PETROLOGY AND BULK COMPOSITION OF PRIMITIVE ENRICHED OLIVINE BASALTIC SHERGOTTITE NORTHWEST AFRICA 4468. A. J. Irving[1], S. M. Kuehner[1], R. L. Korotev[2] and G. M. Hupé
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Discovery: A superbly fresh, fusion crusted 675 gram stone was found in Western Sahara in summer 2006 and acquired after an adventuresome journey [1].

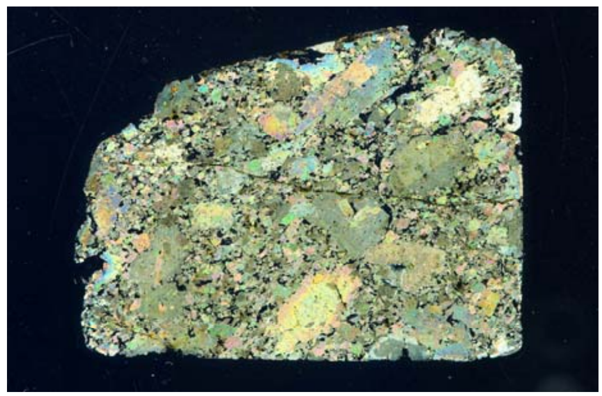
Figure 1: Whole NWA 4468 stone. Note the large pyroxene oikocrysts visible through the fusion crust.

Petrology: Large ovoid pyroxene grains are clearly visible through the black fusion crust (see Figure 1 and a 3-D movie at http://www.lunarrock.com/nwa4468/nwa4468videoredsmall.avi) and in a large area thin section prepared by Michael DePangher (Figure 2).

This specimen consists of pyroxene oikocrysts (2-10 mm across) enclosing chadacrysts of Ti-poor chromite and olivine set in an interstitial matrix of 35% olivine ($Fa_{40.7}$, FeO/MnO = 50.2), 30% clinopyroxene ($Fs_{31.3}Wo_{8.1}$, $Fs_{19.6}Wo_{31.3}$), 25% maskelynite ($An_{38.7-54}Or_{3.9-2.3}$), Ti-chromite, ilmenite, merrillite, Cl-apatite (as prisms up to 0.8 mm long) and pyrrhotite. Pyroxene oikocrysts are zoned from orthopyroxene cores ($Fs_{24.5}Wo_{4.4}$, FeO/MnO = 35.4) with mantles of pigeonite ($Fs_{26.3}Wo_{6.3}$, FeO/MnO = 29.4) to augite rims ($Fs_{17.9}Wo_{33.6}$, FeO/MnO = 24.9). Olivine chadacrysts (as magnesian as $Fa_{28.8}$) typically become progressively more ferroan from core to rim (see Figure 3).

Inclusions (up to 300 μm across) surrounded by radial shock relaxation fractures occur within matrix olivine grains. Some are quenched melt inclusions (Figure 4) and others consist mainly of inhomogeneous K-Na-Ca feldspar 'maskelynite' (e.g., $Or_{52.6}Ab_{40.7}An_{6.7}$ - see Figure 5). Thin, dark, glassy shock veins cross-cutting the meteorite formed before the fusion crust, but appear to have undergone marginal remelting.

Figure 2: Plane-polarized (above) and cross-polarized (below) optical thin section images of NWA 4468. Rock area is 3.8 cm x 2.8 cm. Note fusion crust on top edge and cross-cutting shock glass veinlets.



Bulk Composition: The coarse grainsize and heterogeneity of this specimen precludes obtaining a representative bulk rock composition without sacrificing many grams of rock material, so instead we chose to analyze the very fresh glassy fusion crust. Portions of crust (with minor attached mineral grains) were carefully pried from a ¼-slice of the specimen and two ~20 mg aliquots were analyzed by INAA. Preliminary mean abundances are: (in wt. %) FeO 23.0, Na_2O 1.09; (in ppm) Cs 0.27, Sc 25.6, Cr 5780, Co 72.4, Ni 325, Zn 75, Hf 1.5, Th 0.0.32, La 1.92, Ce 5.1, Sm 1.06, Eu 0.42, Tb 0.32, Yb 1.13, Lu 0.17. The REE pattern (see Figure 6) is subparallel to that of olivine-phyric shergottite NWA 1068, and both are slightly enriched in light REE and depleted in heavy REE relative to all other so-called "enriched" basaltic shergottites.

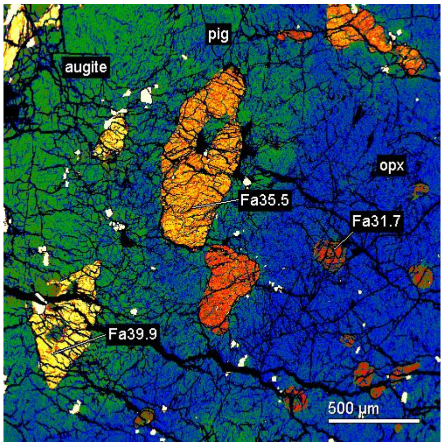


Figure 3: Part of a pyroxene oikocryst (Figure 2, bottom center) enclosing small chromite and olivine chadacrysts, which become progressively more ferroan from orthopyroxene core (right) to augite rim (left).

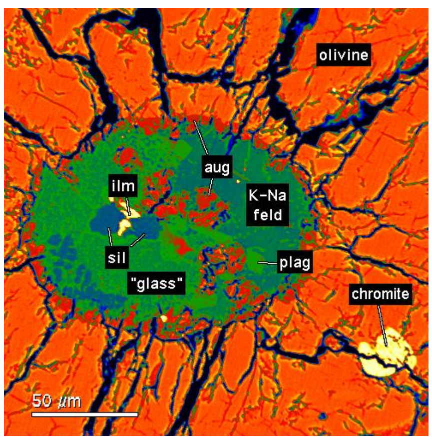


Figure 4: Crystallized melt inclusion surrounded by radial post-shock re-expansion cracks.

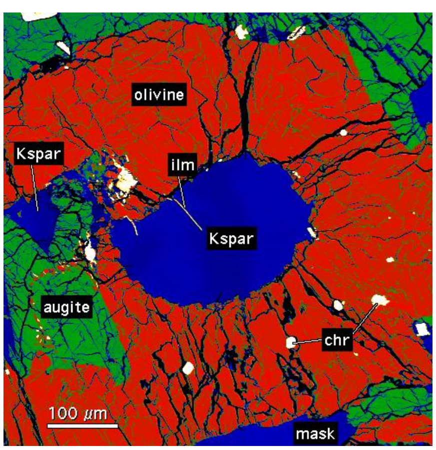


Figure 5: Inhomogeneous K-Na-feldspar 'maskelynite' inclusion surrounded by radial re-expansion cracks.

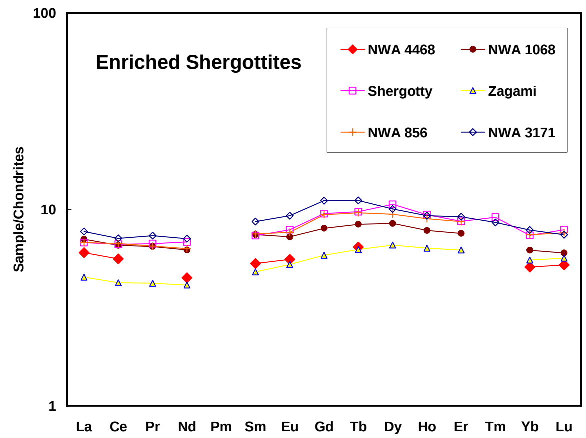


Figure 6: Chondrite-normalized REE abundances of NWA 4468 fusion crust compared with abundances for olivine-phyric shergottite NWA 1068 and other "enriched" *olivine-free* shergottites (data from [2]). Sm/Nd ratio for NWA 4468 from isotope dilution data for interior matrix sample.

Discussion: NWA 4468 does not have an olivine-phyric texture like NWA 1068/1110, yet unlike all other enriched basaltic shergottites NWA 4468 is quite olivine-rich and also has large, early-formed orthopyroxene oikocrysts. Similarities to NWA 1068 in bulk FeO and most Mg-rich olivine composition indicate that NWA 4468 represents a primitive Martian magma, and both of these specimens are less magmatically evolved than Shergotty, Zagami, NWA 3171 and other olivine-free basaltic shergottites.

Preliminary Rb-Sr and Sm-Nd isotopic data for a "whole rock" matrix sample (L. Nyquist, C.-Y. Shih and Y. Reese, pers. comm.) show that NWA 4468 is very similar to NWA 1068 and NWA 3171, and thus probably has a formation age near 175±10 Ma. The chondrite-normalized Sm/Nd ratio is ~1.75, and NWA 4468 appears to represent a melt from the same mantle source as Shergotty, NWA 1068, etc. This source also appears to be more oxidized than older Martian mantle sources [3, 4, 5], possibly as a result of "young" mantle metasomatism by hydrous, halogen-bearing fluids.

References: [1] Hupé G. M. (2006) *Meteorite* **12**, 24-29 [2] Lodders K. (1998) *MAPS* **33**, A183-190; Barrat J.-A. et al. (2001) *MAPS* **36**, 23-29; Jambon A. et al. (2002) *MAPS* **37**, 1147-1164; Barrat J.-A. et al. (2002) *Geochim. Cosmochim. Acta* **66**, 3505-3518; Irving A. J. et al. (2007) *MAPS*, submitted [3] Shearer C. K. et al. (2006) *Amer. Mineral.* **91**, 1657-1664 [4] Herd C. D. K. (2006) *Amer. Mineral.* **91**, 1616-1627 [5] Shearer C. K. et al. (2007) *This conference*.