A multi-method analytical approach to assay the abundance of the components in a ferroan meteorite

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An unknown meteorite found in South Africa which now is part of geoarchaeological collection of the Romanian Academy of Sciences (RAS) by Prof. Gruia's courtesy was analyzed using a combination of the qualitative and/or quantitative analytical methods [1] as scanning electron microscopy (SEM), energy-dispersive X-ray Fluorescence analysis (EDXRF), atomic force microscopy (AFM), micro X-ray diffraction and (μXRD) and infrared spectroscopy (IR).

We analyzed several slices of meteorite via SEM and AFM imaging [2] and EDXRF elemental mapping of their polished surfaces to perform the initial characterization of the olivine aggregates, chondrules, inclusions, matrix and clasts across the surface (Fig. 1).

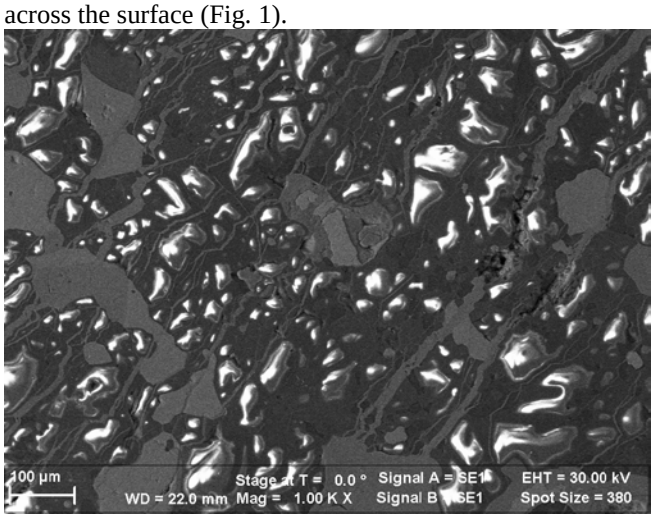

Figure 1: An example of an initial image characterization of the olivine globule with ferroan (Mg0.82Fe0.18)(Mg0.902Fe0.098)(SiO4) inclusion

By using the Amptek's XRF Kit based on SDD/cadmium telluride (Cd-Te) detectors we analyzed 17 elemental constituents in the sample (Table 1) [3]. The nature and distribution of organic and mineral components were checked by IR [4]. Unanalyzed elements were specified stoichiometrically bound with an analyzed element (oxides, carbonates, etc).

The crystal structure analysis was done by μXRD method (Fig. 2) and provided data were further correlated with the microscopic and microanalytical data provided by the other analytical techniques [5].

The performed analyses indicate that all the components of meteorite (inclusions, chondrules and clasts) are clearly delimitated. The results indicate that it is a ferroan meteorite with small inclusions of monticellite and albite (Fig 1).

Element (%)/ Meteorite piece	1	2	3	4	5	6	7	8	9	10
Al			3.26	3.16		4.36	4.16	4.12	4.33	3.36
Cd	0.27	0.29	0.25	0.15	0.13				0.1	0.083
Cr	0.5	18.9	0.63	0.45	0.43	0.51	0.56	0.44	0.51	0.57
Cu		0.14								
Fe	94.1	69.4	54	54.3	93.1	54.2	54.7	53.6	52.6	54.9
Mn	0.43	2.1	0.55	0.56	0.59	0.52	0.53	0.56	0.5	0.52
Mo	<0.011	0.28								
Nb		0.021						0.087		
Ni	4.32	9.08	3.16	2.88	5.32	2.96	3.15	3.04	2.83	2.92
P			0.32	0.34		0.64	0.66	0.57	0.39	0.73
S			2.93	3.18	3.18	3.47	3.11	2.68	2.24	3.57
Sb	0.29	0.27	0.19	0.18	0.13					
Si			34.9	34.9		33.1	32.8	34.5	36.2	33.1
Sn		0.14								
Ti	0.28	0.04	0.11	0.13	0.14	0.12	0.15	0.1	0.12	0.12
V	0.042	0.018								
Zr	0.023									

Table 1: EDXRF estimation of trace elements (%) in meteorite

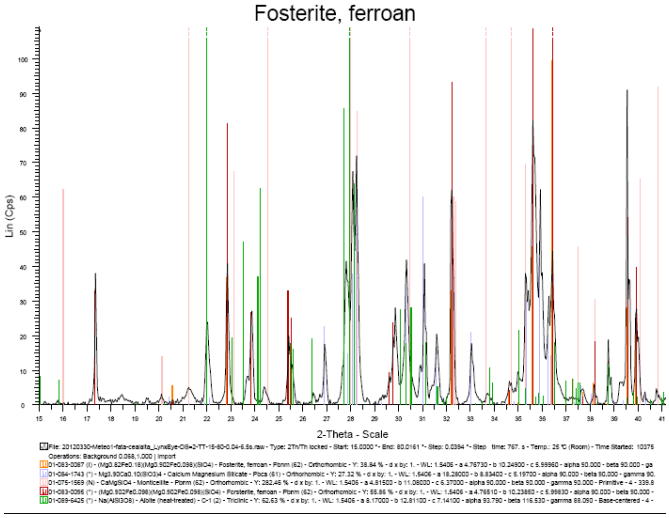

Figure 2: μXRD spectra of fosterite magnesium silicate inclusion (ferroan)

More careful assessment of the meteorite history will be undertaken and interpreted before further studies by other related analytical techniques thus completing the inorganic and organic characterization of the sample.

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