CORONAS AND SYMPLECTITES IN PLUTONIC ANGRITE NWA 2999 AND IMPLICATIONS FOR MERCURY AS THE ANGRITE PARENT BODY. S. M. Kuehner[1], A. J. Irving[1], T. E. Bunch[2], J. H. Wittke[2], G. M. Hupé and A. C. Hupé, [1]Dept. of Earth & Space Sciences, University of Washington, Seattle, WA 98195, (kuehner@u.washington.edu), [3]Dept. of Geology, Northern Arizona University, Flagstaff, AZ 86011.

Introduction: Multiple dark brown stones purchased from Moroccan dealers in 2004 and 2005 have been classified as NWA 2999, and other stones as NWA 3164. Oxygen isotope compositions of whole rock samples of NWA 2999 by laser fluorination [1] (mean $\Delta^{17}O$ = -0.074 +/- 0.01 per mil) are indistinguishable from those determined by [2] for four other angrites, including Angra dos Reis. This material constitutes the tenth known example of the enigmatic angrite meteorites, and exhibits unique mineralogical features that have important implications for the angrite parent body.

Northwest Africa 2999: Optical and electron microprobe examination of 10 thin sections from several stones show that this meteorite is texturally heterogeneous, and contains clear evidence of arrested metamorphic reactions. The overall texture is polygonal-granular, but with large porphyroclasts (up to 6 mm across) of anorthite, spinel and olivine, many with internal sub-grain development. The major minerals have narrow compositional ranges: calcic olivine ($Fa_{39.8-41}$, CaO = 0.6-1.3 wt.%, FeO/MnO = 77-97), Al-Ti-bearing diopside ($Fs_{9.6-11.3}Wo_{53-54}$, Al_2O_3 = 5-9 wt.%, TiO_2 = 0.5-2.4 wt.%, FeO/MnO = 55-130), Cr-pleonaste spinel (Cr_2O_3 = 4.7-8.7 wt.%, Al_2O_3 = 55-60 wt.%, Mg/(Mg+Fe) = 0.44-0.47) and pure anorthite (< 0.02 wt.% Na_2O). Accessory minerals include kamacite, troilite and S-bearing calcium silicophosphate. Kirschteinite-monticellite is absent. Textural similarities among NWA 2999, LEW 86010 and Angra dos Reis suggest that they all may represent thermally-annealed, *formerly brecciated* ultramafic rocks, and probably ancient regolith. Pyroxene in these samples are much more homogeneous in composition than in igneous-textured angrites such as Asuka 881371, LEW 87051, D'Orbigny and NWA 1296 (Figure 1, [3, 4, 5]). Mineral modes determined from BSE images of one NWA 2999 sample are 64% olivine, 23% clinopyroxene, 4% spinel, 1% plagioclase and 8% metal. The bulk rock composition is estimated to contain 34 wt.% SiO_2, 4.5 wt.% Al_2O_3, 33 wt.% FeO, 21 wt.% MgO and 6.5 wt.% CaO.

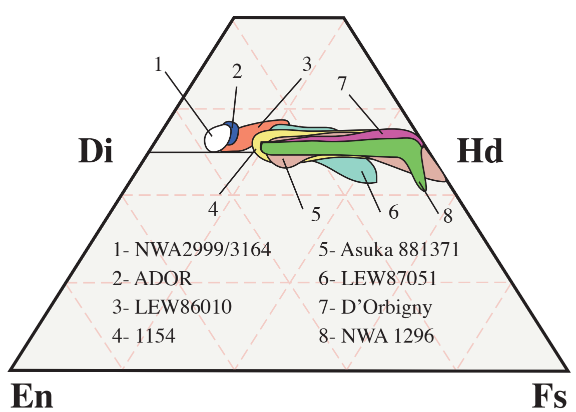

Figure 1. Pyroxene compositions of plutonic (1, 2, 3) and selected "volcanic" (4, 5, 6, 7, 8) angrites. Note the narrow compositional range for plutonic pyroxenes.

Coronas and Symplectites: Two types of disequilibrium textures are found in NWA 2999. (1) Radial symplectitic intergrowths of clinopyroxene (5-9 wt.% Al_2O_3) and spinel (1.6-3.7 wt.% Cr_2O_3) are found between anorthite and olivine porphyroclasts (Figure 2). (2) Spinel grains in contact with clinopyroxene have 10-20 μm wide, discontinuous coronas of anorthite (Figure 3). This texture also is associated with spinel grains in the outer portions of symplectites (Figure 2). By analogy with similar textures in terrestrial rocks we attribute the symplectite formation to near isothermal decompression, whereas the coronas must record a

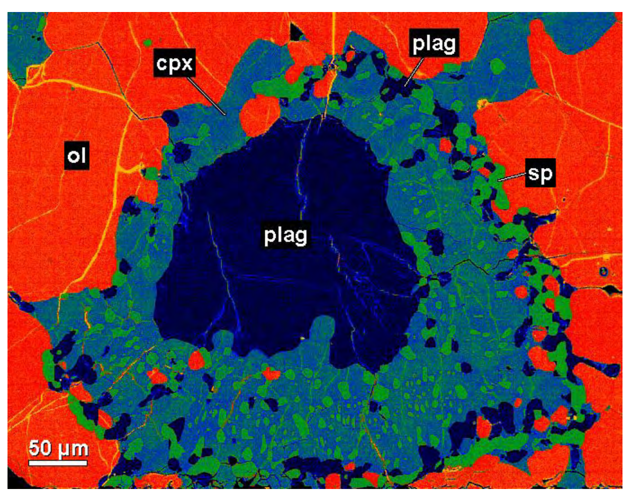

Figure 2. Clinopyroxene-spinel symplectite formed between plagioclase and olivine. Note the small, second-generation plagioclase grains concentrated near the outer margin of the symplectite.

near isobaric cooling path [6]. Olivine-spinel thermometry [7] gives a temperature of 870°C. We believe that these metamorphic textures are forward and reverse examples of the same reaction. The absence of orthopyroxene precludes the direct application of the classic reaction Fo + An = Al-Cpx + Al-Opx + Spinel to determine a reaction pressure, although the upper stability limit of Ol + An in the simple CMAS system is about 6.7kb at 870°C [8], equivalent to about 23 km depth in Earth. We are attempting to model the reactions using the observed phases. However, chemical mass balance of one Cpx + Sp symplectite using BSE modes indicates that the An + Fo reaction produces an excess of Fe and a deficiency in Ca compared with amount observed in the symplectite. The implication is that Fe was removed and Ca added, through interaction with a gas phase; the presence of the S-bearing Ca silico-phosphate and Fe-metal found elsewhere in the sample might be evidence of this. Figure 4 is a schematic illustration of the probable protolith history.

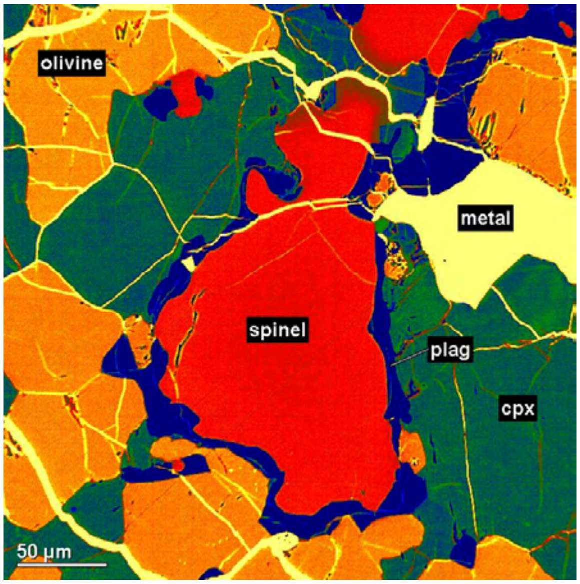

Figure 3. Coronas of plagioclase separating spinel and clinopyroxene, adjacent to olivine.

The Mercury Connection: Papike et al. [9] suggested that angrites might be samples from Mercury based on volatile depletion, and systematics of plagioclase compositions and Fe/Mn ratios in mafic minerals. The spectacular symplectite and corona textures in NWA 2999 evidently require a parent body capable of several kilometers of vertical tectonics. Of the silicate planets, only Earth and Mercury are known to have appropriate tectonic processes. Similar textures are well-known in deep-seated terrestrial plutonic rocks (including mantle peridotites [10]) exhumed by continental plate tectonic collisions, but on Mercury this could be accomplished by thrust faulting, for which there is strong evidence [11]. Dynamical calculations [12] predict that several percent of material ejected from Mercury could reach Earth, so it would not be too surprising to find Hermean meteorites. Additional arguments supporting this conjecture were given by Irving et al. [1].

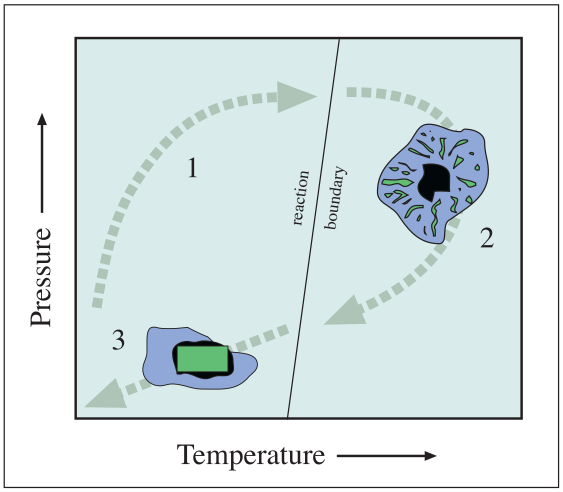

Figure 4. Schematic illustration showing P-T path followed by NWA 2999. 1- Compaction and annealing of regolith. 2- Crossing Fo + An reaction boundary and symplectite formation during decompression. 3- Re-crossing reaction boundary and corona formation during cooling.

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