PRISTINE OLIVINE-PHYRIC SHERGOTTITE NORTHWEST AFRICA 6162: A PRIMITIVE MAGMA WITH ACCUMULATED CRYSTALS DERIVED FROM DEPLETED MARTIAN MANTLE. S. M. Kuehner[1], A. J. Irving[1], C. D. K. Herd[2], M. Gellissen[3], T. J. Lapen[4] and D. Rumble, III[5] [1]Dept. of Earth & Space Sciences, University of Washington, Seattle, WA 98195 (kuehner@ess.washington.edu), [2]Dept. of Earth & Atmospheric Sciences, University of Alberta, Edmonton, AB, [3]Institute of Geosciences, Universität zu Kiel, Germany, [4]Dept. of Earth & Environmental Sciences, University of Houston, TX, [5]Geophysical Laboratory, Carnegie Institution, Washington, DC.

An exceptionally fresh 89 gram achondritic meteorite completely coated by black fusion crust found in 2010 near Lbirat, southern Morocco is a primitive olivine-phyric Martian igneous rock with some similarities to Sayh al Uhaymir 005 and paired stones [1].

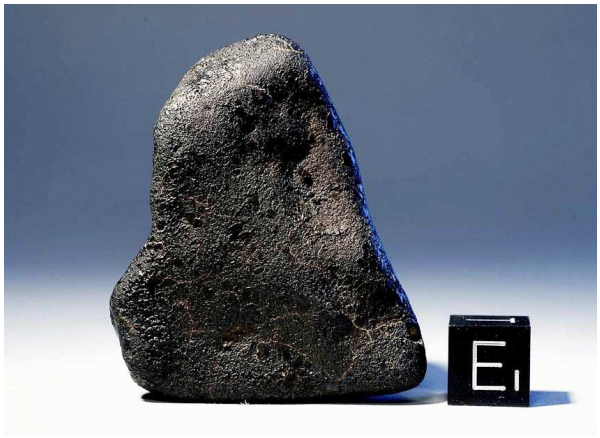
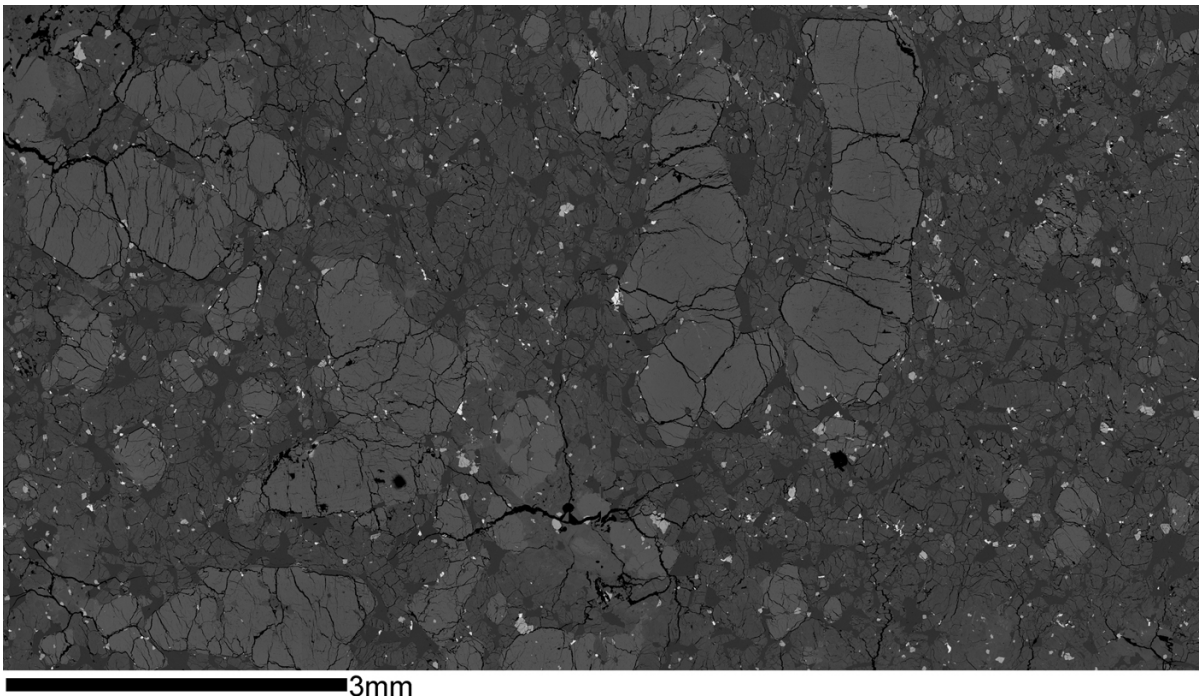


Figure 1. *Whole fusion-crusted Northwest Africa 6162 stone. Photo © S. Ralew.*

Figure 2 (above). *Endcut fragment, showing yellow-green olivine grains in a pale beige pigeonite-rich groundmass. Shock glass pockets are black. Scale cube is 1 cm. Photo © S. Ralew.*

Figure 3 (below). *Back-scattered electron image showing large anhedral olivine macrocrysts in a groundmass of pigeonite (gray), maskelynite (darkest gray), chromite (light gray) and pyrrhotite (bright).*



Petrography: NWA 6162 consists of large (up to 3 mm), anhedral olivine grains (some in clusters) set in a finer grained groundmass of intergrown pigeonite ($Fs_{22.9-28.6}Wo_{5.0-9.7}$, FeO/MnO = 27.5-30.4) and maskelynite ($An_{62.1-65.8}Or_{0.5-0.3}$) with accessory ferroan olivine, Ti-rich chromite [(Cr/(Cr+Al) = 0.768, TiO_2 = 15.6 wt.%], pyrrhotite and Mg-bearing merrillite. Olivine macrocrysts are mildly zoned from cores as magnesian as $Fa_{28.6}$ to rims as ferroan as $Fa_{34.9}$ (FeO/MnO = 48.4-54.2), and contain inclusions of Ti-poor chromite [(Cr/(Cr+Al) = 0.849-0.819, TiO_2 = 0.6-2.5 wt.%)

Oxygen Isotopes: Analyses of two acid-washed whole rock subsamples by laser fluorination gave, respectively: $\delta^{18}O$ = 4.677, 3.979; $\delta^{17}O$ = 2.748, 2.364; $\Delta^{17}O$ = 0.288, 0.271 per mil. These results plot near the mean of the range for many other shergottites [2].

Bulk Elemental Composition: Powders from representative clean wire-sawn dust from NWA 6162 and > 1 g interior slices of depleted shergottites NWA 4925 and 1195 were analyzed by XRF, ICP-MS and TIMS.

	NWA 6162	*NWA 4925*		*NWA 6162**	*NWA 4925*	*NWA 1195*
SiO_2	46.57	44.53	La	0.25	0.15	0.26
TiO_2	0.33	0.78	Ce	0.66	0.44	0.67
Al_2O_3	4.05	4.77	Pr	0.098	0.090	0.111
Cr_2O_3	0.90	0.63	Nd	0.61	0.66	0.72
FeO_T	18.32	16.70	Sm	0.43	0.57	0.56
MnO	0.47	0.51	Eu	0.22	0.46	0.32
MgO	21.75	15.90	Gd	0.85	1.18	1.25
CaO	5.09	6.52	Tb	0.18	0.25	0.26
Na_2O	0.53	0.88	Dy	1.28	1.79	1.83
K_2O	0.02	0.06	Ho	0.28	0.40	0.40
P_2O_5	0.29	0.82	Er	0.82	1.14	1.13
SUM	98.32	92.10	Tm	0.12	0.16	0.16
mg	0.679	0.629	Yb	0.75	1.04	1.03
			Lu	0.12	0.15	0.15

*****V 112, Co 42.5, Ni 223, Hf 0.46, Rb 0.37, Sr 28.7 ppm

Neodymium and Osmium Isotopes: NWA 4925 whole rock has $^{143}Nd/^{144}Nd$ = 0.514975 ± 8 or a modern day ε_{Nd} value of +45.60; analysis of NWA 6162 whole rock is in progress. If NWA 4925 is similar in age to other shergottites (~150-580 Ma), then its Nd isotopic ratio is consistent with a long-term depleted source similar to that indicated for SaU 005, NWA 1195, NWA 5789 and Yamato 980459. Siderophile element abundances and Os isotopic compositions of NWA 4925 and NWA 6162 are being determined.

Discussion: NWA 6162 is a fairly primitive Martian magmatic rock, but its bulk composition plots in the field for ultramafic shergottites (Figure 5). Liquidus olivine should be $Fa_{14.5}$ using a K_D value of 0.36 [3], i.e., 14 mole% less ferroan than the observed macrocryst cores. This implies that some of the olivine crystals in this sample were accumulated into a less

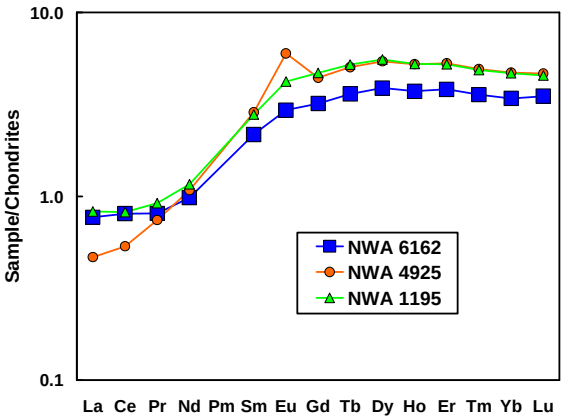
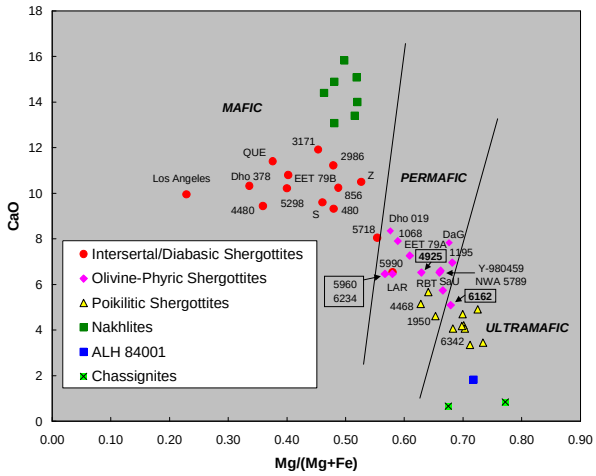


Figure 4 (above). *Chondrite-normalized bulk REE abundances for NWA 6162 and two other depleted olivine-phyric shergottites analyzed in this study by ICP-MS.* **Figure 5 (below).** *Bulk Mg/(Mg+Fe) vs. CaO variation for Martian igneous rocks.*



primitive magma batch. Overall, NWA 6162 has many similarities to SaU 005, and early-formed olivine crystals in both probably were variably modified by reaction with enclosing magmatic liquids (possibly also accounting for the anhedral olivine crystal shapes).

Judging from its freshness, NWA 6162 probably has a much shorter terrestrial residence age than other depleted olivine-phyric shergottites such as SaU 005 (11 ka), NWA 1195, NWA 2046, NWA 2626, NWA 5789, DaG 476, Yamato 980459 (all 40-200 ka), and NWA 4925 (>400 ka) [4], yet all of these specimens might be genetically related and could have been ejected from Mars together around 1 My ago [4].

References: [1] Zipfel J. (2000) *Meteorit. Planet. Sci.* **35**, A178; Gnos E. et al. (2002) *Meteorit. Planet. Sci.* **37**, 835-854 [2] Rumble D. and Irving A. (2009) *Lunar Planet. Sci.* **XL**, #1480 [3] Filiberto J. and Dasgupta (2010) *73rd Meteorit. Soc. Mtg.*, #5295 [4] Nishiizumi K. et al. (2011) *Lunar Planet. Sci.* **XLII**, this conference.

Website: http://www.imca.cc/mars/martian-meteorites.htm