**In Situ** Determination of Siderophile Elements in EL3 Enstatite Chondrites

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**Introduction**

Chondritic meteorites represent the primitive dust accreted from the solar nebula, birthplace of the Sun and planets and, therefore, carry important information on the earliest stages of planet formation. The enstatite chondrites represent a small, chemically unique group of meteorites, characterized by having formed under severely reducing conditions [1]. EL3 enstatite chondrites represent the meteorites least affected by heating and metamorphism in their parent asteroid and may be expected to contain a largely nebular mineralogy. We have described spherical assemblages of Si-bearing Fe-Ni alloy, euhedral enstatite, graphite, and sulfides, found in EL3 chondrites that we interpreted as having crystallized from impact melts [2], although others have interpreted these as nebular condensates. To distinguish these two modes of origin, we have utilized *in situ* determinations of siderophile (metal-loving) elements (e.g., Fe, Co, Ni, Ga, Ge, As, Ru, Rh, Pd, W, Re, Os, Ir, Pt, Au) in metal and sulfide from EL3 chondrites by laser ablation Inductively Coupled Plasma Mass Spectrometry (ICP-MS) [3].

**Experimental**

Analyses were performed using a New Wave UP213 laser ablation system coupled to a Finnigan Element1 ICP-MS at the Plasma Analytical Facility, NHMFL, Florida State University. Metal grains were analyzed with 15-40 µm spot sizes, 10 Hz repetition rate, 75% power output (0.3 mJ). The peaks \(^{57}\text{Fe}, ^{59}\text{Co}, ^{60}\text{Ni}, ^{63}\text{Cu}, ^{69}\text{Ga}, ^{74}\text{Ge}, ^{75}\text{As}, ^{102}\text{Ru}, ^{103}\text{Rh}, ^{106}\text{Pd}, ^{184}\text{W}, ^{185}\text{Re}, ^{192}\text{Os}, ^{193}\text{Ir}, ^{195}\text{Pt}, \text{and } ^{197}\text{Au}, \) were acquired for metals, while additional elements were analyzed in sulfides [3].

**Results and Discussion**

In Fig. 1, the elements are arranged in order of decreasing condensation temperatures, with W condensing above 1800 K, and Ge condensing below 600 K, from a gas of solar composition. On this figure, a condensate metal would have a flat siderophile element pattern in the region W-Rh, which is not observed here. The siderophile element data in metal from EL3 chondrites is strikingly deficient in Re, Os, Ir, and Pt, a characteristic of partial melts. Also shown in Fig. 1 are metallic liquid compositions for a S-rich liquid (orange line) and for a C-rich liquid (green line) calculated to be in equilibrium with bulk EL chondrite metal (red line). The metal in EL3 chondrites is a hybrid product of both C-rich and S-rich metallic liquids, which show extensive liquid immiscibility near their eutectic compositions. These results are in agreement with the observed presence of graphite and Fe-sulfide, neither of which contribute to the siderophile element budget of the assemblage. We conclude, therefore, that the metal-bearing assemblages are quenched impact melts, not nebular features. The ubiquitous presence of these assemblages in all EL3 chondrites studied by [2] strengthens the emerging view that we may not be able to consider the EL3’s as “unequilibrated” or “petrologic type 3” in the conventional sense of the definition [3].

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**References**


**Fig. 1:** Siderophile element pattern for metal from EL3 chondrite, PCA 91020 (black), bulk metal from PCA 92010 (red); C-rich metallic melt (green); S-rich metallic melt (orange).