

**A COMPARATIVE STUDY OF TRACE-ELEMENT DISTRIBUTIONS IN R AND H CHONDRITIC SULFIDES: QUANTITATIVE ASSESSMENT OF ENHANCED SULFUR FUGACITY IN THE EARLY SOLAR SYSTEM.**

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**Introduction:** The R chondrites are a well-established chondrite group that contains chondrules, mineral fragments, sulfides, CAIs, and fine-grained matrix [1-5]. R chondrites have high  $\Delta^{17}\text{O}$  (+2.9) [1,6,7]. They are oxidized as indicated by their high Fe (Fa<sub>37-40</sub>) and Ni (up to 0.25 wt%) contents in olivine and lack of metal [1,6-8]. They are also highly sulfidized, containing abundant pyrrhotite (Fe<sub>1-x</sub>S) and pentlandite [(Fe,Ni)<sub>9</sub>S<sub>8</sub>] as well as other rare phases including chalcopyrite (FeCuS<sub>2</sub>) and reports of pyrite (FeS<sub>2</sub>) [1,2,3,7,9,10]. The R chondrites record one of the most sulfidizing environments in the early Solar System.

Using pyrrhotite-magnetite equilibrium, [9] determined the sulfur fugacity of LAP 04840 (R6) to be iron-troilite (IT) +2. We used Cu-Fe-chalcopyrite equilibrium and the presence of Ni in the pyrrhotite to constrain sulfur fugacity in three R chondrites to IT + 1.6 to 2.8 [10]. Here, we use trace-element abundances in sulfide minerals to constrain the conditions of their formation. Since the H-chondrites are buffered at IT, they serve as a baseline for comparing the elemental abundances in R chondrite sulfides.

**Analytical Techniques:** We analyzed nine assemblages from three R chondrites (LAP031135, LAP04840, and PRE95411). In addition, we analyzed sixteen troilite grains from four H chondrites (Djati-Pengilon, Zag, Oum Dreyga, and Djoumine). Chemical analyses of trace element abundances *in situ* of metals and sulfides are carried out using LA-ICP-MS. The LA system at LPL consists of CETAC LSX-213 Nd:YAG 213 nm laser coupled with the Element 2 ICP-MS. We use the Hoba IVB iron meteorite sample [11] and NIST SRM-1250 as standards for analyzing metals, and MASS-1 USGS sulfide standard for sulfides [12].

**Results:** Compared to H-chondrite troilite, pyrrhotite in R chondrites is enriched in platinum group elements by factors ranging from 100 – 1000 $\times$ . Trace element abundances in R-chondrite pyrrhotites combined with thermodynamic analysis indicate formation at IT+2.3( $\pm$ 0.8) and 1050 K. If these conditions are representative of the nebular environment in which the R chondrites formed, then the determined sulfur fugacity is consistent with an H<sub>2</sub>S/H<sub>2</sub> ratio of this region that is enhanced by a factor of  $\sim$ 670 $\times$  over solar. Detailed characterization of these phases will provide better constraints on their formation.

**References:** [1] Kallemeyn et al., 1996, *Geochimica et Cosmochimica Acta* **60**, 2243-2256. [2] Rubin and Kallemeyn, 1989, *Geochimica et Cosmochimica Acta* **53**, 3035-3044; [3] Weisberg et al., 1991, *Geochimica et Cosmochimica Acta* **55**, 2657-2669; [4] Bischoff and Srinivasen, 2003, *Meteoritics & Planetary Science* **38**, 5-12; [5] Rout and Bischoff, 2008, *Meteoritics & Planetary Science* **43**, 1439-1464; [6] Bischoff et al., 1994, *Meteoritics* **29**, 264-275; [7] Schulze et al., 1994, *Meteoritics* **29**, 275-286; [8] Righter and Neff, 2007, *Polar Science* **1**, 25-44; [9] McCanta et al., 2008, *Geochimica et Cosmochimica Acta* **72**, 5757-5780; [10] Jackson and Lauretta, 2010, *Meteoritics and Planetary Science Supplement*, #5164; [11] Walker et al., 2008, *Geochimica et Cosmochimica Acta* **72**, 2198-2216; [12] Danyushevsky et al., 2011, *Geochemistry: Exploration, Environment, Analysis* **11**, 51-60. **Acknowledgements:** This work was funded by NASA Grant NNX10AH50G (DSL PI).