Analysis of refractory inclusions in the Allende and Axtell CV3 chondrites via electron-backscatter diffraction.

D. Bolser[1], T. Zega[2], S. Simon[3], and L. Grossman[3]. [1]Department of Chemistry and Biochemistry, University of Arizona. E-mail: dbolser@email.arizona.edu [2]Lunar and Planetary Laboratory, University of Arizona. [3]Department of Geophysical Sciences, University of Chicago.

Introduction: Calcium-aluminum-rich inclusions (CAIs) occur in primitive meteorites and are widely accepted as being the first solids to have formed within our solar system over 4.5 billion years ago [1]. Type A CAIs are mainly composed of melilite and many are enclosed in a multilayered shell known as the Wark-Lovering Rim (WLR) [2]. WLRs were hypothesized to have formed by several mechanisms including condensation, metasomatic exchange, and flash heating [3, 4]. In this study we used electron backscatter diffraction (EBSD) to determine the detailed crystal structure of a fluffy and a compact Type A CAI to gain new insight into their origins.

Samples and Methods: We analyzed CAIs previously identified in petrographic thin sections of the Allende (TS25, FTA) and Axtell (AX30, CTA) CV3 chondrites. The thin sections were further polished EBSD with 0.5 μm colloidal silica on an automatic vibromat for approximately three hours. The samples were analyzed on a Hitachi 3400N SEM operating at an acceleration voltage of 20 kV. The stage was positioned at a 70° tilt from the horizontal. Automated EBSD analysis was performed with the HKL Channel 5 software package. Maps were constructed with 0.5 μm step size and a dwell time of 0.5 seconds.

Results and Discussion: We selected local regions of interest comprising both the WLR and the core of the CAIs for analysis. EDS shows that these regions contain spinel, perovskite, hibonite, and secondary alteration phases, consistent with previous measurements [5, 6]. EBSD reveals that local clusters of pyroxene crystals within the WLRs have similar orientations to one another. In Allende TS25, diopside exhibits a preferred crystallographic orientation with respect to the {010} pole. This orientation is also exhibited by several neighboring anorthite grains. In comparison, pigeonite grains in the rim of AX30 exhibit a more complicated texture with polar angles approximately $\varphi=90^0$, $\rho=60^0$ in the {100} stereographic projection. The observations of oriented pyroxene are consistent with more localized measurements on the microstructures of WLRs using transmission electron microscopy (TEM) [7].

We hypothesize that locally similar orientations are reflective of *in situ* nucleation rather than *ex situ* condensation followed by oriented attachment to the melilite inclusion. Crystallization of the pyroxene layer may have begun at several different nucleation sites on the inclusion that later merged together creating the observed microstructure. Such preferred orientation is presumably an energy-minimized growth mode for these crystals within the WLR. Additional structural analysis of CAIs via EBSD will provide clues to grain nucleation and testing of our hypothesis.

References: [1] Grossman, L. 1972. *Geochimica et Cosmochimica Acta* 36:597-619. [2] MacPherson, G.J. 2004. *Treatise on Geochemistry* 201-246. [3] Wark, D. and Boynton, W.V. 2001 *Meteoritics and Planetary Science* 36:1135-1166. [4] Krot, A. et al. 1995 *Meteoritics* 30:748-775. [5] Simon, S.B. et al. 1995 *Meteoritics* 30:42-46. [6] Cosarinsky, M. et al. 2008 *Geochimica et Cosmochimica Acta* 72:1887-1913. [7] Zega, T.J. et al. 2009b *Meteoritics & Planetary Science* 44:A226.