A MICROANALYTICAL (TEM) STUDY OF FINE-GRAINED CHONDRULE RIMS IN NWA 5717.

J. N. Bigolski[1,2,3], D. R. Frank[4], M. E. Zolensky[5], M. K. Weisberg[1,2,3], D. S. Ebel[3], and Z. Rahman[4]. [1]Dept. Phys. Sci., Kingsborough College CUNY, Bklyn, NY 11235. [2]Dept. Earth and Envi. Sci., CUNY, Graduate Center, NY, NY 10016. [3]Dept. Earth and Planet. Sci., American Museum of Natural History, NY, NY 10024. [4]ESCG/NASA, Johnson Space Center, Houston, TX 77058. [5]ARES/NASA, Johnson Space Center, Houston, TX.

Introduction: Northwest Africa (NWA) 5717 is a highly primitive ordinary chondrite of petrologic type 3.05 with ubiquitous fine-grained chondrule rims [1, 2]. Rims appear around ~60% of chondrules and are comprised of micron-sized mineral and lithic fragments and microchondrules that are embdedded in an FeO-rich submicron groundmass that compositionally resembles fayalitic olivine. Some rim clasts appear overprinted with FeO-rich material, suggesting secondary alteration that postdates rim formation. Here we present a microanalytical (TEM) study of the submicron component (i.e. the groundmass) of the rims in order to determine the crystal structures and compositions of their constituent phases and decipher the accretion and alteration history recorded in rims.

Analytical Techniques: Using a focused ion beam (FIB), ultra-thin cross-sections of rim and matrix material surrounding four chondrules were prepared with a Quanta 3D dual-beam field-emission gun at the Johnson Space Center. Subsequent petrologic and geochemical analyses were carried out on a JOEL 2000FX analytical transmission electron microscope (TEM).

Results: The material in rims is composed of micron-sized clasts in a matrix of crystalline and amorphous submicron particles. The typical grain size of particles in the rim groundmass range from 10 – 100 nm, many of which are euhedral, Fe-rich olivine. Fe-rich phyllosilicate occurs along surfaces of Fe-rich olivine, sometimes possessing trace Na and K, and is also present as 5 – 50 nm-sized grains. Phyllosilicate lattice spacings range from 0.82 – 0.95 Å, possibly indicative of saponite. Larger grains (>200 nm) include Fe-rich olivine ($Fa_{29.4-76.9}$), low-Ca pyroxene ($Fs_{15.2-44.5}$ $Wo_{6.9-7.9}$), and enstatite, all ranging up to micron scale. Single micron-sized grains of diopside and augite are also present. Minor amounts of sulfide (pyrrhotite and pentlandite) are associated with submicron particles in the rim groundmass. Forsteritic olivine ($Fo_{87.2-92.3}$), virtually absent in the rim, is the dominant mineral in the sampled matrix material.

Discussion: Rim material is a complex mixture of mineral and lithic fragments, amorphous material and secondary phases. Phyllosilicate occurs along some surfaces of Fe-rich olivine and as discrete grains in the rims, possibly replacing amorphous material. Matrix material, on the other hand, lacks discernable phyllosilicates and is much less oxidized, dominated by Fe-poor silicates. Thus, chondrule rims and adjacent matrix appear to record different alteration histories. Chondrule rims may represent mixtures of silicate, amorphous material and ices that accreted onto chondrule surfaces and were subsequently altered on the parent body or are the result of hydration and heating in icy regions of the nebula [e.g., 3].

References: [1] Bigolski J. N. et al. 2012. Abstract #2426. 43rd Lunar & Planetary Science Conference. [2] Bigolski J. N. et al. 2013. Abstract #2239. 44rd Lunar & Planetary Science Conference. [3] Ciesla F. J. et al. 2003. Science 299, 549-552.