PETROLOGY AND BULK COMPOSITION OF TWO LUNAR FRAGMENTAL BRECCIAS: NORTHWEST AFRICA 7493 AND NORTHWEST AFRICA 7611. C. B. Agee[1], R. L. Korotev[2] and A. J. Irving[3] [1]Institute of Meteoritics, University of New Mexico, Albuquerque, NM, [2]Dept. of Earth & Planetary Sciences, Washington University, St. Louis, MO, [3]Dept. of Earth & Space Sciences, University of Washington, Seattle, WA.

Introduction: Two different lunar breccia meteorites recovered in 2011 and 2012 add considerably to our knowledge of the Moon. NWA 7493 is a typical feldspathic breccia, but with a rare granophyre clast, and NWA 7611 is mingled breccia with intermediate bulk FeO and Sc, and fayalitic olivines suggesting the presence of a mare basalt component.

Figure 1. Cut slices of NWA 7493 and NWA 7611

Northwest Africa 7493: Six matching separate stones (total weight 503 grams) consisting of two larger stones (341 g and 146 g) and four smaller pieces (total 16 g) were found in July 2011 near Zag, Morocco. Sawn slices exhibit a brecciated texture dominated by medium gray, tan and white lithic clasts plus white feldspar grains (up to 5 mm across) set in a sparse, darker gray matrix. Some thin veins of terrestrial weathering products are visible. This material is a fragmental breccia composed primarily of quenched melt clasts and grains of calcic plagioclase ($An_{96.6\pm0.6}Ab_{3.3\pm0}Or_{0.2\pm0.15}$) occurring in a wide range of grain sizes. There are numerous scattered olivine ($Fa_{39.6\pm7.8}$, Fe/Mn=94±8) and zoned pyroxene grains throughout, rare grains of exsolved pigeonite, ilmenite, Ti-chromite, troilite, silica polymorph and metal. Low-Ca pyroxene ($Fs_{37.4\pm7.0}Wo_{4.7\pm1.6}$, Fe/Mn=57±8), more ferroan pigeonite ($Fs_{34.4\pm9.4}$ $Wo_{12.9\pm4.0}$, Fe/Mn=60±5) and high-Ca pyroxene ($Fs_{26.9\pm10.9}Wo_{38.4\pm4.6}$, Fe/Mn=58±9) are present. Shock melt domains contain plagioclase grains set in a matrix of quench crystals. A single "granophyre" clast (100 microns across) composed of intergrown K-feldspar+silica (see Figure 2) was observed. Secondary barite and iron oxide/hydroxide were detected.

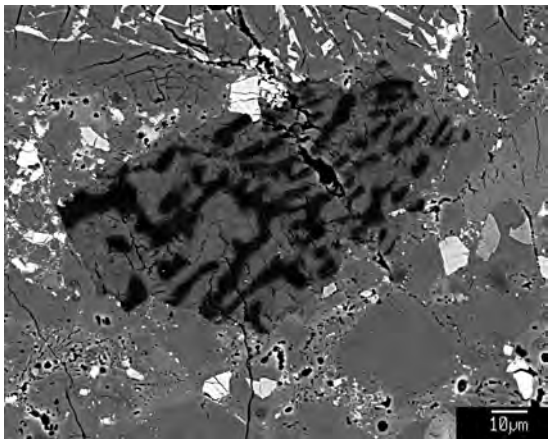

Figure 2. BSE image of a small granophyre clast in NWA 7493 (silica is black, K-feldspar is gray)

Northwest Africa 7611: A single 916 gram stone was found allegedly in Algeria in May 2012. The specimen is a fragmental breccia consisting of plagioclase , pyroxene, and olivine grains (up to 3 mm) set in a darker gray-green matrix, along with scattered gabbroic and dark clasts (up to 1 cm across). A prominent ~1 cm pyroxene-plagioclase gabbroic clast was observed as well as one small clast consists of intergrown hedenbergite+fayalite+silica (after pyroxferroite) - see Fig. 3. The matrix is variable with some domains showing a uniform fine-grained subophitic plagioclase-pyroxene texture, whereas other domains show densely packed mineral clasts ranging from 10-300 µm.

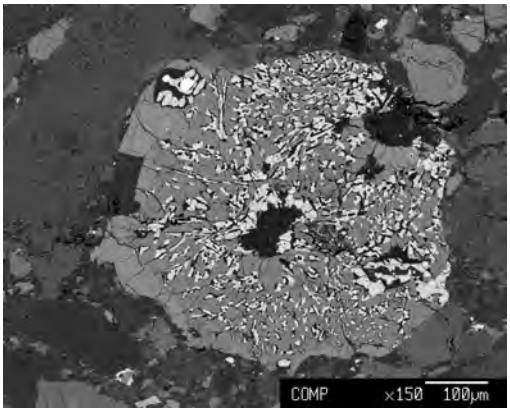

Figure 3. BSE image showing an unusal clast in NWA 7611. Bright phases are fayalitic olivine intergrown with silica (black), all included within pyroxene (medium gray)

There are several sharp boundaries between the various textural domains, with at least two composi-

tionally distinct olivine populations ($Fa_{90.6\pm5.7}$, Fe/Mn=90±4; and $Fa_{31.6\pm11.1}$, Fe/Mn=93±9), and a wide range of pyroxene compositions ($Fs_{43.6\pm13.3}Wo_{20.2\pm8.5}$, Fe/Mn=67±8) indicating multiple lithologies of a mingled feldspathic/mare basaltic fragmental breccia. Pyroxenes in a gabbroic clast ($Fs_{45.3\pm13.1}Wo_{15.4\pm5.3}$, Fe/Mn=69±7). Plagioclase compositions are $An_{93.5\pm1.5}Ab_{6.0\pm1.4}Or_{0.5\pm0.5}$. Accessory ilmenite, silica polymorph, minor zircon, troilite, Ti-bearing chromite, Ni-free iron metal and kamacite are present.

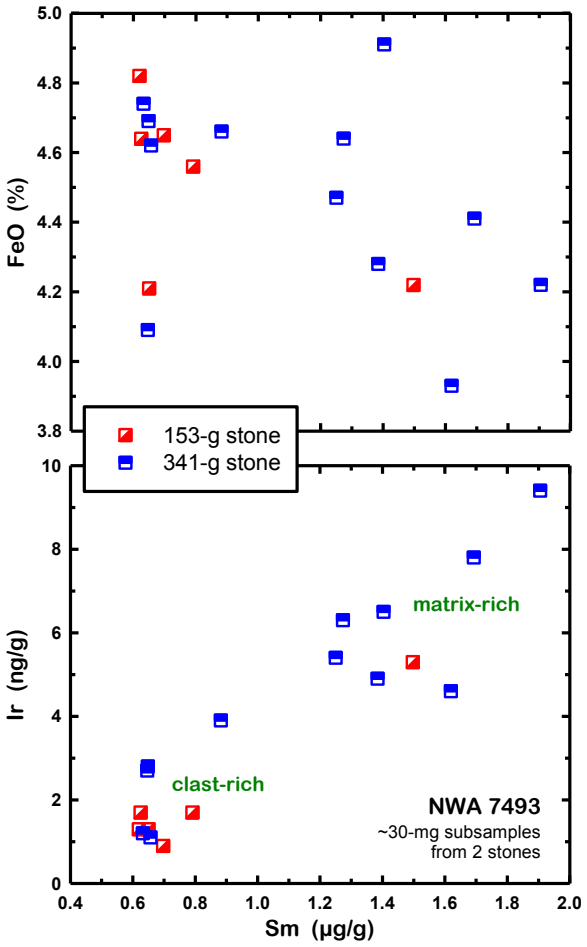

Figure 4. Variation of bulk FeO and Ir with Sm for subsamples from two stones of NWA 7493.

Bulk Compositions: NWA 7493 has the composition of a typical feldspathic lunar meteorite [1]. The meteorite shows a feature seen in several other feldspathic lunar meteorites – concentrations of elements associated with major minerals (e.g., FeO; Figure 4) are moderately constant whereas concentrations of incompatible elements (Sm) vary considerably. Unusual, however, is that siderophile element concentrations (Ir, Figure 4) correlate positively with incompatible element concentrations. This correlation is observed among *different* feldspathic lunar meteorites [2], but we have not previously observed it among subsamples of a single meteorite. The higher-Sm, higher-Ir subsamples tend to be darker, i.e., richer in breccia matrix. This feature suggests that the matrix contains a regolith component, one that has with time and surface exposure accumulated Ir from micrometeorites and Sm from admixture of material from the Procellarum KREEP Terrane by impacts of large meteorites [2].

NWA 7611 is similar to, but in detail different from, several other NWA lunar meteorites (Fig. 5). It is curious that many of the lunar meteorites of "intermediate iron concentration" [3] come from Northwest Africa (Fig. 5).

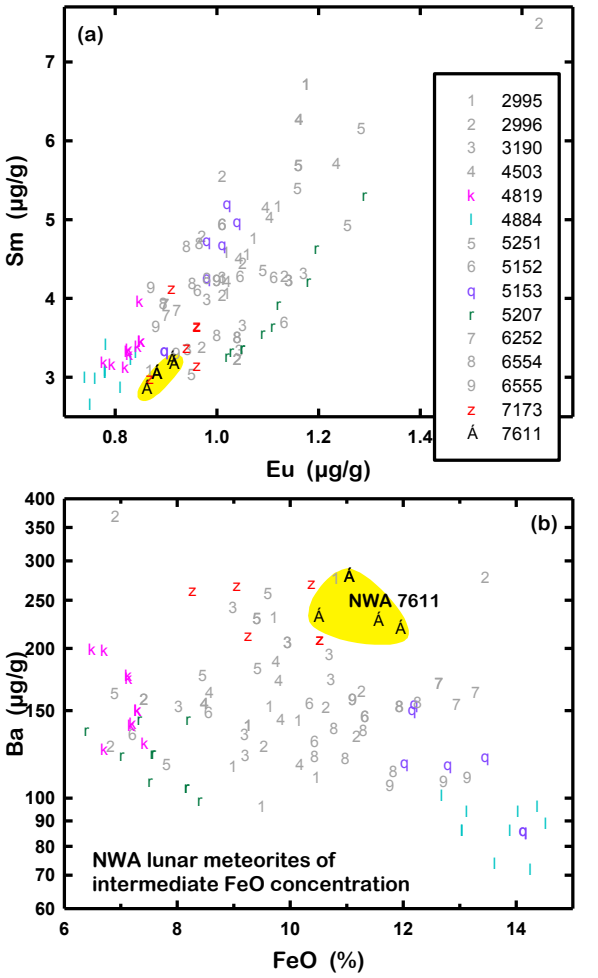

Figure 5. INAA subsample data. All of the gray number symbols represent the 9 presumably paired NWA 2995 et al. stones [3] from Morocco. Although the different symbol colors represent the assumption of 7 different meteorites, pairing relationships among these stones are not well established. (a) Several NWA lunar meteorites are moderately mafic with moderate concentrations of incompatible elements like Sm. NWA 7611 is distinct from most of the others, however. (b) NWA 7611 is rich in Ba from terrestrial contamination. The enrichment, compared to the NWA 2995 et al. stones, probably reflects the different find location.

References:

[1] Korotev R. L. and Irving A. J. (this conference).
[2] Korotev R. L. et al. (2006) *GCA* **70**, 5935–5956.
[3] Korotev R. L. et al. (2009) *M&PS* **44**, 1287–1322.