NORTHWEST AFRICA 1110: A NEW OLIVINE-PHYRIC SHERGOTTITE POSSIBLY PAIRED WITH NORTHWEST AFRICA 1068. [1]C.A. Goodrich (cyrena@higp.hawaii.edu), [1]D. van Niekerk (dionysos@higp.hawaii.edu) and [2]M.L. Morgan (mmorgan@mhmeteorites.com). [1]Hawaii Institute of Geophysics and Planetology, University of Hawaii at Manoa, Honolulu, HI 96822 USA. [2]Mile High Meteorites, PO Box 151293, Lakewood, CO, 80215 USA.

Introduction: Northwest Africa (NWA) 1110 is a 118g olivine-phyric shergottite found in 2001 (at least 40g of additional small fragments have now been found) and tentatively paired with NWA 1068 [1]. We have made 8 sequential thin sections from a 1.25g piece* of NWA 1110, and are studying them by petrographic methods.

Description: NWA 1110 has a porphyritic texture of olivine crystals in a groundmass consisting principally of pyroxenes and plagioclase (maskelynite). Chromite, Fe-Ti oxides (ulvöspinel and ilmenite) and phosphate(s) are the most important minor phases. Modal abundances of olivine (~32%), chromite (0.6%), and Fe-Ti oxides (~5%) were determined by the method of [2]. Pyroxene/plagioclase ratio has not yet been determined, due to extensive terrestrial alteration (Ca-carbonates) in the groundmass.

Olivine crystals are suhedral to anhedral, ranging from ~1.6 mm to <50 µm in size. Compositions range from Fo ~73 to 44. Crystals larger than ~300 µm have cores of Fo ~73-66 and edges of Fo ≥50 (Fig. 1). Smaller crystals are more ferroan and only slightly zoned. This size-composition correlation is similar to that in Sayh al Uhaymir 005 [3,4].

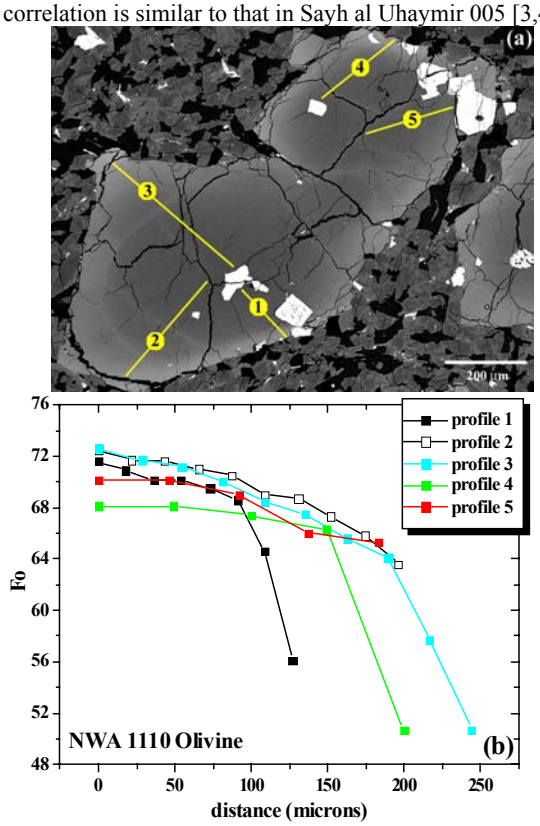

Fig. 1. (a) Back-scattered electron image of olivine crystal in NWA 1110. Numbered lines indicate compositional profiles shown in (b). White inclusions are chromite; those at edge of olivine (center and upper right) have rims of ulvöspinel where in contact with the groundmass.

Pyroxenes range continuously in Ca content from low-Wo (~5) pigeonite to augite (Wo ~33), though two distinct compositional trends of augite and low-Ca pyroxene (pigeonite to intermediate) may be distinguished (Fig. 2). Mg#s of low-Ca pyroxenes range from ~72 to 46; those of augite range from ~69 to 44. Low-Ca pyroxenes show typcal basaltic crystallization trends, with a peak in Wo and Al_2O_3 content at *mg* ~65 reflecting the appearance of plagioclase (Fig. 2). FeO/MnO ratios in pyroxenes are similar to those in other shergottites (32±2 by wt.; 1σ, n = 209).

Low-Ti chromite occurs as euhedral to subhedral grains included in olivine (type 1) of Fo 73 to 50 (Fig. 1), and, as in other olivine-phyric shergottites [3-8], as cores of composite grains (type 2) with rims of ulvöspinel (Fig. 3) included in the more ferroan olivine (Fo ≤62) and in the groundmass. Ulvöspinel also occurs as individual grains, commonly associated with ilmenite. Type 1 chromites are significantly more abundant and larger (up to ~150 µm) that in Sayh al Uhaymir 005, Dhofar 019 and lithology A of Elephant Moraine A79001 [3-5]. They show a small range of Cr# (~0.86-0.84) with normal zonation, and have magnetite contents (recalculated from EMP analyses) of ~4-9% (Fig. 5). Chromite cores of type 2 grains are similar. Ulvöspinel rims have lower Cr# and significantly higher magnetite contents (Fig. 5). In contrast to type 2 spinels in other olivine-phyric shergottites [3-5,8], in which there is a significant gap in Ti (and in some cases magnetite) content between cores and rims, compositional trends between cores and rims are nearly continuous in some grains (Fig. 4,5). Fe#s of chromites (~0.77-0.92) are correlated with Fo of enclosing olivine (chromites in the groundmass extend this correlation, assuming equilibrium with the most ferroan olivine), indicating subsolidus reequilibration at temperatures of ~1050-850°C [9].

Assemblages of early chromite plus co-crystallizing olivine and pyroxene yield an oxygen fugacity (fO_2) estimate [8] of QFM –1.7 (at 1024°C).

Comparison of NWA 1110 to NWA 1068: In terms of modal mineralogy, texture, olivine and pyroxene compositions and general characteristics of spinels, NWA 1110 is very similar to NWA 1068 [6]. NWA 1068 is unique among olivine-phyric shergottites in having a nearly flat bulk REE pattern [6], similar to basaltic shergottites Shergotty, Zagami, NWA 856 and Los Angeles. However, if the correlation between fO_2 and La/Yb ratio among shergottites observed by [10] continues to hold, NWA 1110 should be moderately LREE-depleted. Bulk and in-situ trace element analyses are needed to further examine the possibility that NWA 1110 and NWA 1068 are paired.

References: [1] Russell S.S. et al. (2002) Met. Bull. 86, *MAPS* **37**, A157. [2] van Niekerk D. (2003) this volume. [3] Goodrich C.A. (2002) *LPI Contribution No. 1134*, 17. [4] Goodrich C.A. (2003) *GCA*, in press. [5] Taylor L.A. et al. (2002) *MAPS* **37**, 1107. [6] Barrat J.A. et al. (2002) *GCA*

66, 3505. [7] Folco L. et al. (2000) *MAPS* **35**, 827. [8] Goodrich C.A. et al. (2003) this volume. [9] Sack R.O. and Ghiorso M.S. (1991) *Am. Mineral.* **76**, 827. [10] Herd C.D.K. et al. (2002) *GCA* **66**, 2025.

*Additional samples of NWA 1110 can be obtained from Matt Morgan (mmorgan@mhmeteorites.com).

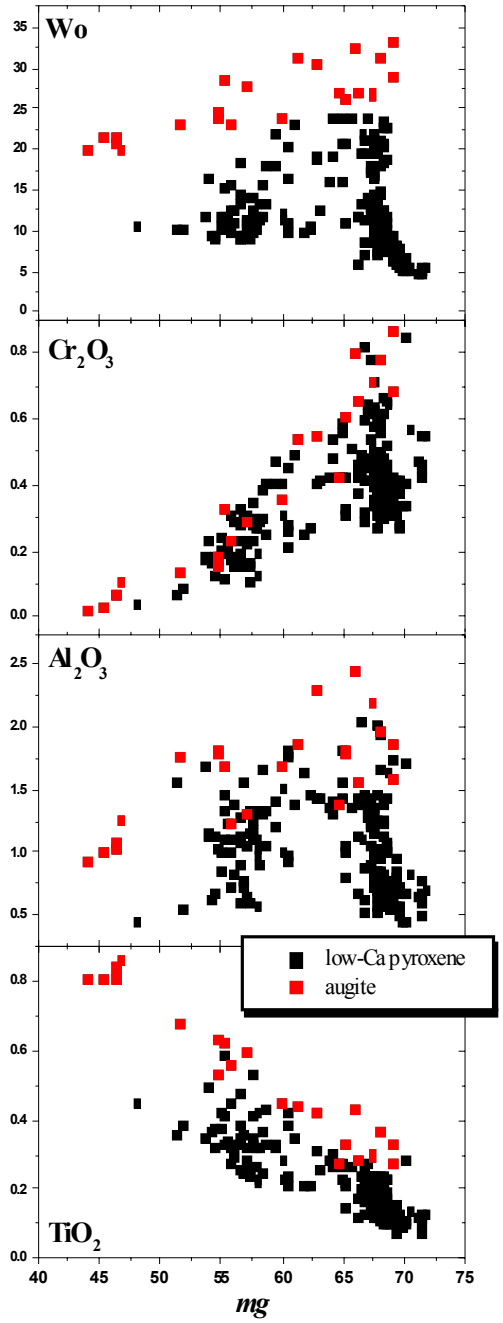

Fig 2. Compositional variation (oxides in wt.%) of pyroxenes in NWA 1110. Though Wo contents vary continuously from ~5 to 35, two distinct trends of augite and low-Ca pyroxene (pigeonite to intermediate) can be distinguished. Peak in Al_2O_3 trend of low-Ca pyroxene at *mg* ~65 indicates onest of plagioclase crystallization.

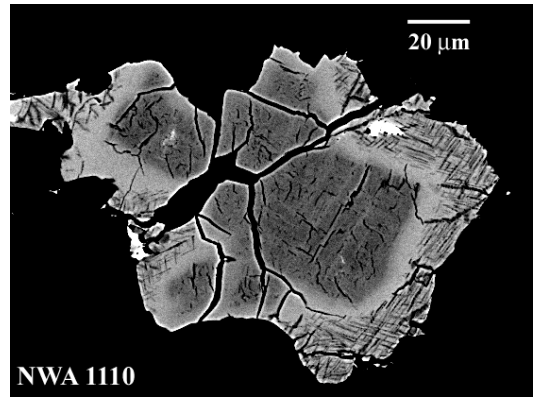

Fig. 3. Back-scattered electron image of type 2 spinel grain with low-Ti chromite core and chromian ulvöspinel rim (outermost edge has coarsely exsolved ilmenite). Despite sharp appearance of the core/rim boundary, compositional variation across it is nearly continuous (Fig. 4).

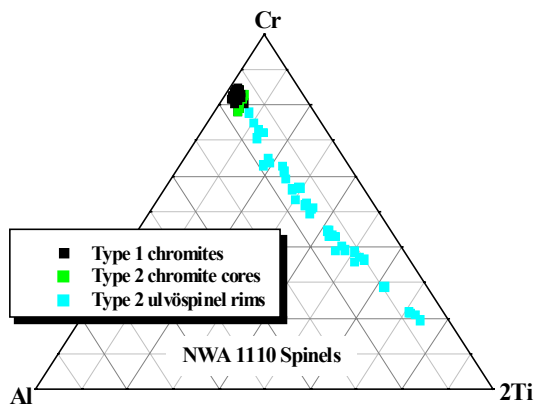

Fig. 4. Spinels in NWA 1110 in the system chromite (Cr) – ulvöspinel (2Ti) – spinel (Al).

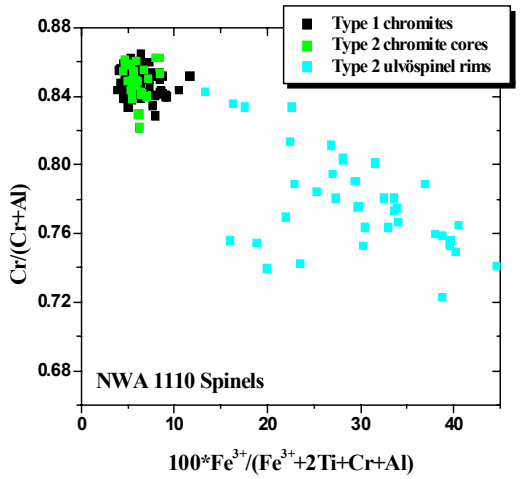

Fig. 5. Cr#s of spinels in NWA 1110 are similar to those in other olivine-phyric shergottites, but magnetite contents of both chromite and ulvöspinel are significantly higher [3-5,8].