CHARACTERISING PRIMITIVE CHONDRITE MATRIX: A SEM/TEM/EBSD STUDY OF ACFER 094

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Introduction: The matrix component of primitive solar system materials, being composed largely of sub-µm phases, has a relatively unconstrained size frequency distribution (SFD). In addition, literature on the crystallography and chemistry of matrix phases is sparse [1, 2], particularly with regard to matrix metal. Acfer 094 is an ungrouped carbonaceous chondrite, arguably one of the most mineralogically primitive [1-3]. The work we present here is part of a major project, using an array of techniques, to constrain both aspects of primitive matrix.

Method: SEM imaging of Acfer 094 revealed a landscape of chondrules and isolated metal grains set in a fine matrix background. EBSD analysis was performed on a selection of metal grains across the entire sample with a focus on matrix metal. The crystallographic structure of the grains was determined through orientation mapping. In addition, a 10 µm TEM section of the matrix was prepared using a focused ion beam lift-out technique to investigate both the sub-micron matrix grains, and for TEM imaging to define a matrix SFD. TEM-EDS was employed to distinguish crystalline structures from amorphous layers and will allow element mapping at a range of resolutions to quantify the finest primitive matrix materials. Differentiation between grains and sample porosity will be achieved through contrast differences generated by tilting the section. The SFD of matrix grains will be obtained by applying image processing software to TEM images.

Results: EBSD crystallographic orientation mapping of matrix metal reveals a complicated crystal structure with several crystal orientations across a single grain. In comparison chondrule metal grains (internal chondrule; 5~15 µm, chondrule rim; ~10-30 µm) appear to have homogeneous crystal structures. TEM-EDS analysis has revealed amorphous and sub-micron crystalline structures within the matrix component consistent with previous findings [1, 2]. Element mapping will further constrain the primitive matrix chemical composition.

Discussion: Comparison of the crystallographic orientations between larger matrix metal (~50 µm) and chondrule metal suggests that these regions may not share a common thermal history, which has implications for formation theories and chondrule/matrix complementarity [4]. Chemical and crystallographic data on sub-µm matrix metals, and SFD results, will be presented at the conference.

References: [1] Greshake, A. 1997. *Geochemica et Cosmochemica Acta* 61:437-452. [2] Bland, P. A. et al. 2007. *Meteoritics & Planetary Science* 42:1417-1427. [3] Newton, J. et al. 1995. *Meteoritics* 30:47-56. [4] Bland, P. A. et al. 2005. *Proceedings of the National Academy of Sciences. USA* 102:13755-13760.