QUANTIFIED, WHOLE SECTION, MAIA XRF MAPPING OF TRACE ELEMENTS IN ALLENDE.

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Geologists and planetary scientists share a problem; neither can make direct observation of the fundamental processes controlling the evolution of earth and planetary bodies. The science circumvents this problem by probing the nature of rocks and meteorites to elucidate these fundamental processes indirectly. This can be thought of as a process of forensic mineralogy. X-ray based techniques such as electron microprobe and EDS SEM can reveal information about the distribution of trace elements in rocks that is critical in determining physical processes. However, these techniques are limited by the detection limits for important trace elements (~1000-10,000 ppm) and the area that can be mapped (~100's µm) because of the low count times for most analyses. While techniques such as LA-ICP-MS have helped to reduce the detection limit problem (~ppb's) the spatial resolution (20-80 µm spot) and time for data collection is commonly not useful for understanding fine scale processes and textural zonation in geological samples. In this paper we present an application of a new Synchrotron-based technique for mapping the distribution of trace elements at micron-scales across whole thin sections (cm's). The technique has been used to collect whole section maps (~2.5 cm x 1 cm) from 3 thin sections of Allende at the Australian Synchrotron XFM beamline (July 2011).

The technique to collect whole thin section trace element maps couples the high energy of the Australian Synchrotron XFM beamline with a custom designed and built 384-array Si-pin X-Ray detector (CSIRO-Brookhaven MAIA-384 detector system; [1, 2]). The MAIA detector allows for data to be collected using a 2 µm spot size at very low dwell times (~0.1-0.5 ms), resulting in maps of entire sections in ~3-5 hours. The MAIA is an Energy Dispersive System which allows for the collection of a large energy range spectrum with very high sensitivity. Hence there is no need to constrain the elements of interest a-priori. Post-processing of the data is performed using the GeoPIXE software (v6.4) which allows for the fitting of the spectrum using a dynamic analysis matrix method [3] to help strip peak overlap effects in the element matrix. This coupled with measurements on reference foils also allows for quantification of the data. Although the sensitivity of the X-Ray response changes throughout the energy range detection limits can range from 50-1000 ppm. A key advantage of the coupled full energy spectrum and DA peak fitting approach is that unknown elements can be modeled from the data, leading to observation of the spatial distribution of unexpected chemistry. The high energy of the beam also allows X-rays to be generated from throughout the thickness of the thin section. In some instances this presents a problem, but it also allows us to map rare buried phases that would otherwise be missed by surface techniques (ie. gold and platinum particles identified in Allende [4]). Our results show for the first time the potential of this technique to help decipher spatial and textural variations in trace element chemistry between CAIs, chondrules, matrix, and other Allende components at the cm-scale.

References: [1] Ryan, C.G., et al., *AIP Conference Proc*. 1221 (2010) 9-17; [2] Kirkham, R., et al., AIP Conference series, 1234 (2010) 240-243; [3] Ryan, C.G., et al., *Nucl. Meth B*, (1995) 104 157-165. [4] Bland et. al., *MetSoc2012 this volume*.