BULK COMPOSITIONS OF CHONDRULES AND THE NATURE OF CHONDRULE PRECURSOR MATERIALS.

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Chondrules, by definition, have been heated at least to the point of partial melting. This heating destroyed chondrule precursor materials, which were presumably mostly fine-grained. Despite many years of effort, we are still unclear about the nature of precursor materials. Bulk compositions of chondrules can potentially provide some insights into this question, but chondrule bulk compositions are not very well defined. For the CV chondrites, existing data for chondrule bulk compositions, including chondrules from Allende [1,2] and Vigarano [2], do not provide a definitive picture of the diversity of primary compositions [3]. Here, we use bulk compositions of a large suite of chondrules from the CV_{ox} chondrite, Mokoia [4,5], to resolve existing discrepancies regarding CV chondrule bulk compositions, and as a basis to discuss precursor components. Bulk oxygen isotope data obtained for 20 of the chondrules [6] enable us to relate bulk chemical and isotopic properties.

The 90 Mokoia chondrules studied have masses of 0.1 to 22.5 mg. Detailed studies of the petrology of 20 of the largest chondrules show that metamorphism and secondary alteration are minimal. Chondrule densities, mean chondrule compositions, and the range of abundances for most elements, are essentially identical for different chondrule size fractions.

Among the chondrules analyzed, all major element abundances show a range of about a factor of ten. This is significantly greater than would be expected from analytical errors, matrix adhering to chondrules, or secondary alteration effects. While some of the variation might be attributable to chemical (e.g. volatilization or condensation) or physical (e.g. metal loss) processes during chondrule formation, much of it can reasonably be attributed to variations in the assembly of fine-grained precursor materials. Variations in chemistry lead to the inference that fine-grained material included: 1) a refractory component, possibly inherited from disaggregated CAIs, 2) an FeO-poor ferromagnesian component such as olivine and / or pyroxene, 3) an oxidized ferromagnesian component, and 4) a metal component. These are similar to components inferred for Allende chondrules [1]. Bulk oxygen isotopic compositions of chondrules can be explained if refractory and ferromagnesian precursor materials shared similar oxygen isotopic compositions of $\delta^{17}O$, $\delta^{18}O$ around -50 ‰, and then significant exchange occurred between the chondrule and surrounding ^{16}O-poor gas while the chondrules were molten.

If the diversity of chondrule compositions can indeed be attributed to mixing of various dust components, it is necessary to invoke different source regions for these components, as well as a mixing mechanism that is compatible with maintaining the fundamental differences between chondrite groups.

References: [1] Rubin A. E. and Wasson J. T. 1987 *Geochim. Cosmochim. Acta* 51: 1923-1937. [2] McSween H. Y. Jr. 1977 *Geochim. Cosmochim. Acta* 41: 1777-1790. [3] Jones R. H. et al. 2005 *Chondrites and the Protoplanetary Disk,* eds. A. N. Krot et al., Astron. Soc. Pacific Conference Series 341, pp. 251-285. [4] Schilk A. J. 1991 Ph. D. Thesis, Oregon State University. [5] Jones R. H. and Schilk A. J. 2000 Abstract #1400, 31st Lunar and Planetary Science Conference [6] Jones R. H. et al. 2004 *Geochim. Cosmochim. Acta* 68: 3423-3438.