NORTHWEST AFRICA (NWA) 13993: A NEWLY CLASSIFIED BRECCIATED EUCRITE

M. C. Valdes[1,2] and P.R. Heck[1,2], [1]Robert A. Pritzker Center for Meteoritics and Polar Studies, Negaunee Integrative Research Center, The Field Museum of Natural History, Chicago, IL, USA. (mvaldes@fieldmuseum.org) [2]Department of The Geophysical Sciences, The University of Chicago, Chicago, IL, USA.

Introduction: NWA 13993 was collected in Northwest Africa, purchased by Terry Boudreaux in 2020, and subsequently acquired by the Field Museum in the same year. The specimen is a single, 807 g stone partly covered with a glassy fusion crust that has preserved flow lines. The brecciated interior is light gray-to-tan in color and hosts at least two distinct, fine-grained matrix lithologies. Within the matrix exist mineral and lithic fragments as well as darker (dark gray to black) rounded clasts, approximately 0.5-1 cm in diameter.

Petrography: The specimen has a brecciated, ophitic to sub-ophitic texture. Larger (up to 1.5 mm) euhedral pyroxene and plagioclase grains. NWA 13993 was studied in polished thick sections using the TESCAN LYRA3 field-emission scanning electron microscope in the Department of Geophysical Sciences at the University of Chicago and aWITec alpha300 Raman spectroscopy system at the Field Museum. BSE/SEM imaging reveal that the modal abundances of pyroxene and plagioclase are nearly equal and are set in fine-grained subhedral matrix. Both low-Ca pyroxene (pigeonite) and high-Ca pyroxene (augite) are present, but pigeonite is more abundant by far (representing ~85% of the pyroxene modal abundance). Pigeonite exhibits very narrow (~0.1 μm) augite exsolution lamellae, and the original igneous Fe/Mg/Ca zoning is preserved. Within the matrix exist large (up to 1 cm) rounded clasts with variably fine-grained (up to 1 mm) textures. Intergranular silica polymorph, chromite, troilite, and Fe metal are also present. A secondary brecciated matrix lithology, which makes up approximately 20% of the area of the cross-section studied, is larger-grained and more pyroxene-rich than the primary matrix lithology. Dendritic-textured chrome-spinel is a common minor phase throughout the specimen. There are also light-colored veins which contain long plagioclase/silica polymorph needles. Oxdized Fe is visible in the hand sample as groupings of red grains, together up to 1 cm in diameter, primarily localized to the secondary matrix lithology.

Geochemistry: Low-Ca pyroxenes exhibit a compositional range of $Fs_{48.5\text{-}55.9}Wo_{5.7\text{-}13.3}$, with an average of $Fs_{53.3\pm2.09}Wo_{6.9\pm1.86}$, an average FeO/MnO of 38.9±1.1, and an average mg# of 42.6±2.0 (n=30). High-Ca pyroxenes exhibit a compositional range of $Fs_{32.0\text{-}49.5}Wo_{21.2\text{-}49.3}$, with an average of $Fs_{38.7\pm7.89}Wo_{33.9\pm14.4}$, an average FeO/MnO of 41.4±0.72, and an average mg# of 40.9±5.8 (n=4). Feldspars have the limited range of $An_{90.49\pm0.78}$ (n=12). Plagioclase K_2O contents are very low, ≤0.2 wt%. Chrome-spinel grains show a wide range in composition, with TiO_2 ranging between ~1 and 24 wt%, Al_2O_3 between ~3 and 17 wt% and Cr_2O_3 between ~13–21 wt%.

Comparison to other brecciated eucrites: The petrology and chemistry of NWA 13993 are in agreement with those of other brecciated eucrites, as detailed by [1]. Plagioclase in this specimen is highly calcic and homogenous, which is a characteristic of many cumulate-type eucrites (basaltic eucrites, on the other hand, exhibit a considerable range in Ca content, $An_{74\text{-}94}$ [2-3]). However, the Fs and Wo contents of pyroxenes, and the average mg# of low-Ca pyroxenes, are in better agreement with basaltic eucrites [1]. The range in compositions of chrome-spinel grains in NWA 13993 are more in agreement with those reported for basaltic eucrites (TiO_2 1-23 wt%, Al_2O_3 3-18 wt%, Cr_2O_3 18-59 wt%) than those reported for cumulate eucrites (TiO_2 0.5-12 wt%, Al_2O_3 5-10 wt%, Cr_2O_3 39-55 wt%) [4-5]. Texturally, NWA 13993 is more alike basaltic eucrites. At present, more measurements are needed to confirm this brecciated eucrite as cumulate or basaltic.

References: [1] Mittlefehldt, D. W. (2015) GCA 75. 155-183. [2] Lovering, J. F. (1975) Meteoritics 10, 101-114. [3] Mayne, R. G. et al. (2009) GCA 73, 794-819. [4] Bunch, T. E. and Keil, K. (1971) Am. Mineral., 146-157. [5] Mittlefehldt, D. W. and Lindstrom, M. M. (1993) Antarctic Meteorite Res. 6, 268.