KEEPING UP WITH THE DIVERSITY OF ANGRITES: NORTHWEST AFRICA 15317, NORTHWEST AFRICA 15507 AND OUED NAMOUS 001. 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 & Planet. Sciences, Washington University, St. Louis, MO, USA, [3]Inst. of Meteoritics, University of New Mexico, Albuquerque, NM, USA.

Introduction: With a current total of 25 unpaired examples, the angrites remain perhaps the most petrologically diverse group of achondrites. Rather than being derived from a single intact and extant parent body, it seems more likely that angrites have been sampled over the last 56 million years [1] from multiple small bodies within the main asteroid belt representing portions of a former early solar system differentiated planetoid which underwent collisional disruption.

Following our recent work on diabasic angrites NWA 12004 and NWA 12320, porphyritic angrite NWA 12774, and protogranular, relatively metal-rich angrite NWA 14758 [2, 3, 4], we describe here further specimens which continue to expand the diversity among members of this fascinating meteorite group.

Northwest Africa 15317: This very fresh 299.3 gram partially fusion-crusted stone has a porphyritic dendritic or arborescent texture, reminiscent of that in NWA 7203 [5] but coarser (see Figure 1). Larger grains (up to 1.5 mm) of compositionally-zoned Al-Ti-augite (pink with purple-brown rims in thin section; $Fs_{22.9-47.1}Wo_{50.5-53.2}$, FeO/MnO = 83-134, Al_2O_3 5.4-8.7 wt.%, TiO_2 1.9-4.7 wt.%,) and Ca-bearing olivine ($Fa_{47.7-77.7}Ln_{2.1-8.6}$, FeO/MnO = 70-90) plus smaller laths of anorthite ($An_{99.3-99.8}Or_{0.0}$) are set within finer grained interstitial regions composed of intergrowths of the same phases plus kirschsteinite ($Fa_{64.3-81.5}Ln_{33.1-15.3}$, FeO/MnO = 62-74), troilite, ulvöspinel, silicoapatite and calcite.

Northwest Africa 15507: This 867 gram specimen has a relatively even-grained microgabbroic texture (mean grainsize ~1.4 mm) – see Figure 2. It is composed predominantly of zoned Al-Ti-augite ($Fs_{16.7-38.1}Wo_{53.8-51.9}$, FeO/MnO = 137-239, Al_2O_3 5.5-8.5 wt.%, TiO_2 0.1-1.9 wt.%), Ca-bearing olivine ($Fa_{56.5-59.9}Ln_{2.1-4.3}$, FeO/MnO = 83-85) and anorthite ($An_{99.1-100.0}Or_{0.0}$), together with accessory kirschsteinite ($Fa_{38.6-45.1}Ln_{47.3-46.7}$, FeO/MnO = 79-83), hercynite, rhönite [$Ca_{2.04}(Mg_{0.32}Fe^{2+}_{4.25}Fe^{3+}_{0..47}Ti_{0.33}Al_{0.61})(Si_{3.74}Al_{2.26})O_{20}$], FeO/ MnO = 238-354), low-Ni kamacite, Ti-free magnetite and troilite. Anorthite-rich regions contain tiny vesicles and cathodoluminescence reveals a complex subgrain structure (see Figure 3). Rhönite is also present in microgabbroic angrite NWA 4590 [6], and in both specimens it apparently contains some ferric iron. In that regard it has been recently proposed [7] that the oxidation state of angrite magmas increases over the course of closed system fractional crystallization.

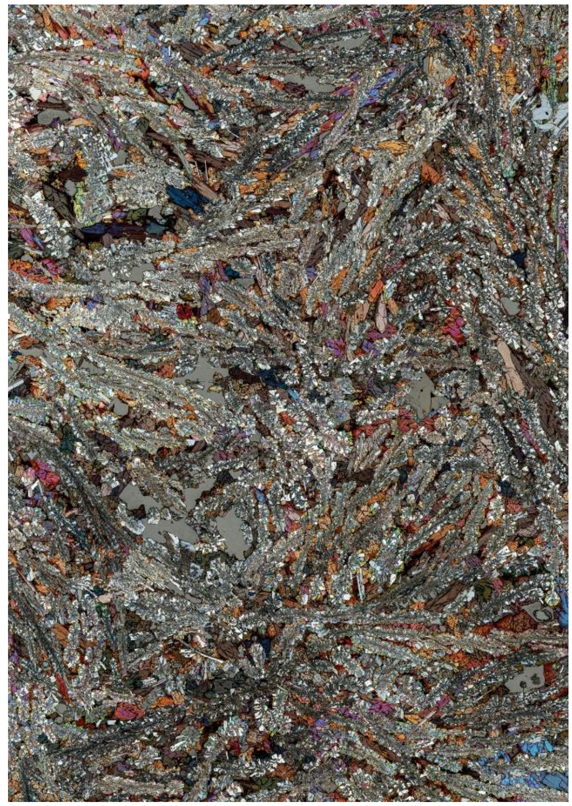
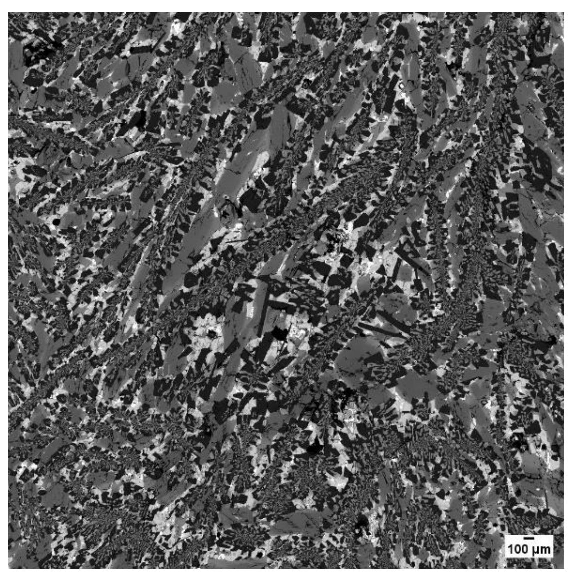


***Figure 1**. Arborescent textures in NWA 15317 **A**. (above) Partially cross-polarizedl thin section image **B**. (below) Back-scattered electron image*



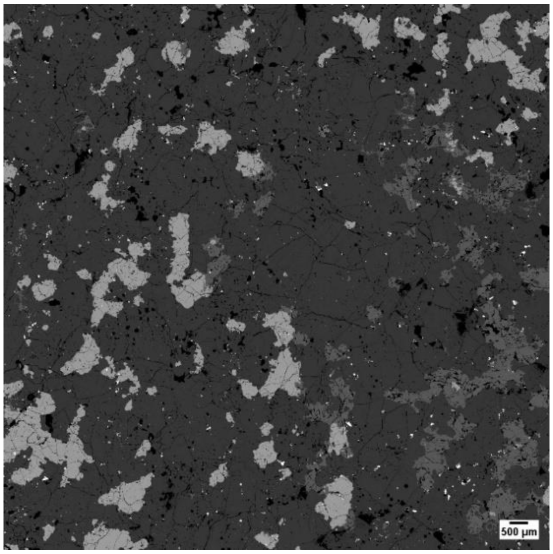


Figure 2. *Back-scattered electron image of NWA 15507 showing microgabbroic texture, olivine (light gray), augite (medium gray) and anorthite (dark gray)*

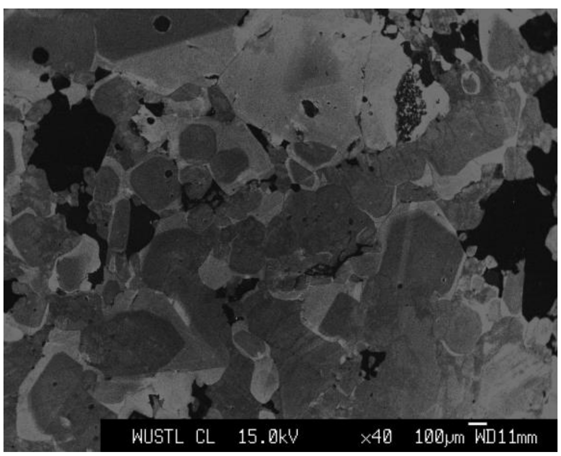


Figure 3. *Cathodoluminescence image of anorthite in NWA 15507. The complex substructure may reflect multiple episodes of crystal growth.*

Oued Namous 001: Colleagues at the University of New Mexico recently classified an angrite found as multiple stones in northwestern Algeria [8]. We also have classified a 16.7 gram paired stone found in the southern part of same strewnfield but located in the adjacent unnamed dense collection area.

Our very fresh specimen has an intergranular texture (mean grainsize ~0.2 mm) with olivine xenocrysts and sporadic spherical vesicles (up to 2 mm in diameter). It is composed of stubby euhedral grains of anorthite ($An_{99.6-100.0}Or_{0.3-0.0}$), mildly zoned Al-Ti-augite (cores $Fs_{19.5-21.5}Wo_{51.8-51.4}$, FeO/MnO = 72-98, Al_2O_3 6.4-8.0 wt.%, TiO_2 1.2-1.4 wt.%) and strongly zoned olivine

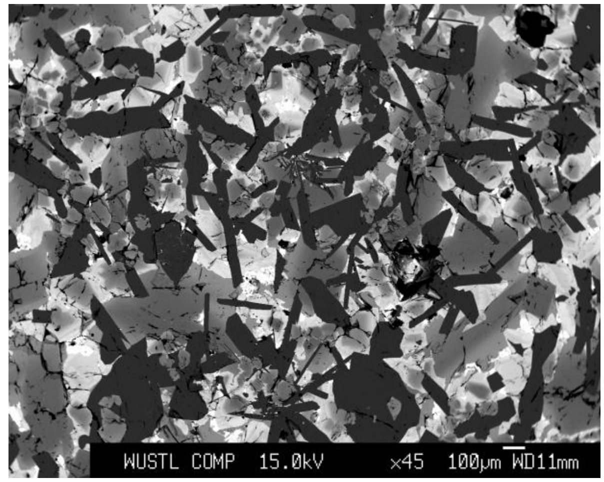


Figure 4. *Back-scattered electron image of specimen paired with Oued Namous 001 showing zoned augite (medium gray to light gray), anorthite (darkest gray stubby prismatic grains) and a vesicle (black, upper right corner)*

($Fa_{39.2-49.8}Ln_{1.5-2.4}$, FeO/MnO = 83-92) with successive rims of kirschsteinite ($Fa_{59.1-61.0}Ln_{36.7-34.7}$, FeO/MnO = 68) and Ca-rich fayalite ($Fa_{78.8-85.4}Ln_{20.3-12.9}$, FeO/MnO = 78-83), together with accessory ulvöspinel, troilite and silicoapatite -- see Figure 4. Sparse larger (up to 4 mm), more magnesian olivine xenocrysts (cores $Fa_{15.9}Ln_{0.1}$, FeO/MnO = 85) are present and are mantled sequentially by more ferroan olivine, kirschsteinite and Ca-rich fayalite.

Oxygen Isotopes: Analyses by laser fluorination at UNM on acid-washed subsamples of NWA 15317 and NWA 14758 gave the following results (all data linearized and $\Delta^{17}O$ calculated for a TFL slope of 0.528):

NWA 15317: $\delta^{17}O$ 2.353, 2.457, 2.283; $\delta^{18}O$ 4.734, 4.802, 4.529; $\Delta^{17}O$ -0.146, - 0.079, -0.108 per mil

NWA 14758: $\delta^{17}O$ 2.606, 2.619, 2.817; $\delta^{18}O$ 5.118, 5.170, 5.554; $\Delta^{17}O$ -0.097, - 0.111, -0.115 per mil

References: [1] Nakashima D. *et al.* (2018) *Meteorit. Planet. Sci.* **53**, 952-972 [2] Irving A. *et al.* (2019) *Lunar Planet. Sci.* **L**, #2758 [3] Irving A. *et al.* (2020) *Lunar Planet. Sci.* **LI**, #2399 [4] Irving A. *et al.* (2022) 85th *Meteorit. Soc. Mtg.*, #6366 [5] Hayashi H. *et al.* (2022) *Meteorit. Planet. Sci.* **57**, 105-121 [6] Kuehner S. and Irving. A. (2007) *Amer. Geophys. Union Fall Meeting*, abstract #P41A-0219 [7] Bell, A. *et al.* (2023) *Geochim. Cosmochim. Acta*, in press [8] *Meteorit. Bull.* (2022).

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