# UNGROUPED ULTRAMAFIC ACHONDRITES NORTHWEST AFRICA 13921 AND NORTHWEST AFRICA 13955: OLIVINE-BEARING IGNEOUS ROCKS UNLIKE EUCRITES OR DIOGENITES DERIVED FROM UNKNOWN DIFFERENTIATED PARENT BODIES.

A. J. Irving[1], P. K. Carpenter[2] and K. Ziegler[3], [1]Dept. of Earth & Space Sciences, University of Washington, Seattle, WA, USA, irvingaj@uw.edu; [2]Dept. of Earth & Planetary Sciences, Washington University, St. Louis, MO, USA; [3]Institute of Meteoritics, University of New Mexico, Albuquerque, NM, USA.

As the number of meteorites being recovered continues to increase, it should not be surprising that specimens are found which are unlike familiar categories, and which must be derived from unrecognized parent bodies.

**Northwest Africa 13921**: This is a complex specimen consisting of some polymineralic lithic clasts and irregularly-shaped mineral grains within a dominant quench-textured groundmass (see Figure 1). Lithic clasts are relatively coarse grained gabbroic assemblages composed of olivine ($Fa_{29.4-40.9}$, FeO/MnO = 53-63), patchily-zoned low-Ca pyroxene (orthopyroxene $Fs_{17.5}Wo_{1.0}$, FeO/MnO = 27; $Fs_{25.9-27.7}Wo_{1.0-4.7}$, FeO/MnO = 38-47) to pigeonite $Fs_{36.9-45.5}Wo_{5.9-10.0}$, FeO/MnO = 28-32) and calcic plagioclase ($An_{87.3-93.1}Or_{0.5-0.1}$) together with accessory kamacite, taenite, Ti-chromite and troilite. Separate irregularly-shaped (apparently resorbed) mineral grains are olivine, orthopyroxene, pigeonite, subcalcic augite ($Fs_{40.4-48.6}Wo_{20.0-26.7}$, FeO/MnO = 28-31), subcalcic ferroaugite ($Fs_{72.0}Wo_{24.4}$, FeO/MnO = 43), exsolved pigeonite (host $Fs_{46.3}Wo_{11.4}$; exsolution lamella $Fs_{29.1}Wo_{36.1}$; FeO/MnO = 31-32), silica polymorph and calcic plagioclase. The groundmass is composed mainly of radiating arrays of very thin, acicular, strongly-zoned pyroxene grains, some of which are oriented perpendicular to edges of the larger mineral grains and appear to have nucleated on them. Accessory phases in the matrix include kamacite (with taenite rims), ilmenite, troilite and pentlandite.

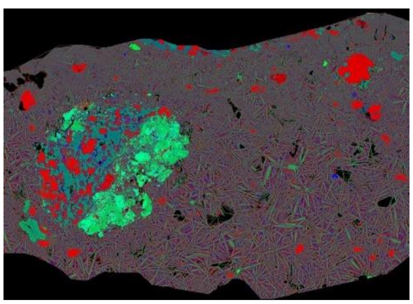

*__Figure 1__. Elemental X-ray map of NWA 13921. Key: red (Al), green (Mg), blue (Fe).*

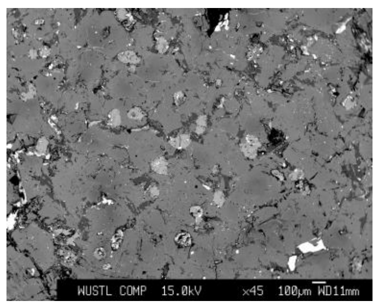


*__Figure 2__. BSE image of NWA 13955. Olivine (light gray), zoned pyroxene (medium gray), plagioclase (darker).*

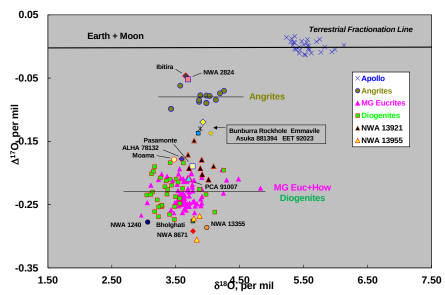


*__Figure 3__. Oxygen isotope plot for eucritic achondrites. Data from [1], [2], [3], [4] and other sources.*

**Northwest Africa 13955**: This specimen has a cumulate texture (see Figure 2) and contains sporadic vesicles or vugs. It is composed of subhedral grains of olivine (~20 vol.%, $Fa_{33.8-34.8}$, FeO/MnO = 41-44) and low-Ca pyroxene (~70 vol.%, zoned from small orthopyroxene cores ($Fs_{19.1-20.5}Wo_{0.7-0.8}$, FeO/MnO = 29-30) to thick mantles of pigeonite ($Fs_{25.1-26.7}Wo_{7.7-7.8}$, FeO/MnO = 28-29), together with intercumulus calcic plagioclase (<10 vol.%, $An_{79.9-86.3}Or_{1.1-0.5}$) and accessory chromite (with variable Ti content) and Fe-Ni metal (intermediate between kamacite and taenite).

**Oxygen Isotopes**: Acid-washed subsamples of NWA 13921 analyzed by laser fluorination yield results which plot closer to the TFL than the broad field for "main group" eucrites and diogenites, and near the value for anomalous eucrite Pasamonte (see Figure 3). Values for NWA 13955 plot below the range for "main group" diogenites and eucrites. We conclude that each of these specimens must be a crustal sample from different, previously unrecognized differentiated parent bodies with oxygen isotopic compositions distinct from those for typical eucrites or diogenites. Furthermore, as we have argued previously [1, 2], it is impossible to ascertain which (if any) of the known groups of eucrites (now 7 or 8 distinct types) or diogenites may necessarily derive from asteroid 4Vesta.

**References:** [1] Wiechert U. *et al.* (2004) *Earth Planet. Sci. Lett.* **221**, 373-382. [2] Scott E. *et al.* (2009) *Geochim. Cosmochim. Acta* **73**, 5835-5853. [3] Barrett T. *et al.* (2017) *Meteorit. Planet. Sci.* **52**, 656-668. [4] Benedix G. *et al.* (2017) *Geochim. Cosmochim. Acta* **208** doi.10.1016/j.gca.2017/03.030. [5] Irving A. *et al.* (2014) *77th Meteorit. Sci. Mtg.*, #5251. [6] Irving A. *et al.* (2018) *LPS* **XLIX**, #2247.