NORTHWEST AFRICA 2975: AN EVOLVED BASALTIC SHERGOTTITE WITH VESICULAR GLASS POCKETS AND TRAPPED MELT INCLUSIONS. J. H. Wittke[1], T. E. Bunch[1], A. J. Irving[2], M. Farmer and J. Strope, [1]Dept. of Geology, Northern Arizona University, Flagstaff, AZ 86011 (James.Wittke@nau.edu), [2]Dept. of Earth & Space Sciences, University of Washington, Seattle, WA 98195.

Discovery: A 70.1 gram crusted stone (Figure 1) purchased in Morocco in November 2005 (but probably found in Algeria) is a new basaltic shergottite. This exceptionally fresh specimen contains veins and patches of shock-produced vesicular glass, and also has distinctive late-stage, partially crystallized igneous melt inclusions within iron-titanium oxide grains.

Figure 1. Complete NWA 2975 stone, showing very fresh fusion crust. Image © M. Farmer.

Petrology: NWA 2975 is a medium-grained, subophitic to granular volcanic or hypabyssal rock composed predominantly of pyroxenes (57.3 vol.%) and completely maskelynitized plagioclase (38.3 vol.%) with accessory opaque phases (2.7 vol.%) and phosphates (1.7 vol.%). Prismatic pyroxene and maskelynite grains (up to 3.1 mm long) exhibit a weak preferred orientation. Vesicular, black glass veins (up to 3 mm wide) and pockets (up to 6 mm across) are prominent (see Figure 2). Pigeonite ($Fs_{35.2-57.6}Wo_{2.6-16.5}$; FeO/MnO = 28-38) and augite ($Fs_{27.2-41.5}Wo_{30.8-35.2}$; FeO/MnO = 29-39) show mottled compositional zoning, but to a lesser extent than in most other basaltic shergottites (see Figures 3, 4, 5). The Fe-rich rims of pigeonite grains contain very thin (0.2-0.5 microns wide) orthopyroxene exsolution lamellae, but no symplectites after former pyroxferroite were observed. Large maskelynite grains are homogeneous in composition ($An_{55.0}Or_{1.8}$), whereas maskelynite and feldspathic glass in mesostasis regions is more variable in composition ($An_{48-60}Or_{9.2}$). Accessory phases include ulvöspinel, ilmenite, chlorapatite, merrillite, pyrrhotite, Si-Al-K-Na-rich glasses and baddeleyite.

Figure 2. Interior of NWA 2975, showing vesicular glass pockets and veins. Image © M. Farmer.

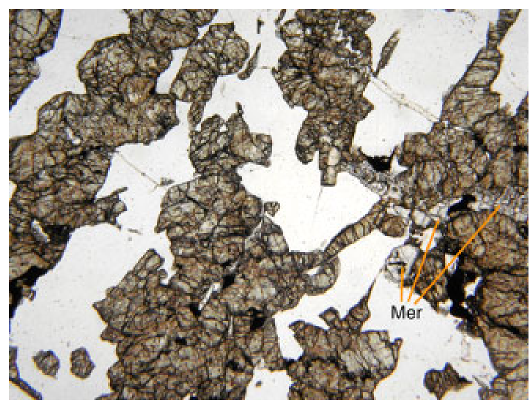
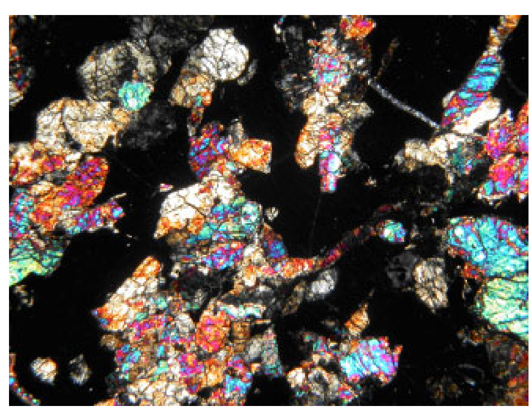


Figure 3. Plane-polarized (above) and cross-polarized (below, 2.35 mm wide) thin section images, showing pyroxenes (brown/colors), maskelynite (white/black) and oxides/sulfides (black).



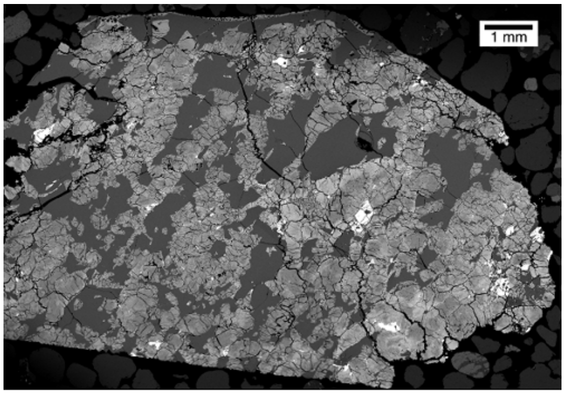


Figure 4. Back-scattered electron image showing preferred orientation of maskelynite grains (dark gray). Pyroxenes are medium to light gray and Fe-Ti oxides are white.

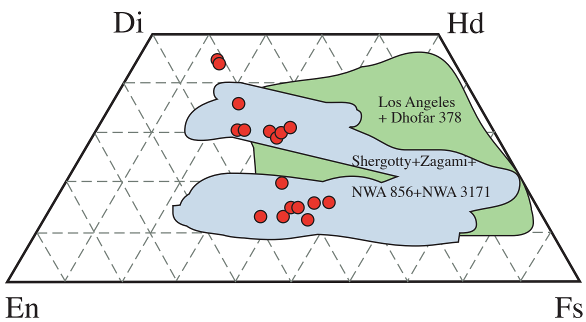
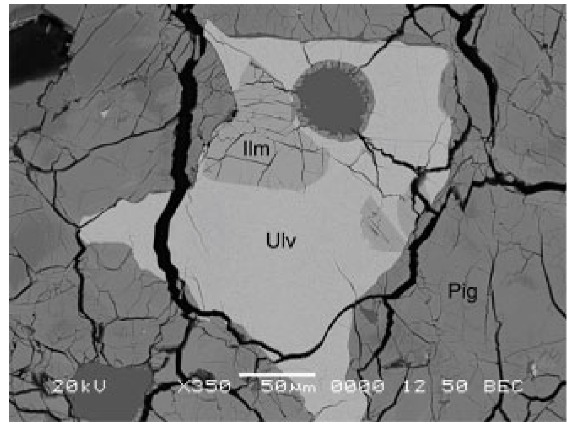


Figure 5. Pyroxene compositions in NWA 2975 (red) compared with those in other evolved basaltic shergottites (data from this work, [1], [2])

Melt Inclusions: Ellipsoidal to spheroidal trapped melt inclusions (15-60 microns in longest dimension) are widespread within ulvöspinel grains, and exhibit marginal rims of Fe-rich pigeonite ($Fs_{73.5}Wo_{5.8}$)+ merrillite+pyrrhotite around cores of Si-Al-K-Na-rich glass (see Figure 6). Calculated average bulk composition for three melt inclusions based on analyzed phases and their modes is (in wt.%): SiO_2 70.2, TiO_2 0.8, Al_2O_3 8.5, FeO 2.1, MnO 0.2, MgO 2.35, CaO 3.5, Na_2O 0.95, K_2O 2.1 and P_2O_5 2.8, with trace amounts of NiO, CoO and S. One melt inclusion contains only fayalite (Fa_{84}) daughter crystals mantled around a core of glass containing 78 wt.% SiO_2 and 6.4 wt.% K_2O.

Fractional Crystallization of Shergottite Magmas: Among the 11 known basaltic shergottites lacking olivine, NWA 2975 represents the most evolved Martian magmatic liquid composition, other than Dhofar 378 and Los Angeles. Pigeonite and augite core compositions in NWA 2975 ($Fs_{35.2}$ and $Fs_{27.2}$, respectively) are both more ferroan than for the corresponding phases in NWA 856, NWA 3171, Zagami, Shergotty and NWA 1669 [1]; only Dhofar 378 and Los Angeles have more ferroan pigeonite cores [2] (and their pyroxenes do not have distinct high-Ca and low-Ca compositional trends – see Figure 5). Despite the relatively evolved pyroxene compositions in NWA 2975, the plagioclase is not as sodic as in the other examples discussed; this suggests a slightly more calcic bulk composition and perhaps more rapidly arrested crystallization of this specimen (which may be consistent with the greater abundance of glass-rich melt inclusions).



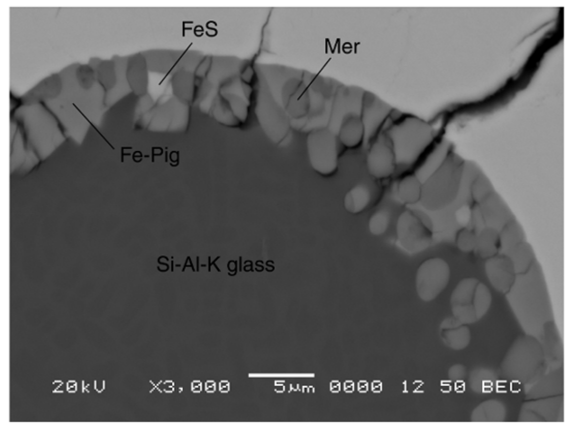


Figure 6 a, b. Back-scattered electron images of a quenched melt inclusion within an ulvöspinel grain, showing daughter crystals of ferropigeonite, merrillite and pyrrhotite rimming glass (dark).

References: [1] Irving A. J. et al. (2004) *67th MetSoc*, #5229; McCoy T. J. et al. (1992) *GCA, 56*, 3571-3582; Stolper E. M. and McSween H. Y., Jr. (1979) *GCA, 56*, 3571-3582; Stoffler D. et al. (1986) *GCA, 50*, 889-913; Jambon A. et al. (2003) *66th MetSoc*, #5071 [2] Ikeda Y (2002) *LPSXXXIII*, #1434; Rubin A. E et al. (2000) *Geology, 28*, 1011-1014; Mikouchi T. (2000) *MAPS, 35*, A110; Xirouchakis D. et al. (2002) *GCA, 66*, 1867-1880.