QUANTIFYING THE MODAL MINERALOGY OF FINE-GRAINED CAIs IN ALLENDE.

O. N. Menzies[1], P. A. Bland[1], G. Cressey[2] and S. S. Russell[2].
[1]Department of Earth Science and Engineering, South Kensington Campus, Imperial College, London SW7 2AZ, UK. [2]Department of Mineralogy, The Natural History Museum, London, SW7 5BD, UK. E-mail: o.menzies@imperial.ac.uk.

Introduction: A plethora of isotopic and mineralogical research has been carried out on CAIs in Allende using a range of analytical tools; however, the fine-grained inclusions whose mineralogy is more difficult to both identify and quantify have been less thoroughly studied. Most petrographic, and hence mineralogical, studies have been carried out on polished sections; but section work is limited due to the 2-dimensional nature of the sample and thus little work has been done to quantify the abundance of alteration products in CAIs. Here we obtain modal mineralogical data for fine-grained CAIs using MicroSource XRD. This allows us to investigate samples as small as 0.018mm^3 (as described for bulk carbonaceous chondrites by [1]). That MicroSource XRD is a grain-size-independent tool means that it is most beneficial in observing alteration products in fine-grained inclusions. Modal mineralogical data of bulk CAIs can be used to relate trace element and isotopic data to specific abundances of mineral phases, to identify fine-grained alteration minerals and to assess whether sequences of progressive alteration exist among CAIs.

Methodology: Twenty two CAIs were hand-picked from the meteorite Allende. Each inclusion was divided in two; one piece was made into a thick polished section and the other piece ground to a fine powder. BSE images and quantitative chemical analyses were carried out on the polished sections using a Jeol 5900LV SEM and Cameca SX50 electron microprobe. Quantitative modal mineralogical analyses were carried out on the powders using the MicroSource XRD with PSD system as outlined in [1].

Discussion: The CAIs were classified, according to the scheme of [2], by SEM on the polished sections; 13 were found to be either fine-grained, spinel-rich (fgsr) inclusions or amoeboid olivine aggregates (AOAs). The modal mineralogy of each inclusion was quantified to within ~2wt% for each mineral phase. The bulk wt% of Ca and Al were calculated from the modal mineralogical data and used to group inclusions that must have had similar primary mineralogies. Bulk wt% Fe, Na and Cl, calculated in the same manner, were used to assess the amount of Fe-alkali-halogen metasomatism experienced. Some of the findings of the XRD analysis that were not clear from the SEM study include: 1) the so-called 'fgsr' inclusions contain only 7-23wt% Fe-rich spinel; 2) melilite remains in several fgsr inclusions suggesting that these inclusions were protected from intense alteration; 3) plagioclase, probably secondary in origin, is abundant in some fgsr inclusions; 4) a number of fgsr inclusions were altered preferentially by Fe-alkali-halogen metasomatism and others by alteration of melilite to plagioclase; 5) the AOAs show evidence of having undergone more Fe metasomatism than Fe-alkali-halogen metasomatism although alteration proceeded to a similar maximum degree as in the fgsr inclusions.

Conclusions: This preliminary study provides the first modal mineralogy of CAIs by MicroSource XRD, allowing alteration sequences to be assessed. CAIs from less altered, primitive carbonaceous chondrites are the next target of this work, to further investigate CAI formation and evolution.

References: [1] Bland, P. A., et al. 2004. *MAPS* 39:3-16. [2] Grossman, L. 1975. *GCA* 39:433-454.