DO REDOX REACTIONS PLAY A ROLE IN THE FORMATION HISTORY OF THE MESOSIDERITES?
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Introduction: Recent work by [1] indicates that the mesosiderites are isotopically identical to the HEDs, strongly suggesting that they originate from the same parent body. One argument against this theory is the differences between the silicates within the two meteorite groups. Mesosiderite pyroxenes tend to have higher MgO concentrations and lower Fe/Mn ratios, which show a positive correlation with Fe/Mg [2]. Previous authors have suggested that these differences can be explained by oxidation-reduction reactions between the metallic and silicate portion of the mesosiderites [2,3].

In order to test such models for mesosiderite formation complementary data sets for both the silicate and metal are needed. However, while the silicates have been widely studied, most studies of the metal have focused on the large nodules within the mesosiderites and not the metal that co-exists with the silicate in the matrix. In this study we focus on the relationship between specific silicate grains within the mesosiderites and their surrounding matrix metal in order to understand the nature of any reactions that may have occurred. Here we present preliminary results from the mesosiderite Crab Orchard.

Evidence for redox reactions from silicate clasts: In the first part of this study we examined silicate clasts within Crab Orchard [4]. The pyroxenes display overgrowths, which were formed during metal-silicate mixing. One diogenite-like clast exhibited a complex overgrowth history with a thin inner rim of augite between its Mg-orthopyroxene core and FeO-rich orthopyroxene rim. We suggested that crystallization of the CaO-rich inner rim preceded phosphate crystallization, with CaO, P2O5, and FeO present in the melt as a result of redox reactions, including oxidation of P from the metal [4].

Does the metal contain evidence for redox reactions?: If the silicates in mesosiderites are undergoing reduction of FeO due to interaction with the metal, as predicted above, then we would expect the associated metal to be depleted in readily oxidizable elements, e.g. P and W, relative to the metal nodules with Crab Orchard and other iron meteorites of a similar composition (Tagounite, Cumpas, and Casas Grandes). LA-ICP-MS was performed on the matrix metal within Crab Orchard associated with the silicate clasts studied in [4] and our analyses show no such depletions. The matrix metal within Crab Orchard has the same composition as measured for its metal nodules [5] and the IIIAB irons given above [6,7], apart from slight depletions relative to both Cu and Ga (lost as volatiles?).

Conclusions: The data presented here argue against an oxidation-reduction environment during the metal-silicate mixing stage for mesosiderites. The overgrowths on the silicate clasts may instead represent redistribution of FeO, CaO, and MgO between the different silicate components. However, more work is needed to fully understand how the low FeO contents of the silicates and mesostasis minerals could have occurred in the absence of redox reactions.