Ambiguous Geochemical Signature of the Ejecta of Lonar Crater, India

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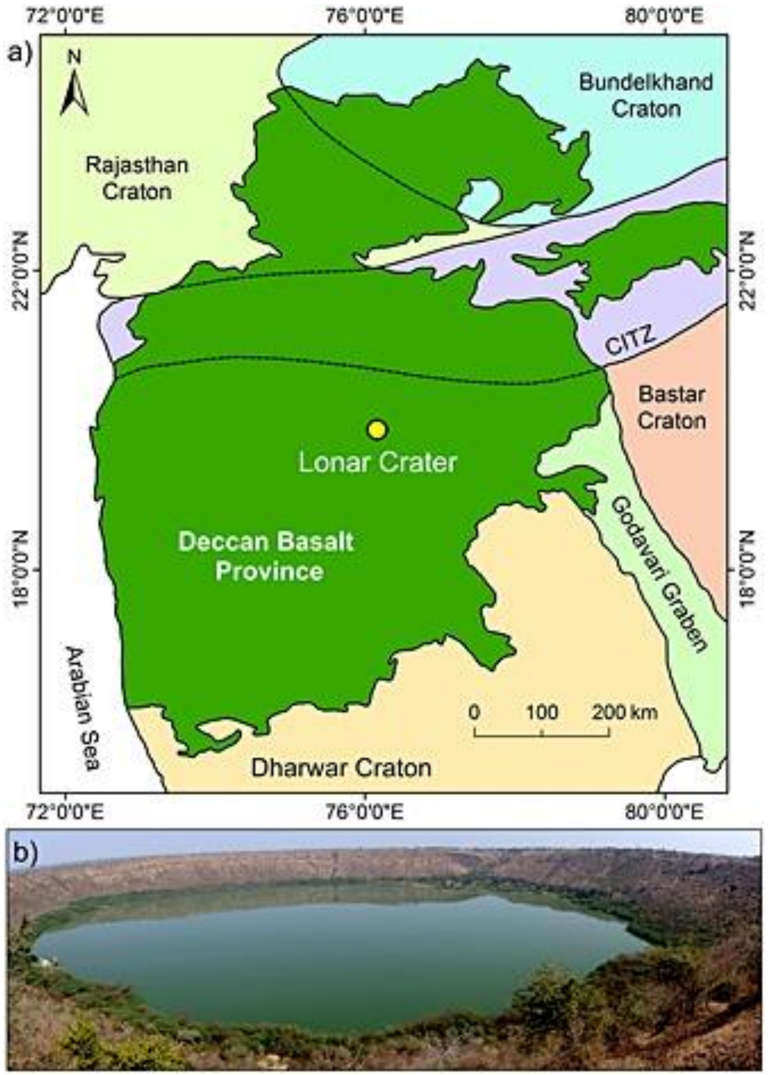
Lonar Crater: India

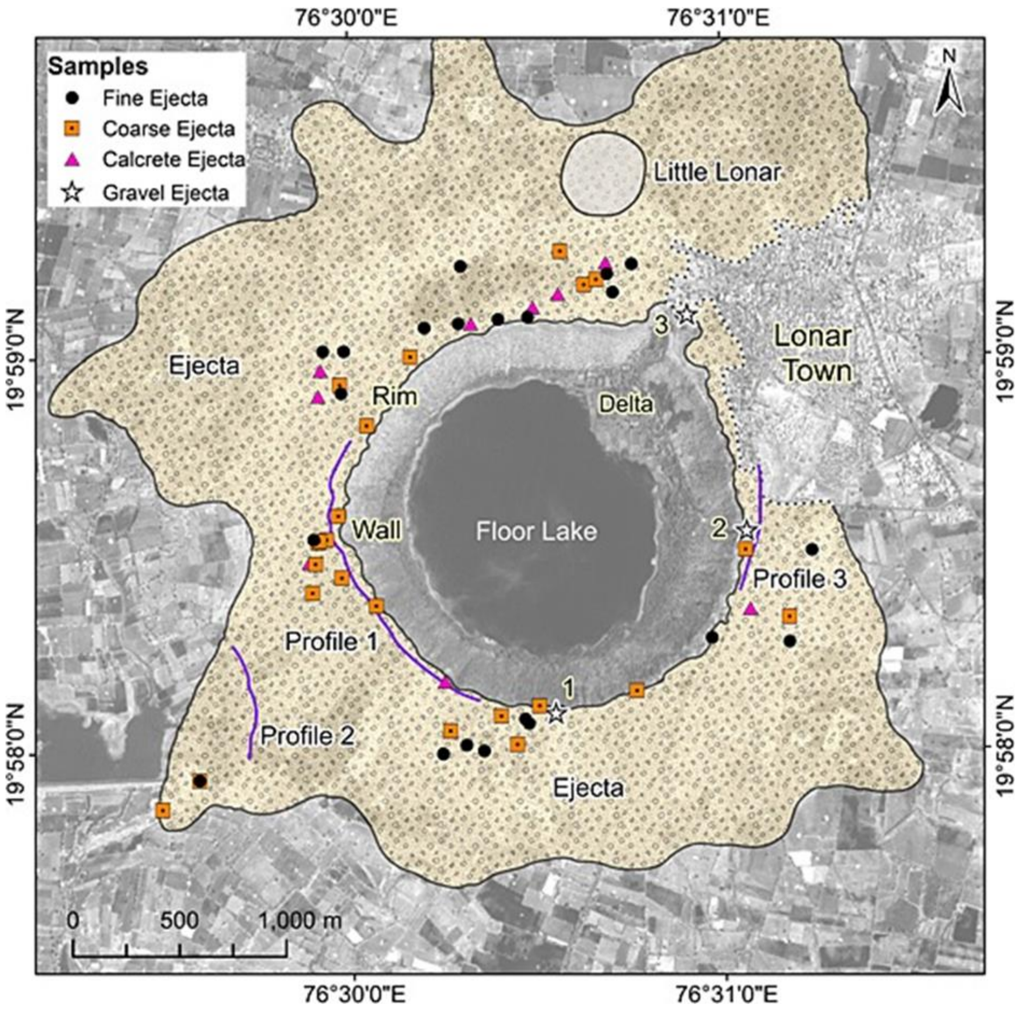


The Deccan Traps are one of the largest volcanic provinces in the world, consisting of more than 2-km-thick flat-lying basalt lava flows covering an area of nearly 500,000 km2 in west-central India; estimates of the original area covered by the lava flows are as high as 1.5 million km2, and the volume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

Lonar Crater: India

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).

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.



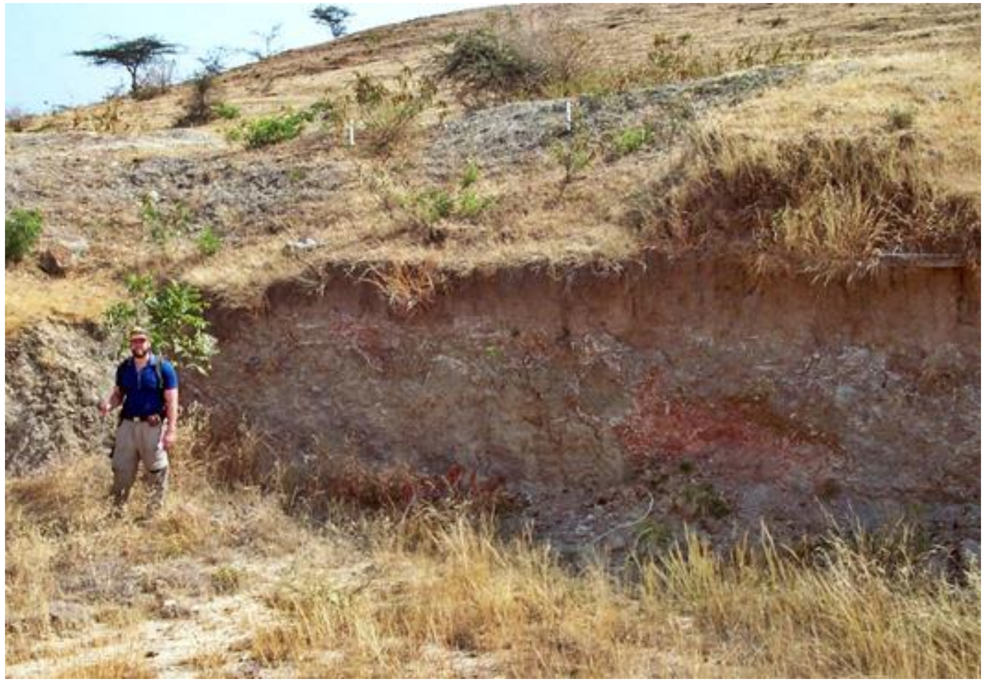
Indian Space Research Organisation's Cartosat image of Lonar Crater showing the locations of ejecta samples.

Geologic setting

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.

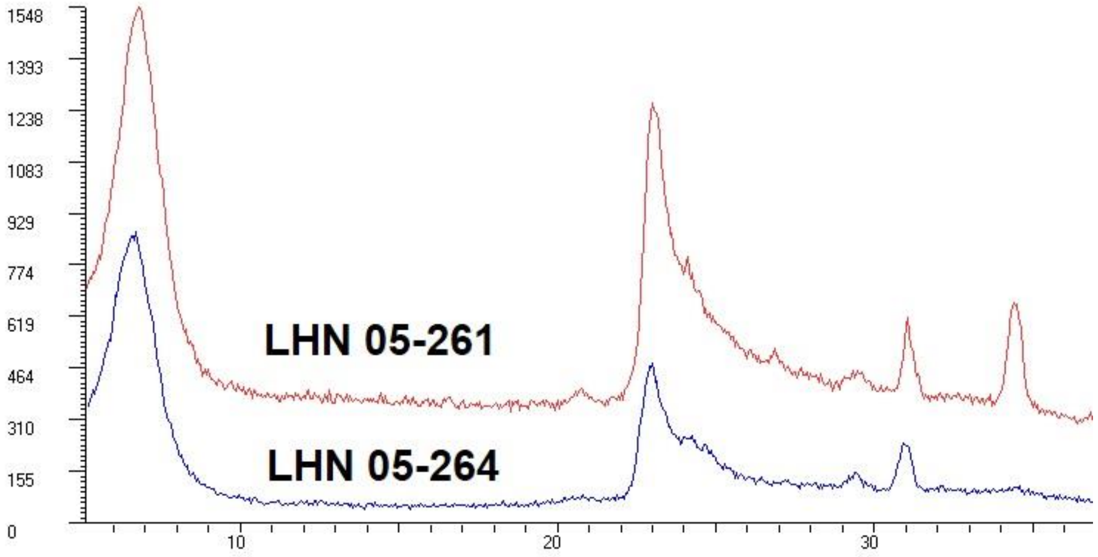
Geologic setting

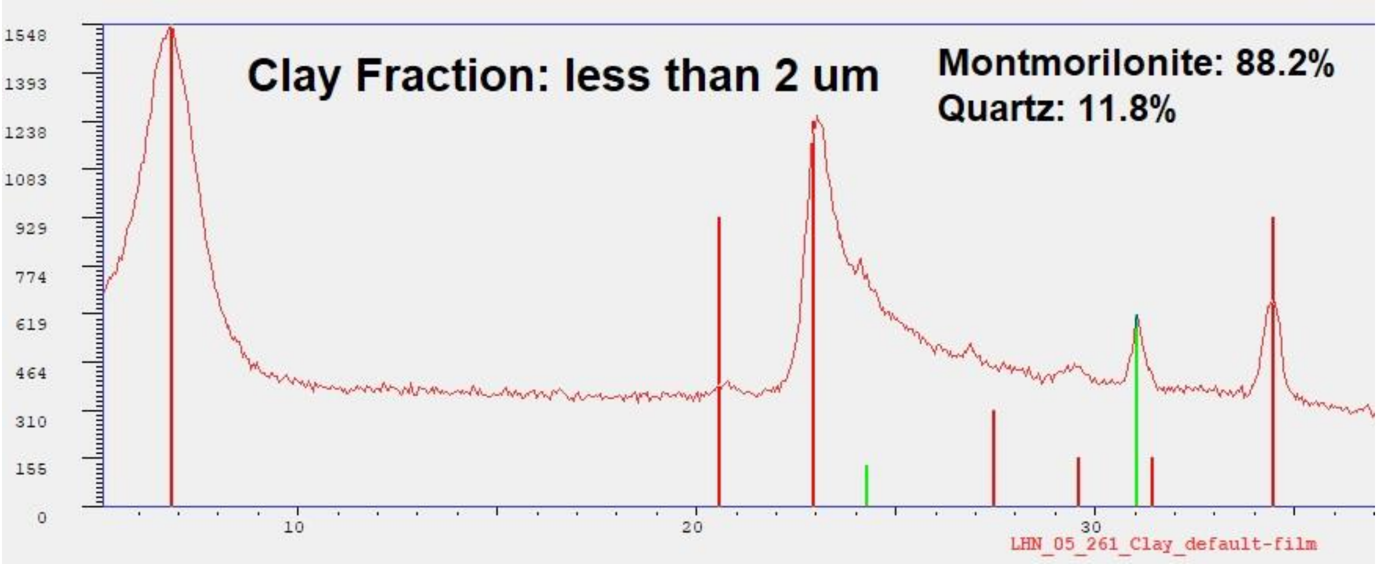


Reb bole laterally continuous in Deccan Plateau extensively cemented by veins of quartz and zeolite. The zeolite was identified to be of heulandite by the earlier workers.

Amygdules, present in some of the vesicles are green zeolite, white calcite, and/or translucent gray quartz (based on preliminary microprobe analysis).

LC09 – 261 Paleosol

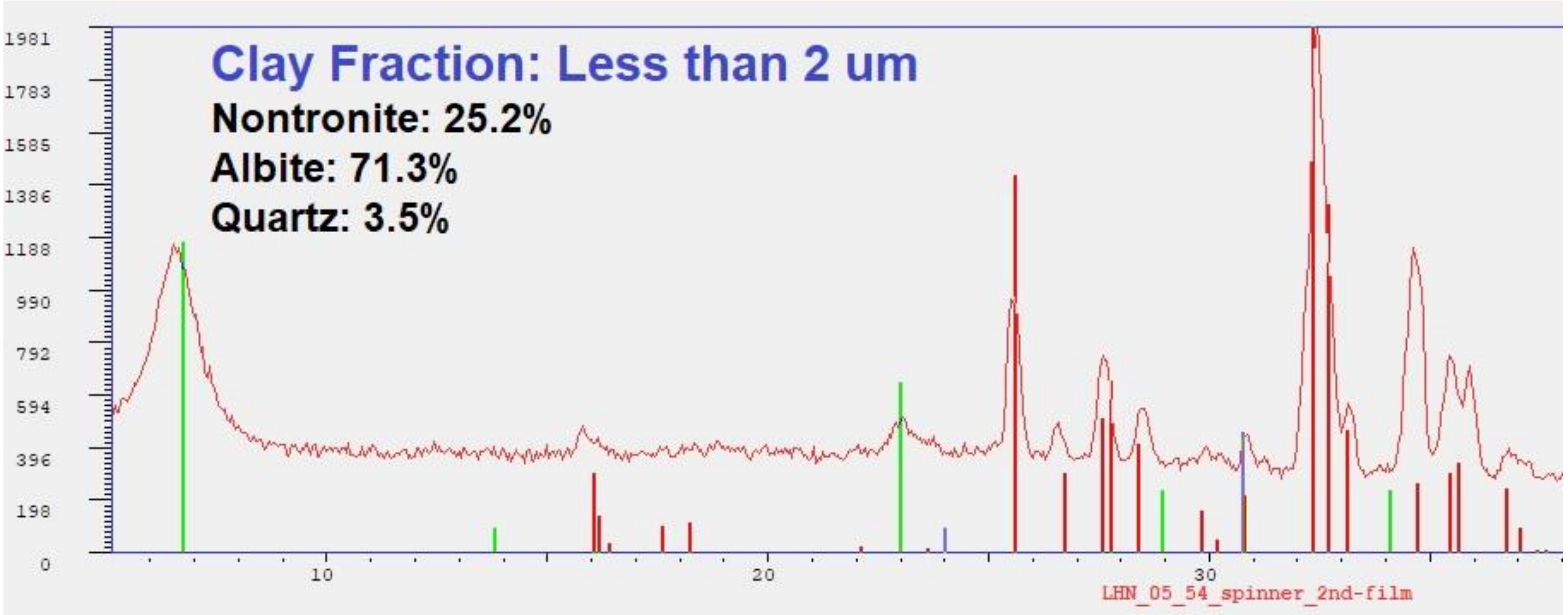




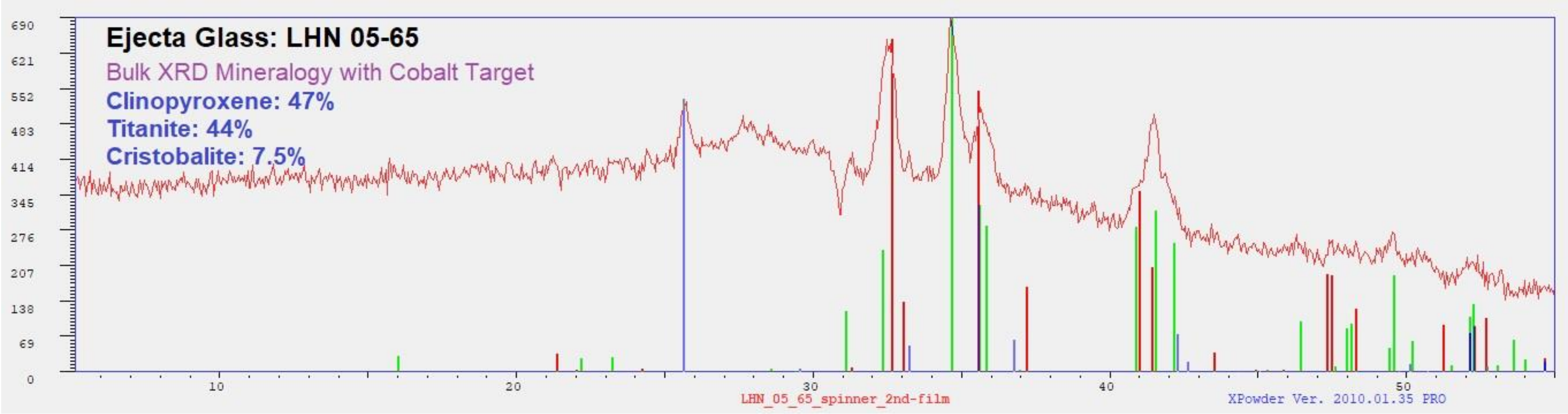
Sample Code	Sample Type	Ba	Cr	Co	Ni	Cu	Zn	Ni/Cr	Co/Cr
LC 09-261	Paleosol	91	120	29	70	150	80	0.583	0.242
LC 09-264	Paleosol	83	70	42	50	210	80	0.714	0.6

LHN05 – 54
Preimpact Altered Rock

Sample Code	Sample Type	Ba	Cr	Co	Ni	Cu	Zn	Ni/Cr	Co/Cr
LHN 05-54	Preimpact alterted Basalt	156	50	40	40	210	80	0.8	0.8



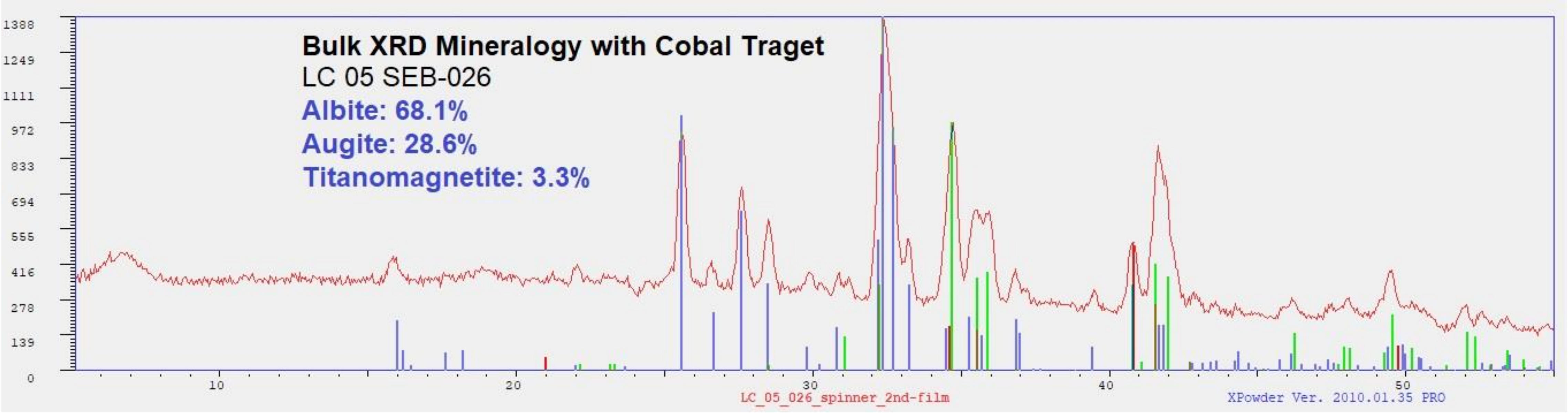
LHN 05 – 65
Impact Melt, Glass locality, parts of single big clast



Sample Code	Sample Type	Ba	Cr	Co	Ni	Cu	Zn	Ni/Cr	Co/Cr
LHN 05-65	Impact melt glass	218	80	44	70	200	130	0.875	0.55

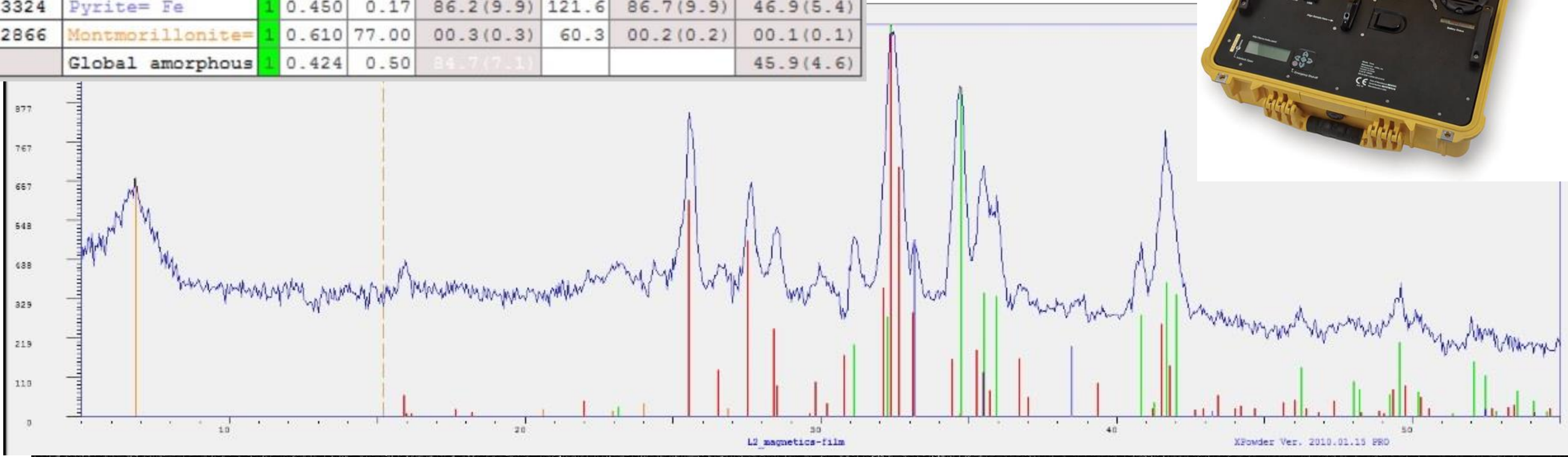
LC-05-SEB-026
Fresh side of Boulder

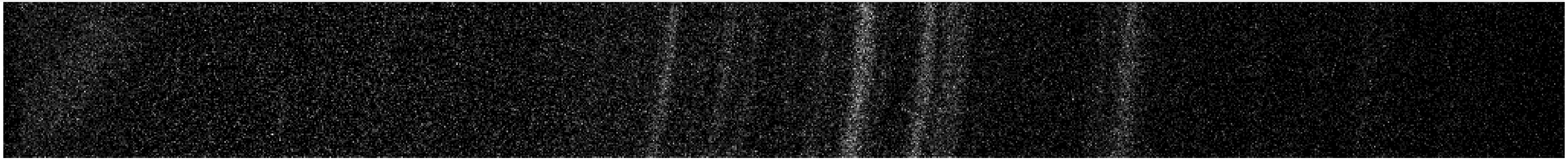
Sample Code	Sample Type	Ba	Cr	Co	Ni	Cu	Zn	Ni/Cr	Co/Cr
LC-05-SEB-026	Boulder	159	70	46	60	210	130	0.857	0.657



Ejecta of South Western Rim (L2)

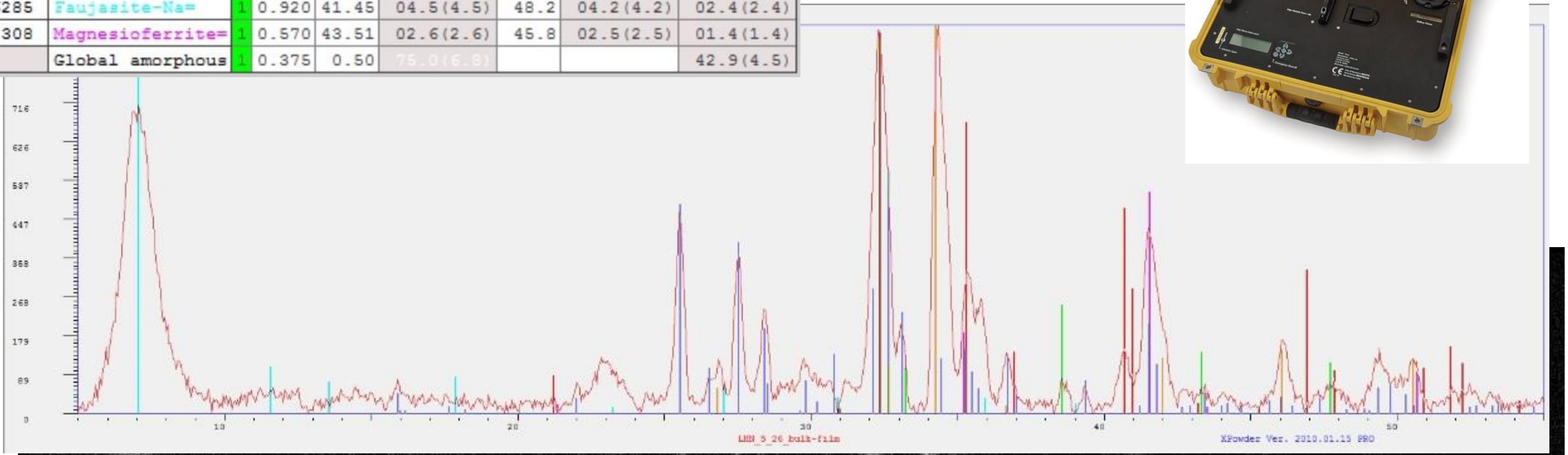
Set-Fil	Phase name	Q	Fract	RIR.	% W Unc Ab	m/rho	% W Xtal	% W Xtal+A
015705	Diopside= Ca.7	1	0.840	7.51	03.6(3.6)	73.9	03.5(3.5)	01.9(1.9)
011050	Andesine= Ca.24	1	1.000	3.30	09.9(5.2)	88.5	09.6(5.2)	05.2(2.8)
023324	Pyrite= Fe	1	0.450	0.17	86.2(9.9)	121.6	86.7(9.9)	46.9(5.4)
012866	Montmorillonite=	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)

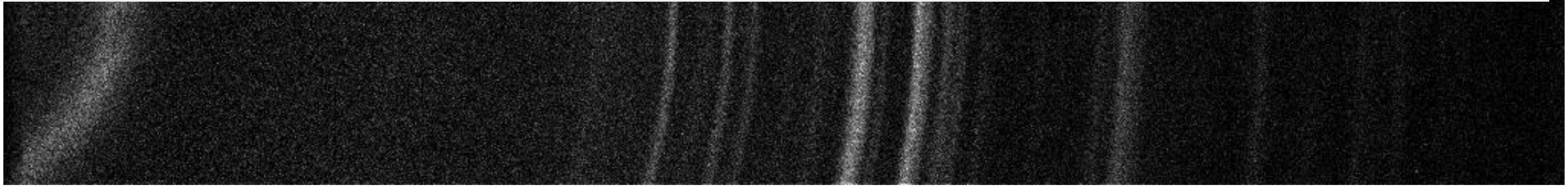




Ejacta Samples of Kalapani

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)





Results INAA Analysis

Higher vale of Ni/Cr and Co/Cr in the sample of altered basalt

Sample Code	Sample Type	Ba	Cr	Co	Ni	Cu	Zn	Ni/Cr	Co/Cr
LHN 05-65	Impact melt glass	218	80	44	70	200	130	0.875	0.55
L 2 BULK	Bulk Ejecta	148	80	33	50	50	80	0.625	0.413
LHN 04-8	Bulk Ejecta	124	100	39	50	150	110	0.5	0.39
LHN 05-26	Bulk Ejecta	105	60	34	50	150	90	0.833	0.567
L 244 B	Bulk Ejecta	281	70	36	60	140	80	0.857	0.514
L-60	Shocked Basalt	111	140	53	80	170	200	0.571	0.379
LHN 05-51	Altered Basalt	243	30	38	40	240	80	1.333	1.267
LC-05-SEB-026	Boulder	159	70	46	60	210	130	0.857	0.657
LHN 05-54	Preimpact alterted Basalt	156	50	40	40	210	80	0.8	0.8
LC 09-261	Paleosol	91	120	29	70	150	80	0.583	0.242
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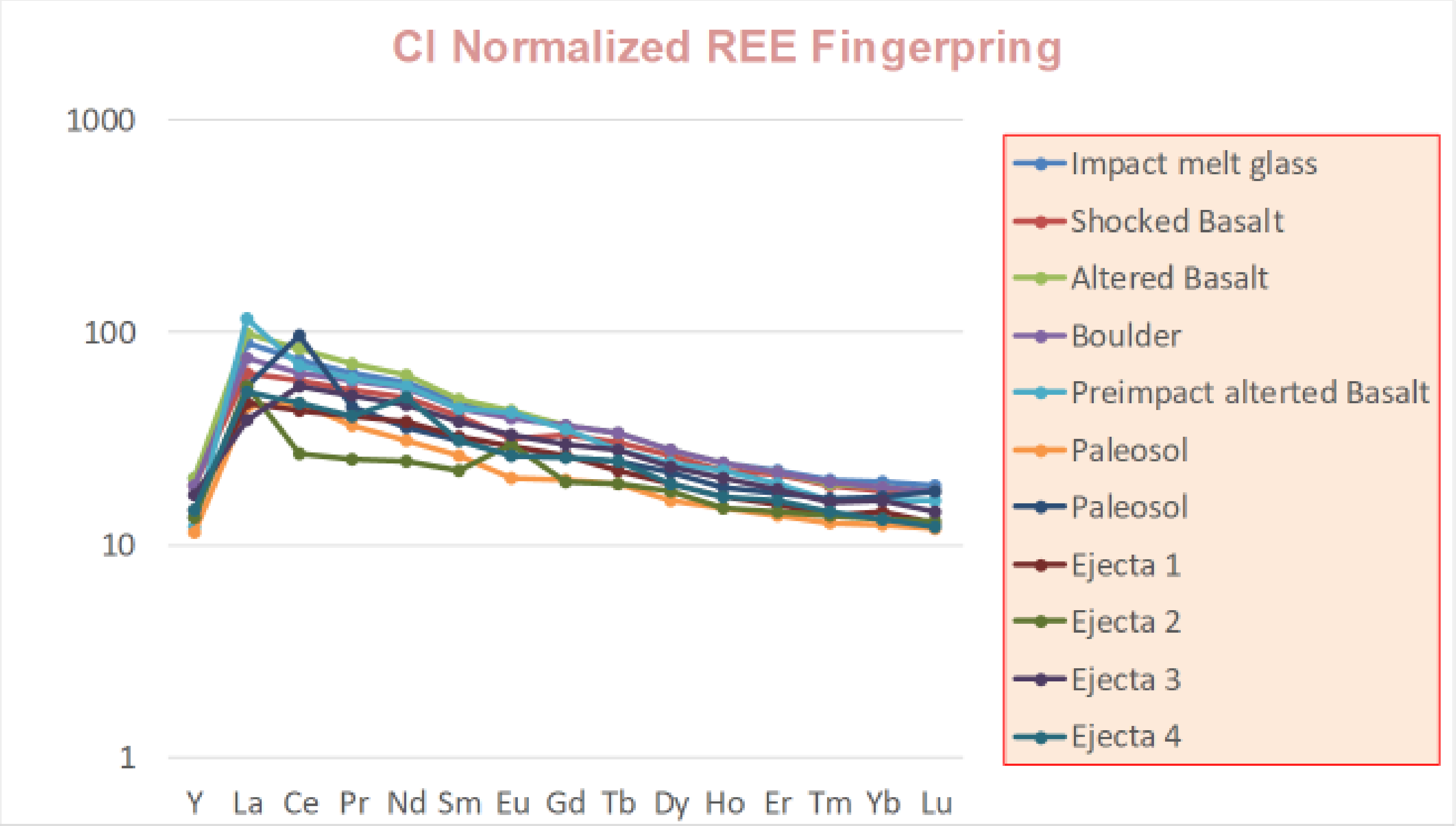
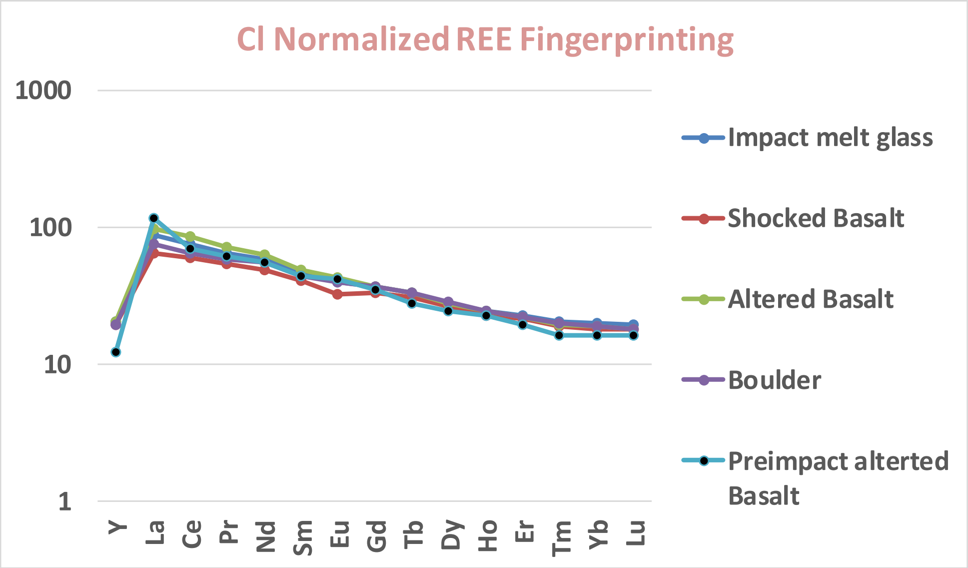
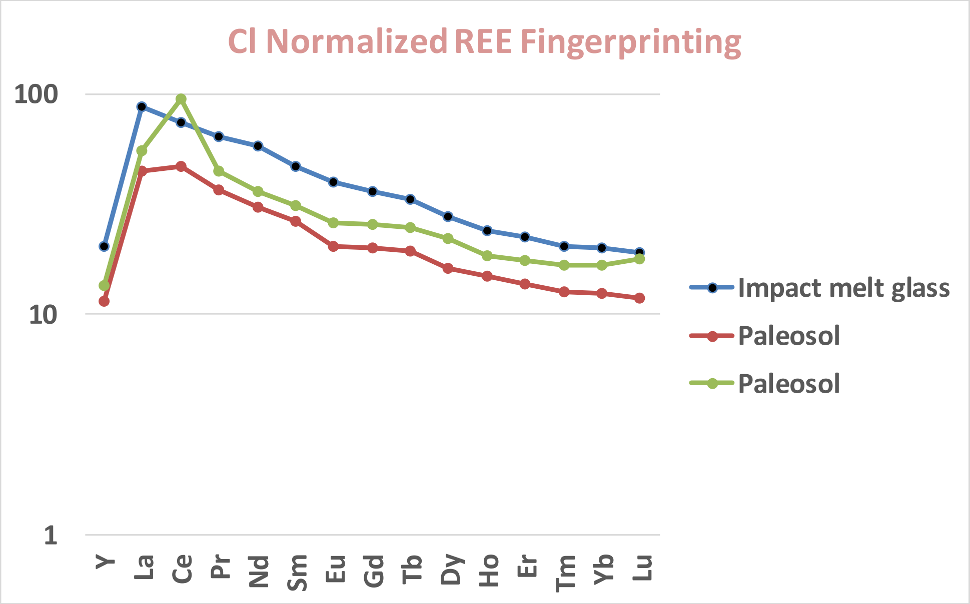
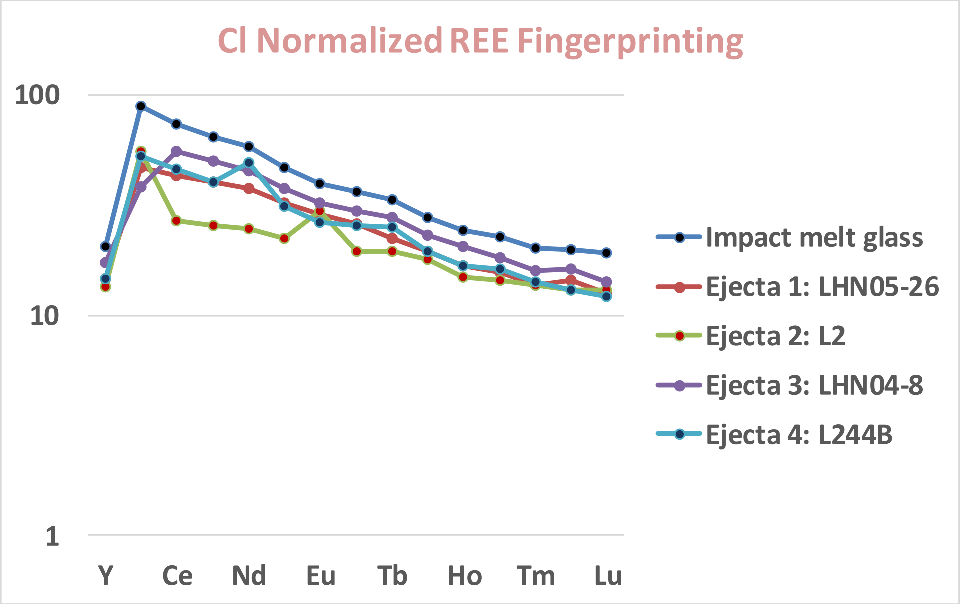


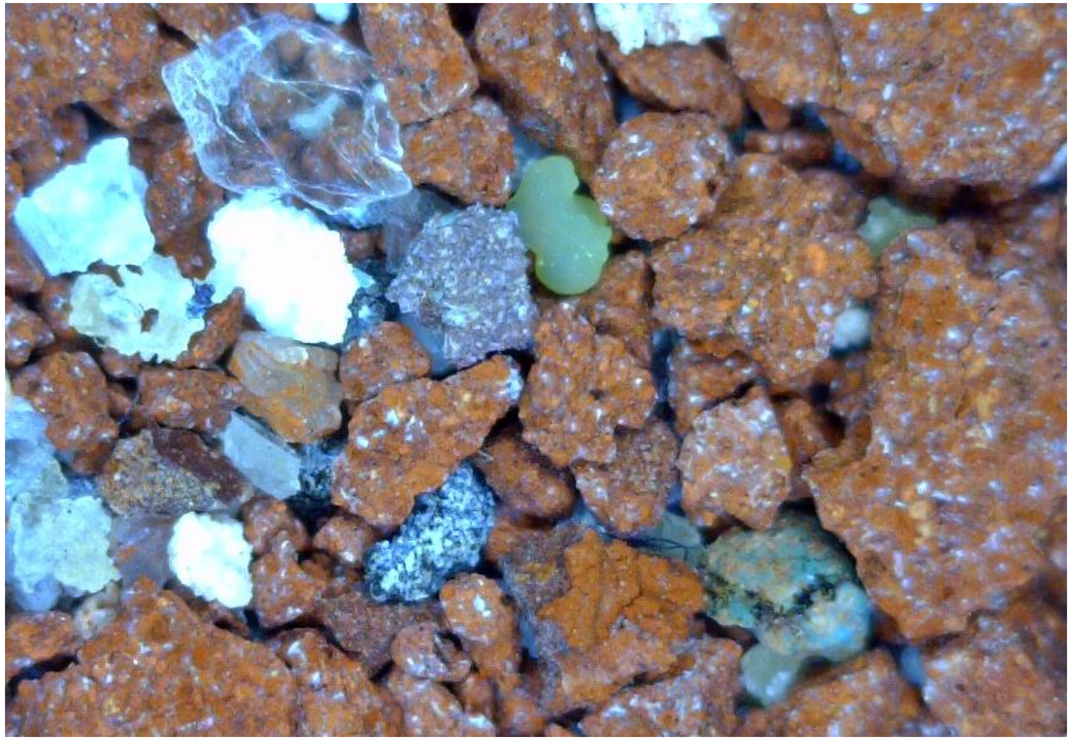
The ambiguity!

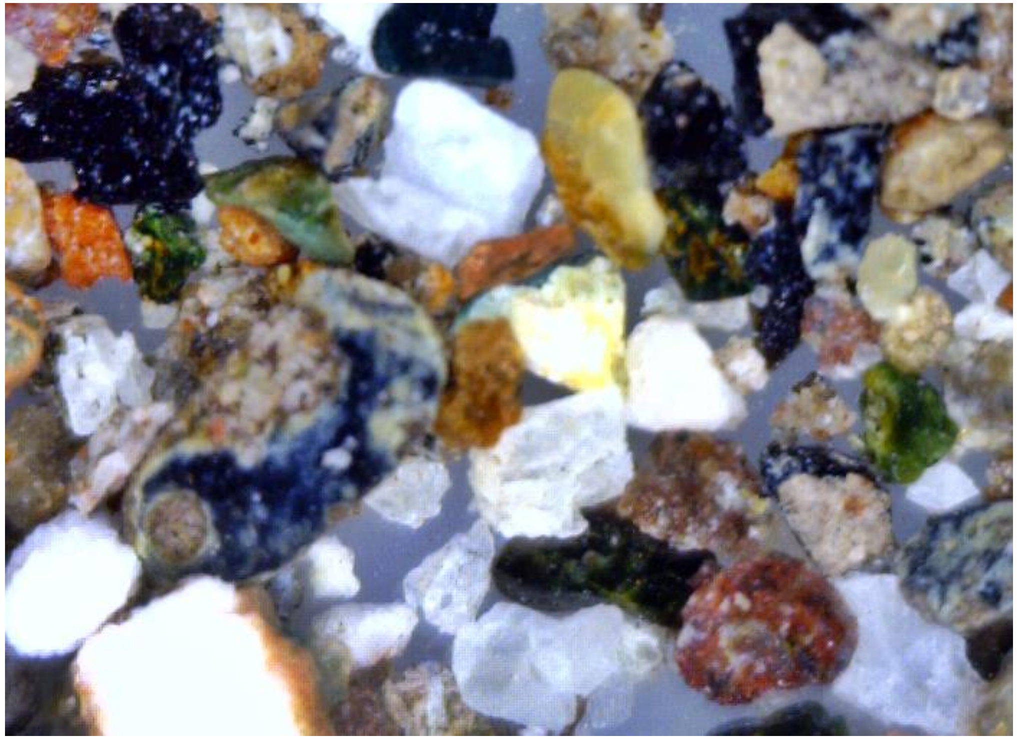
LHN 05 – 65 Impact Melt









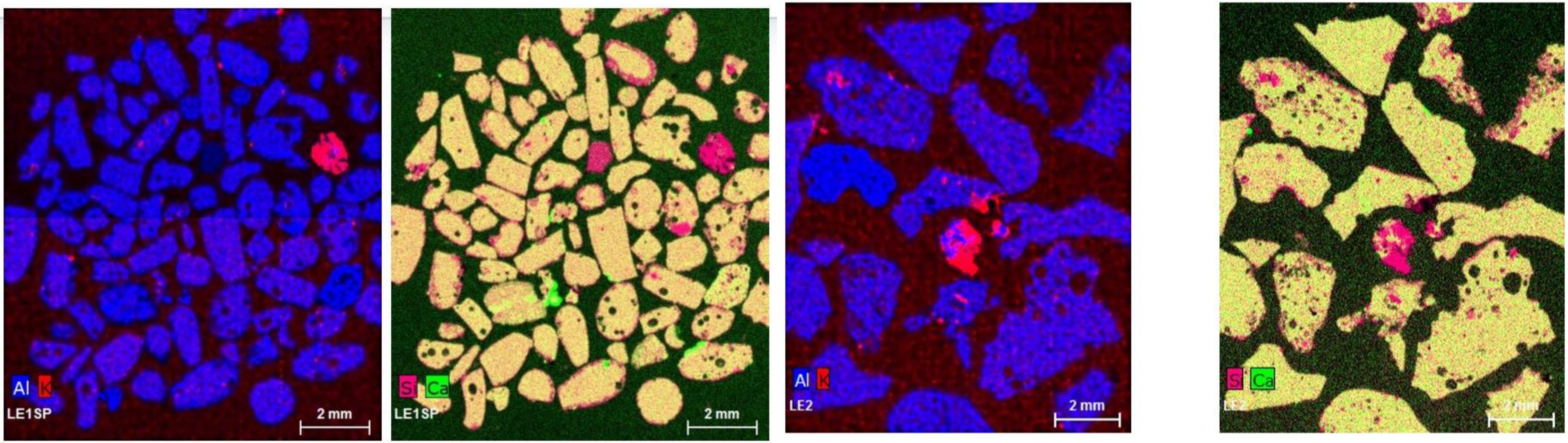


Another ambiguity?

Glauconites!

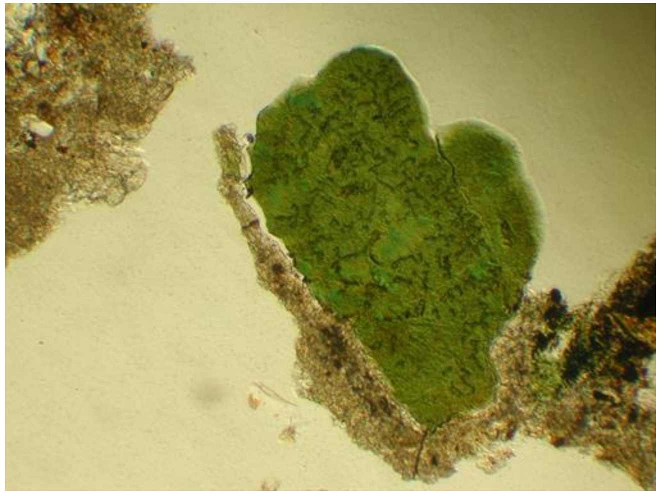
Ejecta Spherules:

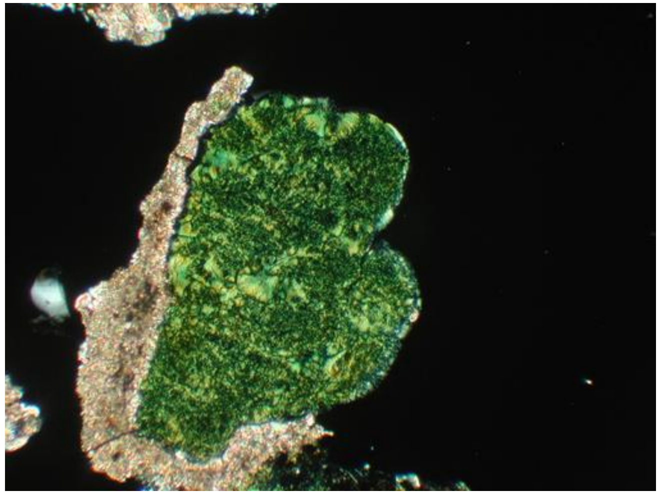
Elemental Mapping by u-XRF (Tornado M4)

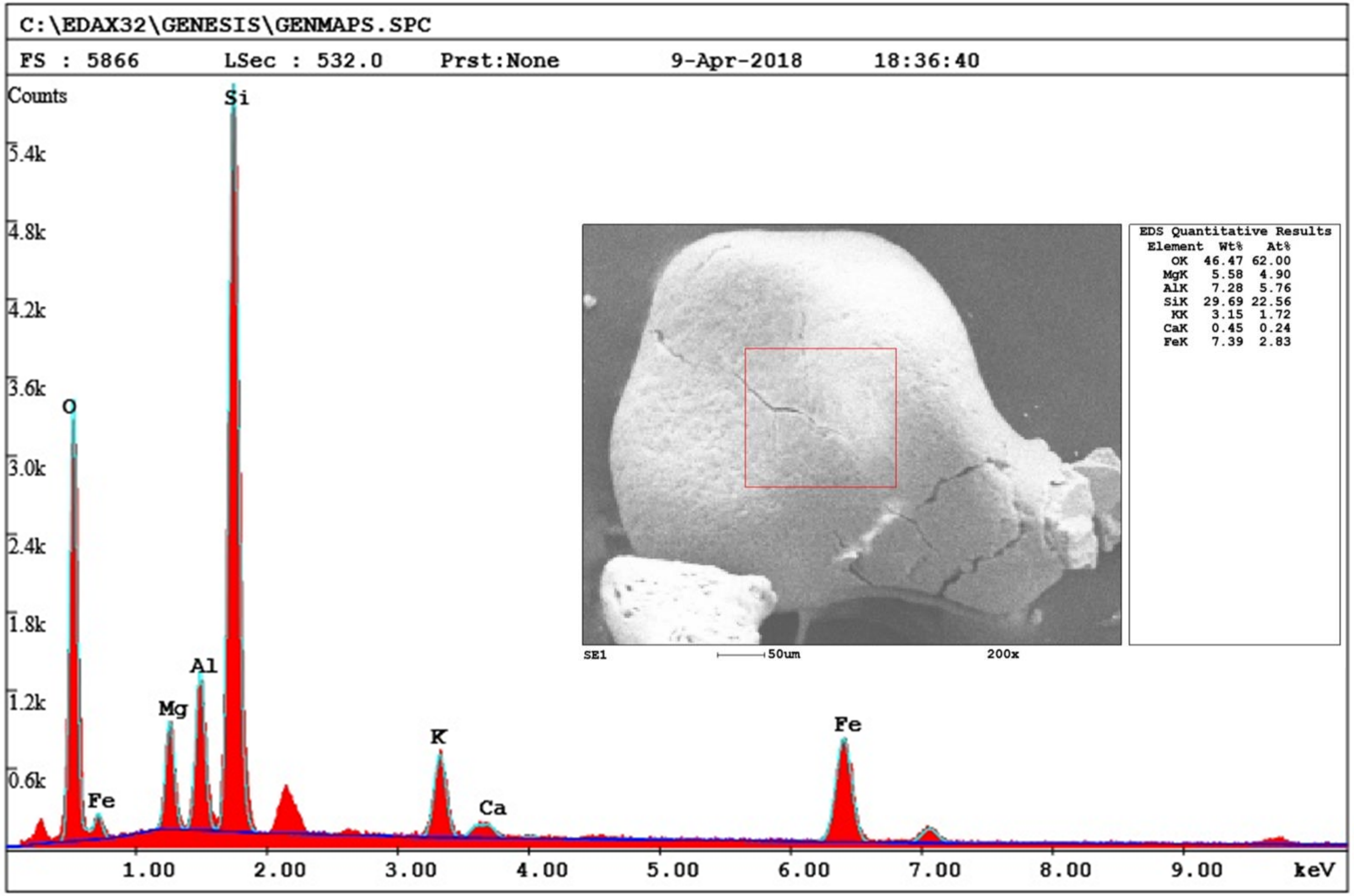


SEM-EDS analysis

Hitachi SU 70 equipped with EDAX







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**

Apparently doesn't match with the known geological setting of Lonar Crater.

Observation:

I. The prevalence of altered albite (NaAlSi3O8) and andesine ($(Na,Ca)Al_{1-2}Si_{3-2}O_8$) 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.

II. Absence of explicit evidences of the projectile in the impact melt.

III. The impact cratering probably occurred on the weathered basaltic rocks or on the intertrapean sediments that was depleted in certain metals

IV. the zeolites probably developed due to post-impact alteration and finally climatic condition probably facilitated the calcification of the ejecta blanket and the preservation of the ejecta fallout.

III. Glauconites are still under investigation!

Thanks!

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