A 500 MICRON ZONED CHROMIAN SPINEL WITH ALUMINIAN ENSTATITE FROM ALLENDE (CV3)

E. R. Lewis[1] , J. Ehman[2], and D. S. Ebel[1]. [1]Department of Earth and Planetary Sciences, American Museum of Natural History, New York, USA. erlewis@uchicago.edu, debel@amnh.org. [2]Upper Darby, PA.

Introduction: An inclusion dominated by a subhedral, translucent, gemmy, 500 μm grain of spinel was found in a 3.4 g slab butt of the Allende (CV3) meteorite by Mr. J. Ehman, who recognized its importance. Chromian spinels are enigmatic constituents of CM [1] and CV chondrites [2].

Methods: The slab was polished with diamond laps without epoxy, carbon coated, and mounted in a custom-made holder. Spot (1μm) analysis profiles of minerals, and x-ray elemental stage maps of the inclusion at 1μm/pixel resolution were obtained by electron microprobe. Grain boundaries and small mineral inclusions were imaged at high resolution and analyzed using FE-SEM EDS. X-ray diffraction patterns of spinel and suspected aluminous enstatite were collected using a Rigaku microdiffractometer with a ~100μm collimator directed onto the sample surface. All work was done at the AMNH.

Results: The spinel rims contain up to 3.8 wt% Cr_2O_3 and up to 7 wt% FeO, decreasing to 0.4 wt% Cr_2O_3 and 0.3 wt% FeO in the homogeneous core. Mn, Fe, and Ti all show a strong correlation with Cr in rim-core profiles, however Fe and Ti have an inverse relationship at the edge of the grain where a series of FeO peaks correspond to sharp decreases in TiO_2. The diffraction pattern for spinel (10 min. collection, 16 peaks) indexed to cubic cell parameter 8.0877 with error 0.0085, and displayed the sharp peaks of a single crystal. Several 5-10μm inclusions of calcium-aluminum silicate are present in the spinel, surrounding small indentations in the surface. These are likely Al-diopside.

The spinel grain is surrounded by grains of aluminous low-Ca pyroxene (6-13 wt% Al_2O_3), with 43% of Al calculated to be in the tetrahedral site. This Al-rich pyroxene contains only 0.7-0.9 wt% FeO, and <1.0 wt% CaO, markedly different from the Al-rich Ca-poor pyroxene found in chondrules from Semarkona [3]. XRD showed peaks consistent with aluminian enstatite orthopyroxene (opx) PDF #076-2428 [4], particularly at low angles ($27<2\theta<29$). In the raw image plate pattern, the opx yields smeared spots admixed with sharp spinel spots and very diffuse rings of matrix olivine, indicating the opx is in several orientations. Grains of Fe-Ni sulfide (10μm) and Fe-Ni metal (3μm) are both present in the opx.

Discussion: This spinel does not display the common 'patchy' texture nor the 'chevron' banded zoning texture, both reported by [2]. Two sides of the spinel resemble the embayed Cr-enriched core-rim texture of [2, fig.1h] however, a third side has discrete even bands of Cr-rich spinel, all congruent to crystal boundaries, totaling ~120 μm in thickness. A fourth side is Cr and Fe-poor, with a large chip missing. This fourth side abuts the largest opx-rich region. Fe-Ni grains are distributed throughout the opx on all sides. A variety of explanations may be offered to explain the existence of this complex inclusion in Allende.

References: [1] Simon et al. 1994. *Geochimica et Cosmochimica Acta* 58:1313-1334. [2] Simon et al. 2000. *Meteoritics & Planetary Science* 35:215-227. [3] Rubin A.E. 2004. *American Mineralogist* 89: 867-872. [4] Ganguly J. & Ghose S. 1979. *Contributions to Mineralogy & Petrology* 69: 375-385.