PETROLOGY AND COMPOSITION OF LUNAR METEORITE NORTHWEST AFRICA 7022: AN UNUSUALLY SODIC ANORTHOSITIC GABBROIC IMPACT MELT BRECCIA WITH COMPOSITIONAL SIMILARITIES TO MILLER RANGE 090036. S. M. Kuehner[1], A. J. Irving[1] and R. L. Korotev[2] [1]Dept. of Earth & Space Sciences, University of Washington, Seattle, WA 98195 (kuehner@ess.washington.edu), [2]Dept. of Earth & Planetary Science, Washington University, St. Louis, MO 63130.

Introduction: A 444 gram achondrite with partial fusion crust found near Tindouf, Algeria in February 2011 is dominated by a lithology not previously characterized in returned lunar samples. About two-thirds of the stone consists of a fragmental breccia composed of a variety of lighter colored, mostly angular mineral and rock clasts in a dark gray matrix. The other one-third of the stone is comprised of a single large (up to 4 cm in longest dimension), light gray, fine grained, melt-textured clast (which itself contains small remnant clasts) – see Figures 1 and 2.

Figure 1. *Closeup view of whole Northwest Africa 7022 stone showing the contact between the dark breccia lithology (below) and the fine grained clast (above). Width = 6 cm. Image © J. Utas.*

Petrography: The large, light gray clast contains sparsely-distributed angular grains of olivine ($Fa_{40.6-47.6}$; FeO/MnO = 114-117) and calcic plagioclase set in an melt-textured (ophitic) aggregate of calcic plagioclase ($An_{85.4-85.9}Or_{0.5}$) and zoned pigeonite ($Fs_{22.8-28.8}Wo_{5.9-22.2}$; FeO/MnO = 52-74), with accessory ilmenite, armalcolite, fayalite, troilite, silica polymorph, baddeleyite, merrillite, kamacite and rare zircon. Ilmenite (associated with baddeleyite and kamacite forms intersertal aggregates between tabular plagioclase grains (see Figures 3 and 4). The complex dark matrix portion consists of angular grains of olivine, low-Ca pyroxene, calcic plagioclase, Ti-bearing chromite, silica polymorph, silica+K-feldspar intergrowths, kamacite, feldspar-rich clasts (including additional melt-textured clasts), and sparse glass fragments containing tiny vesicles.

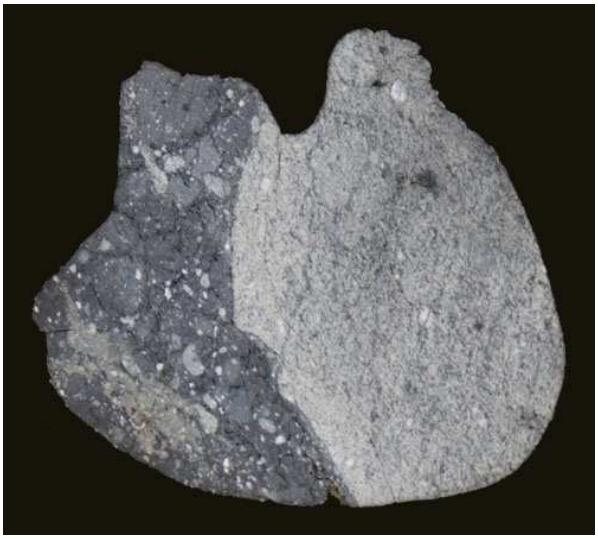

Figure 2. *Interior slice of Northwest Africa 7022 showing the two distinct lithologies. Note the sparse white clasts within the large melt-textured clast (right). The darker gray breccia portion (left) consists of smaller melt-textured clasts plus clasts of more feldspathic and KREEPy lithologies in a partly vitric matrix. Width = 6 cm. Image © A. Giesy.*

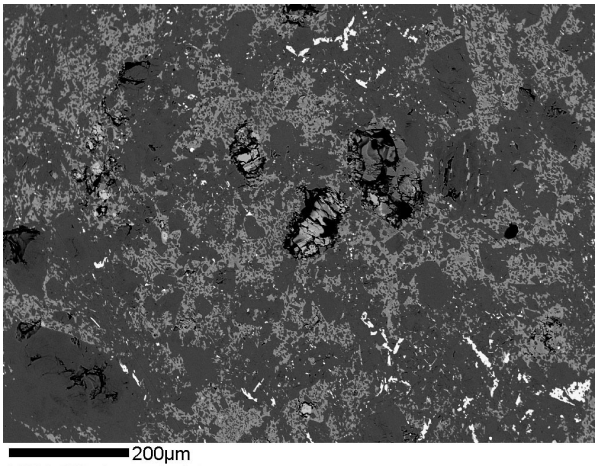

Figure 3. *Back-scattered electron image of a polished surface of the large melt-textured clast, showing angular clasts of olivine (center) and calcic plagioclase (dark gray). White intersertal grains are ilmenite.*

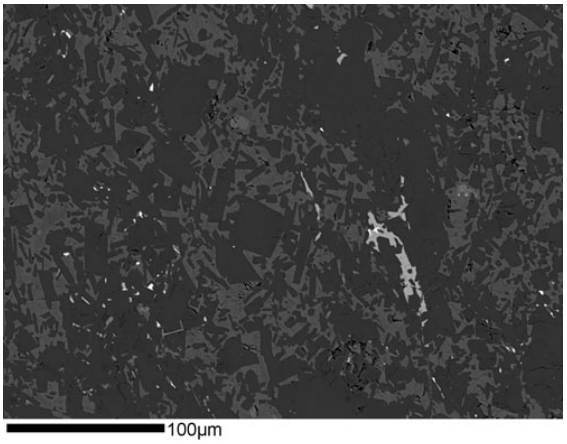

Figure 4. *Back-scattered electron image showing detail of the melt-textured matrix in the large clast. Brightest grains are baddeleyite (associated with largest ilmenite grain) and kamacite.*

Bulk Elemental Compositions: Preliminary elemental abundances determined by INAA on subsamples of NWA 7022 are as follows (matrix/clast): 5.2/6.2% FeO, 0.60/0.70% Na_2O, 10.3/ 13.4 ppm Sc, 200/140 ppm Ni, 5.6/9.1 ppm Sm, 1.36/1.54 ppm Eu, 2.0/3.0 Th. Concentrations of incompatible elements are at the high end of the range for feldspathic lunar meteorites [1, 2]. The composition of the fragmental matrix can be matched reasonably well as a mixture of 60% melt-textured clast + 40% highly feldspathic lunar meteorite (i.e., those with 3-4% FeO – see Figure 5).

NWA 7022 is notable among lunar samples for its somewhat elevated sodium content (manifested by the bytownite rather than anorthite composition of its constituent plagioclase). However, the matrix lithology is almost indistinguishable in compositional parameters from Miller Range 090036 ([3, 4] – see Figures 5 and 6).

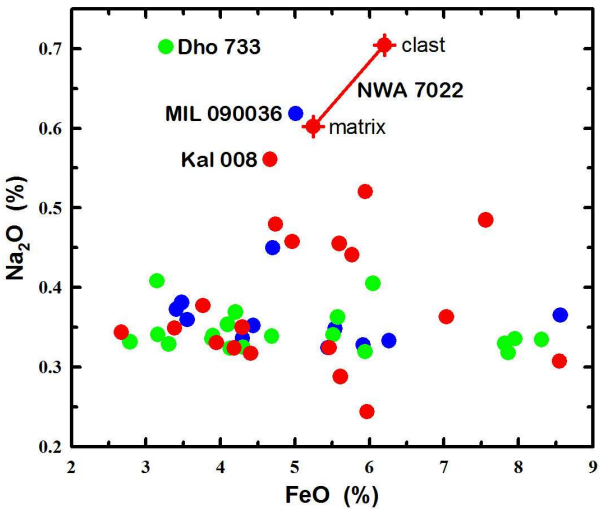

Figure 5. *Fe-Na comparison of the two lithologies of NWA 7022 to other feldspathic lunar meteorites. Red = Oman. Green = Africa. Blue = Antarctica.*

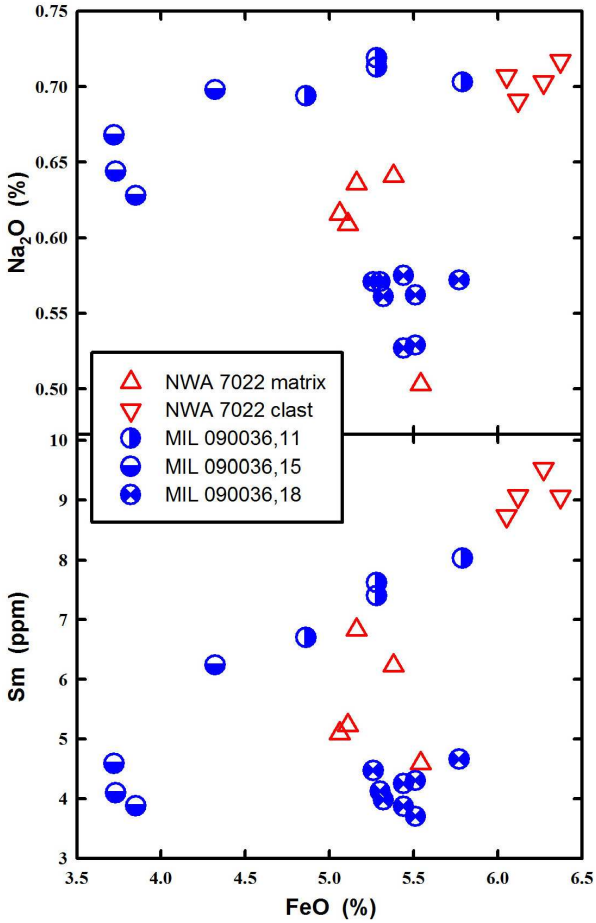

Figure 6. *Comparison of subsamples of NWA 7022 matrix and clast lithologies to subsamples of three samples of MIL 090036 [3]. All points represent 30–40 mg of material.*

Discussion: On the basis of both textures and mineral compositions we conclude that the large clast in NWA 7022 is a product of impact melting of a relatively sodic anorthositic gabbroic protolith with some admixture of KREEP component. The presence of relict clasts is typical of impact melted lunar highlands rocks [e.g., 5]. Compositionally, the components of NWA 7022 are most similar to Miller Range 090036, but we are unaware of any rock among the returned Apollo or Luna samples with a similar composition.

References: [1] Korotev R. et al. (2012) *This conference* [2] http://meteorites.wustl.edu/lunar/moon_meteorites.htm [3] Korotev R. et al. (2011) *Lunar Planet. Sci.* **XLII**, #1999 [4] Liu Y. et al. (2011) *Lunar Planet. Sci.* **XLII**, #1261 [5] Papike J. et al. (1998) *Reviews in Mineralogy* **36**, p. 5-153 – 5-161.