

UNDERSTANDING METAL-SILICATE MIXING IN MESOSIDERITES. L. R. Caves¹, R. G. Mayne¹, T. J. McCoy², W. F. McDonough³, and R. D. Ash³ ¹Monnig Meteorite Collection, Texas Christian University, Fort Worth, TX 76129, USA (l.caves@tcu.edu) ²Department of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560, USA ³ Department of Geology, University of Maryland, College Park, MD 20742, USA.

Introduction: Mesosiderites are a mixture of silicates and metal, which have been linked to the HED parent body 4Vesta. The metal portion of mesosiderites is also compositionally similar to the IIIAB irons [1,2]. Mesosiderite silicates were mixed with metal, recrystallized and rapidly cooled. The slow metallographic cooling rates recorded by mesosiderite metal indicate mixing followed by deep burial within an asteroidal body [3]. Several models for the formation of mesosiderites have been proposed, but no single model can completely explain their multi-stage history.

Oxygen isotope compositions of mesosiderites and eucrites are identical, consistent with the HEDs and mesosiderites originating from a common parent body [4,5]. However, there are notable differences between the two groups. These include the differing Fe-Mn-Mg systematics in mesosiderite pyroxenes, which reflect an FeO reduction trend and not the magmatic trend seen in the HEDs [6] (Figure 1). Phosphates and tridymite are also more abundant in mesosiderites than howardites and eucrites. These differences have been attributed to redox reactions occurring the metal-silicate mixing stage of mesosiderite formation [1,2,6,7,8,9].

Preliminary Work: A preliminary study of the mesosiderite Crab Orchard examined the evidence for redox reactions as the cause of the low FeO contents of mesosiderite silicates [10]. As previous work focused mainly on the silicate portion, this study examines the metal. If redox reactions occurred between the metal and silicate portions of mesosiderites, then: 1) the matrix metal within mesosiderites may be depleted in readily oxidizable elements (e.g. P, W) relative to the metal nodules that are not in contact with the silicate phase; or, 2) all metal in mesosiderites is depleted in readily oxidizable elements. This depletion should be visible when compared to IIIAB irons of a similar composition. LA-ICP-MS analyses of the matrix metal within Crab Orchard were compared to that in the literature for the metal nodules, and the IIIAB irons, Tagounite, Cumpas, and Casa Grandes

Evidence for Redox in Mesosiderite Metal: Here we reassess the data from [10] and detail an ongoing expansion of this work.

Crab Orchard matrix metal contents are depleted in P, Cu, and Ga with respect to the IIIAB irons (Figure 2). There was no P data available in the literature for metal nodules in Crab Orchard; however, Cu was de-

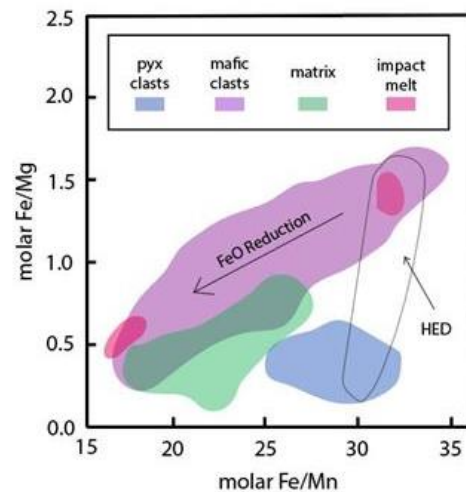
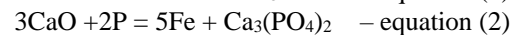
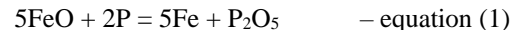


Figure 1: Fe-Mn-Mg systematics in mesosiderite pyroxenes showing reduction trends compared to the magmatic trend in HED pyroxene [3].

pleted in the matrix metal relative to the metal nodule and the Ga content of the metal nodule lay between that of the IIIAB irons and the matrix metal (Figure 2).

P and W are readily oxidized elements and, therefore, the depletion seen in P could be the result of redox reactions; however, no such depletion is observed in W, although differences in W contents between mesosiderites and IIIABs have been noted in other studies [1,2,9]. The location of the relevant buffers in fO_2 space are relevant. The buffer $P-P_2O_5$ lies below $W-WO$, and so the oxidation of P occurs before W and accounts for the depletion in P and not W, as observed. A very simplified equation of P oxidation (equation 1), predicts the Fe content of the metal to increase with P depletion. This reaction takes place in the presence of CaO in the Ca-rich pyroxenes (equation 2), which increases the equilibrium constant of P almost 30 times [13].



However, metal and silicate redox reactions cannot explain the observed depletion in Cu, as it is not included in the silicate phases, indicating that other processes must be occurring, such as sulfidization. More data are needed to better understand these processes.

Expanded Study: Four additional mesosiderites of varying petrologic class and degree of metamorphism were selected – Chinguetti, Chaunskij, Vaca Muerta,

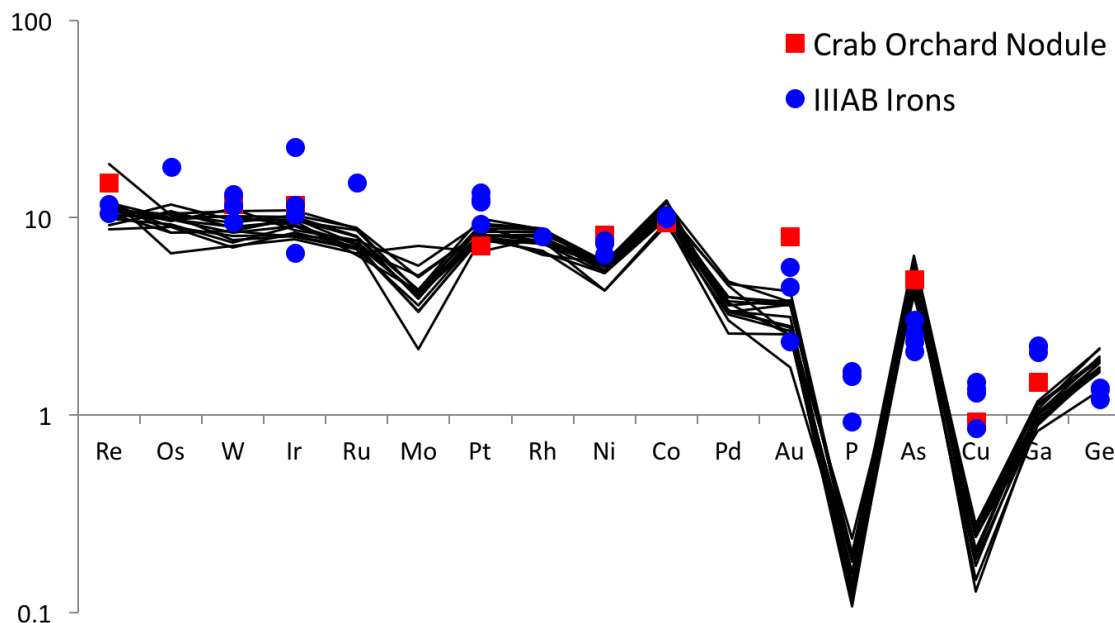


Figure 2: Preliminary work showing the composition of Crab Orchard matrix metal (black lines) and metal nodules [8], compared to IIIAB irons [11,12]. A depletion in P is observed in the matrix metal. All data is given relative to CI.

and RKPA 79015. Thick sections of each meteorite containing both matrix metal and metal nodules were requested on loan from the National Meteorite Collection, located in the National Museum of Natural History, Department of Mineral Sciences (USNM1590, USNM1682, USNM3205, USNM3256). Each section was analyzed using the Department of Mineral Science's FEI NovaSEM 600 Scanning Electron Microscope (SEM) to produce elemental x-ray maps and back-scattered electron (BSE) images. Electron microprobe (EMP) analyses of both silicate and metal portions of each mesosiderite were collected using the JEOL 9800R/5.

LA-ICP-MS analyses of the matrix metal and metal nodules within each section, including additional analyses of Crab Orchard, were performed at the Plasma Mass Spectrometry Lab at the University of Maryland-College Park.

The new, larger dataset will be analyzed for evidence of redox reactions and other processes that may have been occurring during the metal-silicate mixing phase of mesosiderite formation.

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