A RATHER THICK, MULTILAYERED, ACCRETIONARY RIM ON A RATHER LARGE CAI IN THE NWA 10758 CV3 CHONDRITE.

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Introduction: Northwest Africa (NWA) 10758 is a Bali type oxidized CV3, and section JSC1 contains a large (~ 2.4 x 1.4 cm), melilite-rich, type A Ca-Al rich inclusion (CAI), briefly introduced by Ross et al. [1]. The exceptional feature of this CAI is a thick (locally >5mm) fine- to coarse-grained, accretionary rim exhibiting at least 6 distinct layers. As such, this rim may sample a very wide region of the nebula, and mineralogically-diverse "clouds" of dust, and thus warrants detailed characterization.

Techniques: We performed electron beam analyses of the rim, including SEM/EDS (JEOL JSM-7600 FEG-SEM with an Oxford Ultimax EDS) and EPMA (JEOL JXA-8530F FEG-EPMA) on a polished mount, and HRTEM/EDS (JEOL 2500SE STEM with a JEOL SDD EDX) on a FIB cut from one rim layer.

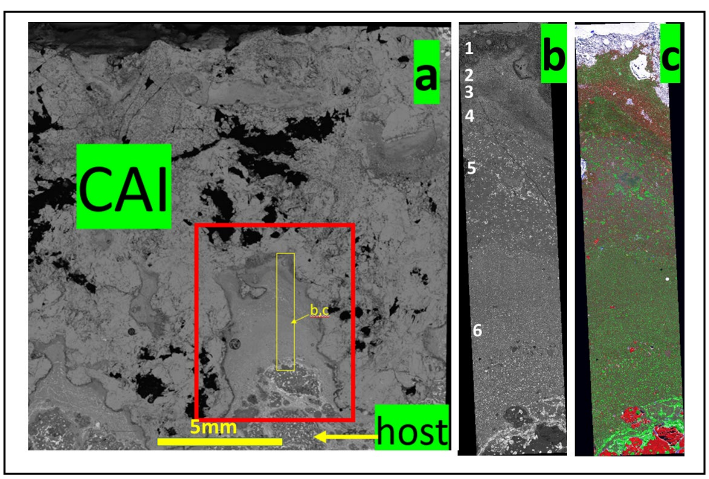
Mineralogy: The accretionary rim is of course dominated by olivine Fa23-71. This range is exceeded by the range reported for the host Fa1-74 [1,2]. [1] reported that accretionary rim olivine nearest the CAI (layer 1, see Figure 1b) was somewhat more enriched in iron than that nearest the host matrix (layer 6), but element mapping (Fig. 1b) indicates that the olivine compositional variations are probably more complex.

The accretionary rim olivine crystal morphologies range from anhedral to euhedral, with significant porosity between the crystals. TEM analysis of a FIB slice from layer 4 shows that the olivine crystals are commonly elongated along the crystallographic C axis. Pyroxenes in the matrix of rim layer 4 include orthoenstatite and clinoenstatite, frequently intergrown. Enstatite whisker crystals are also present. Magnetite, with lesser chromite is common within the rim layers, probably a consequence of the post accretionary oxidation that is characteristic of Bali-type CV3 chondrites. Ca phosphates are a minor component. Terrestrial weathering has significantly affected the meteorite - there are thin veinlets of iron oxyhydroxides throughout the sample. Fe-Ni sulfides and metal in particular have been altered.

As with other accretionary rims on CAI, this one contains tiny separate CAIs. We investigated one (5 µm across) in rim layer 4, and found that it consists of melilite and perovskite rimmed by diopside. A second larger (~50 µm in size), spherical CAI in layer 6 consists of melilite containing crystals of perovskite and corundum.

The wide compositional range of olivine, presence of disordered pyroxene, presence of enstatite whisker crystals, and high sample porosity indicate that post-accretionary chemical and physical processing of the accretionary rim has not been sufficiently severe to completely erase the memory of pre-accretionary mineralogy. It may be possible to determine detailed mineralogy of the diverse dust "clouds" that this CAI traversed in the nebula, as each successive layer is characterized.

References: [1] Ross et al. (2017) 80th Annual Meeting of the Meteoritical Society, 6378.pdf; [2] Meteoritical Bulletin entry for NWA 10758.



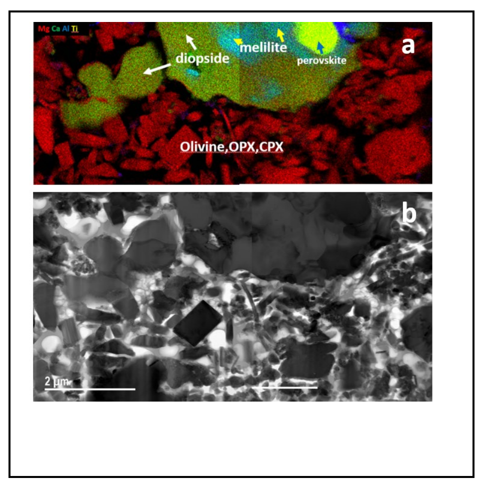


Figure 1 (left): (a) BSE of CAI and accretionary rim (red box) with next views outlined in yellow box; (b) BSE "slice" of rim, with layers numbered 1-6; (c) EDS element map – Mg is red, Fe is green, Ca is blue, Al is grey.

Figure 2 (right): Bright field scanning TEM image (b) and EDS element map (a) of a CAI in rim layer 4, and surrounding rim matrix. Mg is red, Ca is green, Al is blue, Ti is yellow. Scale bar measures 2µm.