TRACE ELEMENT CARRIER PHASES AT MICRON-SCALE IN ALLENDE MATRIX AND CHONDRULES.


Introduction: Understanding the mineralogy of the volatile and moderately volatile carrier phases in pristine chondrite matrix would inform our choice of model for volatile depletion [1,2]. Refractory μm-sized metal nuggets associated with CAIs [3,4] have been used to constrain oxidation and sulphidization processes [5], as well as cooling rates during equilibrium condensation [4]. Finding the carriers of refractory elements in situ at the μm-scale in matrix and chondrules (the assumption that they are hosted solely in CAIs bears examination given that CI chondrites have solar PGE abundances and ICP-MS analysis of Allende matrix indicates ‘chondritic’ PGE abundances), and constraining the mineralogy and detailed chemistry of these and other trace and minor element carrier phases, would be immensely valuable in understanding a wide variety of nebula and parent body processes.

Method: Exploring this area requires mapping the distribution of trace elements at high spatial resolution. Previously we used a variety of complementary microanalytical techniques [6], and observed carrier phases for several elements consistent with conditions approaching equilibrium condensation. Data for the current study were collected using the new CSIRO-Brookhaven Maia-384 detector system [7] installed on the Australian Synchrotron XFM beamline. Each pixel of the maps (~2 μm) contains a full XRF spectrum in the energy range ~3.5 to 18 keV. The SXRF technique also gives greater sensitivity to rare buried phases and trace elements, with detection limits ~10-100 ppm. Individual maps are 10,000 × 4500 pixels at full resolution.

Results and Discussion: Our data reveal the exceptional mineralogical and compositional heterogeneity of chondritic material at the μm-scale. We observe grains of Pd,Cu,Sn alloy in a FeNi sulphide/silicate rim around a barred olivine chondrule, within 30 μm of Os nuggets. Elsewhere we see Os and Pt nuggets in a fine-grained sulphide inclusion, and Pt apparently also isolated in matrix. We observe a large (10-20 μm) Au concentration associated with FeNi metal at the edge of a chondrule, and remarkably, what appear to be μm-scale Hg enrichments. Although their presence outside of refractory inclusions is unusual, some of these associations (Pt and Os with FeNi metal and sulphide) have been described previously within CAIs, and may therefore have a similar origin. But a variety of other elemental associations are new, potentially providing insights into new processes.