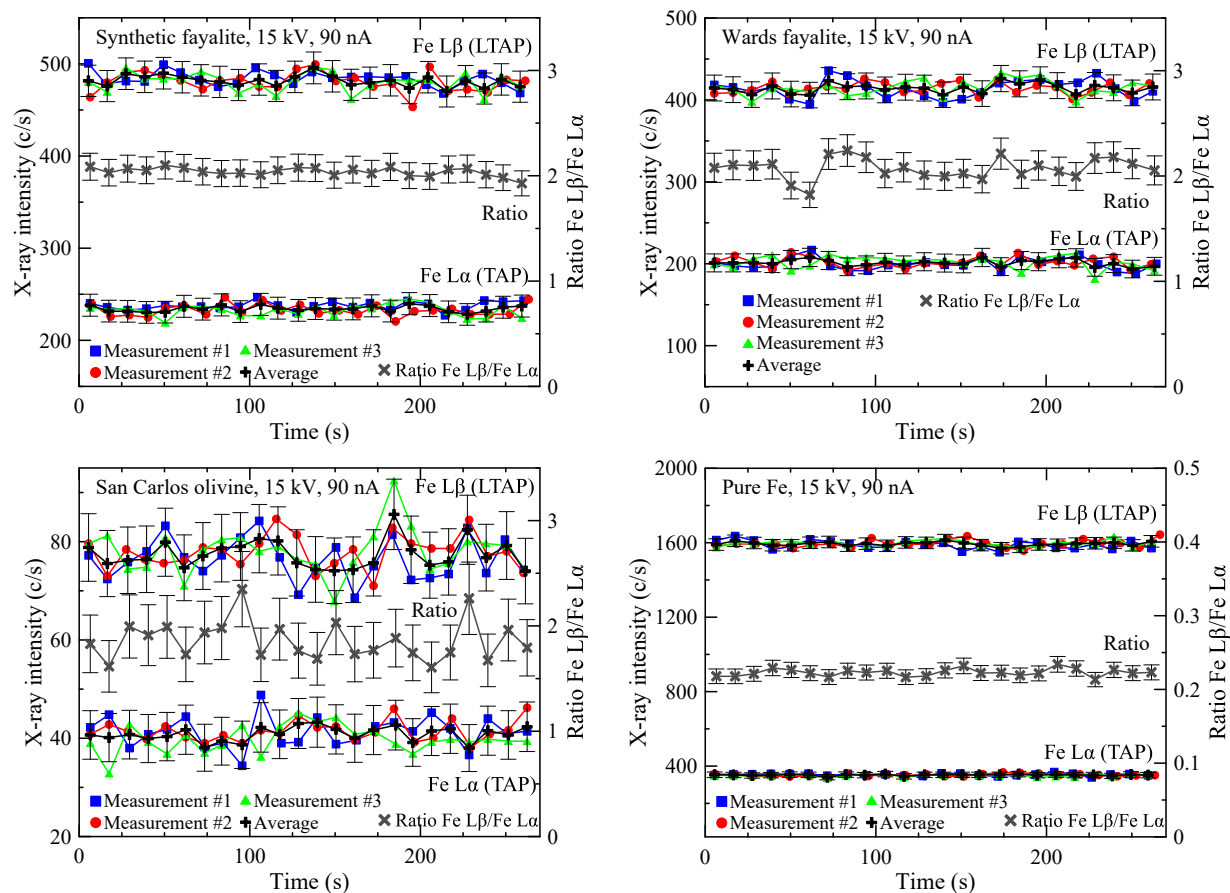


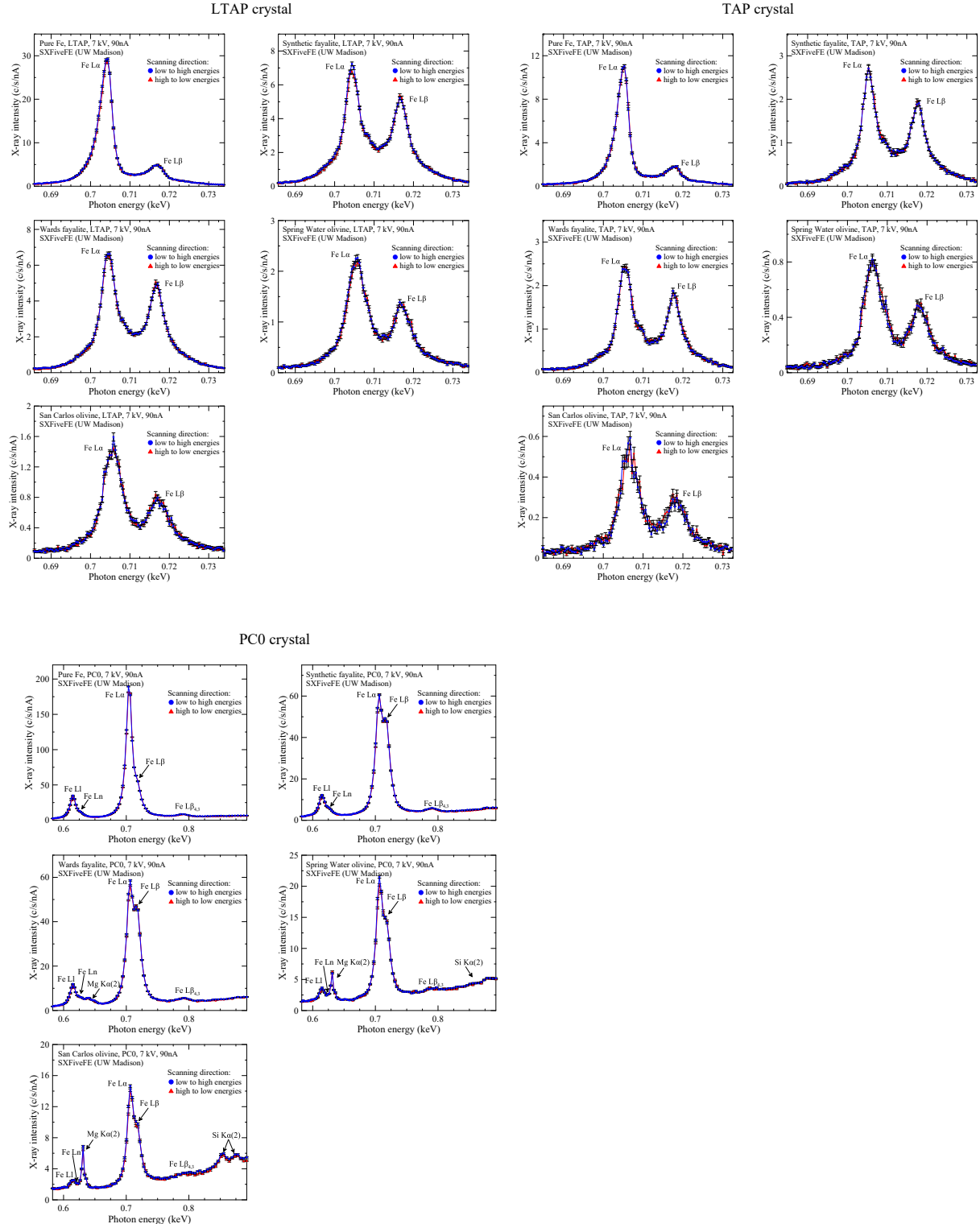
# Supplementary materials: Figure 1.

Evolution over time of the Fe  $L\alpha$  and Fe  $L\beta$  X-ray intensities and ratio Fe  $L\beta$ /Fe  $L\alpha$ .



**Supplementary materials: Figure 2.**

Fe La- $\beta$  spectra recorded at 7 kV with monochromator crystals moving in opposite directions (from low to high energies and from high to low energies). Each spectrum is an average of three spectra. Spectra recorded on the SXFiveFE microprobe using the cryo-chiller device (see text for more details).



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**Supplementary Table 3.** Nominal composition measured at 15 kV using the traditional  $K\alpha$  X-ray lines and composition measured at 7 kV using the non-traditional Fe  $L\alpha$  X-ray line with different standards.

Quantifications were performed using the PAP matrix correction algorithm and MAC values from the MAC30 compilation (see text for details).

The Fe standard used to perform the quantification using the  $K\alpha$  X-ray line was the pure Fe standard.

Sample name	Traditional quantification at 15 kV using the $K\alpha$ X-ray lines						Totals
	Mg wt%	Si wt%	Ca wt%	Fe wt%	Mn wt%	Oxygen wt%	
Syn Fayalite	0.01	13.46	0.00	53.90	0.16	30.83	98.36
Wards Fayalite	0.30	13.70	0.07	50.44	3.48	31.30	99.29
SH111	12.73	16.10	0.15	32.59	0.67	36.31	98.55
SH11	14.63	16.34	0.19	30.16	0.66	37.16	99.15
SH25	17.28	16.99	0.18	26.34	0.53	38.51	99.83
SH9	20.63	17.53	0.13	21.25	0.44	39.81	99.78
SH15	22.97	18.12	0.14	18.64	0.29	41.25	101.41
Springwater	26.32	18.61	0.01	13.14	0.25	42.37	100.70
USNM San Carlos#2	29.50	19.14	0.07	7.47	0.11	43.80	100.10

Traditional quantification at 7 kV using the Fe $L\alpha$ X-ray line					
Fe standard: Wards fayalite		Fe standard: Pure Fe		Fe standard: SH111	
Fe wt%	Err %	Fe wt%	Err %	Fe wt%	Err %
51.3	4.81	35.90	33.40	46.63	13.50
50.4	0.03	35.29	30.03	45.83	9.14
36.0	-10.40	24.81	23.89	32.59	0.02
33.6	-11.27	23.08	23.49	30.37	-0.70
30.9	-17.22	21.16	19.68	27.92	-5.99
26.6	-25.29	18.14	14.60	24.04	-13.13
24.5	-31.56	16.67	10.60	22.13	-18.70
18.3	-39.39	12.35	5.98	16.49	-25.52
12.0	-60.83	8.04	-7.56	10.80	-44.47

