

Angrites

Northwest Africa 2999

Morocco or Algeria
Find: 2005
Achondrite (angrite)

History: Twelve individual dark brown stones totaling 392 g, each with a thin fusion crust, were purchased from a Moroccan dealer in Tagounite by G. Hupé in August 2004.

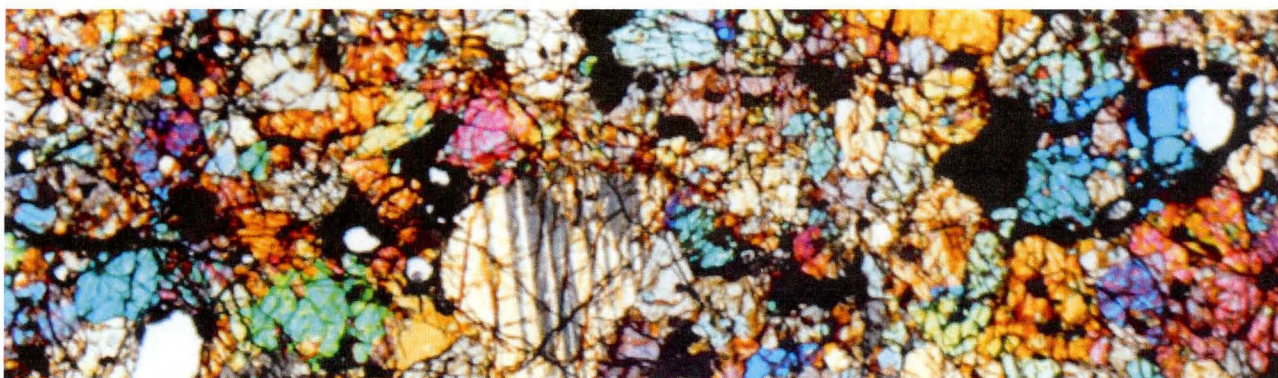
Physical Characteristics: Grain size is predominantly from 0.1 to 0.5 mm, but all stones have irregularly distributed, larger yellowish plagioclase grains (up to 6 mm across) exhibiting an iridescent luster.

Petrography: (A. Irving and S. Kuehner, *UWS*; T. Bunch and J. Wittke, *NAU*) Based upon examination of thin sections of all separate stones, this meteorite is texturally heterogeneous. Terrestrial weathering has resulted in partial replacement of metal and minor grain boundary staining by iron hydroxides. The overall texture is protogranular, but there are large porphyroclasts of anorthite, spinel, and polygranular olivine. Anorthite also occurs as narrow (10-20 μm wide) coronas around spinel grains adjacent to clinopyroxene and both spinel and diopside are compositionally zoned away from the coronas. Texturally, this meteorite is very different from most angrites.

Geochemistry: The major minerals are Ca-rich olivine ($\text{Fa}_{39.8-41.0}$; $\text{FeO/MnO} = 77-97$; $\text{CaO} = 0.6-1.3 \text{ wt\%}$), Al,Ti-bearing diopside ($\text{Fs}_{9.6-11.3}\text{Wo}_{53-54}$; $\text{FeO/MnO} = 55-130$; $\text{Al}_2\text{O}_3 = 5-9$, $\text{TiO}_2 = 0.5-2.4$ [both wt%]), minor Cr-pleonaste spinel ($\text{Mg}/(\text{Mg}+\text{Fe}) = 0.44-0.47$, $\text{Al}_2\text{O}_3 = 55-60$, $\text{Cr}_2\text{O}_3 = 4.7-8.7$ [both wt%]), pure anorthite (containing $\text{Na}_2\text{O} < 0.02 \text{ wt\%}$), and kamacite, troilite, and S-bearing calcium silicophosphate. Oxygen isotopes: (D. Rumble, *C/W*) Triplicate analyses of acid-washed whole rock samples by laser fluorination gave, respectively, $\delta^{18}\text{O} = 3.839, 4.093, 4.154$; $\delta^{17}\text{O} = 1.974, 2.054, 2.095$; $\Delta^{17}\text{O} = -0.041, -0.095, -0.086$ (all ‰).

Classification: Achondrite (angrite).

Specimens: A 22 g type specimen and one polished thin section are on deposit at *NAU*. Three polished thin sections are on deposit at *UWS*. G. Hupé holds the main mass.





NWA 2999. Image © T. E. Bunch, 2008.

Northwest Africa 3164

Morocco or Algeria
Find: August 2004
Achondrite (angrite)

History: Many dark brown stones (totaling 928 g), were purchased from nomads by A. Aaronson in Rabat in August 2004.

Petrography (T. Bunch and J. Wittke, *NAU*; A. Irving and S. Kuehner, *UWS*): All stones have irregularly distributed larger yellowish plagioclase grains exhibiting a "schiller" luster. The major minerals are Ca-rich olivine, diopside, Cr-bearing pleonaste spinel with subordinate anorthite and spinel and accessory kamacite and troilite. No kirschsteinite or orthopyroxene was found. Primary metal is partly replaced by limonite, which also occurs along grain boundaries. The overall texture is protogranular, but there are large porphyroclasts of anorthite, spinel and polygranular olivine. There are clinopyroxene-spinel symplectites around anorthite porphyroclasts in contact with olivine, and anorthite also occurs as narrow (10-20 micron wide) coronas around spinel grains adjacent to clinopyroxene (Kuehner et al., 2006).

Geochemistry: Ca-rich olivine, $Fa_{39.1-41.2}$, CaO = 1.2 to 1.8 wt%, FeO/MnO = 62-84; Al-Ti-bearing diopside, $Fs_{10.3}Wo_{52}$, Al_2O_3 = 6 to 7 wt%, TiO_2 = 1 to 1.6 wt%, FeO/MnO = 130-142; Cr-bearing pleonaste spinel, Al_2O_3 = 59.7 wt%, Cr_2O_3 = 4.7 wt%, $Mg/(Mg+Fe)$ = 45.7.

Classification: Achondrite (angrite). The characteristic textures and mineral compositions indicate that this material is paired with NWA 2999.

Type specimens: A total of 21 g and one polished thin section are on deposit at *NAU*. Mr. T. Boswell is the main mass holder.

Reference

Kuehner, S. M., Irving, A. J., Bunch, T. E., Wittke, J. H., Hupé, G. M. and Hupé, A. C., 2006, Coronas and symplectites in plutonic angrite NWA 2999 and implications for Mercury as the angrite parent body. *Lunar. Planet. Sci.* **XXXVII**, #1344.

Other Angrites

ID	Location	Date	Class.	Mass (g)	State	Fa	Fs	Comments
Dho 4569	Erfoud, Morocco	2005	ANG	484	S2, mod.	40.3	10.8	Wo ₅₃ ; An ₁₀₀ ; paired with NWA 2999

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