PETROLOGIC, ELEMENTAL AND ISOTOPIC CHARACTERIZATION OF TWO UNUSUAL MARTIAN METEORITES: DEPLETED PERMAFIC MICROGABBROIC SHERGOTTITE NORTHWEST AFRICA 7032 AND INTERMEDIATE PERMAFIC INTERSERTAL SHERGOTTITE NORTHWEST AFRICA 7042.

A. J. Irving[1], S. M. Kuehner[1], G. Chen[2], C. D. K. Herd[2], R. Tanaka[3] and T. J. Lapen[4] [1]Dept. of Earth & Space Sciences, University of Washington, Seattle, WA 98195, USA (irving@ess.washington.edu), [2]Dept. of Earth & Atmospheric Sciences, University of Alberta, Edmonton, Canada, [3]Institute for Study of the Earth's Interior, Okayama University, Misasa, Japan, [4]Dept. of Earth & Environmental Sciences, University of Houston, TX, USA.

Two recently discovered unpaired shergottites from Northwest Africa bring the total number of Martian meteorites to 61 (and counting). Northwest Africa 7032 is a fresh 85 gram fusion-crusted stone with a texture previously not recognized among shergottites, and Northwest Africa 7042 (3033 grams) represents a "missing link" among shergottites of intermediate trace element character.

Northwest Africa 7032

Figure 1. *Two views of whole Northwest Africa 7032 stone (width 5 cm) showing the fusion crust and medium-grained plutonic igneous texture.*

Northwest Africa 7042

Figure 2. *Whole Northwest Africa 7042 stone. The exterior surface is a thin weathering rind.*

Petrography: NWA 7032 is medium grained (grainsize up to 0.9 mm) with a plutonic (non-cumulate), microgabbroic texture (see Figure 3). It is composed of ~40 vol.% olivine ($Fa_{45.7\text{-}46.1}$, FeO/MnO = 49-51), ~35 vol.% clinopyroxene (pigeonite $Fs_{26.6}Wo_{15.7}$; subcalcic augite $Fs_{23.7}Wo_{25.3}$; FeO/MnO = 28-30) and ~20 vol.% maskelynite ($An_{60.0\text{-}62.2}Or_{0.4\text{-}0.3}$), plus accessory chromite (with variable Ti contents), ilmenite, pyrrhotite and rare Mg-merrillite. Shocked plagioclase has been completely converted to water-clear maskelynite, which contains vapor bubbles. All of the constituent minerals exhibit very limited compositional variation.

NWA 7042 consists of complexly-zoned pyroxene and zoned olivine with ~15 vol.% interstitial maskelynite ($An_{48.6\text{-}54.5}Or_{1.7\text{-}1.8}$, in groups of lath-like grains in parallelt intergrowth with ferroan pigeonite), plus accessory Ti-poor chromite, ilmenite (some intergrown with ulvöspinel), pyrrhotite and merrillite (see Figure 3). Olivine is zoned from cores of $Fa_{28.5\text{-}30.1}$ (FeO/MnO = 46-52) to rims of $Fa_{46.0\text{-}48.1}$ (FeO/MnO = 48-52). Both pigeonite ($Fs_{29.0}Wo_{13.4}$,) and subcalcic augite ($Fs_{22.4}Wo_{31.4}$) occur in the cores of pyroxene grains

FeO/MnO = 26-29); rims and matrix grains are ferroan pigeonite ($Fs_{41.5-44.5}Wo_{17.5-9.0}$, FeO/MnO = 35-36).

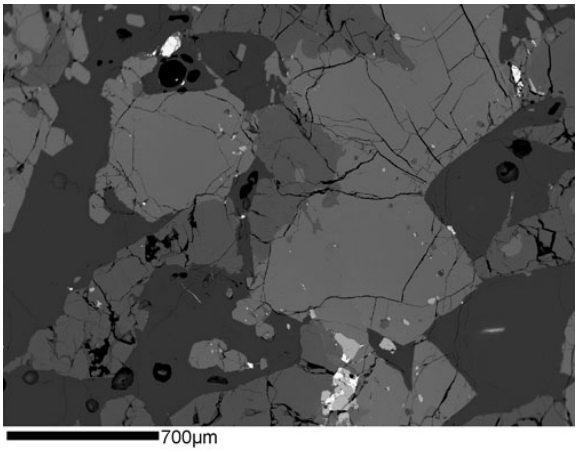
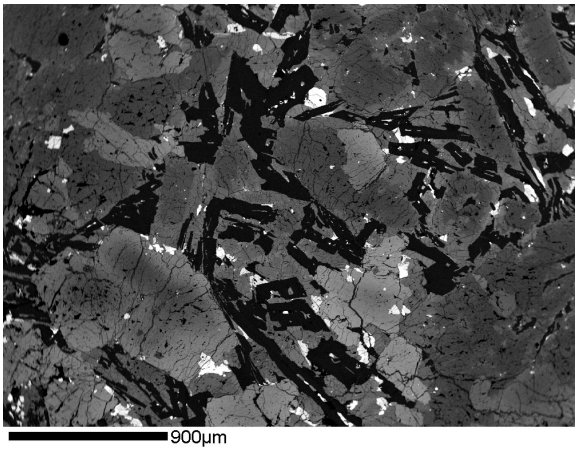


Figure 3. *Back-scattered electron images of NWA 7032 (above) and NWA 7042 (below). Olivine (lightest gray), pyroxene (medium gray), maskelynite (darkest) and chromite+ pyrrhotite (white). Notice the bubbles and lack of zoning in NWA 7032 compared with strong zoning and lath-like maskelynite in NWA 7042.*



Oxygen Isotopes: Analyses of acid-washed whole rock subsamples by laser fluorination gave the following results, respectively: *NWA 7032* $\delta^{18}O$ = 4.599, 4.423; $\delta^{17}O$ = 2.681, 2.577; $\Delta^{17}O$ = 0.259, 0.248 per mil; *NWA 7042* $\delta^{18}O$ = 5.326, 5.079; $\delta^{17}O$ = 3.102, 3.016; $\Delta^{17}O$ = 0.298, 0.341 per mil. The real differences in these values (both between and within specimens) continue the pattern found for many other shergottites [1], which appears to be an intrinsic Martian feature and not a result of terrestrial weathering.

Bulk Elemental Compositions: ICP-MS analyses were conducted on representative clean cutting dust of NWA 7032, and on powder prepared from 1.5 grams of interior material of NWA 7042. Preliminary abundances (NWA 7032/NWA 7042) are (in ppm):

La	0.54/0.90	Eu	0.86/0.79	Er	3.63/1.44
Ce	1.91/2.39	Gd	5.37/2.01	Tm	0.49/0.20
Pr	0.43/0.36	Tb	0.98/0.38	Yb	2.91/1.24
Nd	4.05/1.95	Dy	6.24/2.46	Lu	0.42/0.17
Sm	2.66/1.07	Ho	1.29/0.52	Hf	1.75/1.31

Based on their REE patterns (Figure 4), NWA 7032 has affinities with depleted shergottites whereas NWA 7042 has affinities with intermediate shergottites.

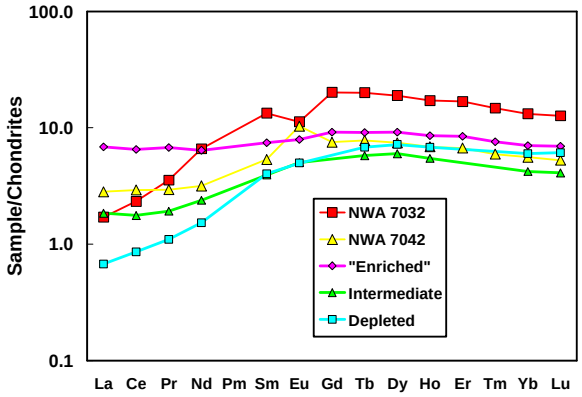


Figure 4. *Chondrite-normalized bulk REE abundances for NWA 7032 and NWA 7042 compared with average patterns for depleted, intermediate and "enriched" shergottites.*

Sr-Nd-Hf Isotopes: Analyses of whole rock powders of NWA 7032 and NWA 7042 are in progress, and will be reported.

Discussion: The plutonic gabbroic texture and relative homogeneity of constituent minerals in NWA 7032 distinguish it from other known shergottites. It does have compositional affinities with QUE 94201 and NWA 5990, which have less coarse, diabasic textures [2]. However, all other depleted shergottites discovered so far are markedly olivine-phyric. NWA 7042 has some textural similarities to NWA 480/1460 [3] and NWA 5029 [4], but differs in containing olivine. There also are some similarities with NWA 2646 [5], yet no poikilitic domains have been observed in NWA 7042.

Both of these specimens are important in expanding the textural and compositional ranges among Martian igneous rocks.

References: [1] Rumble D. and Irving A. (2009) *Lunar Planet. Sci.* **XL**, #1480 [2] Irving A. et al. (2010) *Lunar Planet. Sci.* **XLI**, #1883 [3] Nyquist L. et al. (2009) *Geochim. Cosmochim. Acta* **XL**, #2274 [4] Mikouchi T. and Barrat J.-A. (2009) *72nd Meteorit. Soc. Mtg.*, #5344 [5] Bunch T. et al. (2005) *68th Meteorit. Soc. Mtg.*, #5313.

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