Mineralogical Ambiguity of Lonar Ejecta

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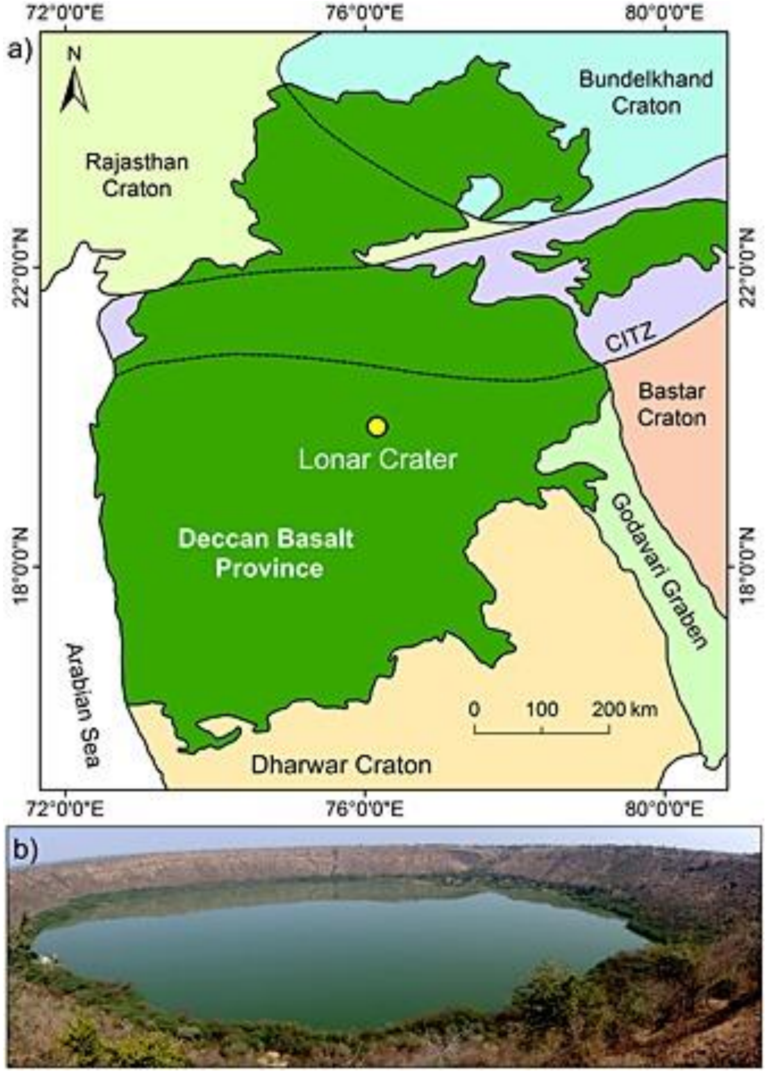
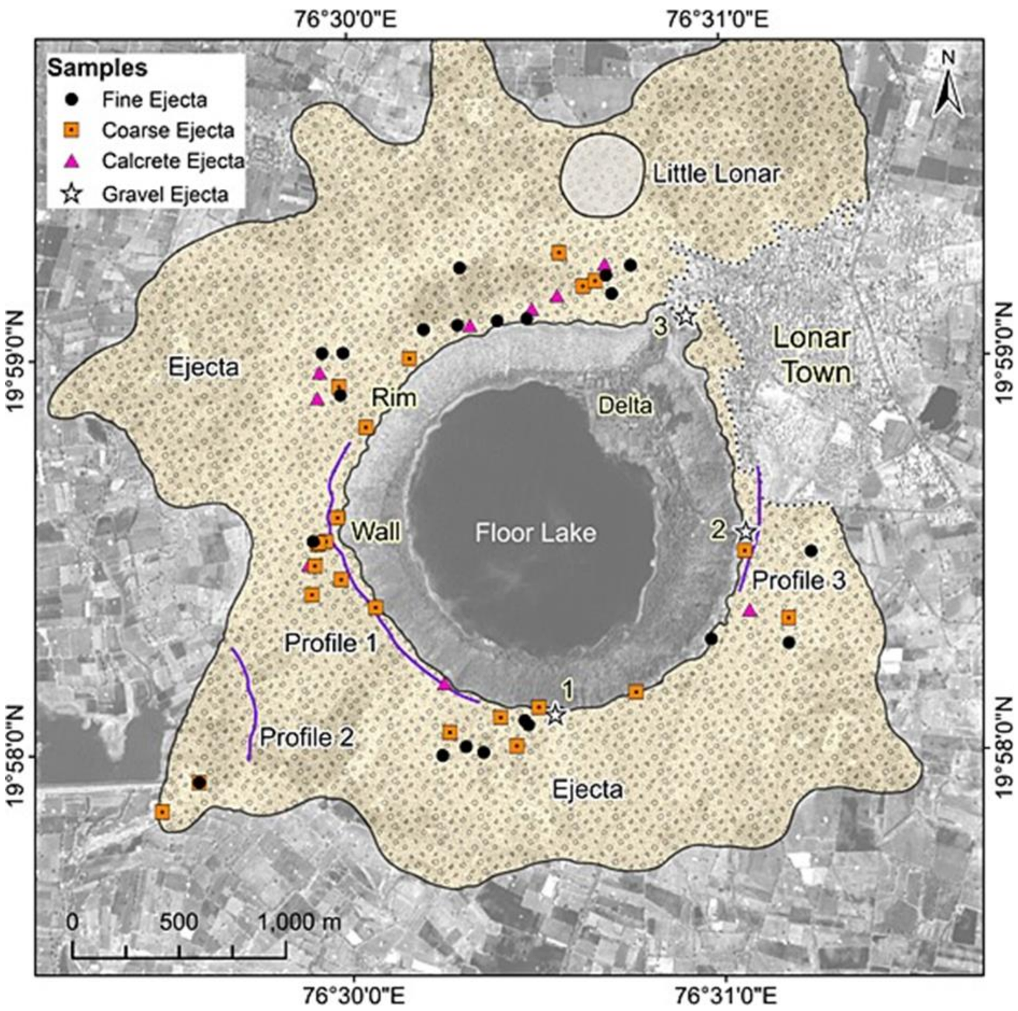
Lonar Crater: India





Indian Space Research Organisation's Cartosat image of Lonar Crater showing the locations of ejecta samples.

Geologic setting

The Deccan Traps are one of the largest volcanic provinces in the world, consisting of more than 2-km-thick flat-lying basalt lava flows covering an area of nearly 500,000 km2 in west-central India; estimates of the original area covered by the lava flows are as high as 1.5 million km2, and the volume of basalt is estimated at ~0.5 million km3 (e.g., Mahoney 1988; Cox and Hawkesworth 1985; Widdowson et al. 2000).

The Deccan basalts were irrupted between ~69 and 63 Ma ago, with a main peak in activity around 66 to 65 Ma (Pandey, 2002 and Courtillot and Renne 2003). Six basalt flows, ranging in thickness between ~8 and 40 m, are seen in and around Lonar village, while four flows are exposed on the crater wall (Ghosh and Bhaduri 2003).

Geologic setting

The comparatively young (50,000 years old) Lonar crater of India is presumably one of the two known terrestrial impact craters that emplaced about 65 million years old Deccan basalt. The impact cratering occurred tens of million years after the formation of the Deccan Basalt and it is very likely that in the meantime the postulated target basalts layers were extensively altered due to weathering.

The presence of caliche, a carbonate-rich material at the base of the impact deposits.

Geologic setting

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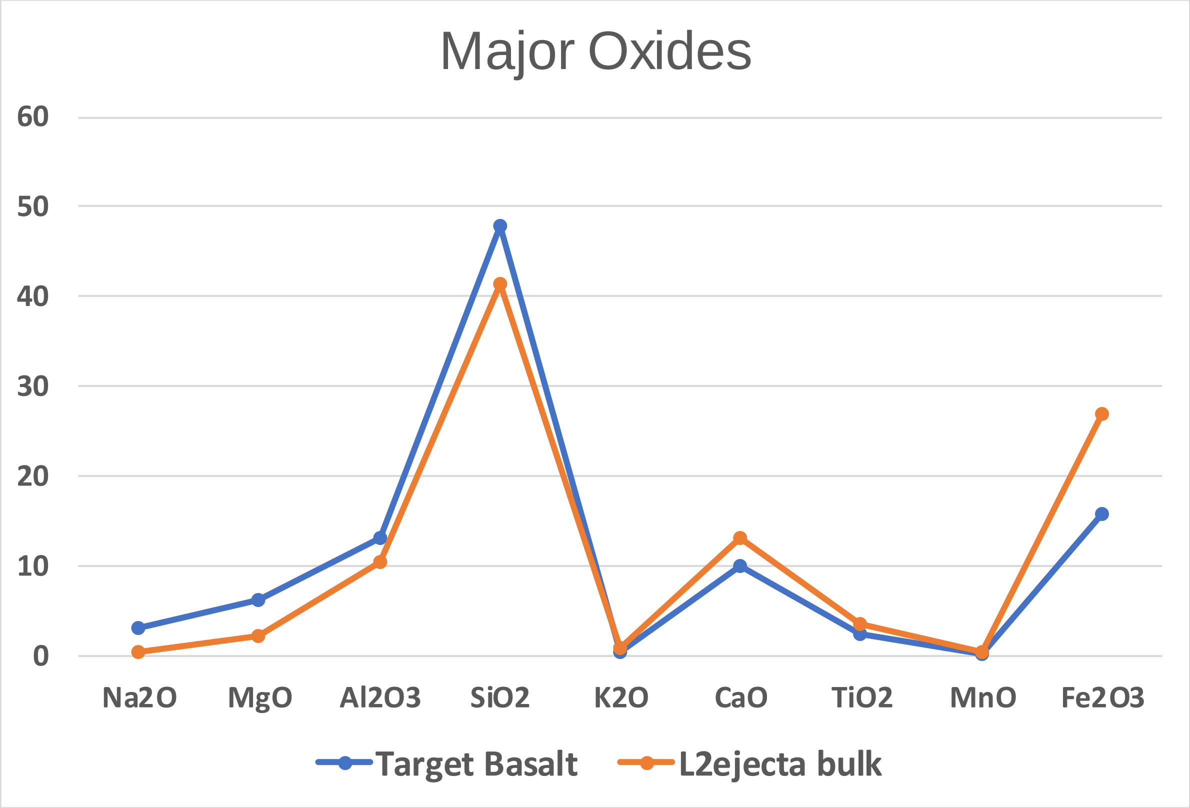
Reb bole laterally continuous in Deccan Plateau extensively cemented by veins of quartz and zeolite. The zeolite was identified to be of heulandite composition.

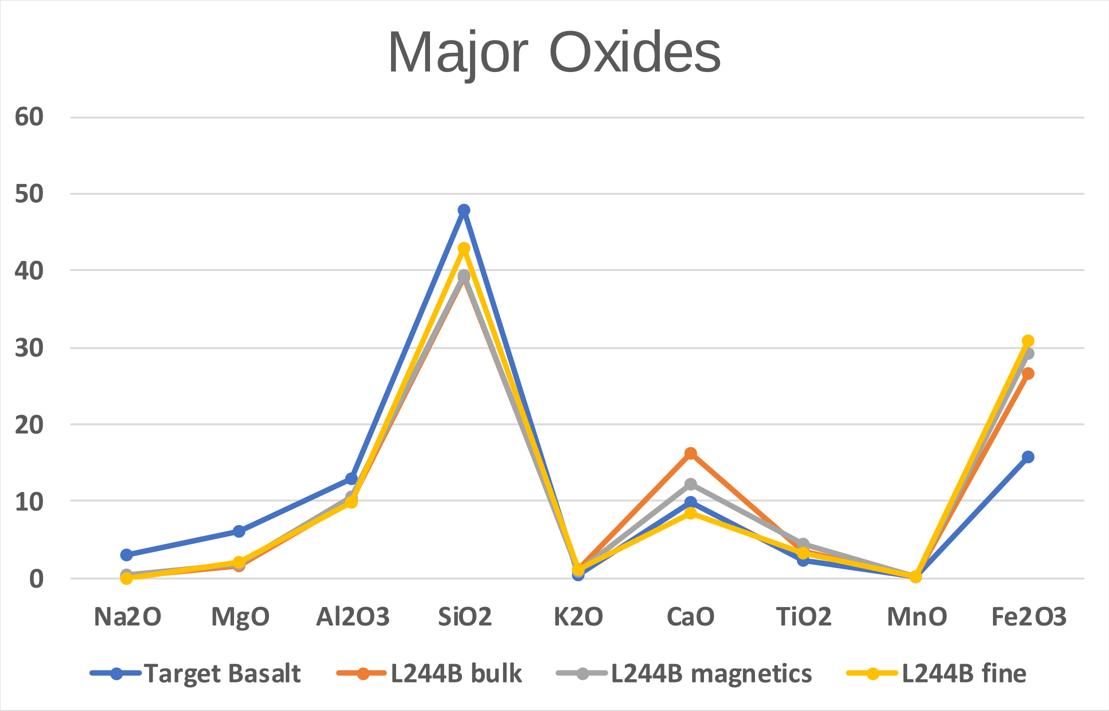
Ejecta of South Rim

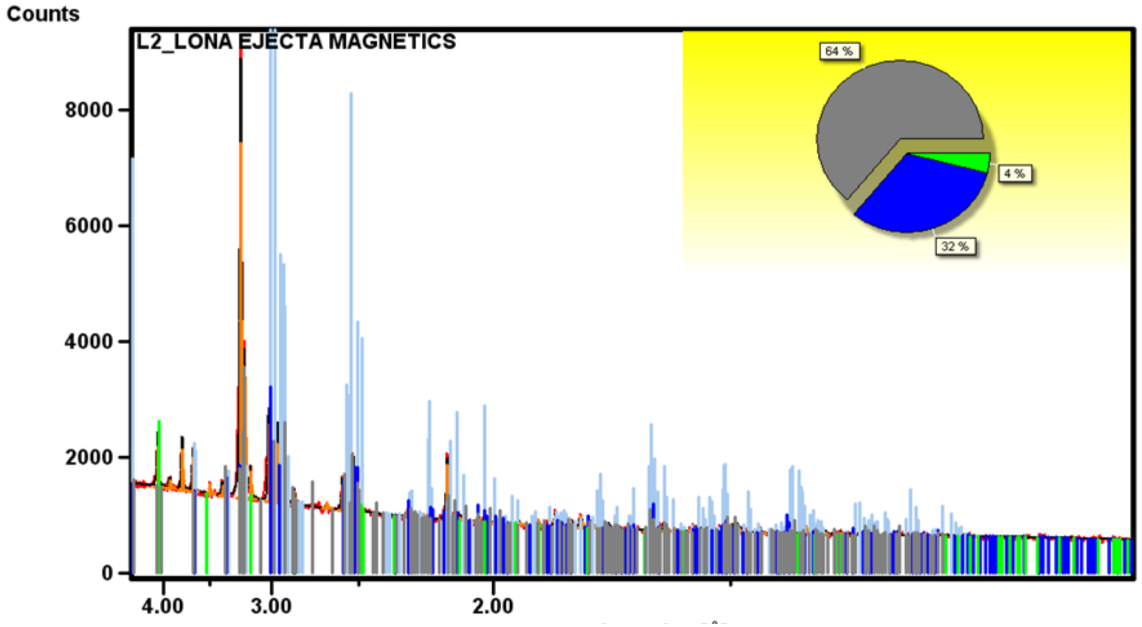
Wt%	Target Basalt	L2ejecta bulk	L2ejecta magnetics
Na2O	3	0.428	0.512
MgO	6.07	2.183	1.844
Al2O3	12.96	10.363	11.381
SiO2	47.82	41.437	41.144
K2O	0.38	0.747	0.577
CaO	9.87	13.135	13.166
TiO2	2.26	3.42	3.663
MnO	0.19	0.306	
Fe2O3	15.827	26.903	

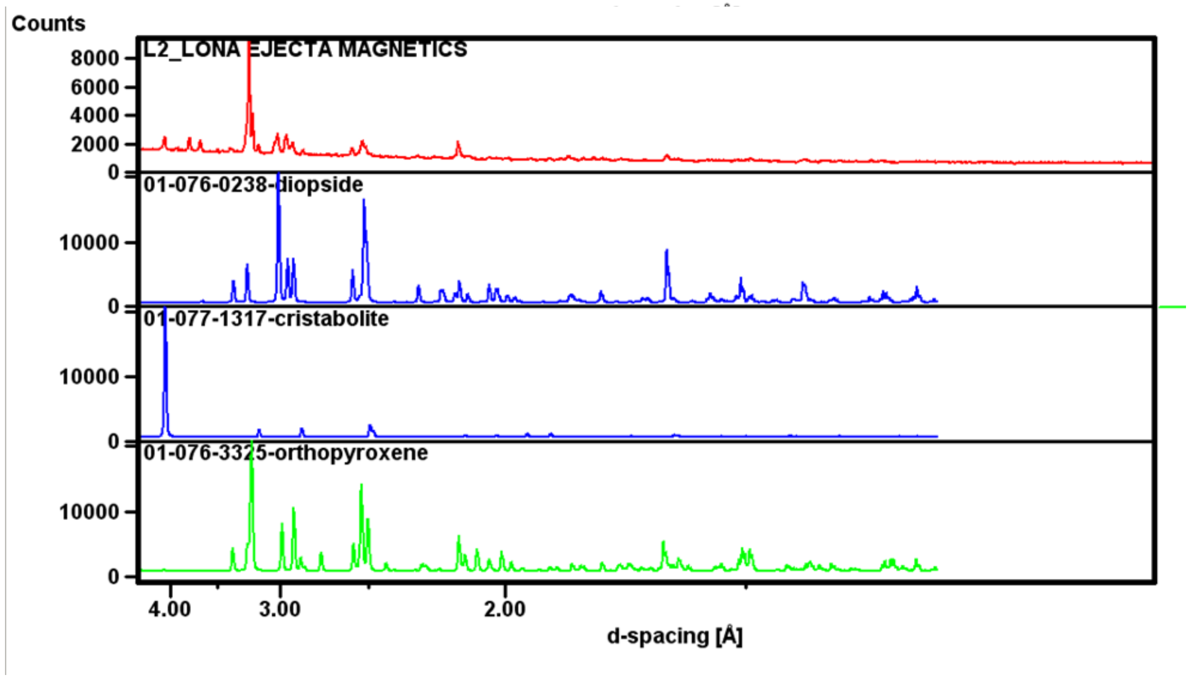


Ejecta of North Rim

Wt%	Target Basalt	L244B bulk	L244B magnetics	L244B fine
Na2O	3	0.209	0.343	0
MgO	6.07	1.687	1.826	2.08
Al2O3	12.96	10.161	10.511	9.831
SiO2	47.82	39.139	39.385	42.86
K2O	0.38	1.11	0.825	1.149
CaO	9.87	16.262	12.185	8.43
TiO2	2.26	3.566	4.374	3.33
MnO	0.19	0.248	0.294	0.229
Fe2O3	15.827	26.608	29.166	30.854







Ejecta samples of South West Rim

Cu target

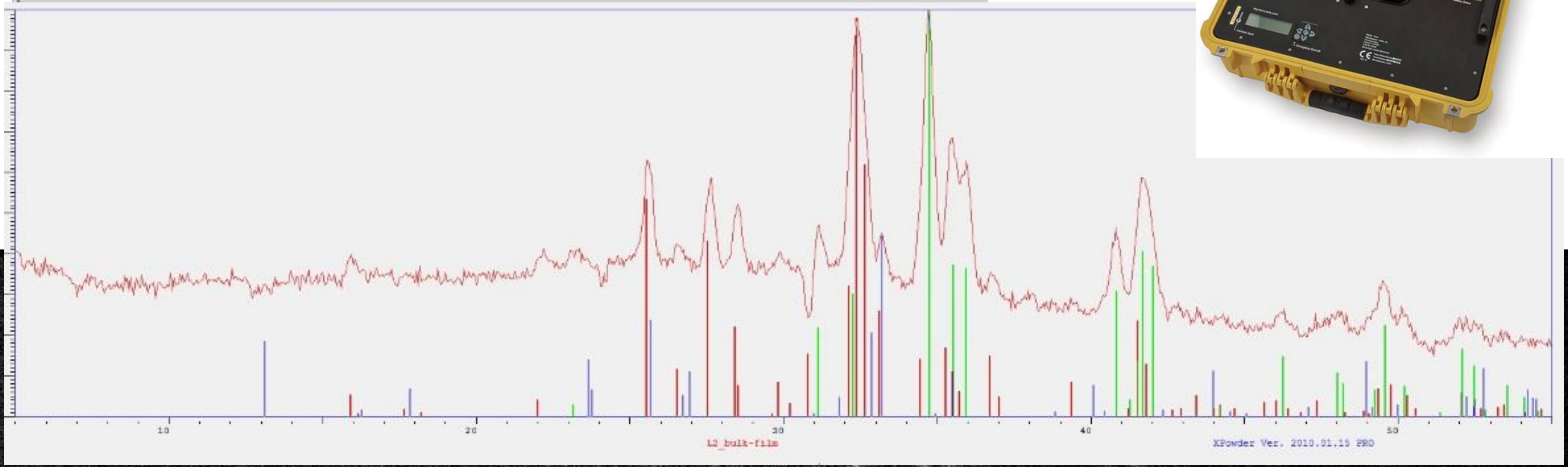
64%: Orthopyroxene

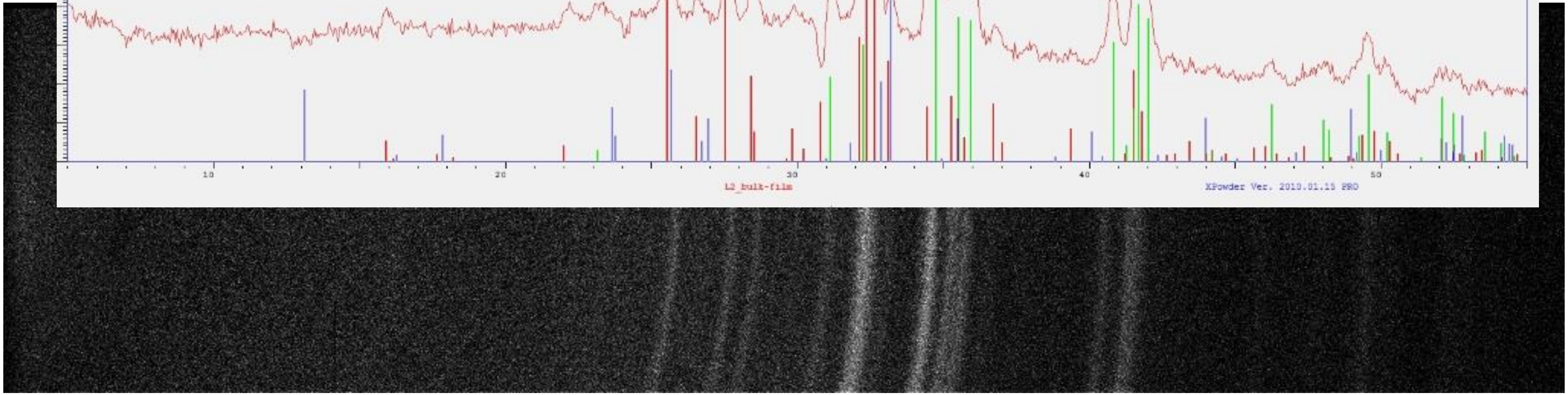
32%: Diopside

4%: Cristabolite

Ejecta of South Western Rim (L2)

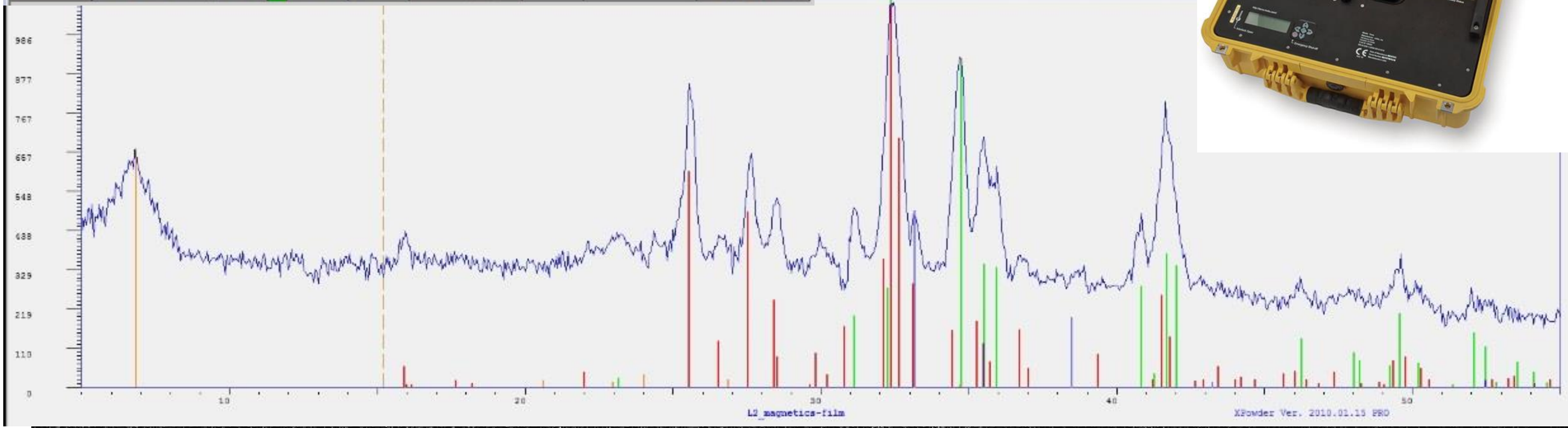
Set-Fil	Phase name	Q	Fract	RIR.	% W Unc Ab	m/rho	% W Xtal	% W Xtal+A
015705	Diopside= Ca.7	1	1.000	7.51	29.8(5.8)	73.9	29.4(5.8)	15.5(3.1)
011051	Andesine= Ca.24	1	0.980	3.30	66.5(6.1)	88.5	66.8(6.1)	35.3(3.2)
022515	Barytocalcite=	1	0.450	27.44	03.7(3.7)	120.4	03.8(3.8)	02.0(2.0)
	Global amorphous	1	0.446	0.50	89.1(7.2)			47.1(4.7)

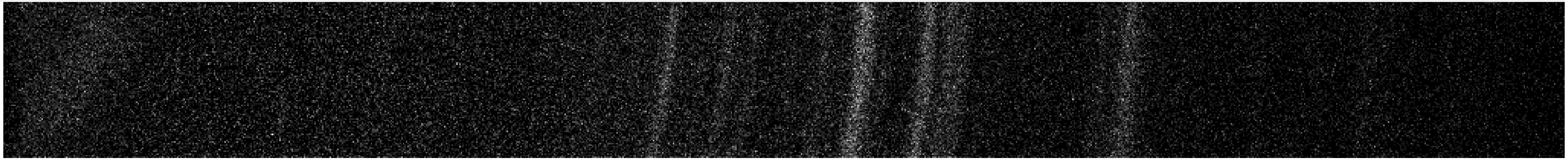




Ejecta of South Western Rim (L2)

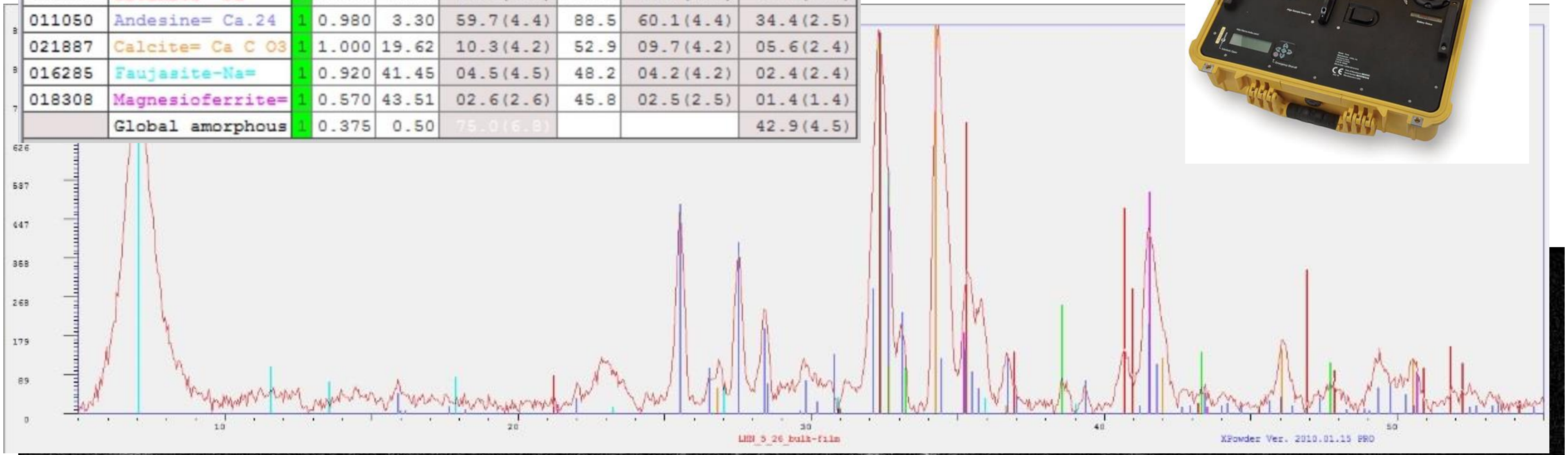
Set-Fil	Phase name	Q	Fract	RIR.	% W Unc Ab	m/rho	% W Xtal	% W Xtal+A
015705	Diopside= Ca.7	1	0.840	7.51	03.6(3.6)	73.9	03.5(3.5)	01.9(1.9)
011050	Andesine= Ca.24	1	1.000	3.30	09.9(5.2)	88.5	09.6(5.2)	05.2(2.8)
023324	Pyrite= Fe	1	0.450	0.17	86.2(9.9)	121.6	86.7(9.9)	46.9(5.4)
012866	Montmorillonite=	1	0.610	77.00	00.3(0.3)	60.3	00.2(0.2)	00.1(0.1)
	Global amorphous	1	0.424	0.50	84.7(7.1)			45.9(4.6)

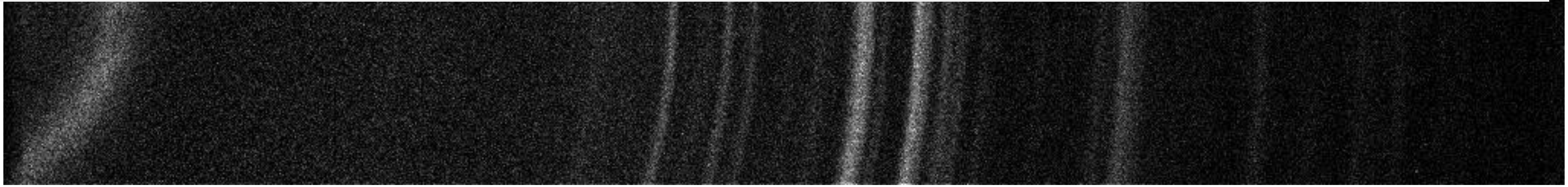




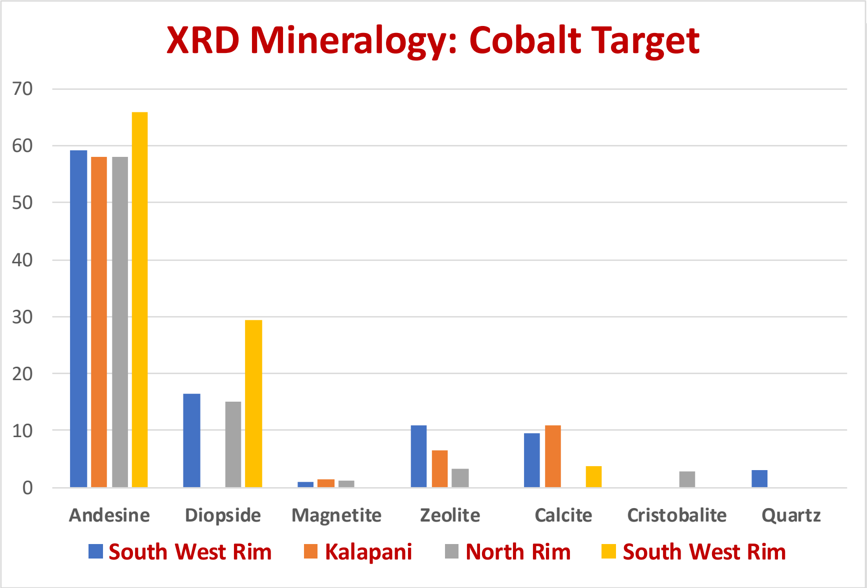
Ejacta Samples of Kalapani

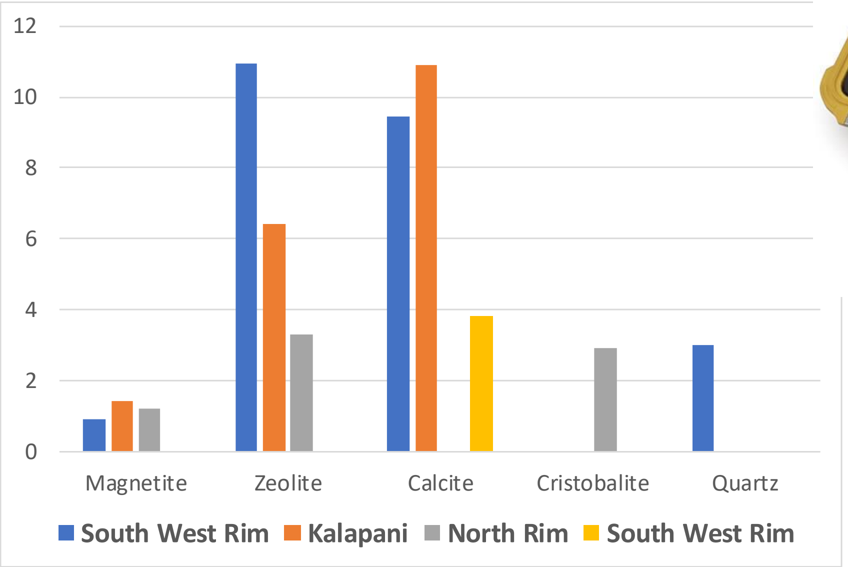
Set-Fil	Phase name	Q	Fract	RIR.	% W Unc Ab	m/rho	% W Xtal	% W Xtal+A
010605	Pyrite= Fe S2	1	0.279	32.18	01.7(1.7)	97.3	01.8(1.8)	01.0(1.0)
016317	Titanite= Ca	1	0.980	9.32	21.2(4.4)	106.6	21.7(4.4)	12.4(2.5)
011050	Andesine= Ca.24	1	0.980	3.30	59.7(4.4)	88.5	60.1(4.4)	34.4(2.5)
021887	Calcite= Ca C O3	1	1.000	19.62	10.3(4.2)	52.9	09.7(4.2)	05.6(2.4)
016285	Faujasite-Na=	1	0.920	41.45	04.5(4.5)	48.2	04.2(4.2)	02.4(2.4)
018308	Magnesioferrite=	1	0.570	43.51	02.6(2.6)	45.8	02.5(2.5)	01.4(1.4)
	Global amorphous	1	0.375	0.50	75.0(6.8)			42.9(4.5)



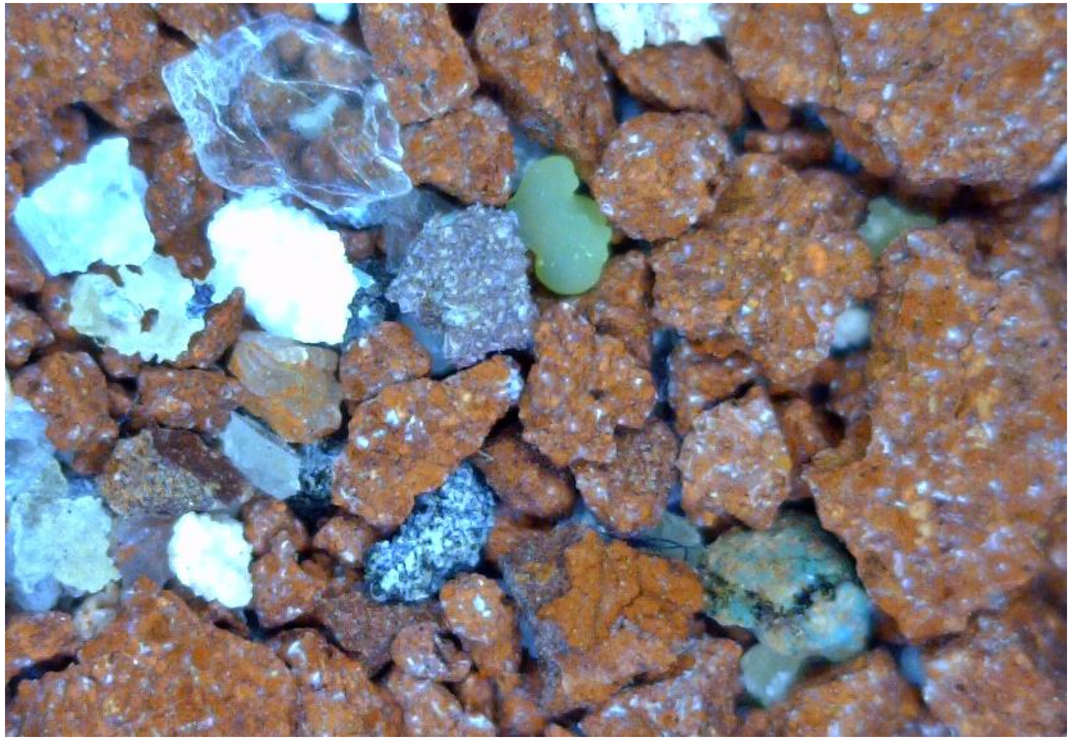


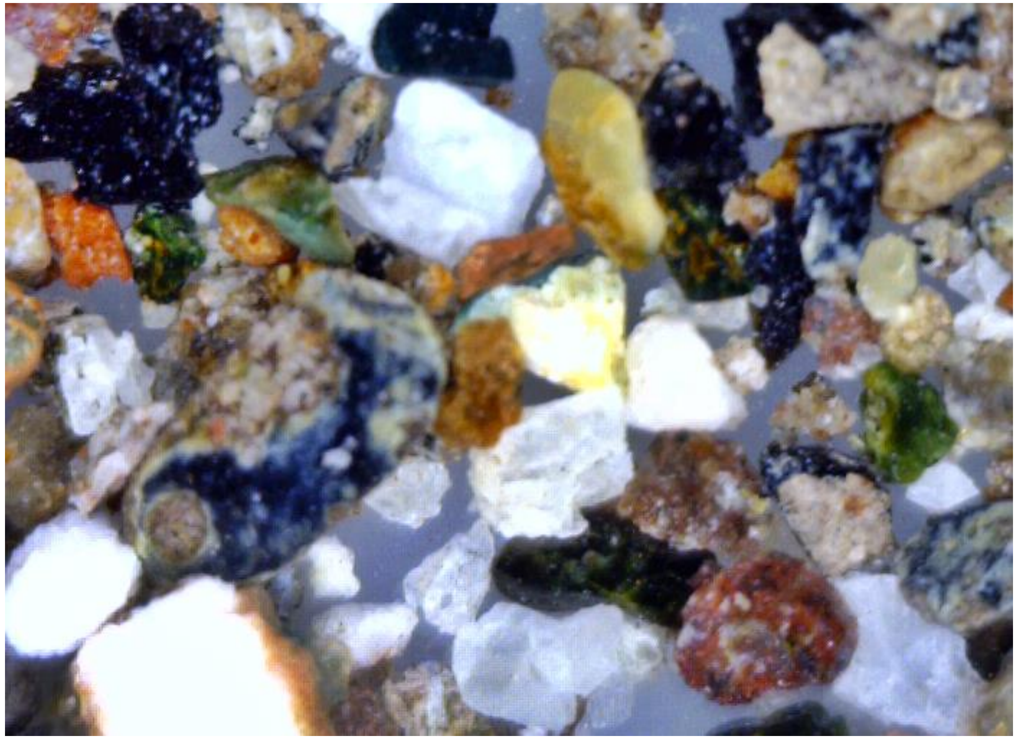
XRD Mineralogy: Cobalt Target





XRD (wt%)	Location	Andesine	Diopside	Magnetite	Zeolite	Calcite	Cristobalite	Quartz
L244B Bulk	South West Rim	59.2	16.4	0.9	10.94	9.45	0	2.98
LHN0526 Bulk	Kalapani	58	0	1.4	6.4	10.9	0	0
LHN04 08 Bulk	North Rim	58.2	15	1.2	3.3	0	2.9	0
L2 Ejecta	South West Rim	66	29.4	0	0	3.8	0	0

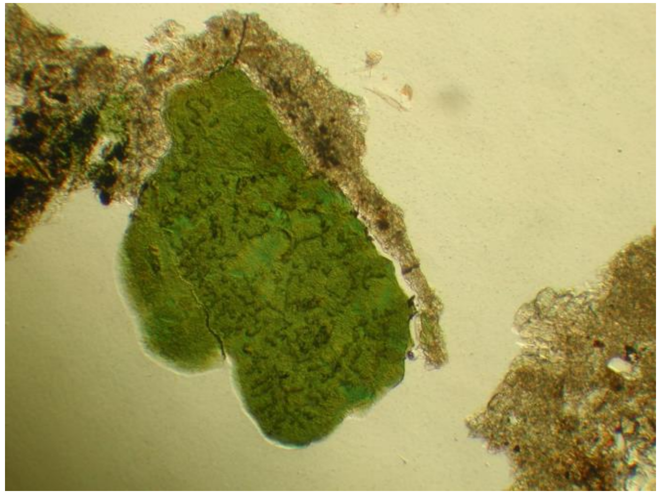


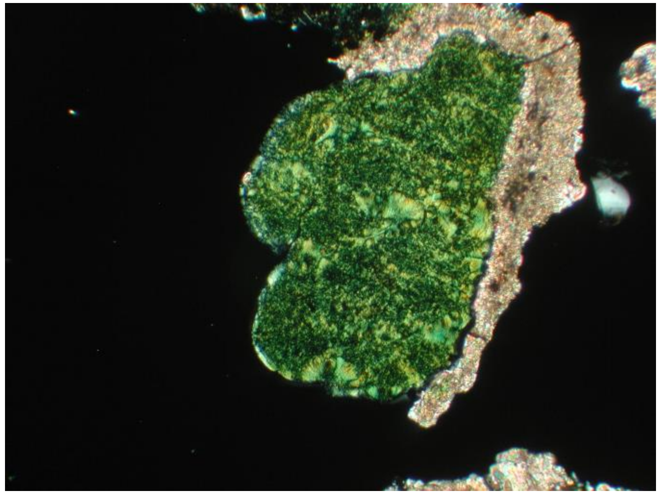


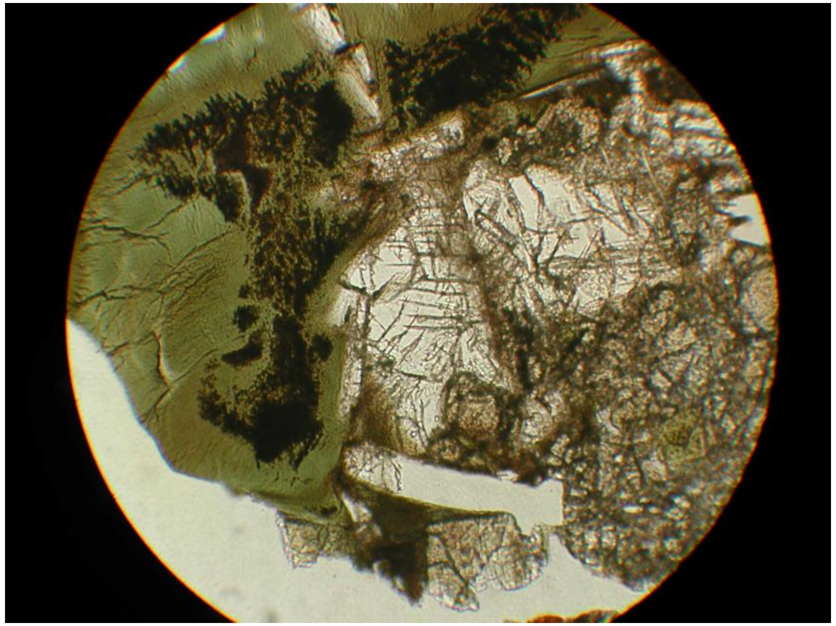
Where is the ambiguity?

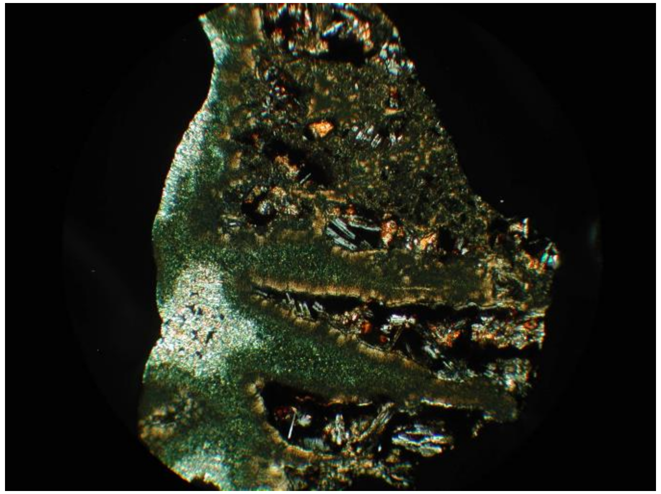
Glauconites!

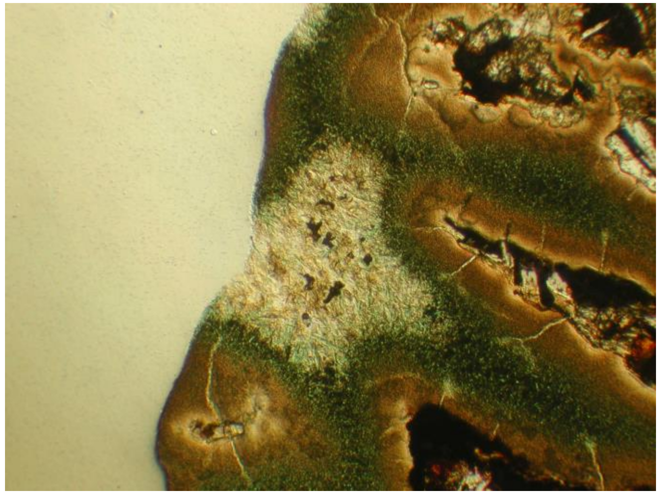
Optical Microscopy with Polarizing Light



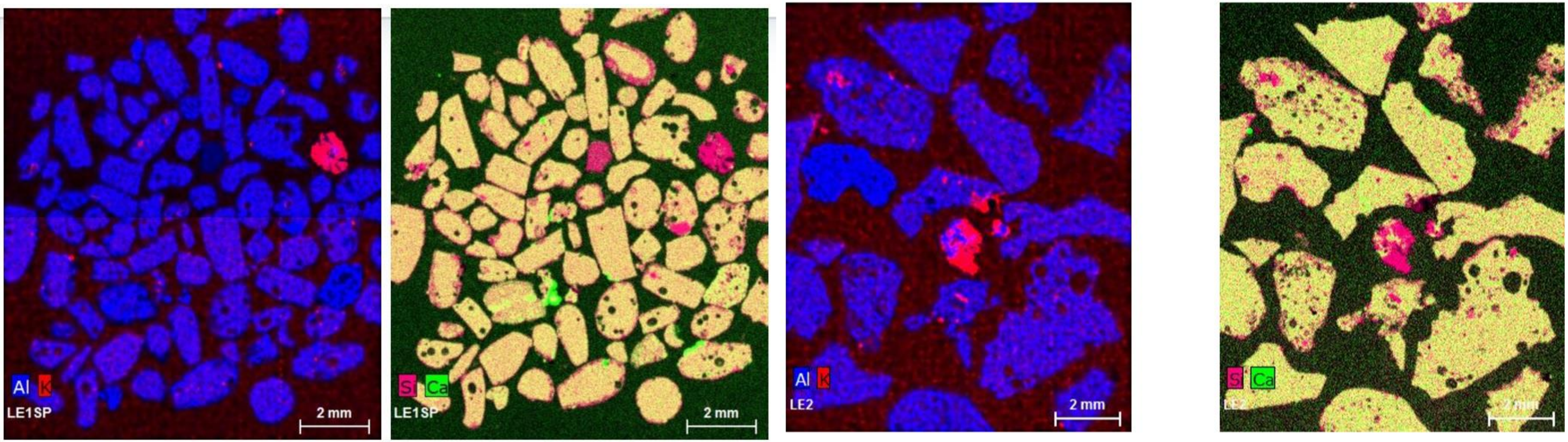




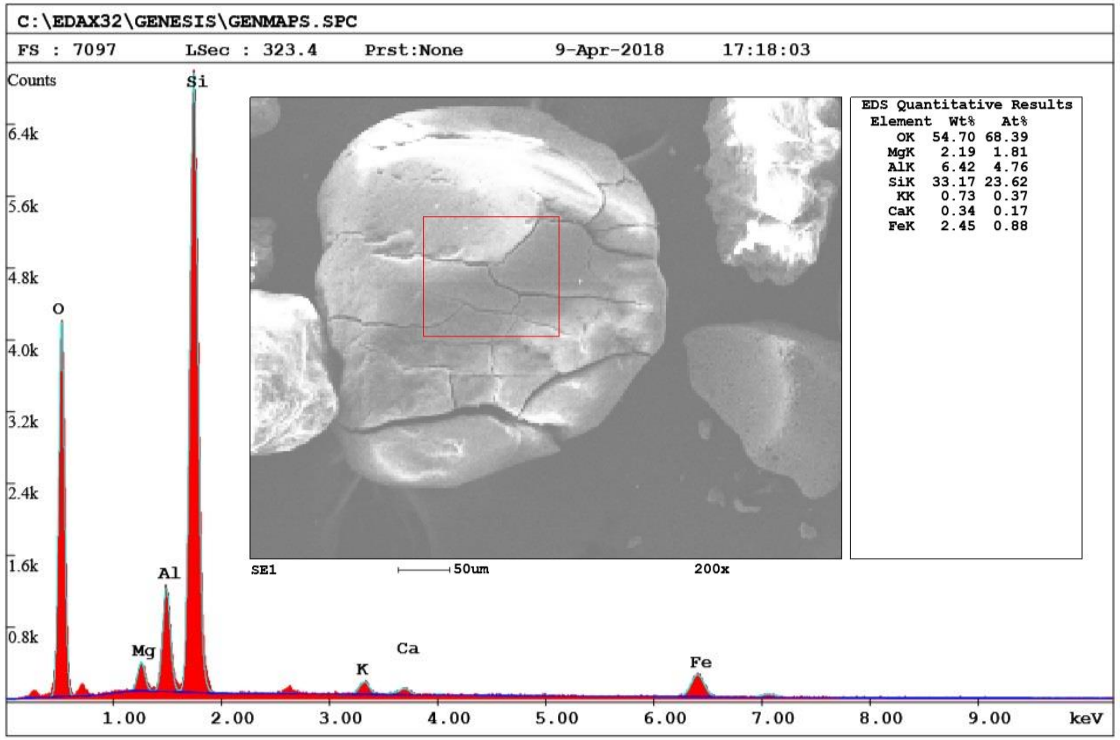


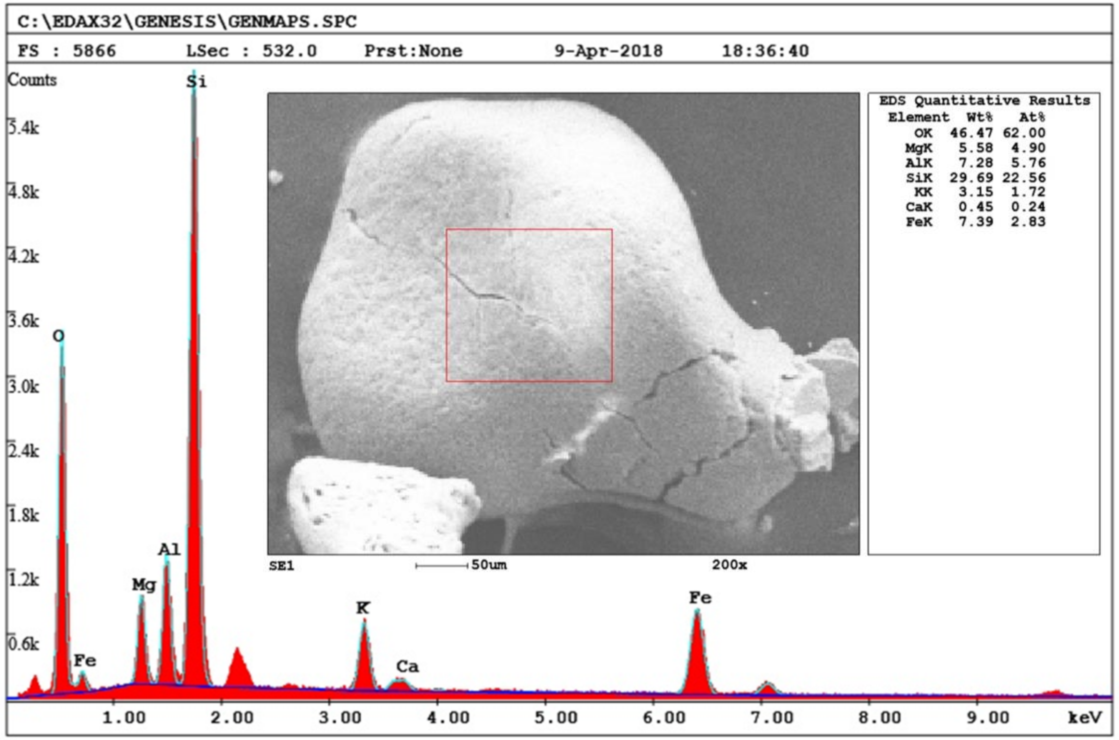


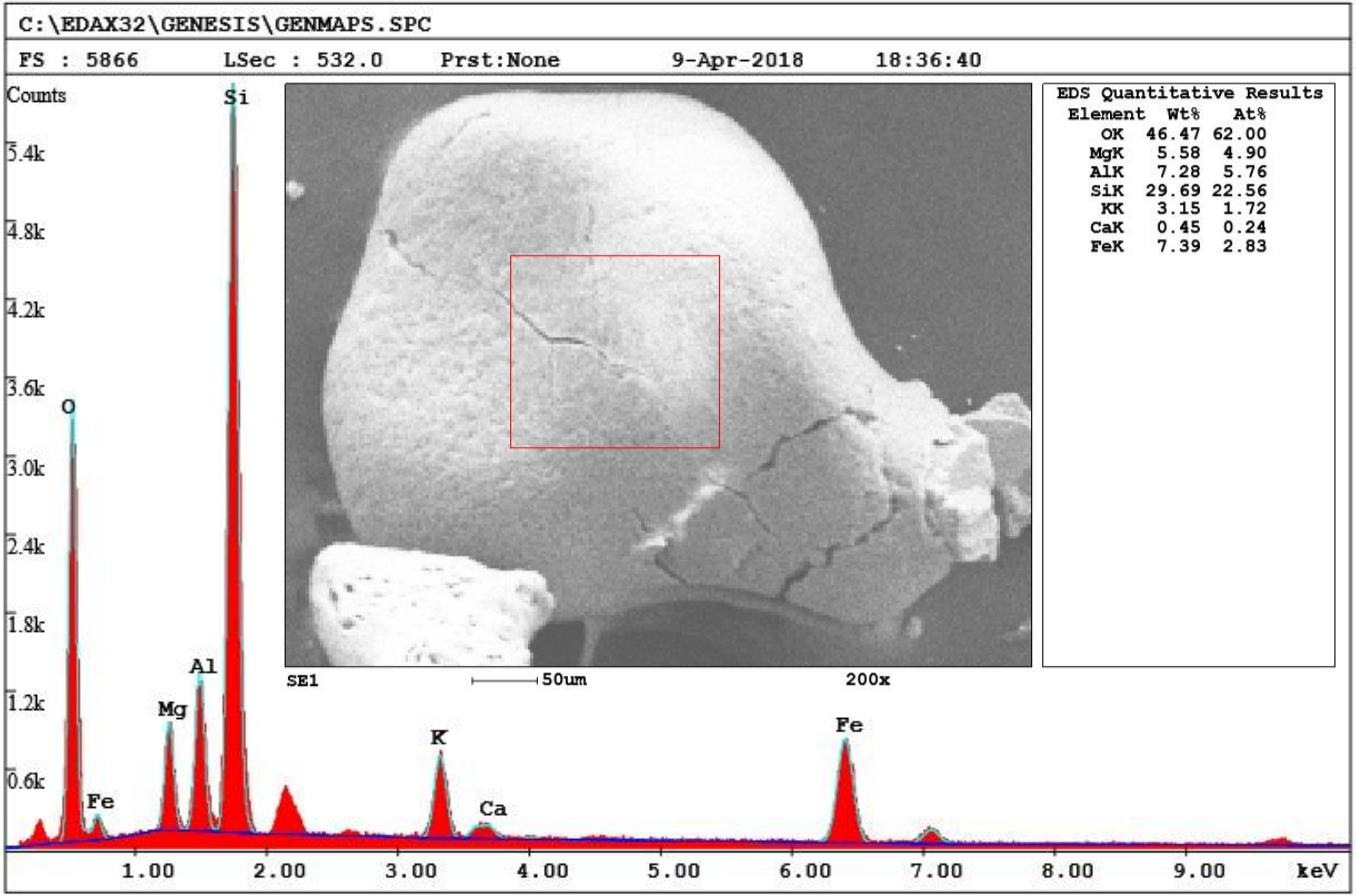
Ejecta Spherules: Elemental Mapping by u-XRF (Tornado M4)



SEM-EDS analysis
Hitachi SU 70 equipped with EDAX



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FS : 5866
LSec : 532.0
Prst:None
9-Apr-2018
18:36:40
Counts
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4.8k
4.2k
3.6k
3.0k
2.4k
1.8k
1.2k
0.6k
O
Fe
Mg
Al
Si
K
Ca
Fe
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
keV
SE1
50um
200x
EDS Quantitative Results
Element Wt% At%
OK 46.47 62.00
MgK 5.58 4.90
AlK 7.28 5.76
SiK 29.69 22.56
KK 3.15 1.72
CaK 0.45 0.24
FeK 7.39 2.83

The most favorable physical environment for the occurrence of glauconites:

I. slow deposition in agitated water, and paucity of clay minerals
II. Saline, oxidizing environment
III. Sufficient organic matter is necessary to create local reducing conditions.
IV. Higher than normal amounts of iron and potassium

Although potassium is probably less restrictive than iron. Magnesium is also an essential constituent but is likewise readily available in a normal marine environment.

Observation

The prevalence of andesine presents some ambiguity in matching the ejecta with tholeiitic basaltic target and suggest that multiple phases of pre and post-impact alterations probably accountable for the present mineralogical assemblage. The impact cratering probably occurred on the weathered basaltic rocks that was depleted in certain metals and the zeolites probably developed due to post-impact hydrothermal alteration and finally climatic condition probably facilitated the calcification of the ejecta blanket and the preservation of the ejecta fallout.

The characterization of glauconites are still under investigation!

Thanks!

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