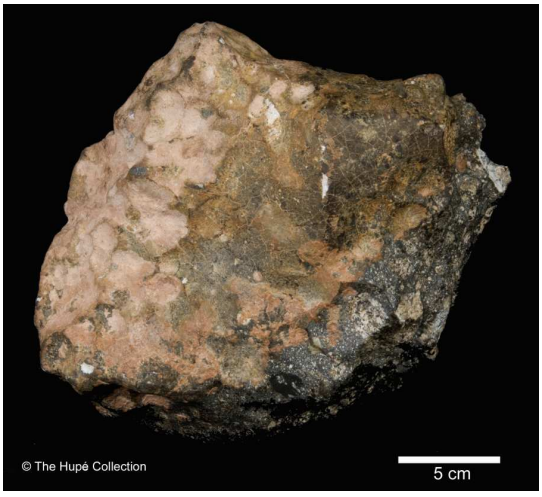
PETROLOGY AND BULK COMPOSITION OF LARGE LUNAR FELDSPATHIC LEUCOGABBROIC BRECCIA NORTHWEST AFRICA 5000. A. J. Irving[1], S. M. Kuehner[1], R. L. Korotev[2], D. Rumble III[3] and A. C. Hupé [1]Earth & Space Sciences, University of Washington, Seattle, WA 98195 (irving@ess.washington.edu), [2]Earth & Planetary Sciences, Washington University, St. Louis, MO, [3]Geophysical Laboratory, Washington, DC.

Introduction: A very large (11.528 kilogram) and fresh lunar meteorite found in southern Morocco in summer 2007 represents the second largest known lunar specimen. This cuboidal, 27 cm x 24 cm x 20 cm feldspathic rock is a near-monolithologic breccia composed predominantly of metal-bearing leucogabbroic clasts in a gray, partly glassy matrix (Figures 1A, 3).

Figure 1: Whole NWA 5000 stone. **A. (above)** Note very large gabbro clast mostly eroded by moisture and sand ablation. **B. (below)** Inferred underside (as found in the desert). Note regmaglypts coated with desert patina (left) and translucent fusion crust with fine contraction cracks (upper right).



Less abundant are black, vitreous-appearing clasts containing small whitish inclusions (Figure 2), small fine-grained white to medium gray clasts, and grains of metal (up to 4 mm). Pale greenish, translucent fusion crust with fine contraction cracks and regmaglypts are preserved on part of the stone (Figure 1B).

Figure 2: Inferred orientation as found in the desert. Note sparse black, vitreous clasts on top front edge and one in direct contact with eroded gabbro behind it.

Figure 3: Complete 19 cm slice cut parallel to the top surface shown in Figure 2. Note metal grains with minor rusty staining in leucogabbroic clasts and matrix.

Petrology: Some clasts are themselves breccias, implying that multiple impact and mixing events have affected a leucogabbroic to gabbroic anorthosite protolith. Most clasts consist of coarse grained (0.5-2.7 mm) calcic plagioclase ($An_{96.1\text{-}98.0}Or_{<0.1}$), pigeonite ($Fs_{32.0\text{-}64.5}Wo_{6.7\text{-}13.1}$, FeO/MnO = 51.1-62.0, some with fine exsolution lamellae) and olivine ($Fa_{23.9\text{-}58.8}$, FeO/MnO = 81-100) with accessory kamacite (up to 2 mm), merrillite, Mg-ilmenite, Ti-chromite, baddeleyite, rare zirconolite, silica polymorph, K-feldspar and troilite. Some gabbro clasts have shock injection veins composed mostly of glass containing myriad fine troilite blebs and engulfed mineral fragments.

Black, vitreous-appearing clasts consist of sporadic, small angular fragments (apparently surviving relics) of gabbro and related mineral phases in a very fine grained, non-vesicular matrix of thin pigeonite laths (up to 20 μm long x 2 μm wide) and interstitial plagioclase with tiny kamacite spheres, irregular grains of schreibersite and rare troilite (see Figure 4).

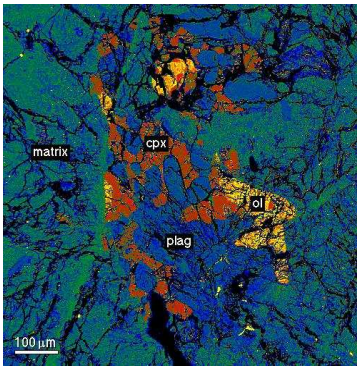
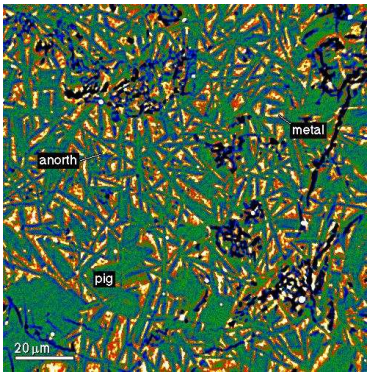


Figure 4: False-color BSE images of black impact melt clast. **A (above)** Relict gabbro fragment in fine matrix. **B (below)** Texture of quenched matrix.



Oxygen Isotopes: Replicate analyses of a gabbro clast by laser fluorination gave $\delta^{17}O$ = 2.601, 2.684; $\delta^{18}O$ = 5.014, 5.033; $\Delta^{17}O$ = -0.036, +0.037 per mil; the mean $\Delta^{17}O$ value falls within error on the TFL.

Bulk Composition: INAA of 10 small subsamples gave preliminary mean abundances of: (in wt. %) FeO 5.30, Na_2O 0.43; (in ppm) Sc 10.0, Cr 915, Co 19.6, Ni 240, Hf 1.0, Th 0.44, Ba 290, La 3.11, Ce 8.4, Sm 1.42, Eu 0.89, Tb 0.29, Yb 1.11, Lu 0.156, with considerable scatter (see Figure 5). The REE pattern has a moderate positive Eu anomaly. One leucogabbro subsample containing a grain of apparently igneous metal has 15.4 wt.% FeO, 6060 ppm Ni, 388 ppm Co, 300 ppb Ir and 102 ppb Au (with Ni/Co like in some irons). Two aliquots from a single black impact melt clast have higher Na contents (and one has much higher Cr) than the gabbroic subsamples; this may reflect a sampling effect both in the original production of shock melt and in modal heterogeneity between subsamples.

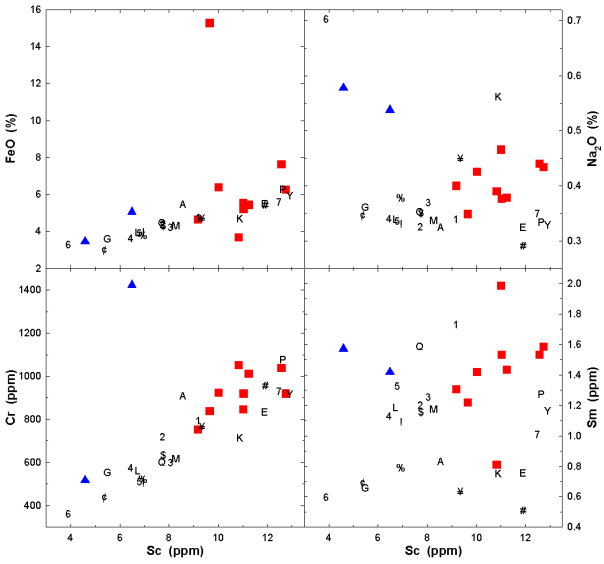


Figure 5: Compositions of NWA 5000 subsamples in comparison to other feldspathic lunar meteorites (keyboard symbols). Red squares = gabbro and matrix subsamples; blue triangles = black impact melt clast.

Conclusions: Based on our preliminary studies, NWA 5000 incorporates portions of an ancient feldspathic leucogabbroic massif in the lunar highlands, which was brecciated and veined by injected impact melt, then mixed in further impacts with sparse amounts of other lithologies, indurated during shallow burial, and finally ejected into an Earth-crossing orbit.

Reference: [1] Korotev R. L. (2005) *Chemie Erde* **65**, 297-346.

Acknowledgements: We very much appreciate the photographic and editing skills of Pat McGiffert, Adrian Giesy and Jim Wittke.