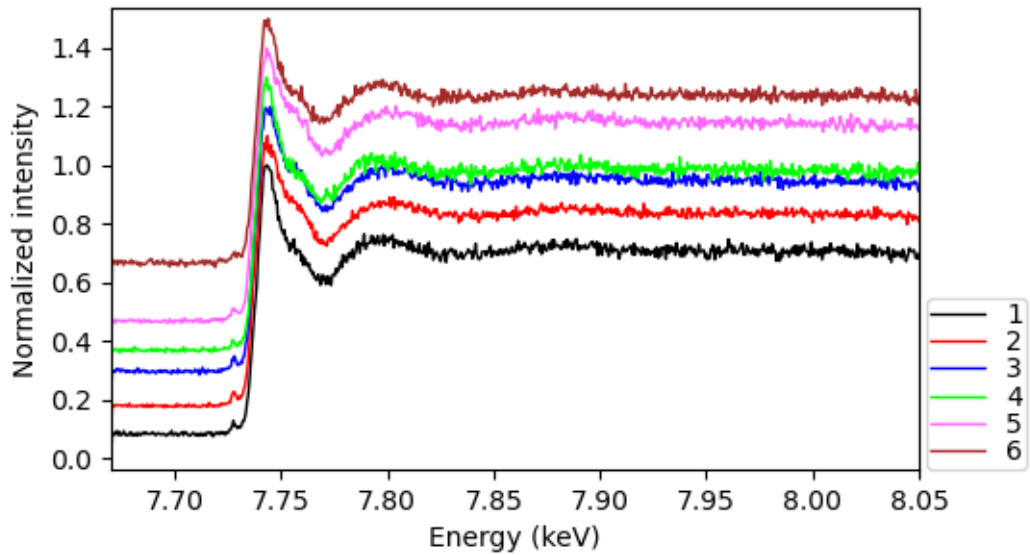


Figure 106: XANES Spectra at the Co K-edge measured on small grains from cross-section P15a.

2.9. *Monk by the Sea* by Caspar David Friedrich

2.9.1. Information about the painting

Table 19: Information about the painting

Name	Painter	Date	Type	Museum	Cross-section n°
Monk by the Sea	Caspar David FRIEDRICH	1808 - 1810	Oil on canvas	Alte Nationalgalerie Museen zu Berlin	P7



Figure 107: Image of the painting with location of the cross-section. *Monk by the Sea*, Caspar David Friedrich, 1808-1810, Alte Nationalgalerie Museen zu Berlin. © Staatliche Museen zu Berlin, Nationalgalerie / Foto : Kristina Mösl, Francesca Schneide.

2.9.2. Images of the cross-section

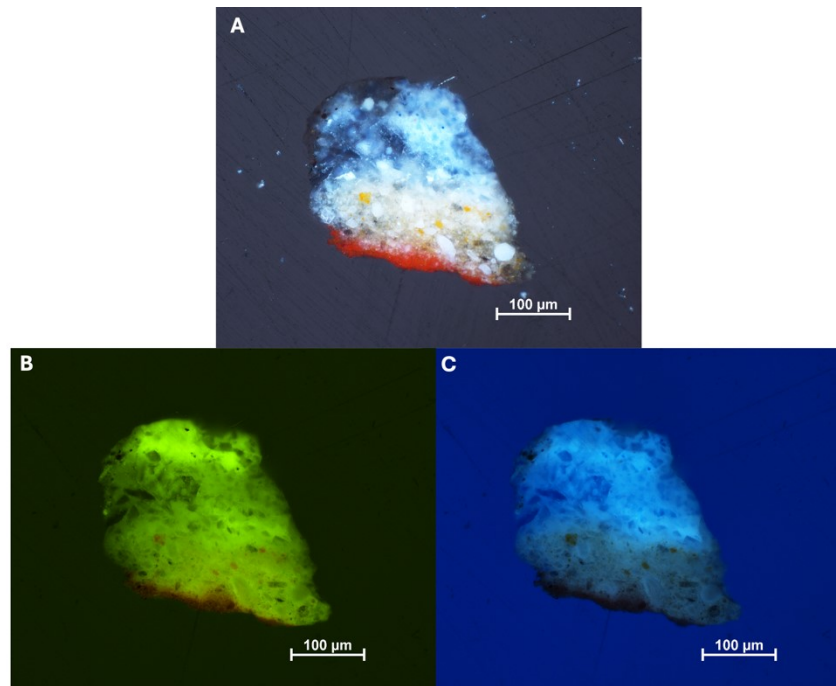


Figure 108: Micrographs of the cross-section P7. A: Under white light. B: under near UV light. C: Under UV light

2.9.3. μ -XRF and XANES analysis of the cross-section

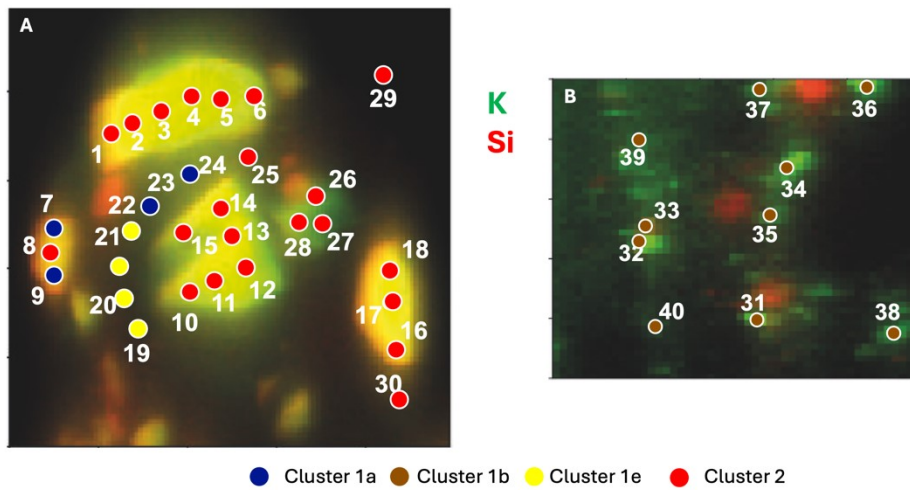


Figure 109: K and Si elemental maps obtained by μ -XRF at 3.7 keV with locations of XANES at the K K-edge points colored by function of their clusters. A: Map of the small containing layer. B: map of the nearest layer to the surface of the painting

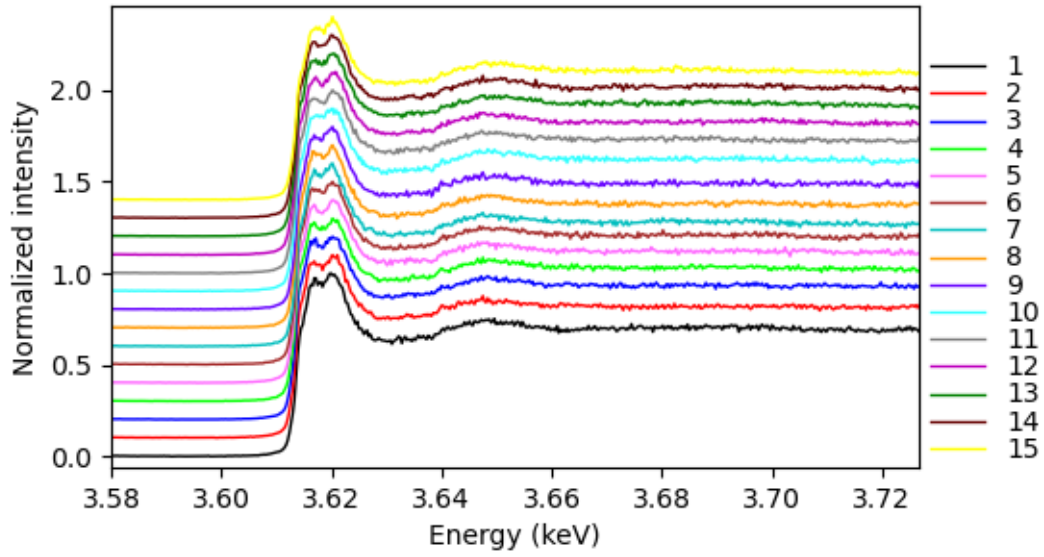


Figure 110: XANES spectra at the K K-edge measured on cross-section P7.

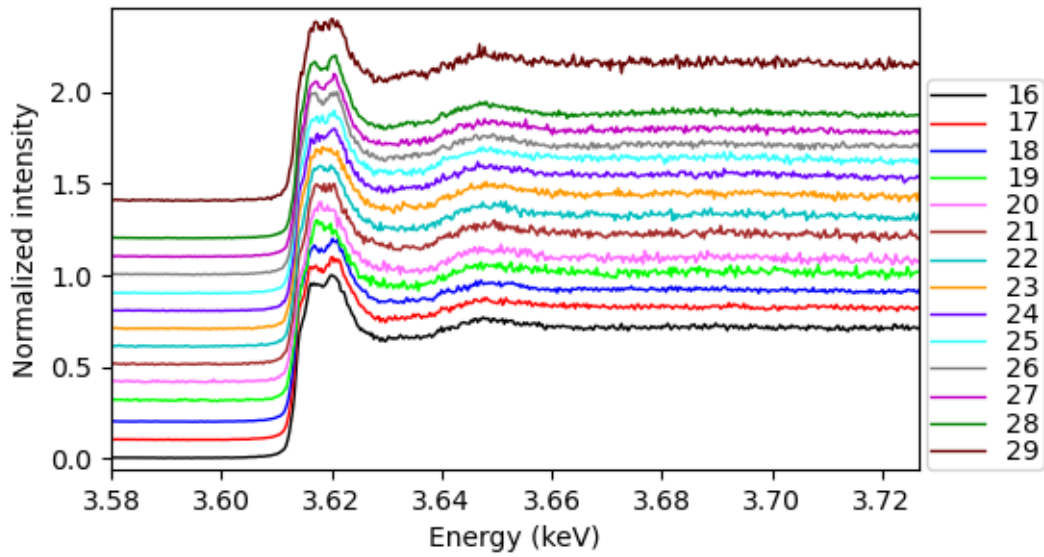


Figure 111: XANES spectra at the K K-edge measured on cross-section P7.

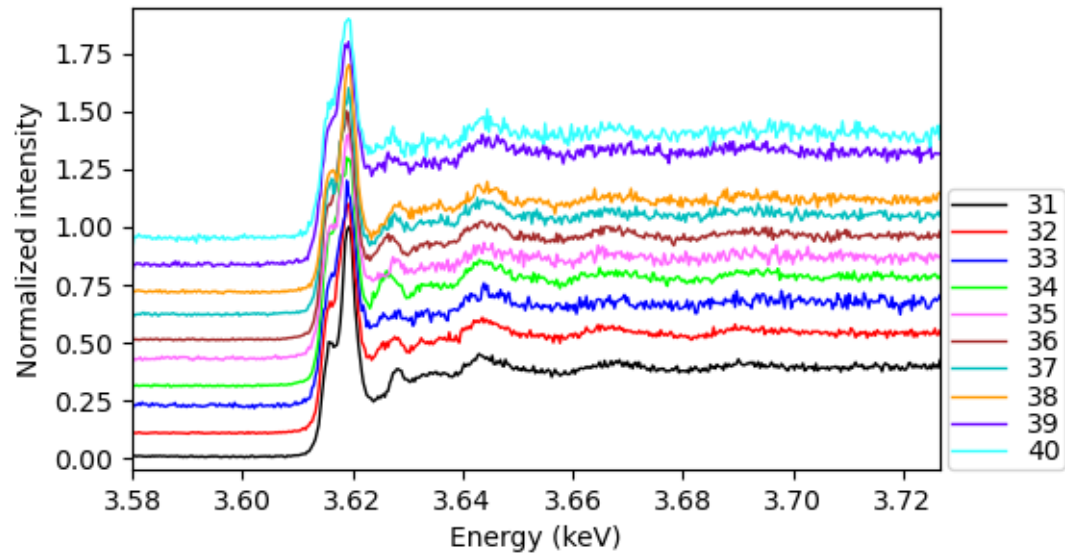


Figure 112: XANES spectra at the K K-edge measured on cross-section P7.

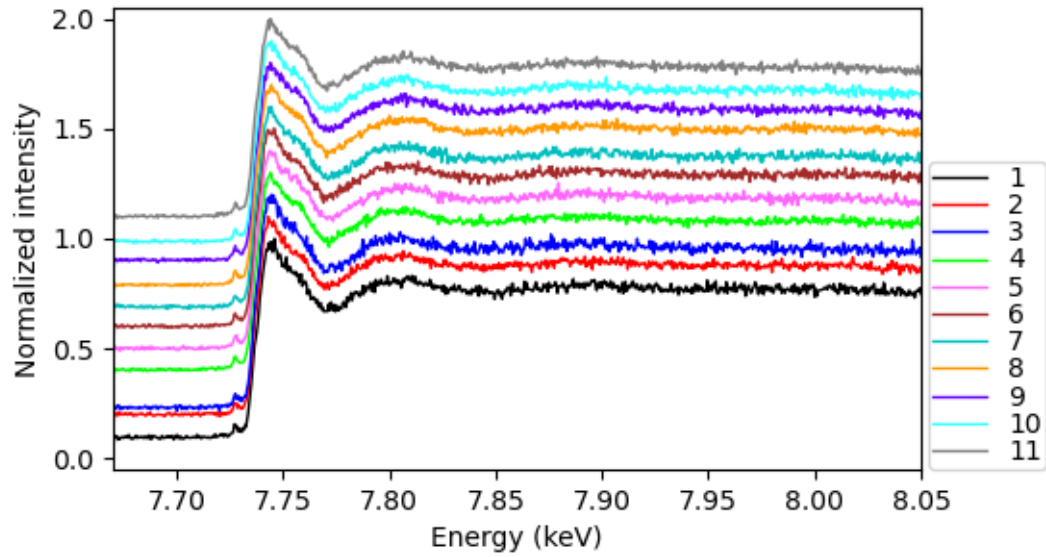


Figure 113: XANES Spectra at the Co K-edge measured on small grains from cross-section P7.

3. Clusterization results

3.1. Cluster 1a

Table 20: Composition of cluster 1a

Cluster	Sample	Analysis point
1a	P15a	1
1a	P15a	2
1a	P15a	3
1a	P15a	14
1a	P15a	15
1a	P15a	16
1a	P15a	17
1a	6732	3
1a	6732	15
1a	4150	4
1a	2719	1
1a	2719	2
1a	2719	5
1a	2719	6
1a	2719	7
1a	2719	10
1a	2719	12
1a	2719	17
1a	2719	25
1a	P7	7
1a	P7	9
1a	P7	23
1a	P7	24
1a	NS4	35
1a	NC3	6
1a	LS4	10
1a	LS4	20
1a	LC4	34
1a	LC4	35
1a	12575	2
1a	12575	7
1a	7850	3
1a	7850	5

3.2. Cluster 1b

Table 21: Composition of cluster 1b

Cluster	Sample	Analysis point
1b	P7	31
1b	P7	32
1b	P7	33
1b	P7	34
1b	P7	35
1b	P7	36
1b	P7	37
1b	P7	38
1b	P7	39
1b	P7	40
1b	4150	11
1b	4150	12

3.3. Cluster 1c

Table 22: Composition of cluster 1c

Cluster	Sample	Analysis point
1c	P15a	4
1c	4150	1
1c	4150	2
1c	6732	10
1c	6757	1
1c	6757	2
1c	6757	4
1c	6757	5
1c	6757	6
1c	6757	7
1c	6757	8
1c	6757	9
1c	6757	10
1c	6757	11
1c	6757	17
1c	6757	18
1c	6757	21
1c	6757	22
1c	6757	23
1c	6757	24
1c	2177	1

3.4. Cluster 1d

Table 23: Composition of cluster 1d

Cluster	Sample	Analysis point
1d	12575	1
1d	12575	1
1d	12575	5
1d	12575	8
1d	12575	9
1d	12575	10
1d	2177	2
1d	2177	4
1d	2177	5
1d	2177	6
1d	2177	7
1d	2177	8
1d	2177	9
1d	2177	10
1d	2177	11
1d	2177	12
1d	2177	13
1d	2177	14
1d	2177	15
1d	2177	16
1d	2177	18
1d	7850	1
1d	7850	2
1d	7850	3
1d	7850	6
1d	6732	17
1d	P15a	7
1d	P15a	8
1d	P15a	9
1d	P15a	10
1d	P15a	11
1d	P15a	12
1d	P15a	13

3.5. Cluster 1e

Table 24: Composition of cluster 1e

Cluster	Sample	Analysis point
1e	P7	19
1e	P8	20
1e	P9	21
1e	P10	22
1e	P15a	5
1e	P15a	6
1e	4150	3
1e	4150	7
1e	4150	9
1e	6732	2
1e	6732	19
1e	7850	7
1e	2177	3
1e	2177	17
1e	2719	8
1e	2719	11
1e	2719	18
1e	2719	19
1e	2719	20
1e	2719	21
1e	2719	22
1e	2719	23
1e	2719	24

3.6. Cluster 1f

Table 25: Composition of cluster 1f

Cluster	Sample	Analysis point
1f	2719	3
1f	2719	4
1f	2719	13
1f	2719	14
1f	2719	15
1f	2719	16
1f	6757	3
1f	6757	12
1f	6757	13
1f	6757	14
1f	6757	15
1f	6757	16
1f	6757	19
1f	6757	20
1f	4150	10

3.7. Cluster 2

Table 26: Composition of cluster 2

Cluster	Sample	Analysis point	Cluster	Sample	Analysis point	Cluster	Sample	Analysis point
2	CL0	1	2	CL3	4	2	SL0	9
2	CL0	2	2	CL3	5	2	SL0	10
2	CL0	3	2	CL3	6	2	SL0	11
2	CL0	4	2	CL3	7	2	SL0	12
2	CL0	5	2	CL3	8	2	SL0	13
2	CL0	6	2	CL3	9	2	SL0	14
2	CL0	7	2	CL3	10	2	SL0	15
2	CL0	8	2	CL3	11	2	SL0	16
2	CL0	9	2	CL3	12	2	SL0	17
2	CL0	10	2	CL3	13	2	SL0	18
2	CL0	11	2	CL3	14	2	SL0	23
2	CL0	12	2	CL3	15	2	SL0	26
2	CL0	13	2	CL3	16	2	SL0	27
2	CL0	14	2	CL3	17	2	SL0	28
2	CL0	15	2	CL3	19	2	SL0	29
2	CL0	16	2	CL3	20	2	SL0	30
2	CL0	17	2	CL3	21	2	SL0	31
2	CL0	18	2	CL3	22	2	SL0	32
2	CL0	19	2	CL3	23	2	SL0	33
2	CL0	20	2	CL3	24	2	SL0	34
2	CL0	21	2	CL3	25	2	SL0	35
2	CL0	22	2	CL3	26	2	SL4	22
2	CL0	23	2	CL3	27	2	SL4	24
2	CL0	24	2	CL3	28	2	CW0	4
2	CL0	25	2	CL3	30	2	CW0	5
2	CL0	26	2	CL3	31	2	CW0	6
2	CL0	27	2	CL4	1	2	CW0	7
2	CL0	29	2	CL4	2	2	CW0	8
2	CL0	29	2	CL4	3	2	CW0	11
2	CL0	30	2	CL4	23	2	CW0	12
2	CL0	31	2	SL0	3	2	CW0	13
2	CL0	32	2	SL0	4	2	CW0	14
2	CL0	33	2	SL0	6	2	CW0	15
2	CL0	35	2	SL0	7	2	CW0	16
2	CL3	1	2	SL0	8	2	CW0	17

Cluster	Sample	Analysis point	Cluster	Sample	Analysis point	Cluster	Sample	Analysis point
2	CW0	18	2	SW0	12	2	SW3	30
2	CW0	19	2	SW0	13	2	SW3	31
2	CW0	20	2	SW0	14	2	SW3	32
2	CW0	21	2	SW0	15	2	SW3	33
2	CW0	22	2	SW0	16	2	SW3	34
2	CW0	23	2	SW0	17	2	SW3	35
2	CW0	24	2	SW0	18	2	P7	1
2	CW0	25	2	SW0	19	2	P7	2
2	CW0	26	2	SW0	20	2	P7	3
2	CW0	27	2	SW0	21	2	P7	4
2	CW0	28	2	SW0	22	2	P7	5
2	CW0	29	2	SW0	23	2	P7	6
2	CW0	30	2	SW0	24	2	P7	8
2	CW0	31	2	SW0	25	2	P7	10
2	CW0	32	2	SW0	26	2	P7	11
2	CW0	33	2	SW0	27	2	P7	12
2	CW0	34	2	SW0	28	2	P7	13
2	CW0	35	2	SW0	29	2	P7	14
2	CW3	1	2	SW0	30	2	P7	15
2	CW3	2	2	SW0	31	2	P7	16
2	CW3	3	2	SW0	32	2	P7	17
2	CW3	4	2	SW0	33	2	P7	18
2	CW3	5	2	SW0	34	2	P7	25
2	CW3	7	2	SW0	35	2	P7	26
2	SW0	1	2	SW3	19	2	P7	27
2	SW0	2	2	SW3	20	2	P7	28
2	SW0	3	2	SW3	21	2	P7	29
2	SW0	4	2	SW3	22	2	P7	30
2	SW0	5	2	SW3	23	2	4150	6
2	SW0	6	2	SW3	24	2	4150	8
2	SW0	7	2	SW3	25	2	6732	4
2	SW0	8	2	SW3	26	2	6732	9
2	SW0	9	2	SW3	27	2	6732	11
2	SW0	10	2	SW3	28	2	6732	12
2	SW0	11	2	SW3	29	2	6732	14

Cluster	Sample	Analysis point
2	6732	16
2	12575	4
2	12575	6

3.8. Cluster 3

Table 27: Composition of cluster 3

Cluster	Sample	Analysis point	Cluster	Sample	Analysis point	Cluster	Sample	Analysis point
3	CL0	34	3	CL4	32	3	SL4	4
3	CL3	2	3	CL4	33	3	SL4	5
3	CL3	29	3	SL3	7	3	SL4	6
3	CL3	32	3	SL3	8	3	SL4	7
3	CL3	33	3	SL3	9	3	SL4	8
3	CL3	34	3	SL3	10	3	SL4	9
3	CL3	35	3	SL3	11	3	SL4	11
3	CL4	4	3	SL3	12	3	SL4	12
3	CL4	5	3	SL3	13	3	SL4	13
3	CL4	6	3	SL3	14	3	SL4	14
3	CL4	7	3	SL3	15	3	SL4	17
3	CL4	8	3	SL3	16	3	SL4	19
3	CL4	9	3	SL3	17	3	SL4	21
3	CL4	10	3	SL3	18	3	SL4	23
3	CL4	11	3	SL3	19	3	SL4	25
3	CL4	12	3	SL3	20	3	SL4	26
3	CL4	13	3	SL3	21	3	SL4	27
3	CL4	14	3	SL3	22	3	SL4	28
3	CL4	15	3	SL3	23	3	SL4	29
3	CL4	16	3	SL3	24	3	SL4	30
3	CL4	17	3	SL3	25	3	SL4	31
3	CL4	18	3	SL3	26	3	SL4	32
3	CL4	19	3	SL3	27	3	SL4	33
3	CL4	20	3	SL3	28	3	SL4	34
3	CL4	21	3	SL3	29	3	SL4	35
3	CL4	22	3	SL3	30	3	CW3	8
3	CL4	24	3	SL3	31	3	CW3	9
3	CL4	25	3	SL3	32	3	CW3	10
3	CL4	26	3	SL3	33	3	CW3	11
3	CL4	27	3	SL3	34	3	CW3	12
3	CL4	28	3	SL3	35	3	CW3	13
3	CL4	29	3	SL4	1	3	CW3	14
3	CL4	30	3	SL4	2	3	CW3	15
3	CL4	31	3	SL4	3	3	CW3	16

Cluster	Sample	Analysis point	Cluster	Sample	Analysis point	Cluster	Sample	Analysis point
3	CW3	17	3	CW4	16	3	SW3	15
3	CW3	18	3	CW4	17	3	SW3	16
3	CW3	19	3	CW4	18	3	SW3	17
3	CW3	20	3	CW4	19	3	SW3	18
3	CW3	21	3	CW4	20	3	SW4	1
3	CW3	22	3	CW4	21	3	SW4	2
3	CW3	23	3	CW4	22	3	SW4	3
3	CW3	24	3	CW4	23	3	SW4	4
3	CW3	25	3	CW4	24	3	SW4	5
3	CW3	26	3	CW4	25	3	SW4	6
3	CW3	27	3	CW4	26	3	SW4	7
3	CW3	28	3	CW4	27	3	SW4	8
3	CW3	29	3	CW4	28	3	SW4	9
3	CW3	30	3	CW4	29	3	SW4	10
3	CW3	31	3	CW4	30	3	SW4	11
3	CW3	32	3	CW4	31	3	SW4	12
3	CW3	33	3	CW4	32	3	SW4	13
3	CW3	34	3	CW4	33	3	SW4	14
3	CW3	35	3	CW4	34	3	SW4	15
3	CW4	1	3	CW4	35	3	SW4	16
3	CW4	2	3	SW3	1	3	SW4	17
3	CW4	3	3	SW3	2	3	SW4	18
3	CW4	4	3	SW3	3	3	SW4	19
3	CW4	5	3	SW3	4	3	SW4	20
3	CW4	6	3	SW3	5	3	SW4	21
3	CW4	7	3	SW3	6	3	SW4	22
3	CW4	8	3	SW3	7	3	SW4	23
3	CW4	9	3	SW3	8	3	SW4	24
3	CW4	10	3	SW3	9	3	SW4	25
3	CW4	11	3	SW3	10	3	SW4	26
3	CW4	12	3	SW3	11	3	SW4	27
3	CW4	13	3	SW3	12	3	SW4	28
3	CW4	14	3	SW3	13	3	SW4	29
3	CW4	15	3	SW3	14	3	SW4	30

Cluster	Sample	Analysis point
3	SW4	31
3	SW4	32
3	SW4	33
3	SW4	34
3	SW4	35
3	2719	9
3	2719	27
3	6732	1
3	6732	5
3	6732	6
3	6732	7
3	6732	8
3	6732	13
3	6732	18
3	4150	5

4. XANES at the K K-edge of references

4.1. KOH

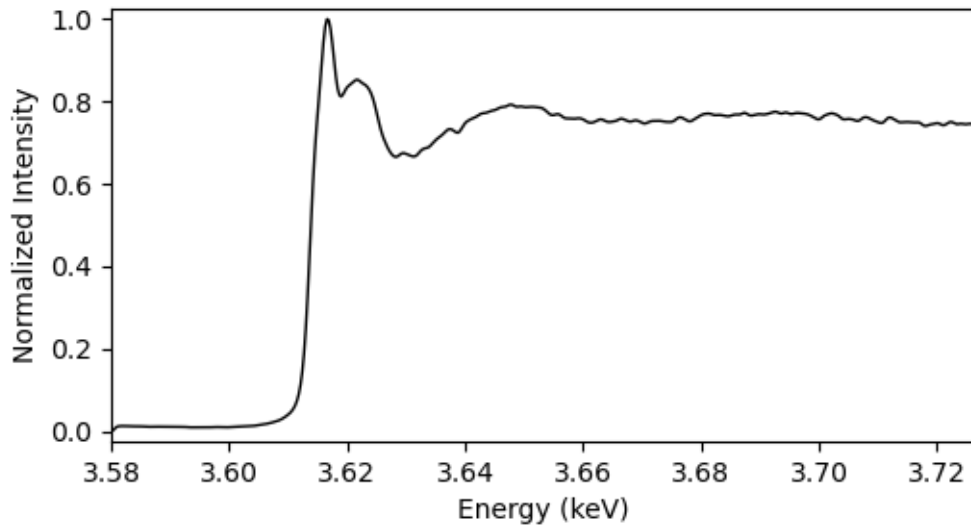


Figure 114: XANES spectrum at the K K-edge of KOH

4.2. K₂SO₄

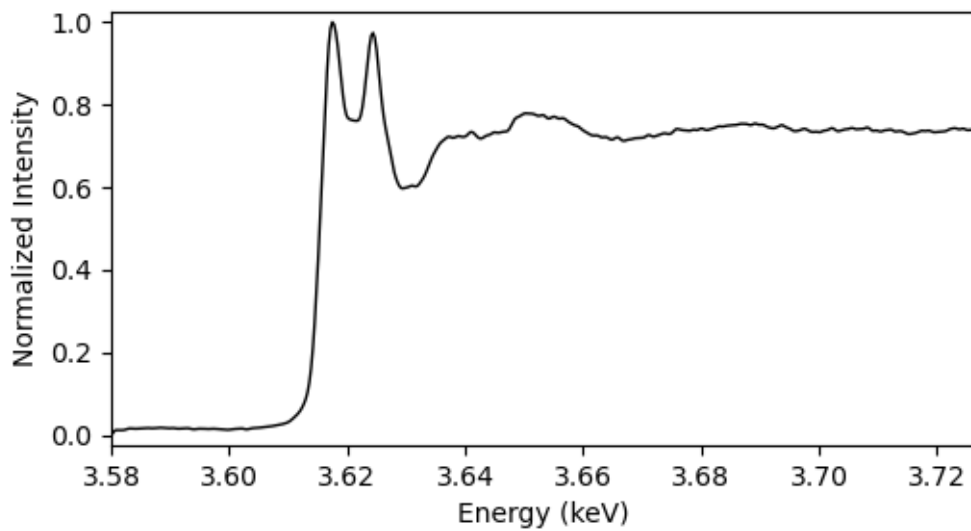


Figure 115: XANES spectrum at the K K-edge of K₂SO₄

4.3. $\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$

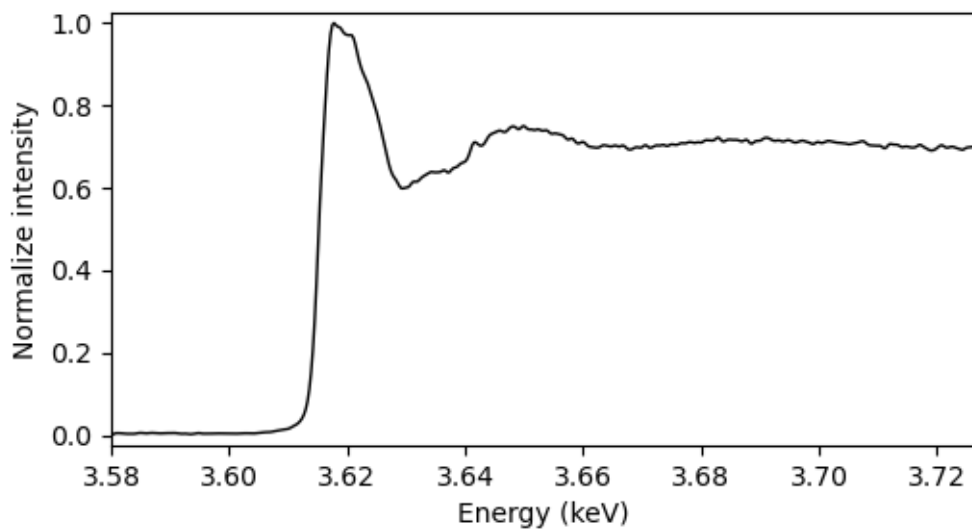


Figure 116: XANES spectrum at the K K-edge of $\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$

4.4. KCl

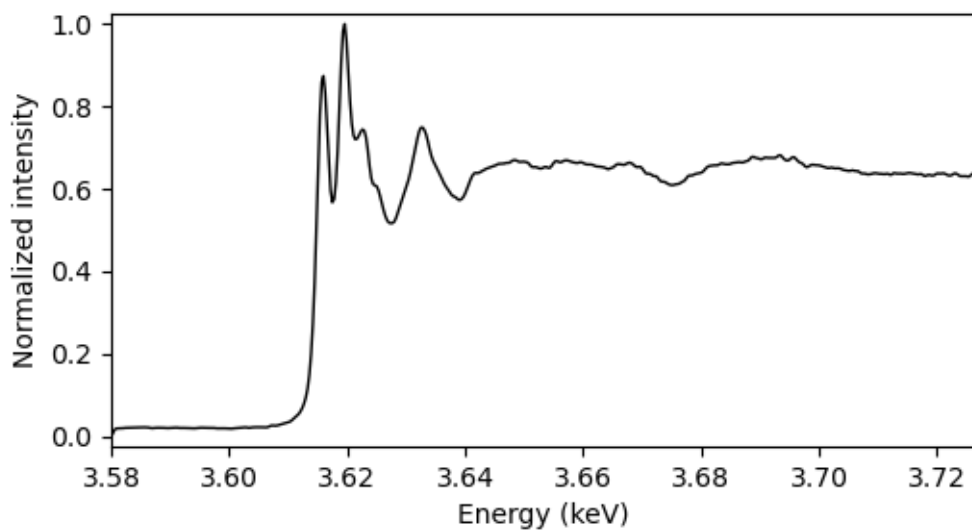


Figure 117 XANES spectrum at the K K-edge of KCl

4.5. KBr

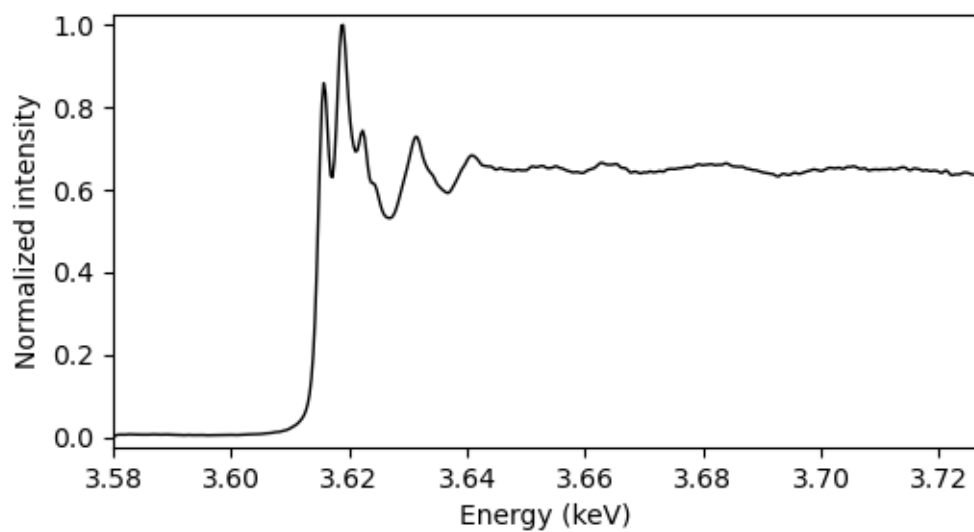


Figure 118: XANES spectrum at the K K-edge of KBr

4.6. KI

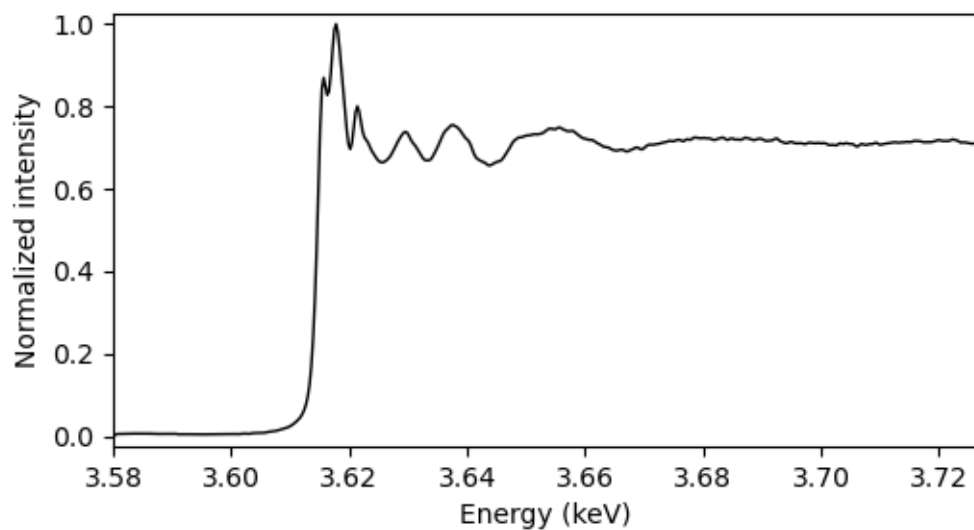


Figure 119: XANES spectrum at the K K-edge of KI

4.7. K-Oleate

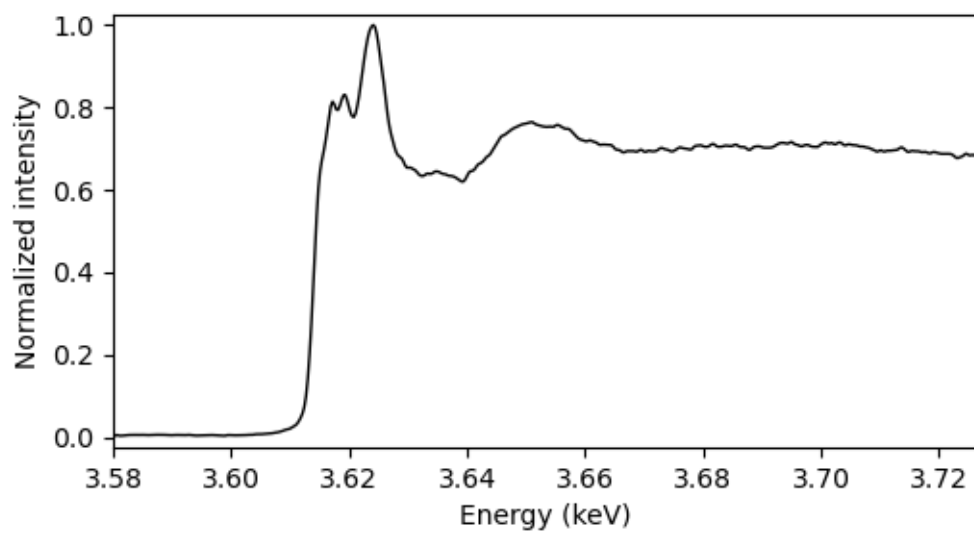


Figure 120: XANES spectrum at the K K-edge of K-oleate