PETROLOGY AND COMPOSITION OF LUNAR MARE BASALT METEORITE NORTHWEST AFRICA 8632 FROM CHWICHIYA, MOROCCO. R. L. Korotev[1], A. J. Irving[2], A. Wittmann[1], S. M. Kuehner[2], H. Chennaoui-Aoudjehane[3] and L. Labenne, [1]Dept. of Earth & Planetary Sciences, Washington University, St. Louis, MO, 63130 USA, (korotev@wustl.edu), [2]Dept. of Earth & Space Sciences, University of Washington, Seattle, WA, USA, [3]Dept. of Earth Sciences, Hassan II University, Casablanca, Morocco.

Introduction: NWA 8632, an unpaired lunar mare basalt meteorite, is a small (23.8 gram), dense black stone lacking fusion crust found in the Chwichiya region of southern Morocco. The find site was confirmed using GPS to be at 27°20.783' N, 11°52.05' W.

Here we describe its petrographic characteristics, and compare its bulk composition with those for other mare basalts found as meteorites or returned by sampling missions to the Moon.

Figure 1. *Whole NWA 8632 stone. © L. Labenne.*

Petrography: The specimen has a porphyritic texture and consists of subhedral zoned olivine phenocrysts (up to 2.3 mm long, yellowish in thin section, cores $Fa_{32.5–32.8}$, FeO/MnO = 90–100, rim $Fa_{48.8}$, FeO/MnO = 98) within a finer grained, quench-textured groundmass. The groundmass is composed mainly of elongate, skeletal, zoned clinopyroxene grains (clear with pink rims), smaller very ferroan olivine grains ($Fa_{72.6–74.1}$, FeO/MnO = 91–97), and interstitial regions (opaque in thin section) consisting of ilmenite needles, Ti-chromite, fine clinopyroxene, fayalite and glass.

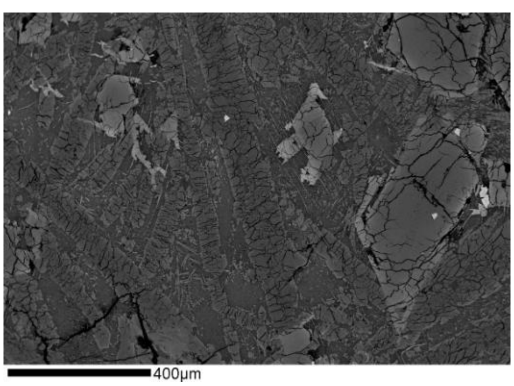


Figure 2. *BSE image of NWA 8632 highlighting the porphyritic texture, with olivine phenocrysts set in a much finer grained, quenched, plagioclase-free and oxide-poor groundmass.*

Clinopyroxene compositions include augite ($Fs_{23.7–27.1}Wo_{40.1-40.5}$, FeO/MnO = 53–55, TiO_2 = 2.4–2.6 wt.%, Al_2O_3 = 5.9–6.1 wt.%), subcalcic augite ($Fs_{26.6–27.0}Wo_{30.8–36.1}$, FeO/MnO = 54–60, TiO_2 = 1.9–2.1 wt.%, Al_2O_3 = 4.7–5.6 wt.%) and rims of ferroan subcalcic augite ($Fs_{41.9}Wo_{34.1}$, FeO/MnO = 63, TiO_2 = 3.2 wt.%, Al_2O_3 = 8.1 wt.%). Plagioclase is apparently absent. Small patches and veinlets of pale yellow devitrified glass are present (see Figure 3b), and probably represent shock melting during impact-induced ejection from the Moon.

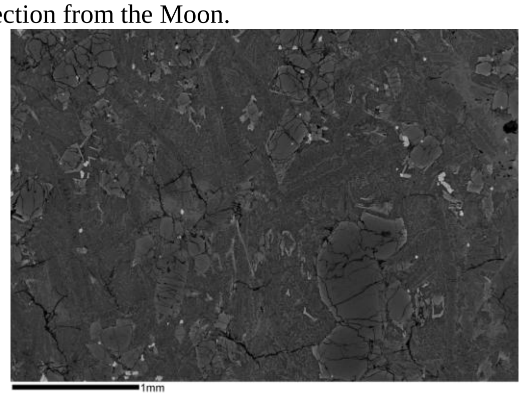
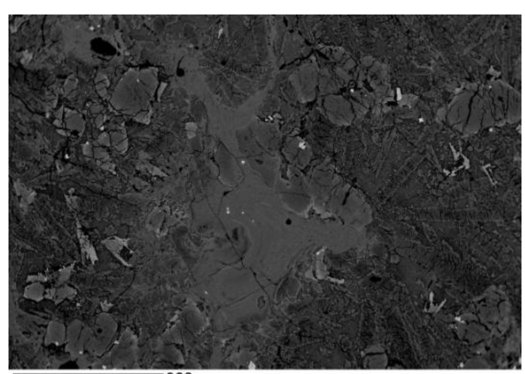


Figure 3. *BSE images of NWA 8632.* ***a (above)***. *Detail of pyroxene-rich groundmass and ferroan rims on olivine microphenocrysts.*
b (below). *Pocket and veinlets of devitrified glass cutting phenocrysts and groundmass.*



Bulk Chemical Composition: We analyzed three subsamples (total 64.2 mg) by instrumental neutron activation (Table 1). Major-element concentrations were determined by EPMA of "fused beads" [1] on two of the INAA samples (Table 1). NWA 8632 is a low-Ti basalt most similar in composition to, but in detail distinct from, NWA 032/479 and Apollo 12 pigeonite basalts [2].

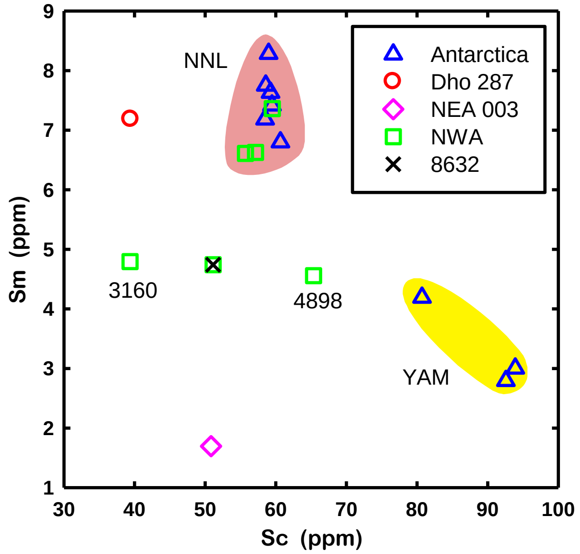


Figure 4. *Correlation of Sc and Sm abundances for NWA 8632 and other mare basalt meteorites. The NNL field comprises NWA 032/479, NWA 4734, and the 6 LAP stones. The YAM field comprises Yamato 793169, Asuka 881757, and MIL 05035.*

Compositional Relationships Among Mare Basalts: The Apollo and Luna missions to the Moon provided us with samples of mare basalts of diverse chemical types, and the burgeoning collection of mare basalts found on Earth as meteorites (now at least 10 specimens from four different countries) has added much to that knowledge. It is nevertheless remarkable that thus far not a single mare basalt meteorite matching the high-Ti samples at the Apollo 11 and Apollo 17 landing sites has been recovered (Fig. 5). In other words, if we had not gone to the Moon to obtain these rocks, we would not (yet) know about their existence from meteoritic specimens (although we could have inferred their existence from remote sensing, e.g., [3]). Thus we would be missing a significant part of the petrologic, compositional, and isotopic data on which to base models of lunar petrogenesis and evolutionary history.

References: [1] Korotev R. et al. 2009 *M&PS* **44**, 1287–1322. [2] Papike. J. et al. 1998 in *Reviews in Mineralogy* **36**, p. 7-1–7-11. [3] Lucey P. G. et al. (2000) *J. Geophys. Res.* **105**, 20,297–20,305.

Table 1. Mean composition of NWA 8632. The standard deviations (SD) are based on *N*=3 INAA determinations.

	%		ppm	SD
SiO_2	44.4	Sc	51	3
TiO_2	2.5	Co	49	2
Al_2O_3	8.0	Ni	<200	
Cr_2O_3	0.46	Sr	166	38
FeO	22.6	Ba	785	60
MnO	0.30	La	7.8	0.3
MgO	10.7	Ce	21.5	0.5
CaO	9.7	Nd	15.	3
Na_2O	0.28	Sm	4.74	0.10
K_2O	0.12	Eu	0.89	0.04
P_2O_5	0.09	Tb	1.15	0.02
SO_3	0.26	Yb	4.10	0.06
S	99.4	Lu	.579	0.004
Mg'	46.5	Hf	3.44	0.12
		Ta	038	0.07
		Ir	<5	ppb
		Au	<7	ppb
		Th	1.25	0.05
		U	0.50	0.34

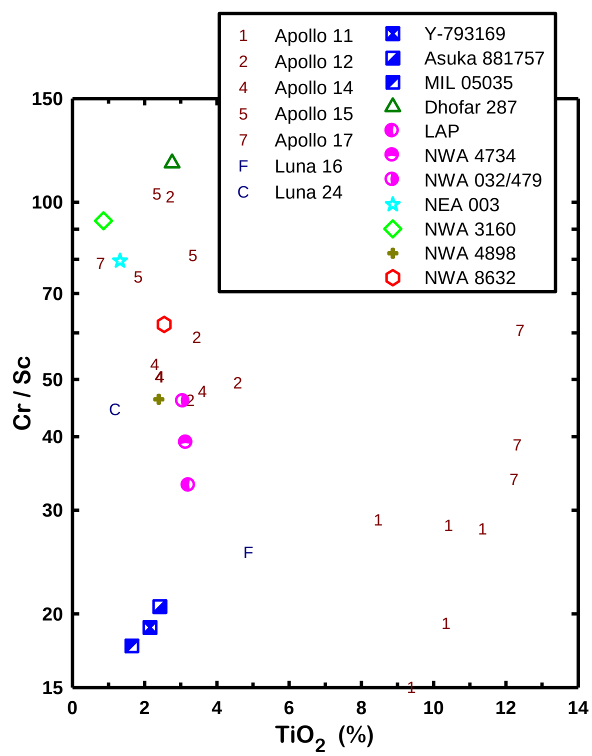


Figure 5. *Each alphanumeric point represents the mean composition of a major compositional group of mare basalts from the Apollo and Luna missions (e.g., Apollo 11 group A, Apollo 12 olivine, etc.). Cr/Sc is a proxy for Mg/Fe.*