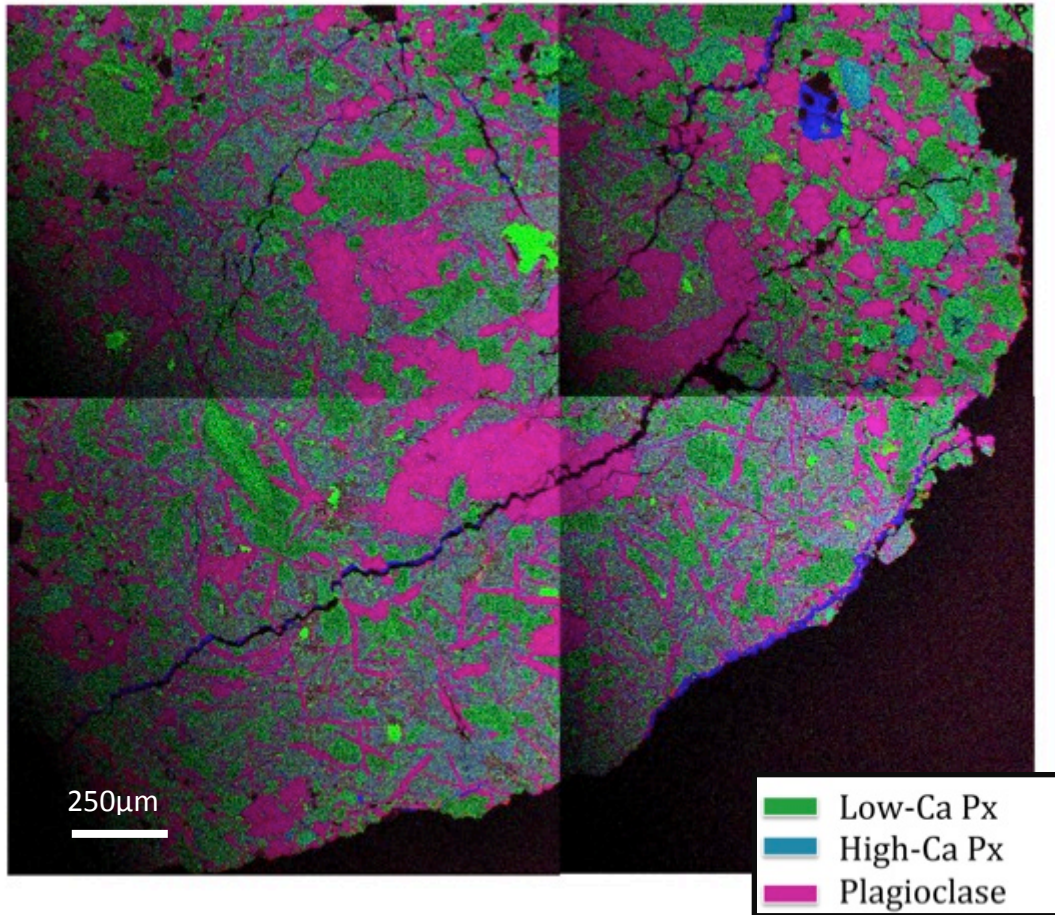


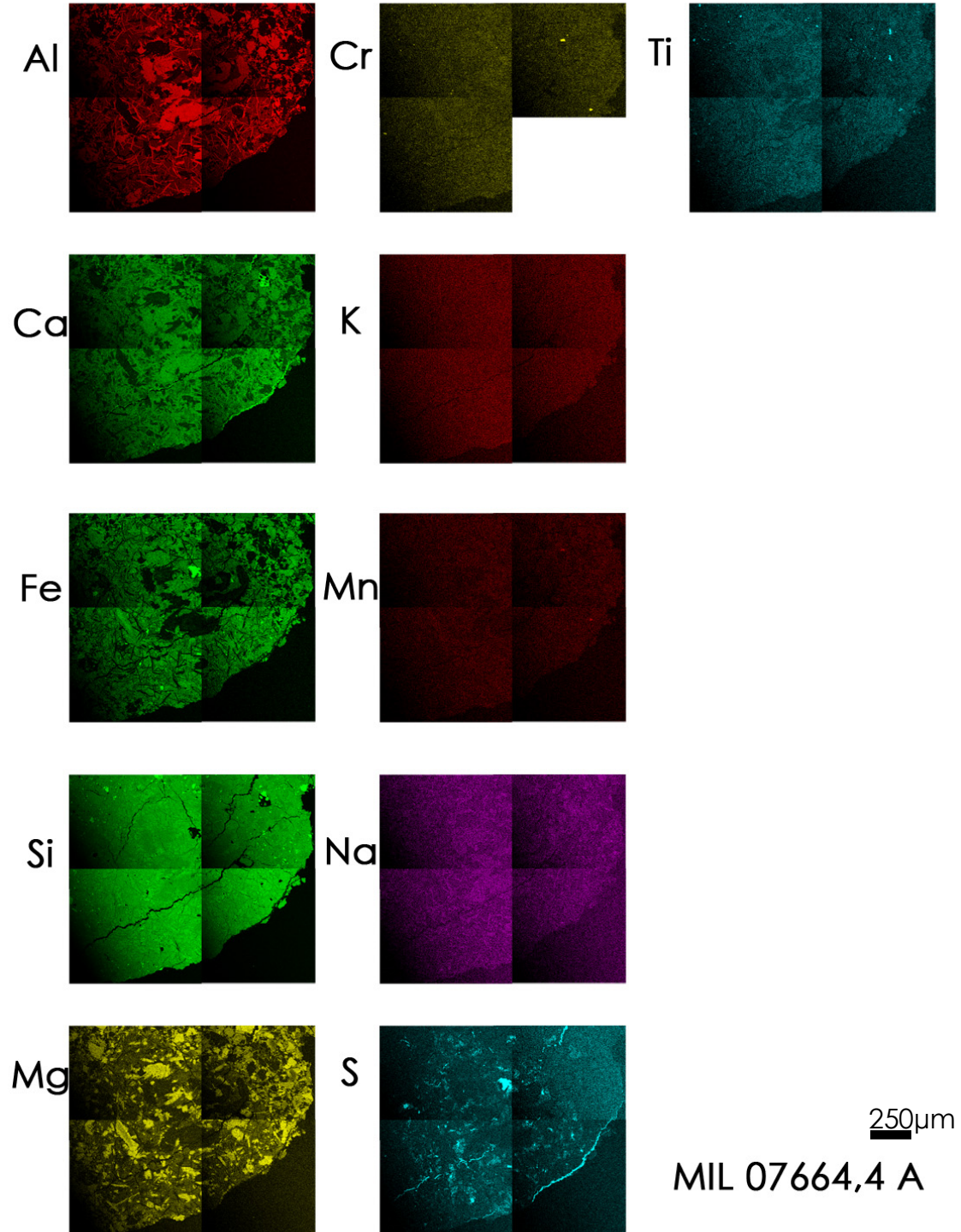
*Appendix A – MIL 07664,4A*

*A1. SEM Mineral Map*

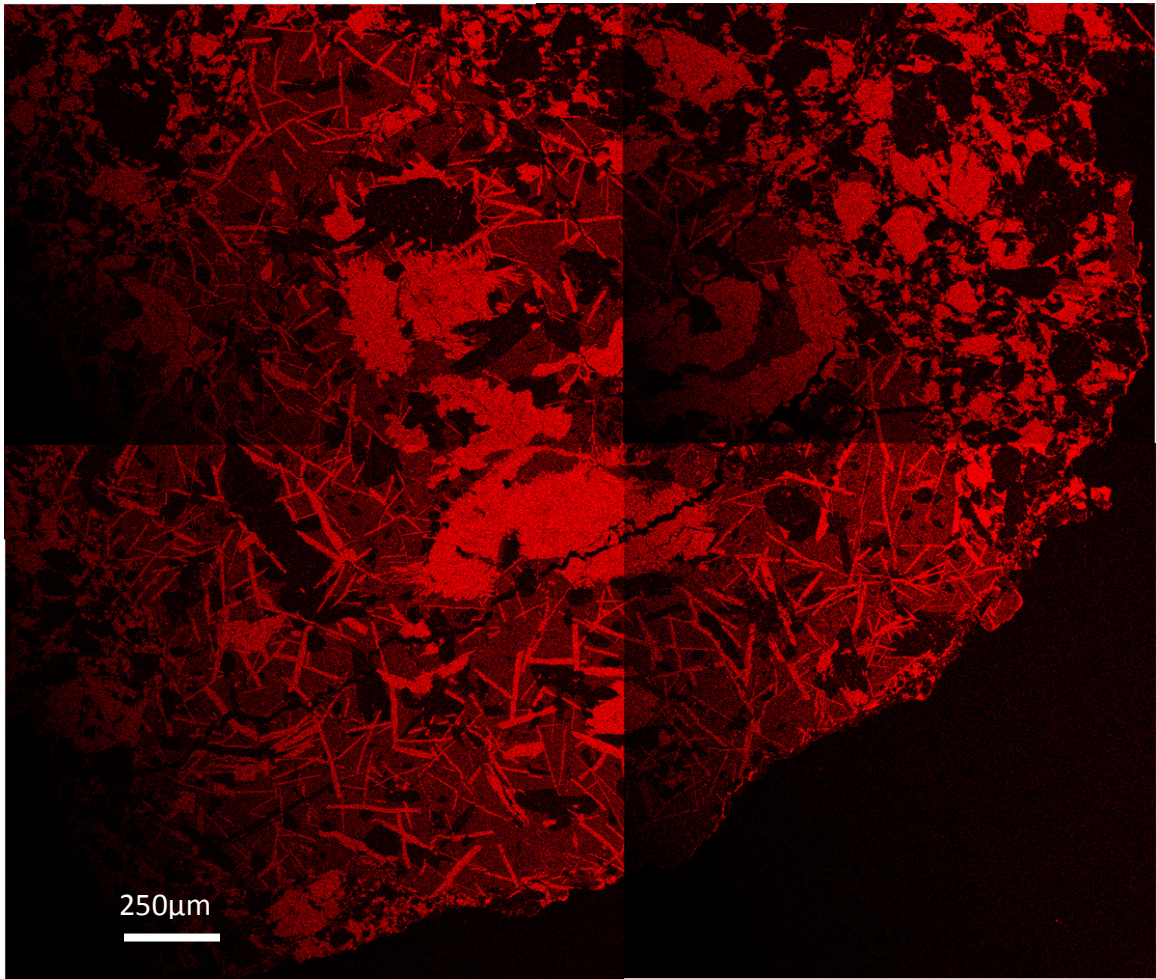


*MIL 07664,4 A has a composition of large zoned and smaller quenched pyroxene grains and crystals. Plagioclase appears as large anhedral grains and skeletal laths.*

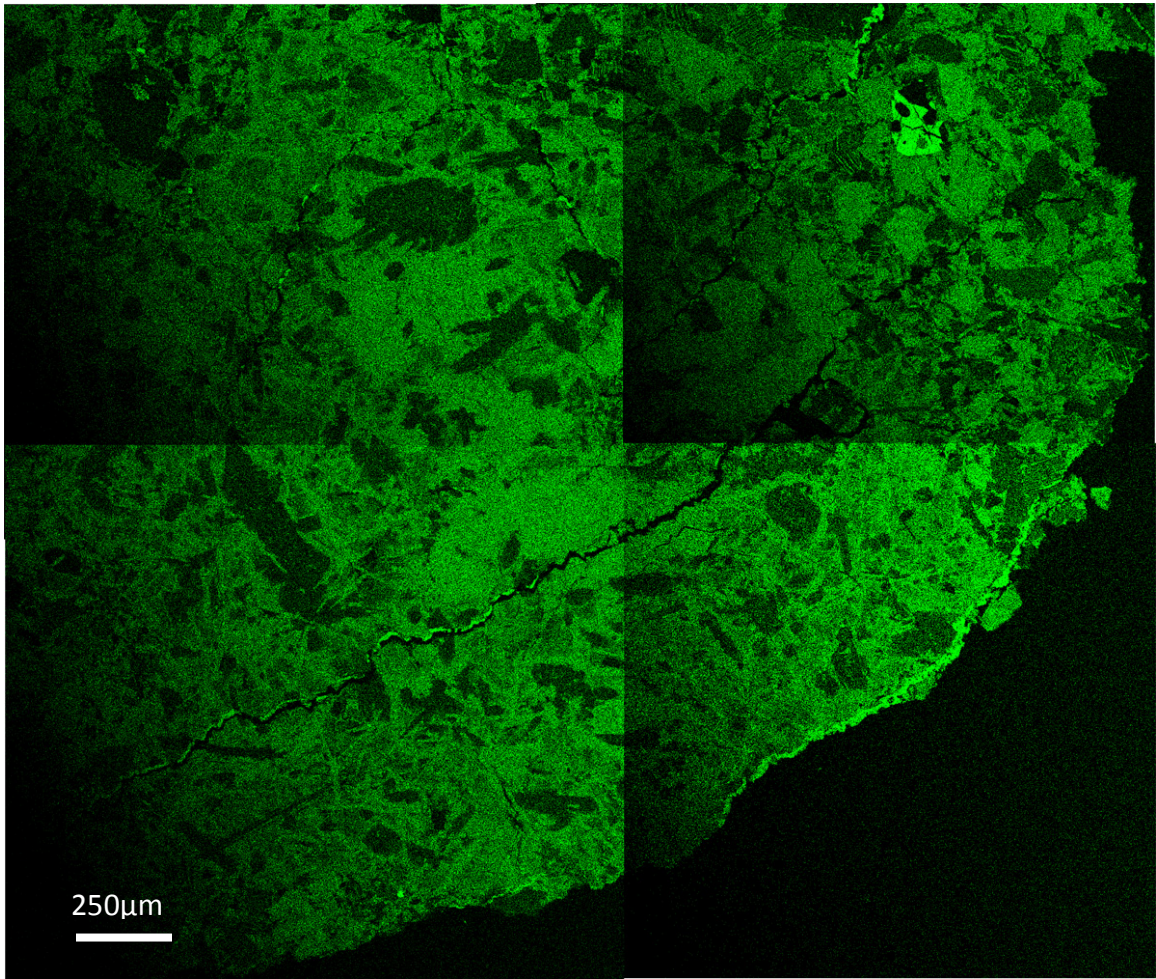
**A2. SEM Elemental X-ray maps** (All clasts were analyzed for eleven elements (Al, Ca, Fe, Si, Mg, Cr, K, Mn, Na, S, and Ti); however if some are extremely dark, this is due to the fact that the element appeared below the detection limit of the SEM, thus showing a colored map with no distinguishable data. For this reason, we have not included a full size element map of K, Na, and Mn.



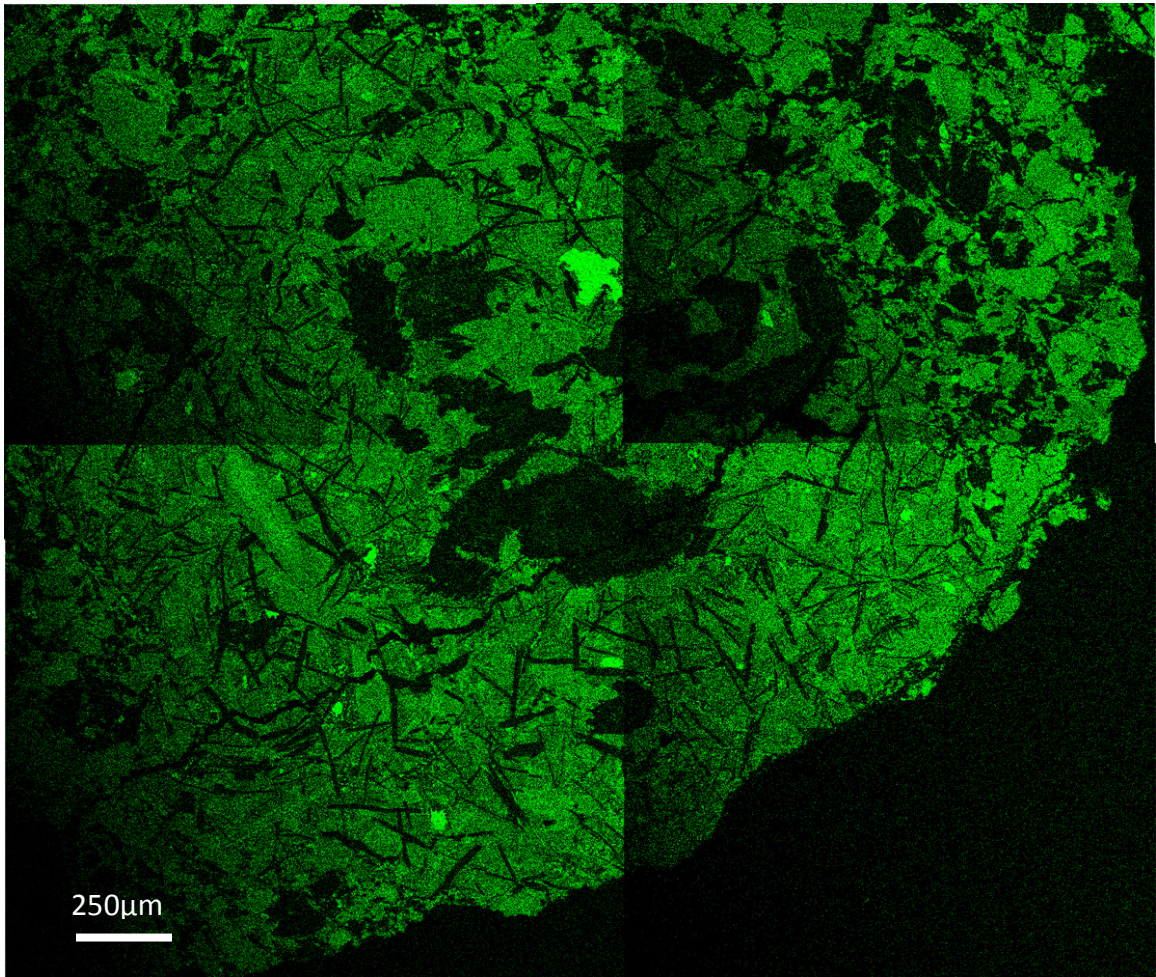
Al



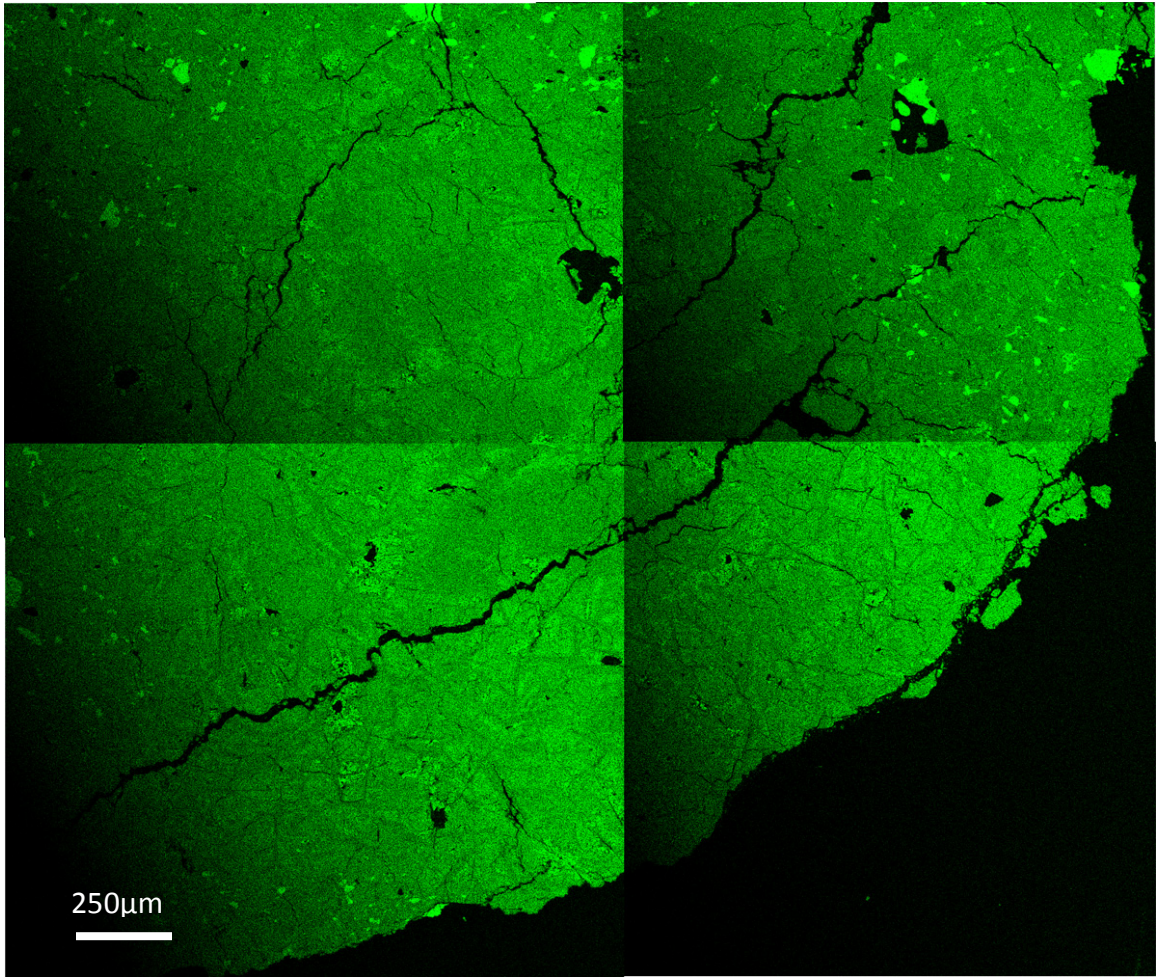
Ca



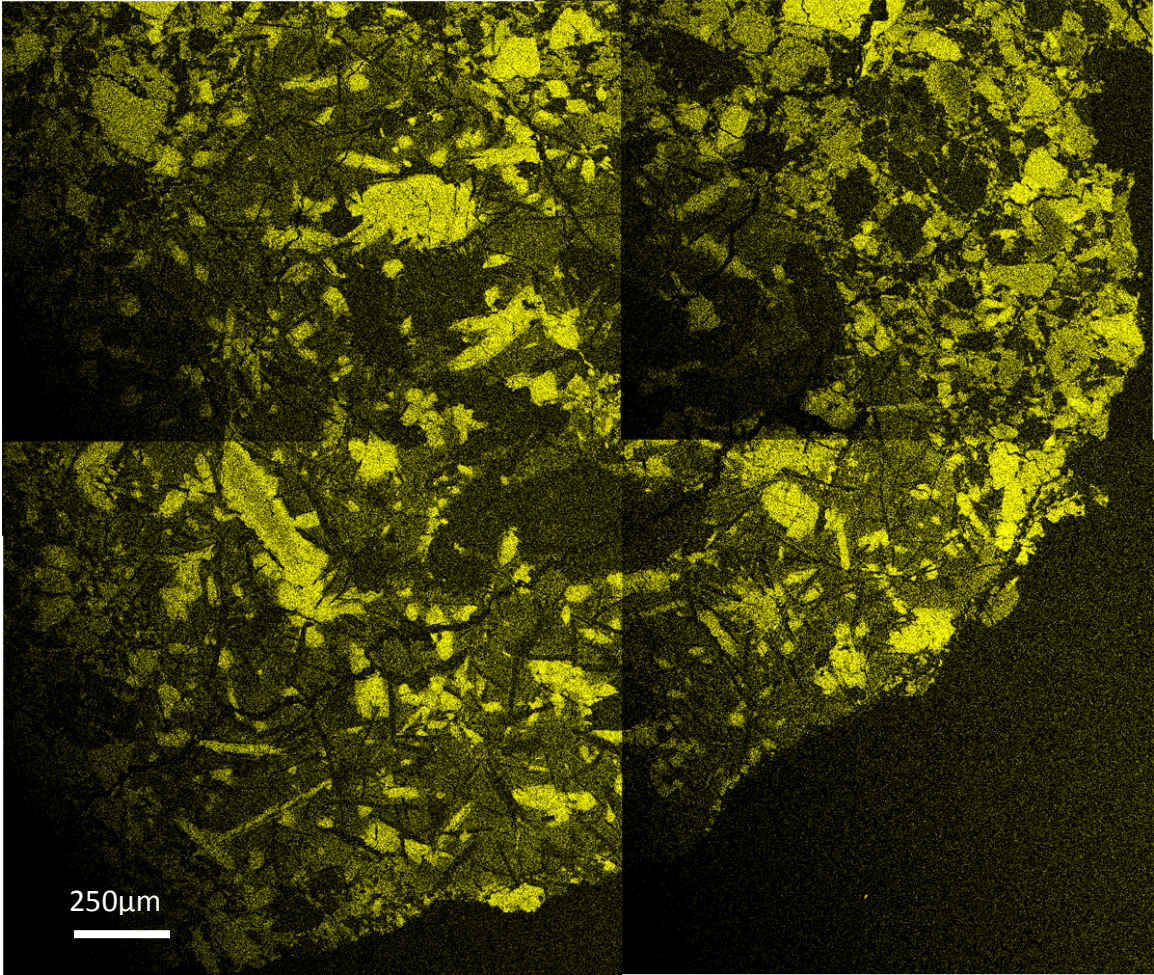
**Fe**



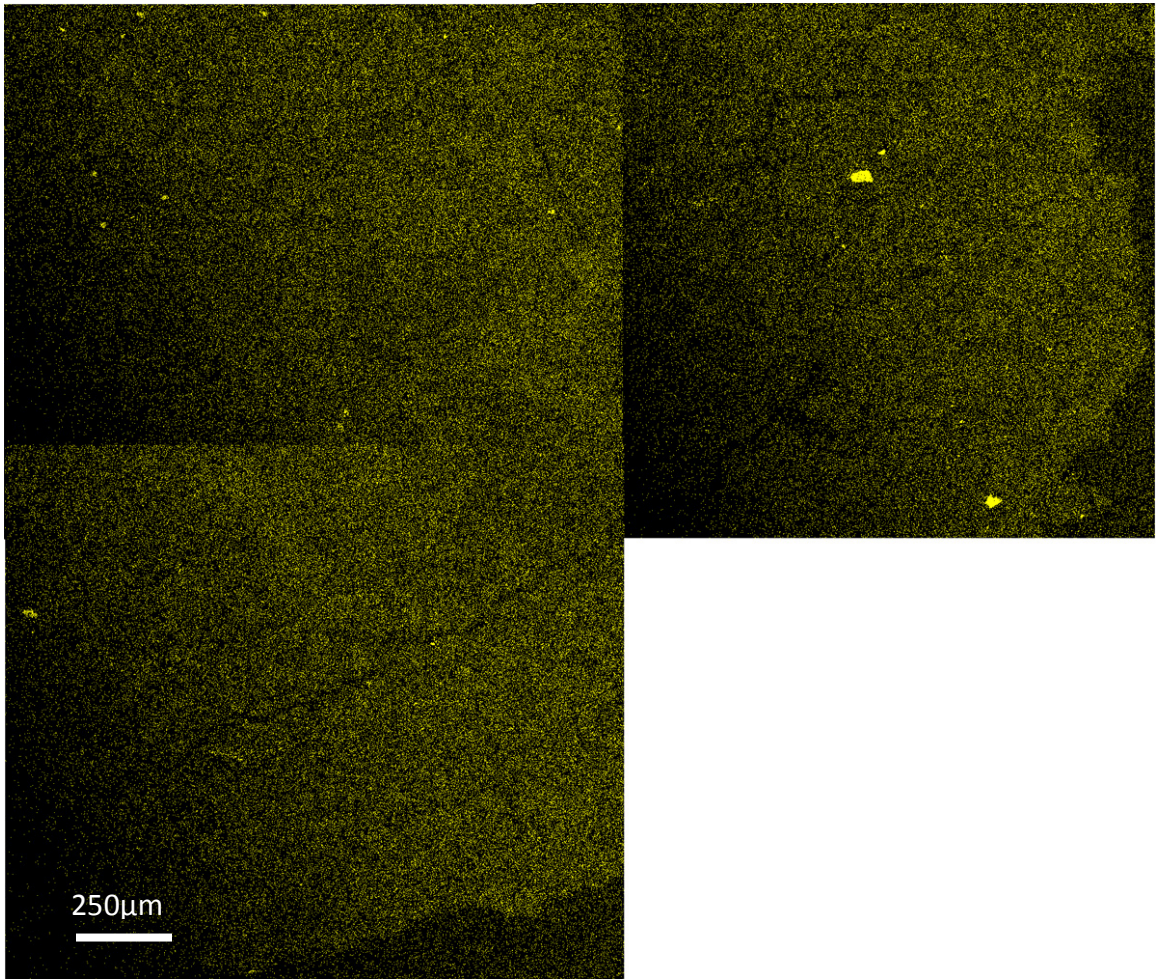
Si



**Mg**

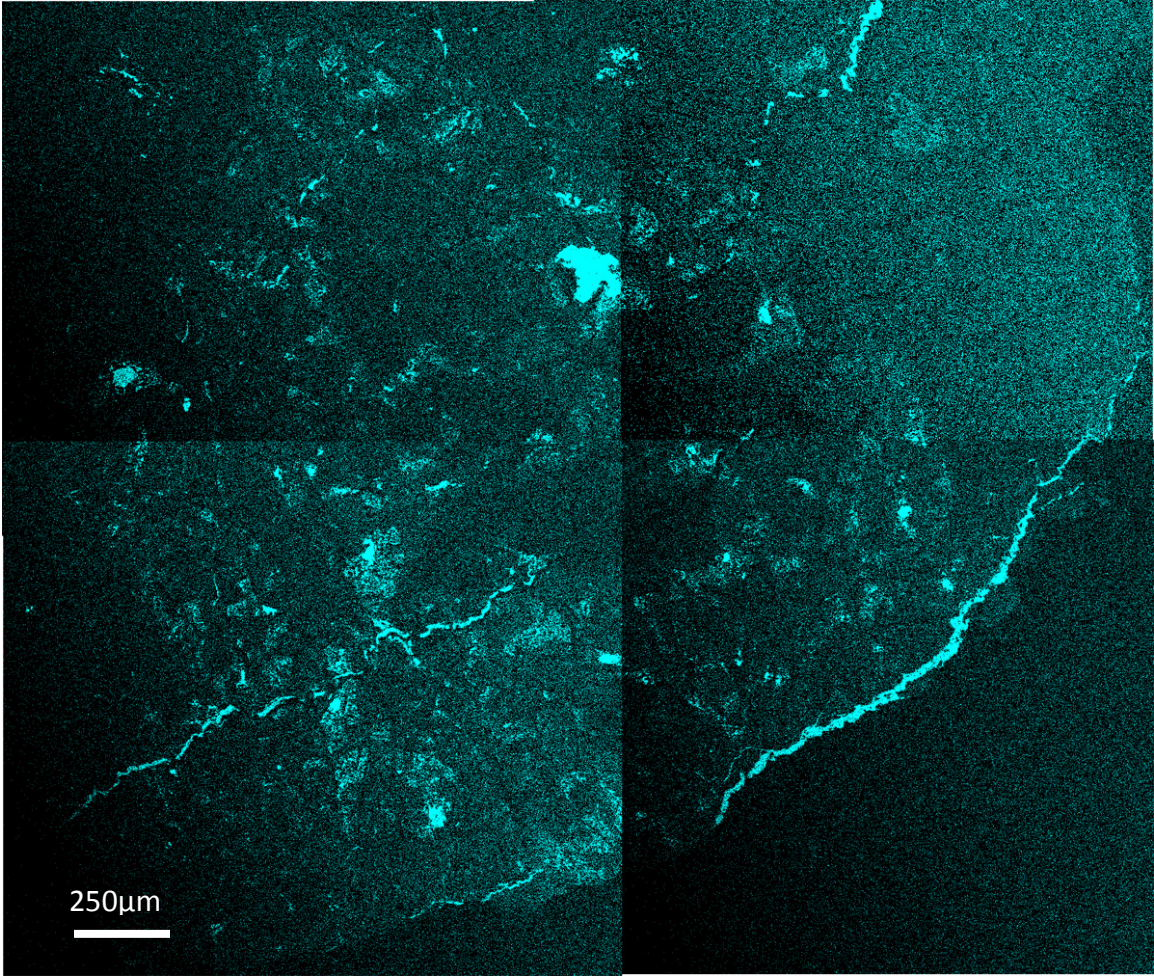


Cr

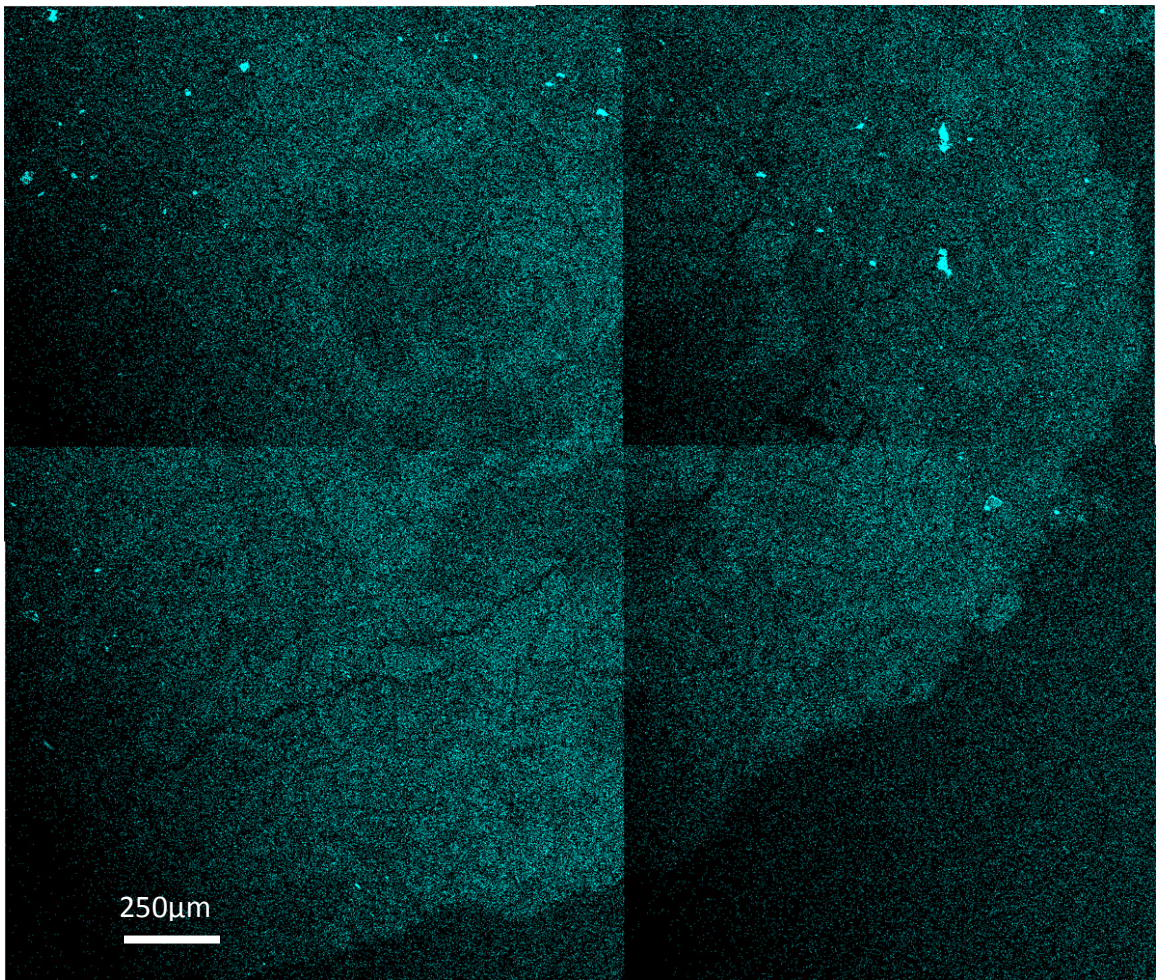




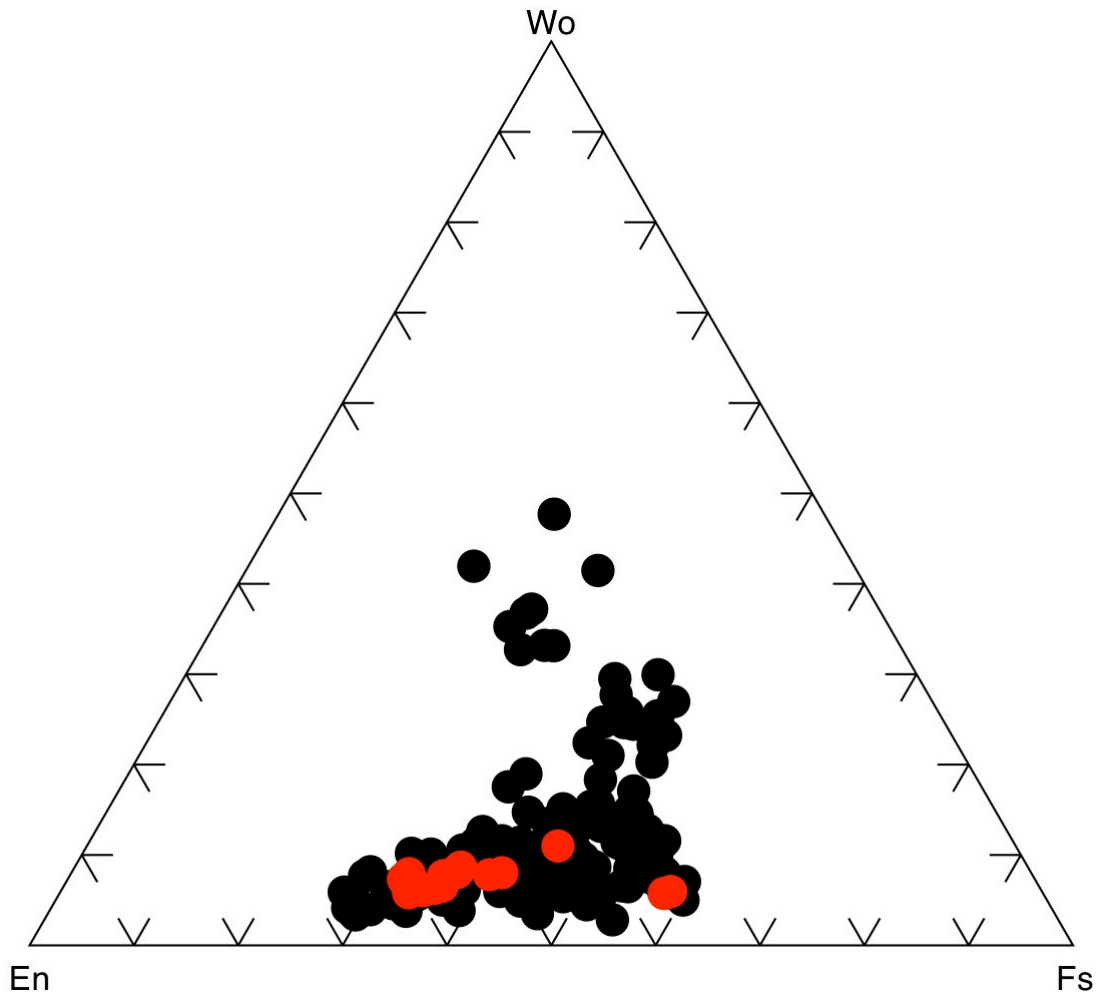
S



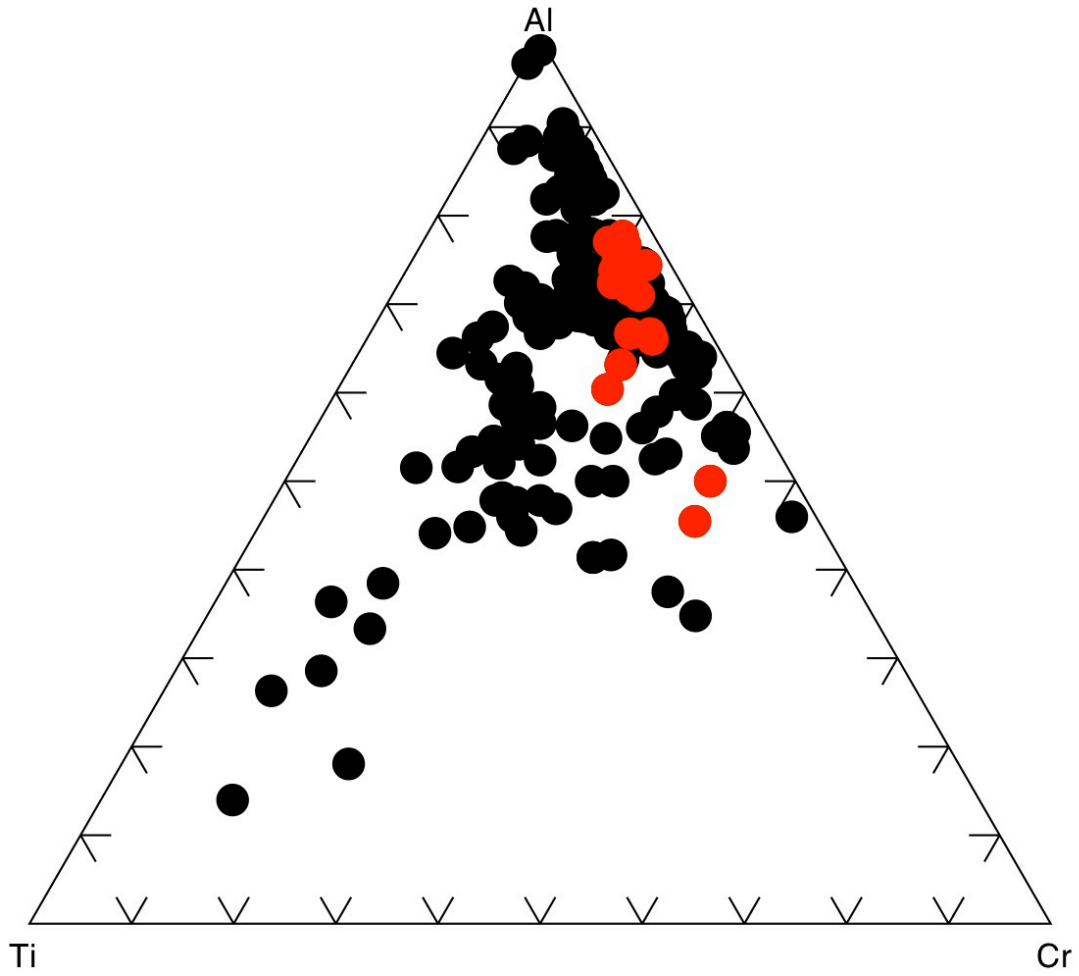
**Ti**



***A3. Major element data of pyroxene (red) compared to all other samples***



*A4. Minor element data of pyroxene (red) compared to all other samples*



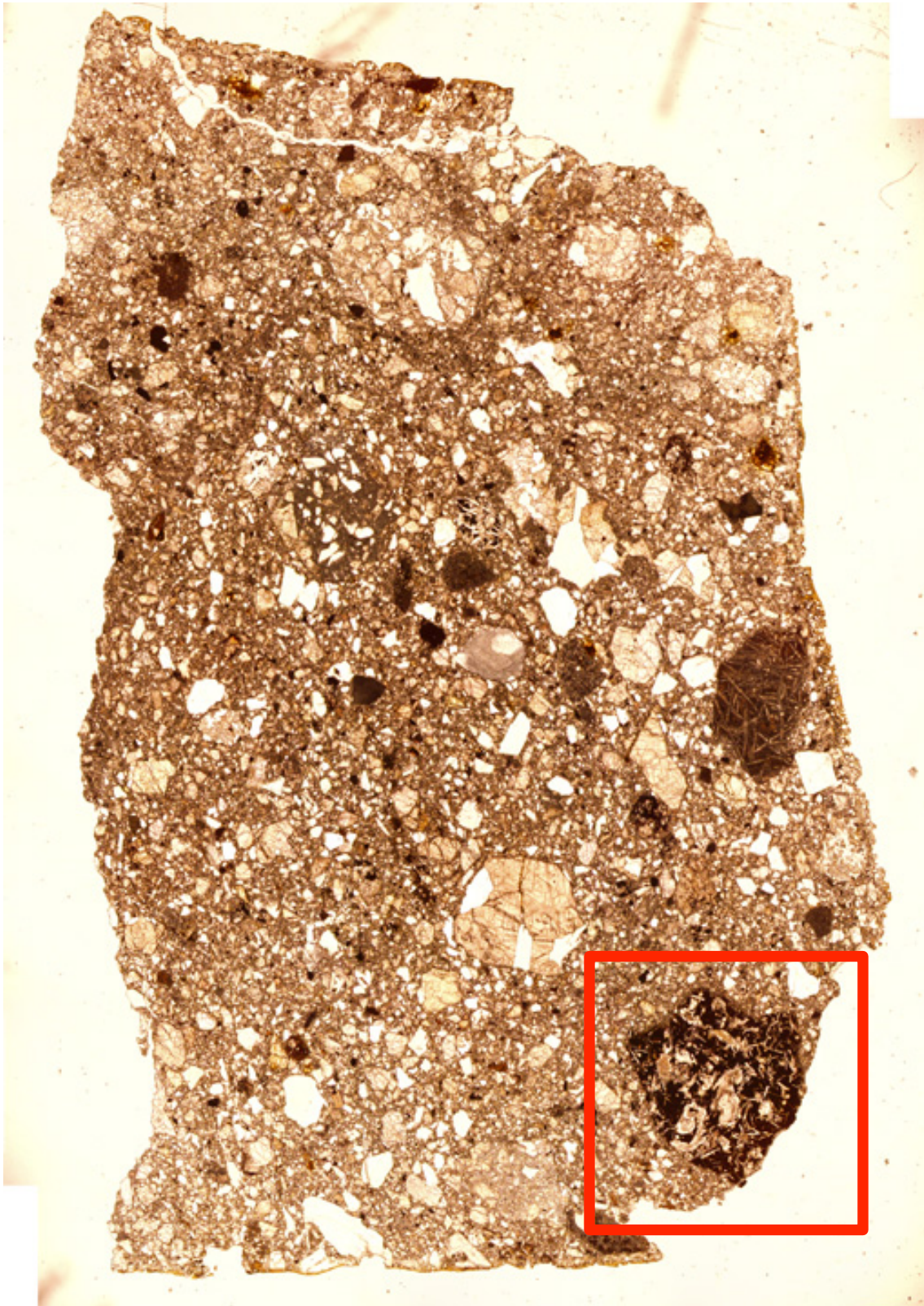
## A5. Pyroxene analyses

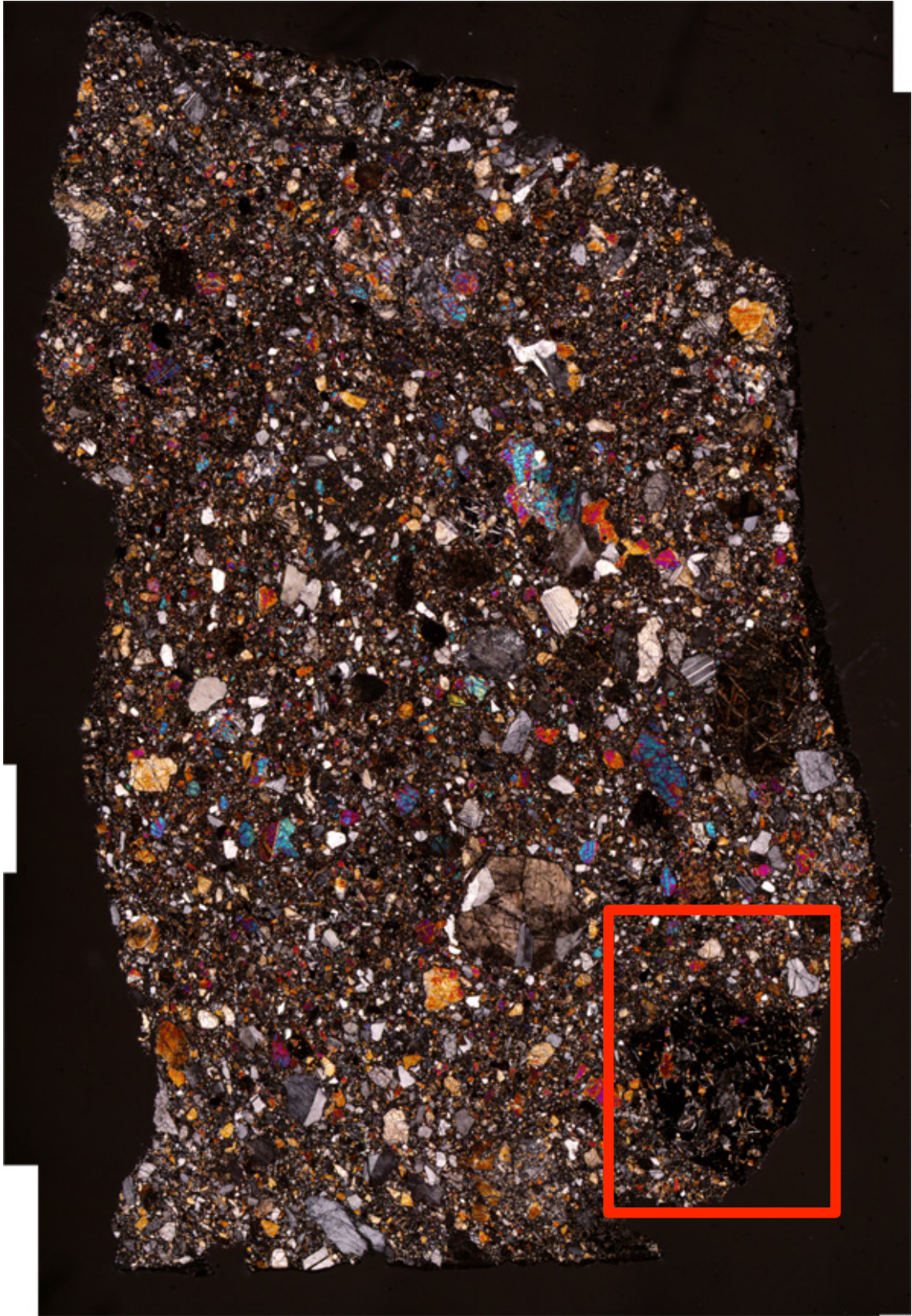
SiO <sub>2</sub>	49.11	49.07	51.65	52.77	51.60	51.96	51.26	51.80	50.86	50.89	50.59
CaO	2.70	2.78	3.16	2.86	3.05	3.42	3.76	2.97	3.87	3.42	3.79
Na <sub>2</sub> O	n.d.	n.d.	0.01	0.02	0.02	0.01	n.d.	n.d.	n.d.	0.04	n.d.
MgO	12.19	11.90	19.95	21.48	20.21	21.20	18.03	20.82	17.49	20.57	20.42
TiO <sub>2</sub>	0.13	0.08	0.10	0.09	0.12	0.08	0.22	0.12	0.14	0.15	0.24
FeO	34.69	34.88	22.54	21.08	22.05	20.70	24.82	21.71	25.35	20.27	19.78
Al <sub>2</sub> O <sub>3</sub>	0.34	0.27	0.80	0.82	1.25	1.45	0.85	0.79	0.79	2.39	2.70
K <sub>2</sub> O	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
MnO	1.16	1.18	0.83	0.79	0.81	0.76	0.85	0.80	0.88	0.73	0.76
Cr <sub>2</sub> O <sub>3</sub>	0.45	0.31	0.48	0.46	0.57	0.64	0.50	0.48	0.44	0.85	0.89
Total	100.77	100.47	99.51	100.37	99.68	100.21	100.29	99.48	99.82	99.31	99.17
Si	1.96	1.96	1.96	1.97	1.95	1.94	1.96	1.96	1.96	1.92	1.91
Ca	0.12	0.12	0.13	0.11	0.12	0.14	0.15	0.12	0.16	0.14	0.15
Na	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Mg	0.72	0.71	1.13	1.19	1.14	1.18	1.03	1.17	1.00	1.16	1.15
Ti	0.00	n.d.	n.d.	n.d.	n.d.	n.d.	0.01	n.d.	n.d.	n.d.	0.01
Fe	1.16	1.17	0.72	0.66	0.70	0.65	0.79	0.69	0.82	0.64	0.63
Al	0.02	0.01	0.03	0.03	0.05	0.06	0.04	0.03	0.03	0.10	0.11
K	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Mn	0.04	0.04	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.02
Cr	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.03	0.03
Total	4.03	4.02	4.01	4.00	4.01	4.01	4.01	4.01	4.01	4.01	4.01
Wo	5.76	5.96	6.53	5.80	6.28	6.97	7.81	6.06	8.04	7.13	7.93
En	36.29	35.57	57.19	60.76	58.14	60.12	52.03	59.26	50.71	59.81	59.67
Fs	57.94	58.47	36.27	33.44	35.58	32.91	40.16	34.68	41.25	33.06	32.40
SiO <sub>2</sub>	50.87	50.49	51.64	51.49	51.22	51.27	50.58	51.46	52.46	50.98	
CaO	3.88	4.14	3.04	3.54	3.39	3.72	5.18	3.03	2.97	3.94	
Na <sub>2</sub> O	0.01	n.d.	0.01	0.03	0.01	0.04	n.d.	n.d.	n.d.	0.06	
MgO	19.03	18.68	21.10	21.06	20.81	19.55	14.82	20.71	21.64	19.11	
TiO <sub>2</sub>	0.23	0.22	0.17	0.14	0.13	0.23	0.23	0.16	0.11	0.20	
FeO	22.80	22.66	20.58	19.97	19.91	22.11	27.18	21.42	21.26	22.74	
Al <sub>2</sub> O <sub>3</sub>	2.12	1.96	1.88	1.64	2.18	1.80	0.74	1.69	1.05	1.80	
K <sub>2</sub> O	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.01	n.d.	
MnO	0.84	0.84	0.74	0.75	0.74	0.80	0.95	0.78	0.75	0.80	
Cr <sub>2</sub> O <sub>3</sub>	0.84	0.81	0.70	0.68	0.82	0.75	0.45	0.67	0.50	0.72	
Total	100.60	99.79	99.84	99.30	99.21	100.26	100.12	99.92	100.74	100.35	
Si	1.92	1.92	1.94	1.94	1.93	1.93	1.97	1.94	1.95	1.93	
Ca	0.16	0.17	0.12	0.14	0.14	0.15	0.22	0.12	0.12	0.16	
Na	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
Mg	1.07	1.06	1.18	1.18	1.17	1.10	0.86	1.16	1.20	1.08	
Ti	0.01	0.01	0.01	n.d.	n.d.	0.01	0.01	n.d.	n.d.	0.01	
Fe	0.72	0.72	0.65	0.63	0.63	0.70	0.88	0.67	0.66	0.72	
Al	0.09	0.08	0.08	0.07	0.09	0.08	0.03	0.07	0.04	0.08	
K	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
Mn	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.02	0.03	
Cr	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	
Total	4.02	4.02	4.01	4.01	4.00	4.01	4.01	4.01	4.01	4.02	
Wo	8.06	8.66	6.27	7.31	7.08	7.71	10.99	6.23	5.96	8.17	
En	54.98	54.35	60.59	60.51	60.50	56.47	43.87	59.35	60.64	55.06	
Fs	36.96	36.99	33.14	32.17	32.42	35.82	45.14	34.42	33.40	36.77	

## A6. Plagioclase analyses

SiO <sub>2</sub>	46.17	46.32	45.88	46.72	46.63	45.62	46.34	46.49	44.98
CaO	17.33	16.53	17.18	17.42	17.63	17.90	17.50	17.38	18.33
Na <sub>2</sub> O	1.59	1.83	1.69	1.55	1.57	1.30	1.56	1.69	1.08
MgO	0.08	0.09	0.03	0.07	0.10	0.11	0.07	0.06	0.04
TiO <sub>2</sub>	n.d.	0.04	n.d.	n.d.	0.02	n.d.	0.09	0.07	0.02
FeO	1.12	2.03	1.43	1.13	1.17	0.80	1.07	1.02	0.32
Al <sub>2</sub> O <sub>3</sub>	32.72	31.37	32.03	32.78	32.91	33.76	33.02	32.75	34.56
K <sub>2</sub> O	0.08	0.14	0.08	0.10	0.08	0.07	0.08	0.06	0.05
MnO	0.02	0.04	0.03	0.01	0.02	0.03	0.02	0.03	n.d.
Cr <sub>2</sub> O <sub>3</sub>	0.01	0.01	0.03	n.d.	n.d.	0.02	n.d.	n.d.	0.01
Total	99.12	98.40	98.37	99.78	100.12	99.61	99.73	99.54	99.37
Si	2.15	2.19	2.16	2.17	2.16	2.12	2.15	2.16	2.09
Ca	0.87	0.84	0.87	0.87	0.87	0.89	0.87	0.87	0.91
Na	0.14	0.17	0.16	0.14	0.14	0.12	0.14	0.15	0.10
Mg	0.01	0.01	n.d.	0.01	0.01	0.01	0.01	n.d.	n.d.
Ti	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Fe	0.04	0.08	0.06	0.04	0.05	0.03	0.04	0.04	0.01
Al	1.80	1.74	1.78	1.79	1.79	1.85	1.81	1.79	1.89
K	0.01	0.01	0.01	0.01	0.01	n.d.	0.01	n.d.	n.d.
Mn	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Cr	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Total	5.02	5.03	5.02	5.01	5.02	5.01	5.02	5.01	5.01
An	85.33	82.67	84.42	85.64	85.67	88.03	85.71	84.72	90.13
Ab	14.17	16.53	15.09	13.76	13.84	11.57	13.79	14.99	9.58
Or	0.49	0.79	0.49	0.59	0.49	0.40	0.49	0.29	0.30
SiO <sub>2</sub>	46.31	44.74	46.26	46.36	44.48	44.05	47.32	43.85	
CaO	17.16	17.93	17.63	17.67	18.56	18.98	16.04	18.58	
Na <sub>2</sub> O	1.79	1.10	1.44	1.51	1.07	0.92	2.18	0.86	
MgO	0.05	0.10	0.05	0.18	0.08	0.03	0.04	0.09	
TiO <sub>2</sub>	0.01	0.05	0.04	0.03	n.d.	0.05	n.d.	0.01	
FeO	0.31	0.61	0.84	1.60	0.59	0.51	0.49	0.84	
Al <sub>2</sub> O <sub>3</sub>	33.08	33.98	33.27	33.25	34.35	35.34	32.26	35.09	
K <sub>2</sub> O	0.13	0.07	0.09	0.09	0.05	0.04	0.20	0.04	
MnO	0.02	0.02	0.03	0.04	0.01	0.02	n.d.	0.02	
Cr <sub>2</sub> O <sub>3</sub>	0.01	n.d.	0.02	0.02	n.d.	0.01	n.d.	n.d.	
Total	98.87	98.60	99.65	100.75	99.18	99.94	98.52	99.38	
Si	2.16	2.10	2.15	2.14	2.08	2.04	2.21	2.05	
Ca	0.86	0.90	0.88	0.87	0.93	0.94	0.80	0.93	
Na	0.16	0.10	0.13	0.14	0.10	0.08	0.20	0.08	
Mg	n.d.	0.01	n.d.	0.01	0.01	n.d.	n.d.	0.01	
Ti	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
Fe	0.01	0.02	0.03	0.06	0.02	0.02	0.02	0.03	
Al	1.82	1.88	1.82	1.81	1.89	1.93	1.77	1.93	
K	0.01	n.d.	0.01	0.01	n.d.	n.d.	0.01	n.d.	
Mn	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
Cr	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
Total	5.01	5.01	5.01	5.03	5.03	5.02	5.01	5.03	
An	83.53	89.65	86.73	86.17	90.28	91.83	79.31	92.07	
Ab	15.69	9.95	12.77	13.34	9.43	7.98	19.50	7.73	
Or	0.78	0.40	0.50	0.49	0.29	0.19	1.19	0.20	

**A7. MIL 07664,4A in plane polarized and cross-polarized light-1in. round (2.54cm).** (The red box shows which grain this appendix is referring to)







**A8. BSE image with microprobe points. (rotated 180° clockwise from original SEM map).**

