PETROLOGIC, ELEMENTAL AND ISOTOPIC CHARACTERIZATION OF SHOCK-MELTED, ENRICHED ULTRAMAFIC POIKILITIC SHERGOTTITE NORTHWEST AFRICA 6342. A. J. Irving[1], T. E. Bunch[2], S. M. Kuehner[1], C. D. K. Herd[3], M. Gellissen[4], T. J. Lapen[5], D. Rumble, III[6] and D. Pitt [1]Dept. of Earth & Space Sciences, University of Washington, Seattle, WA 98195 (irving@ess.washington.edu), [2]Dept. of Geology, Northern Arizona University, Flagstaff, AZ, [3]Dept. of Earth & Atmospheric Sciences, University of Alberta, Edmonton, Canada, [4]Institute of Geosciences, Universität zu Kiel, Germany, [5]Dept. of Earth & Environmental Sciences, University of Houston, TX, [6]Geophysical Laboratory, Carnegie Institution, Washington, DC.

A fresh, dense 72 gram achondrite partly coated by black fusion crust found in Algeria in 2010 is an unusual ultramafic shergottite, and is the first such specimen with affinities to the "enriched" Martian mantle source. This meteorite experienced very high shock pressures and temperatures of similar magnitudes to those documented in ALHA 77005 and NWA 4797.

Figure 1. *Cut Northwest Africa 6342 stone (width 4 cm) showing regions rich in olivine (yellow-green) and pyroxene (dark gray).*

Figure 2. *Partially cross-polarized light thin section image showing different textural domains. Dark regions are feldspathic melt pockets. Width = 23 mm.*

Petrography: NWA 6342 is texturally heterogeneous, with both poikilitic and non-poikilitic domains (see Figures 1, 2). Poikilitic domains consist of oikocrysts of pyroxene (mostly pigeonite with some subcalcic augite: $Fs_{17.4\text{-}25.6}Wo_{5.5\text{-}9.0}$ and $Fs_{15.4\text{-}26.1}Wo_{32.3\text{-}31.2}$, FeO/MnO = 24.0-31.7) enclosing chadacrysts of olivine ($Fa_{31.4\text{-}34.6}$, FeO/MnO = 42.0-56.1), with accessory Mg-bearing merrillite, feldspathic material, Ti-bearing chromite, ilmenite, pentlandite and pyrrhotite. Feldspathic "intercumulus" material (~5 vol.%) occurs in pockets interstitial to mafic silicates, and consists of vesicular glass of intermediate plagioclase composition ($An_{48.3\text{-}55.2}Or_{1.5\text{-}0.6}$) containing subparallel to fanning, acicular crystals of pigeonite, ilmenite, merrillite, olivine and sulfides (suggestive of rapid quenching). There is evidence of extensive high intensity shock metamorphism, which includes multiphase vesicular melt pockets, injection veins cutting primary minerals, complete recrystallization of olivine and some pigeonite to micron-sized subgrains within their original grain outlines, and recrystallization of augite grains into microspherulitic domains (see Figures 3a, 3b).

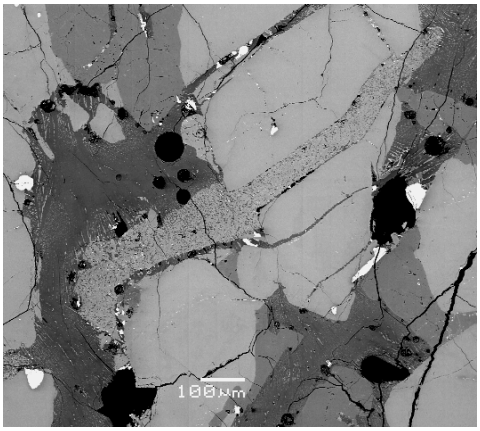
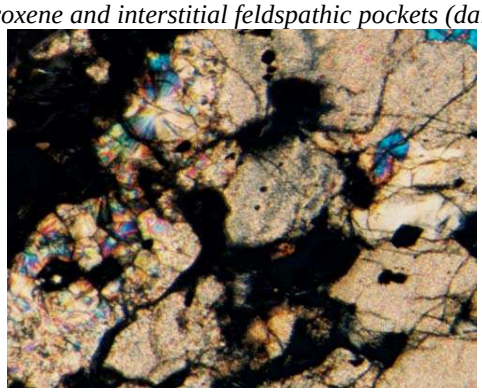


Figure 3a. (above) *BSE image of vesicular melt pocket region with injection veinlets of plagioclase (darker) and merrillite cutting olivine.* **3b. (below)** *Cross-polarized light image (width 2 mm) showing finely recrystallized olivine (beige), spherulitic clinopyroxene and interstitial feldspathic pockets (dark).*



Oxygen Isotopes: Analyses of two acid-washed whole rock subsamples by laser fluorination gave, respectively: $\delta^{18}O$ = 4.08, 3.97; $\delta^{17}O$ = 2.44, 2.38; $\Delta^{17}O$ = 0.292, 0.288 per mil. These values are near the mean of the range found for many other shergottites [1].

Bulk Elemental Composition: Representative whole rock powder prepared from clean wire-saw cutting dust of NWA 6342 was analyzed by XRF (preliminary values below) and by ICP-MS. We also report here new major and trace element data for powder from a 1.9 gram interior slice of evolved enriched mafic shergottite Northwest Africa 5298.

	NWA 6342	*ALHA 77005*[2]	*NWA 5298*		*NWA 6342*	*NWA 5298*
SiO_2	42.44	43.08	48.77	La	0.77	3.15
TiO_2	0.45	0.44	1.06	Ce	1.89	7.52
Al_2O_3	3.33	2.59	8.11	Pr	0.266	1.07
Cr_2O_3	0.97	0.96	0.14	Nd	1.50	5.18
FeO_T	21.11	19.95	19.01	Sm	0.66	2.00
MnO	0.50	0.44	0.48	Eu	0.27	0.79
MgO	25.48	27.69	7.11	Gd	1.02	3.19
CaO	4.06	3.35	10.22	Tb	0.19	0.58
Na_2O	0.85	0.44	1.61	Dy	1.28	3.94
K_2O	0.12	0.03	0.22	Ho	0.27	0.82
P_2O_5	0.67	0.36	0.95	Er	0.72	2.32
SUM	99.98	99.33	97.68	Tm	0.10	0.32
mg	0.683	0.712	0.400	Yb	0.62	2.03
Other abundances:				Lu	0.09	0.29

NWA 6342 V 97, Co 71.8, Ni 4030, Hf 0.69, Rb 0.96, Sr 16.8, Ba 15.8 ppm. NWA 5298 Ni 28, Hf 2.7, Ba 90 ppm

The bulk composition of NWA 6342 has similarities to that of ALHA 77005, and plots within the field for other ultramafic shergottites (see Figure 4). Yet,

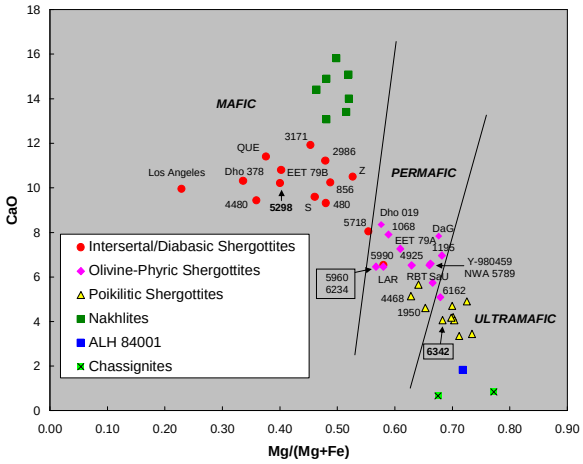


Figure 4. *Variation of Mg/(Mg+Fe) vs. CaO for bulk Martian igneous rocks including NWA 6342. Note that new data are plotted for NWA 5960 and NWA 6234 in lieu of that for paired specimen NWA 2990 [3], which was discarded as unrepresentative.*

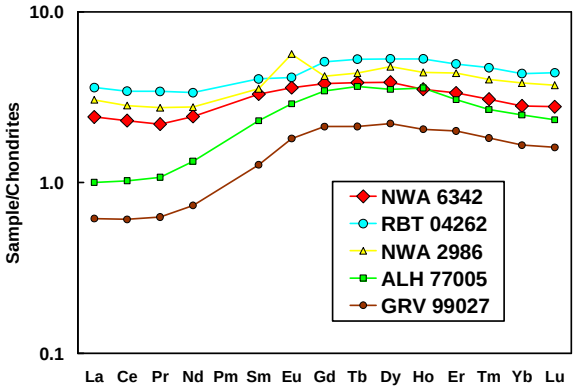


Figure 5. *Chondrite-normalized bulk REE abundances for NWA 6342 compared with patterns for "enriched" shergottites RBT 04262 [4] and NWA 2986 [5], and intermediate ultramafic shergottites ALHA 77005 [2] and GRV 99027 [6].*

NWA 6342 is more enriched in Al, Ca, Na, K and P, with a lower Mg/(Mg+Fe) ratio. Moreover, its REE pattern (see Figure 5) shows a higher Sm/Nd ratio than for other ultramafic shergottites, and is subparallel to patterns for "enriched" shergottites like RBT 04262. Thus, despite broad petrologic similarities to ALHA 77005 [7], NWA 6342 evidently is related to the "enriched" rather than intermediate Martian mantle source.

Sr-Nd-Hf-Os Isotopes: TIMS analyses of whole rock powders of NWA 6342 and NWA 5298 are in progress, and will be reported.

Conclusions: NWA 6342 represents a new type of Martian igneous rock with compositional characteristics that place it at the ultramafic end of the array of "enriched" shergottite specimens, which include a range of mafic to permafic examples. Given the existence of 8 or 9 ultramafic shergottites with intermediate compositional characteristics, it is quite possible that ultramafic shergottites related to the depleted source also await discovery. NWA 6342 experienced a high degree of shock; by comparison with features in NWA 4797 [8], localized pressures were at least 60 GPa (S6 stage of [9]), and localized post-shock temperatures exceeded the melting point of merrillite (1390°C).

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