ANNEALING STUDIES OF AMORPHOUS SILICATES IN ACFER 094 MATRIX

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Introduction: Amorphous silicates are major components of cometary interplanetary dust particles (IDPs) and matrices of certain primitive carbonaceous chondrites (CR 3.0 and Acfer 094). In IDPs, the amorphous silicates are GEMS (glass with embedded metal and sulfides) grains that likely represent non-equilibrium nebular condensates [1]. The amorphous silicates in Acfer 094 matrix show similarities and differences to GEMS grains in IDPs that may be related to incipient aqueous alteration on the parent body [2]. We are performing heating experiments on Acfer 094 matrix to determine the time-temperature-transformation pathway during annealing of the amorphous grains to establish whether the products resemble the common matrix components of CV and CO chondrites (fayalitic olivine) or the equilibrated aggregates observed in primitive IDPs [3,4].

Experimental: Fragments of Acfer 094 matrix were embedded in elemental S and thin sections (~70 nm thick) were prepared by ultramicrotomy and deposited onto Cu or Au TEM grids. The sections were characterized using the JSC JEOL 2500 scanning-transmission electron microscope, including quantitative chemical maps of the thin sections using energy-dispersive x-ray spectrum imaging before and after heating experiments. The annealing experiments are done in flowing N_2 using the same apparatus and procedures of [5]. Here we describe the initial results of our experiments.

Results and Discussion: Acfer 094 matrix consists of fine-grained (<1μm) crystalline silicates (En, Fo and Di) and sulfides (pyrrhotite with rare pentlandite) set in an amorphous silicate matrix. The amorphous material occurs as ~0.5 μm nodules with minor inclusions of nanophase Fe-sulfides and rare FeNi metal grains. The average composition of the amorphous material is richer in O and Fe than average GEMS composition. Acfer 094 matrix nodules contain excess oxygen above that required for stoichiometry, which is consistent with substantial hydration of their silicate matrix [2, 6]. Incomplete hydration of the amorphous silicates suggest that the parent body of Acfer 094 experienced brief low-T (~160 ºC) alteration in weakly alkaline fluid [7].

After ~450 ºC for 2 hours, no major devitrification occurred, but all the sulfide grains were oxidized. The excess oxygen is still present at this heating step, indicating that the speciation is likely strong M-OH bonds. There was no annealing of amorphous material nor growth of the existing crystal silicates indicating that no nucleation crystal growth occurs in this condition. Annealing experiments at progressively higher temperatures are underway.

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