CHONDRULE ACFER I: TRACE ELEMENT ABUNDANCES REFLECT VAPOR FRATIONATION

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Acfer 182 is a member of the CH-carbonaceous chondrite group characterized –among other features- by an average chondrule size (~90 μm) smaller than in most other chondrites and remarkable Ca,Al-rich inclusions (e.g., Bischoff et al., 1993, Webert al., 1995). Acfer 182 (PTS from M6013, NHM, Vienna) is very rich in perfectly round cryptocrystalline (CC) and radiating pyroxene (RP) chondrules (Fig. 1). The RP chondrule Acfer I (Fig. 2-3) has a chemical composition (n=4) of: SiO2: 54.9 wt%, Al2O3: 0.31 wt%, MgO: 43.4 wt%, FeO: 0.5 wt%, CaO: 0.3 wt%, [normative composition: HyEn: 71.7, HyFs: 0.65, OlFo; 26], with a Ca/Al CI ratio (Table).

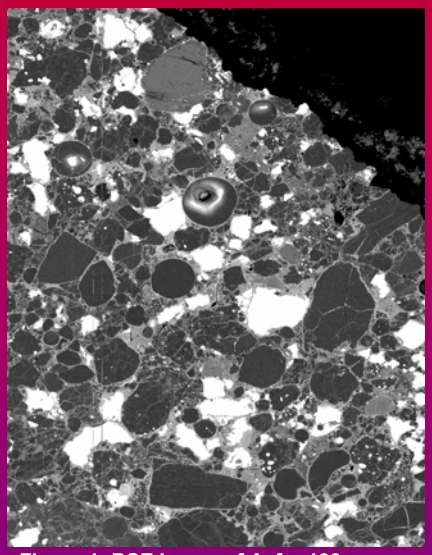

Figure 1: BSE image of Acfer 182.

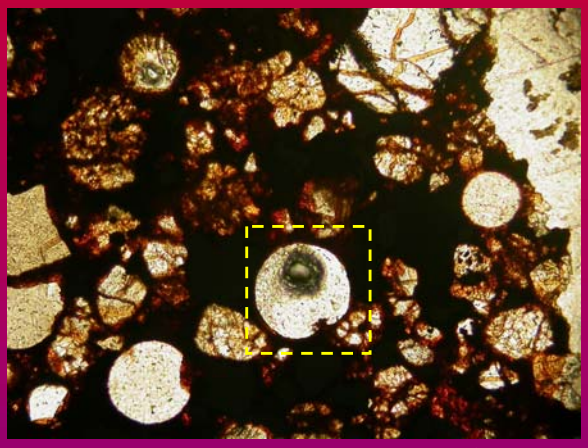

Figure 2: Transmitted light image showing Acfer I chondrule (stippled square). It is a RP chondrule (Fig. 3a), 140 μm in apparent diameter. The black area is the ion microprobe ablation pit.

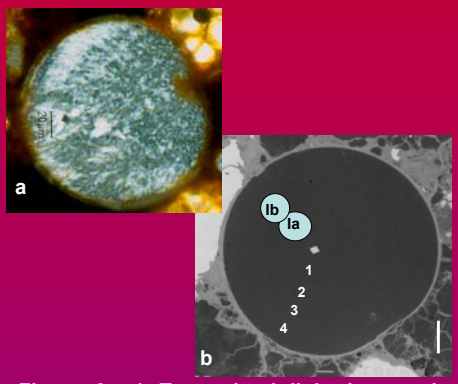

Figure 3: a) Transmitted light image showing Acfer I chondrule before SIMS analyses. b) BSE image of chondrule Acfer I showing the location of the EMP (Table) and SIMS analyses (Ia-Ib), and the tiny (~5μm) Ni-free euhedral metal grain in its centre. The metal is rich in Cr (Fe: 96.2 wt%, Cr: 1.97 wt%). Scale bar: 20 μm

Trace element abundances in Acfer I (Acfer Ia and Ib) are very low (0.01-0.8 x CI) and fractionated. The light REE (LREE) and Eu are around 0.1 x CI, but Ce is relatively high (0.4 x CI). The high REE (HREE) are depleted (~0.02 x CI) with respect to the LREE, except for Yb which is at the same level as the LREE (0.13 x CI). The refractory Y has an abundances similar to Lu (~0.02 x CI), while those of Zr, Sc and Ti are 0.05 x CI, 0.19 x CI and 0.5 x CI, respectively.

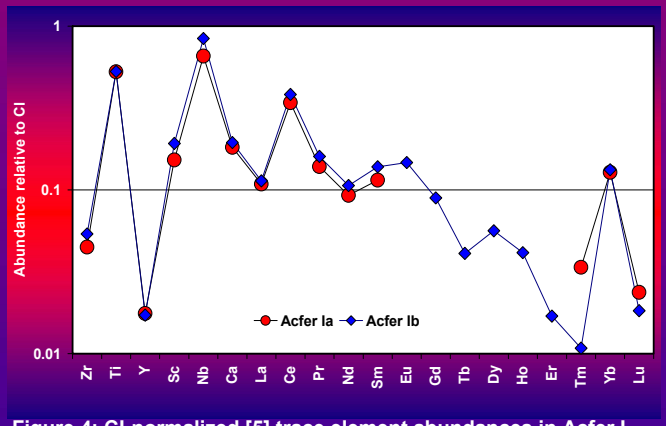

Figure 4: CI-normalized [5] trace element abundances in Acfer I

	1	2	3	4
SiO_2	54.6	55.6	54.7	54.8
TiO_2	0.03	0.04	0.05	bdl
Al_2O_3	0.29	0.33	0.30	0.30
Cr_2O_3	0.65	0.75	0.62	0.61
FeO	**0.30**	**0.34**	**0.44**	**0.78**
MnO	0.05	bdl	0.07	0.08
MgO	43.8	42.8	43.6	43.2
CaO	0.24	0.25	0.28	0.25
Na_2O	0.07	bdl	bdl	bdl
Total	100.0	100.1	100.1	100.0
Ca/Al	*1.09*	*1.02*	*1.24*	*1.12*

Niobium shows the highest abundance, close to chondritic (Fig. 4). The spherical shape of the RP chondrule Acfer I indicates that it was created as a liquid droplet. Its trace element pattern (Fig. 4) is comparable to that found in Type II CAIs [3] and is very common among CAIs from CH chondrites [e.g., 2, 4]. This pattern reflects vapor fractionation and gives evidence of the formation of chondrule Acfer I by condensation form a vapor that was depleted in refractory elements. The fact that Eu and Yb have comparable abundances indicates that both elements were not fractionated by the refractory phase. Because elements from Gd to Er show smoothly decreasing abundances, with Tm being the least abundant of all HREE the removal of refractory elements must have occurred at very high temperatures.

References: [1] Bischoff et al., (1993) GCA 57, 2631-2648; [2] Weber et al., (1995) GCA 59, 803-823; [3] Martin P.M. and Mason B. (1974), Nature 149, 333; [4] Weber D. and Bischoff A. (1994) GCA 58, 3855-3857; [5] Lodders and Fegley (1998) Oxford University Press, New York, 371 pp.