SILICA-RICH OBJECTS IN ACFER 182: A NEW VIEW

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Introduction: Acfer 182 is a member of the CH carbonaceous chondrite group [1], and provides direct information concerning the early solar nebula processes. The CH chondrites [2] are a member of the “CR chondrite Clan” [3, 1] that also includes two other chondrite groups: the CR and CB, subdivided in CBa, and CBb [4-5]. These chondrites are very rich in small chondrules (<90 μm) and chondrule fragments (70 vol. %) [e.g., 2]. A few of these objects have very high SiO₂ contents [6, 7]. These silica-rich objects (SRO) are very rare in carbonaceous chondrites [6, 7]. I report the results of major and trace element studies of some SRO in Acfer 182 (PTS M6013, NHM, Vienna) and compared them with previous studies of SRO, Mg-rich cryptocrystalline (CC) and radiating pyroxene (RP) chondrules in CH chondrites [e.g., 7-12].

Results and Discussion: The studied chondrules (Ch III, VI and XV) with apparent diameters ~90 μm, have amoeboid textures (referred as amoeboid-type objects, from here on) made of silica glass (nearly pure SiO₂) within a silicate (hypersthene normative) matrix. They have bulk abundances of Ca, Al and Mg varying from 0.4 to 0.8 x CI with Cr, Mn, Na and Fe contents that decrease with decreasing volatility. Normalized trace element patterns are flat for the ultra-refractory (Zr, Sc,Nb) and REE elements (with abundances ~ 1-3 x CI), with decreasing and increasing abundances of the moderately volatile (V, Cr, Mn) and volatile elements (Rb, K), respectively. Other SRO from Acfer 182 have emulsion-like textures (referred as emulsion-type objects, from here on) dominated by silicate globules in a silica matrix [e.g., 7, 11]. They exhibit low contents of the ultra-refractory and REE elements (~ 0.01-0.1 x CI) with variable abundances of moderately volatile and volatile elements [11]. The texture of amoeboid- and emulsion-type objects points to co-existence of pyroxene- and silica-normative liquids. Their bulk silica-rich composition (from 74.6 to 86.7 wt% SiO₂) indicate that they formed from a highly-fractionated nebular gas (Si/Mg >1) in which a cosmochemical process was involved, as supported by their Yb and La abundances spreading around the solar ratio. Previous studies of several SRO, in addition to amoeboid- and emulsion-type objects, foresee their formation by liquid immiscibility at high temperatures, above 1968 K, with subsequent fast cooling [12]. However, temperatures ~2000 K would cause grains around 0.2 mm in radius to be fully vaporized [12] as well as extremely low REE contents in those that escaped vaporization. The large variation (one/two orders of magnitude) in trace element abundances revealed by amoeboid- and emulsion-type SRO, signals two chondrule forming regions. Similarly to what has been envisaged for the formation of Mg-rich CC and RP chondrules in Acfer 182 [12]. These chondrule forming regions require a sufficiently high dust/gas ratio to allow formation of stable silicate liquids. Full equilibrium condensation calculations show that it is theoretically possible to have enstatite as the stable liquidus phase in an 800xCI dust-enriched nebular gas at a p^∞ of 10^3 atm, if about 72% of the original Mg is removed (as forsterite?) from the system [13]. Because pyroxene-dominated chondrules need “dust-enriched” regions with similar dust/gas ratios (>500 x CI) as those needed to form BO chondrules (~700 x CI) [14], both objects could have shared the same nebular region. Therefore, formation in the CH chondrule forming region of barred and skeletal olivine (BO, SO) chondrules, as well as Mg-rich CC and RP ones will progressively deplete the gas in Mg and trace element contents, and increase its SiO₂ content. Cooling of such dust-enriched regions, from which Mg and trace elements are gradually removed, might end in the formation of liquids rich in Si and poor in refractory elements (e.g., the SRO precursors).