SILICA-RICH OBJECTS IN ACFER 182: A SIMS STUDY. M.E. Varela[1] and E. Zinner[2], [1]Instituto de Ciencias Astronómicas de la Tierra y del Espacio (ICATE) Av. España 1512 sur, San Juan, Argentina (evarela@icate-conicet.gob.ar), [2]Laboratory for Space Sciences and the Physics Department, Washington University, St. Louis, MO 63130, USA.

Introduction: The carbonaceous chondrite Acfer 182 and paired meteorites (Acfer 207, 214), are members of the CH group, as introduced by [1]. CH chondrites - closely related to CR and CB chondrites (the so-called CR-clan, [2]) - are among the least altered chondrites known. The CH chondrites have high metal contents (20 vol. % FeNi-metal) with significant amounts of Cr. The chemical zoning patterns in some of these metal grains is indicative of formation by condensation at temperatures from 1370 to 1270 K [e.g., 3]. These chondrites are also very rich in small chondrules (<90 µm) and chondrule fragments (70 vol. %) [e.g., 1, 4, 5]. A few of these objects have very high SiO_2 contents [6, 7]. The silica-bearing objects – more common in UOC (e.g., 8) - are very rare in carbonaceous chondrites [6, 7]. Here we report the results of major and trace element studies of some silica-bearing objects in Acfer 182.

Results: The studied objects (sample Acfer 182, from M 6043, NHM, Vienna) are micro-emulsions of silicate globules in a silica matrix. Acfer III is a round cryptocrystalline (CC) chondrule of almost pure SiO_2 (99 wt %, Table) with an apparent diameter of 120 µm (Fig. 1a). An inspection under transmitted light reveals the presence of very small globules located preferentially in the center of the chondrule (Fig 1a-b). One such globule (arrow in Fig. 1b) was big enough to be analyzed, showing high MgO (32.2 wt %) and very low FeO (0.86 wt %) contents (Table).

Table: Chemical compositions of the silicate and silica portions in Acfer III and IV.

	Acfer III	Globule	Acfer IV	Globule
N	*(25)*	*(1)*	*(15)*	*(5)*
SiO_2	98.3	59.7	98.4	49.3
TiO_2	0.02	0.12		0.02
Al_2O_3	0.33	3.40	0.13	0.32
Cr_2O_3		0.58		0.36
FeO	0.40	0.86	1.36	36.6
MnO		0.03		0.12
MgO	0.72	32.2	0.23	11.9
CaO	0.11	3.44		0.11
Total	99.9	100.3	100.1	98.7

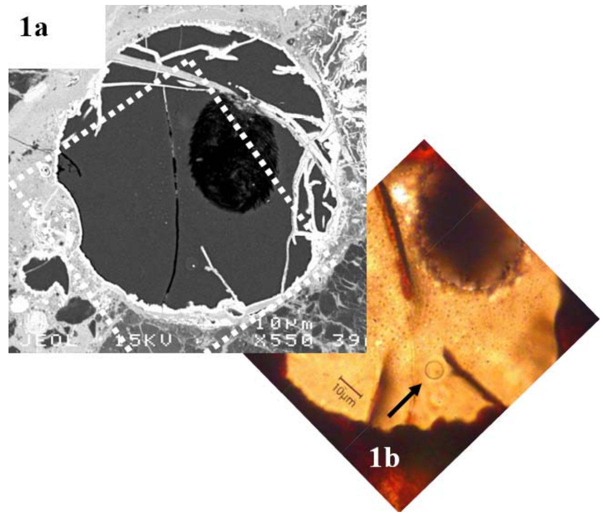

Figure1: BSE and optical image of Acfer III.

Acfer IV is an angular fragment dominated by silicate globules in a silica matrix (Fig 2a-b). The silicates are Fe-rich (36.6 wt %) and the silica portion is nearly pure SiO_2 (98-99 wt %) with low FeO (< 2 wt %) contents. The Fe signal is mainly the result of contamination due to the beam overlap (Table). In both objects the normative mineral composition of globules is dominated by hypersthene: 79 wt %, Acfer III and 98.4 wt %, Acfer IV.

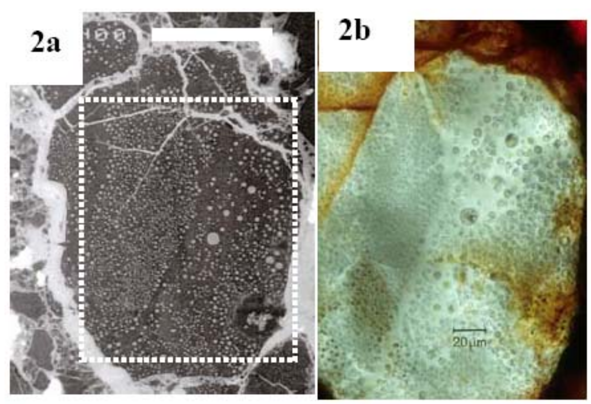

Figure2: BSE and optical image of Acfer IV. White bar in 2a (upper right corner) indicate 100 microns.

Both objects have low trace element abundances varying from <0.01 x CI to chondritic values (Fig. 3-4).

Acfer III has low abundances of Ca (~ 0.07 x CI) and REEs with a flat pattern (Fig. 3). The refractory elements Zr, Al, Ti, and Nb, as well as the more refractory of the moderately volatile elements (Sr and Ba), show higher contents (~ 0.3 x CI) than the REEs. Abundances of the moderately volatile elements V, Cr, and Mn decrease with increasing volatility, and those of the volatiles elements Rb and K reach chondritic values.

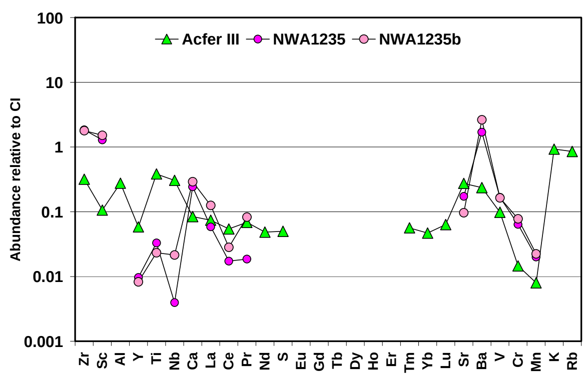

Figure 3

Abundances of the REEs and Ca in Acfer IV are very low (< 0.01 x CI), with a relatively flat pattern (Fig. 4). The refractory elements Sc, Al, and Nb, have contents around 0.1 x CI. The very refractory Zr is very depleted (0.01 x CI), with Ti, Sr and Ba showing similar contents (~0.03 x CI). Abundances of the moderately volatile and volatile elements increase with increasing volatility, from 0.1 x CI to chondritic values.

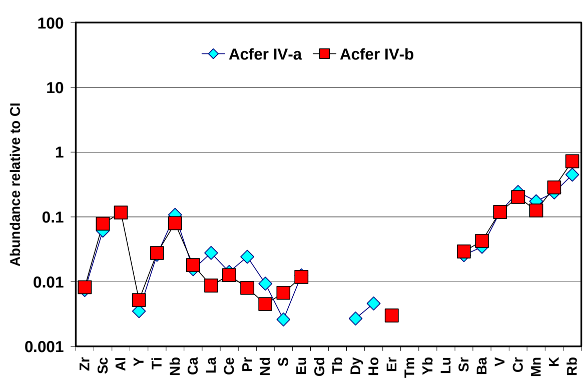

Figure 4

Discussion: Previous studies of silica-rich objects [6, 7] - in which Mn-rich pyroxenes have been observed - suggested formation of their precursors in fractionated nebular systems [6]. In such environments silica may appear as a nebular condensate at medium temperatures (~1230 K) [8]. The micro-emulsion textures – similar to those observed in Acfer III and IV - were considered the result of liquid immiscibility [7]. Given the fact that in the $MgO-SiO_2$ system, the solvus (2 liquids) is reached at very high temperatures (> 1968 K [9]), immiscibility requires reheating of the condensed silica-bearing objects to temperatures as high as 2000 K, with a subsequent fast cooling [7]. But by such a heating event (e.g., by lightning discharges) grains around 0,2 mm in radius will be fully vaporized [11]. If some objects could have escaped complete vaporization, the very low REE contents (this study and [10]) appear – at first sight – to support a high temperature event. However, the abundances of the refractory and moderately volatile elements, limit this view. The low REEs contents in Acfer III are similar to those measured in Si-rich primary glass inclusions (SiO_2: 80 wt %) from the enstatite achondrite NWA 1235 (Fig. 3), in which no textural evidence for thermal metamorphism has been observed [12]. They also share a similar pattern for the moderately volatile elements (V, Cr and Mn), showing decreasing abundances with increasing volatilities. The deficits in Ti and Nb in the NWA 1235 glass inclusions relative to Acfer III indicate that these elements become chalcophile under the strong reducing conditions prevailing during formation of enstatite meteorites.

In Acfer IV, the refractory elements Zr and Nb are fractionated, but opposite to what is expected by high temperatures events, showing low contents of the highly refractory Zr but high concentrations of the less refractory Nb. In addition, the fact that abundances of the moderately volatile and volatile elements increase with increasing volatility clearly indicates that this object did not undergo fast cooling.

References: [1] Bischoff A. et al., (1993) *GCA,* 57, 2631-2648; [2] Weisberg et al., (1995) *Proc. NIPR Symposium on Antarctic Meteorites* 8:11–32; [3] Meibom et al., (2000) *Science* 288, 839-841; [4] Scott E. R. D. (1988) *EPSL,* 91, 1-18; [5] Wiesberg et al., 1988, *EPSL,* 91, 19-32; [6] Petaev et al., (2001) *LPSC 32,* # 1450; [7] Hezel et al., (2003) *MAPS*, 38, 1199–1215; [8] Brigham C. A. et al., (1986) *GCA* 50, 1655-1666: [8] Petaev and Wood. (1998) *MAPS* 33, 1123-1137: [9] Morse (1980) *Basalts and Phase Diagrams;* [10] Hezel et al., (2004) *LPSC 35, #1200*; [11] Horányl et al., (1995) *Icarus*, 114, 174-185; [12] Lorenz et al., (2003) *LPSC 34,* # 1211.