PETROLOGY AND COMPOSITION OF LUNAR MARE FERROAN GABBRO BRECCIA NORTHWEST AFRICA 7007: NEW INSIGHTS INTO THE COMPLEX PETROGENESIS OF NORTHWEST AFRICA 773 AND SIBLINGS. 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, USA (kuehner@ess.washington.edu), [2]Dept. of Earth & Planetary Science, Washington University, St. Louis, MO 63130, USA.

Background: A lunar meteorite found in September 2011 near Smara, southern Morocco is dominated by a lithology previously known only minimally in several subsamples of apparently related lunar meteorites. Following the discovery in 2000 of three stones in southern Morocco (classified together as NWA 773 [1]), additional material exhibiting more lithologic diversity was found in several different places. In 2004-2005 material later revealed to be from a site near Anoual, central Morocco (classified as NWA 2700, NWA 2727, NWA 3160, NWA 3333 and Anoual) was shown to contain clasts of an olivine-phyric basalt, in addition to clasts of the olivine gabbro lithology dominant in NWA 773 [2]. A separate, fully crusted stone composed entirely of the olivine gabbro (NWA 2977) was found near Boudenib, Morocco later in 2005 [3].

Despite the lithologic diversity among the clast types in these specimens [3, 4], all share the same relatively short cosmic ray exposure ages (~45 ka [5]), so it appears likely that all of these stones were part of a single multilithologic meteoroid. In 2011 another stone (NWA 6950) composed entirely of olivine gabbro (and clearly paired with NWA 2977) was found allegedly in Mali, and is described in a companion abstract [6]. The present abstract describes a nearly monolithologic 91 gram breccia stone found also in 2011, which for the first time permits petrologic characterization of a ferroan mare gabbro component among the lithologies in the "NWA 773 clan".

Figure 1. *Whole Northwest Africa 7007 stone (width 4.4 cm) showing the remnant fusion crust. White anorthite clasts are visible. Image © G. Hupé.*

Figure 2. *Cut face of NWA 7007 showing a large ferroan gabbro clast with thin shock melt veinlets and other related debris (width 4.8 cm). Image © G. Hupé.*

Petrography of NWA 7007: The specimen is a crystal-rich regolithic breccia consisting of some larger polymineralic clasts (gabbro and rare ophitic basalt) and apparently related crystal debris in a sparse glassy, microvesicular matrix (see Figures 1 and 2). Major components are anorthite ($An_{92.7\text{-}93.5}Or_{0.2\text{-}0.4}$), complexly-zoned subcalcic augite, ferropigeonite, and relatively large fragments composed of intergrowths of fayalite+hedenbergite+silica (typical of subsolidus inversion assemblages from primary pyroxferroite). Accessory phases include olivine ($Fa_{42.0\text{-}44.4}$; FeO/MnO = 86-93), ilmenite, fayalite ($Fa_{98.4}$; FeO/MnO = 78-84), hedenbergite, silica polymorph, troilite, Ni-free metal and baddeleyite (up to 10 microns across within fayalitic rims on pyroxene).

Zoned subcalcic augite grains (see Figure 3) have cores as magnesian as $Fs_{22.5}Wo_{31.2}$ (FeO/MnO = 46), mantles from $Fs_{34.2}Wo_{29.6}$ to $Fs_{50.0}Wo_{25.9}$ (FeO/MnO = 55-65), and ferropigeonite rims ($Fs_{66.1}Wo_{19.7}$; FeO/MnO = 66). Matrix glass contains abundant small, round vesicles (typical of those representing trapped solar wind gases in other lunar regolith breccias) – see Figure 4.

Bulk Elemental Composition: Preliminary instrumental neutron activation analyses of subsamples of NWA 7007 show that mean Na and Eu concentrations are low (0.24% Na_2O and 0.58 ppm Eu) and the Co concentrations are high (59 ppm), all characteristics of

the "NWA 773 clan". Other average abundances are 19.3% FeO, 40 ppm Sc, 7.4 ppm Sm and 2.3 ppm Th.

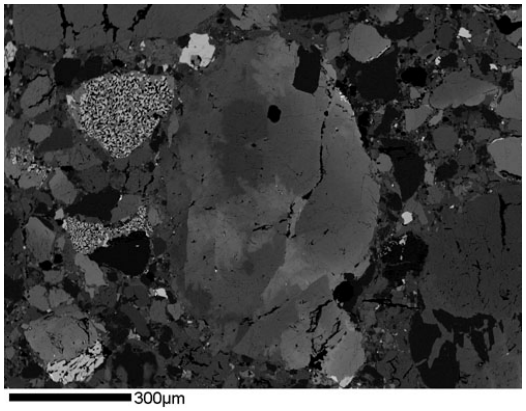


Figure 3. *Back-scattered electron image, showing a large zoned augite grain and intergrowths after sub-solidus breakdown of former pyroxferroite.*

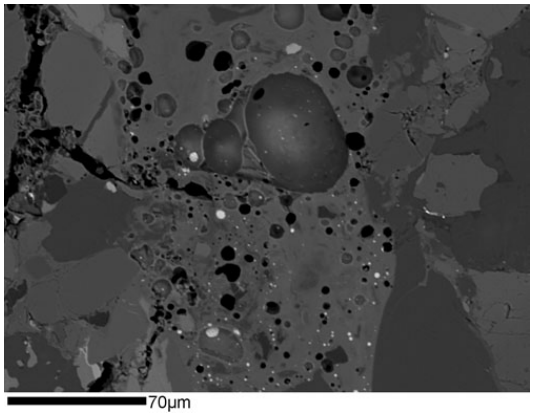


Figure 4. *Back-scattered electron image showing solar wind bubbles in the regolithic matrix.*

Discussion: The ferroan gabbro lithology that dominates NWA 7007 matches in bulk composition several subsamples analyzed previously by us of other specimens of the "NWA 773 clan". In particular, the clan is characterized by relatively low Sc, Na, and Eu and high Co compared to other mafic lunar meteorites and mare basalts of the Apollo and Luna collections (see Figure 5).

So far the only lithology for which a reliable formation age has been obtained is the cumulate olivine gabbro. Three independent studies of both NWA 2977 and NWA 6950 give a weighted average age of 3113±6 Ma [6, 7, 8]. Preliminary analyses of olivine-phyric basalt NWA 3160 suggest that it may be considerably older than this, and perhaps not even genetically related to NWA 2977. Because the ferroan gabbro and olivine-phyric basalt lithologies overlap in some bulk compositional parameters, it now becomes important to obtain a precise formation age for NWA 7007.

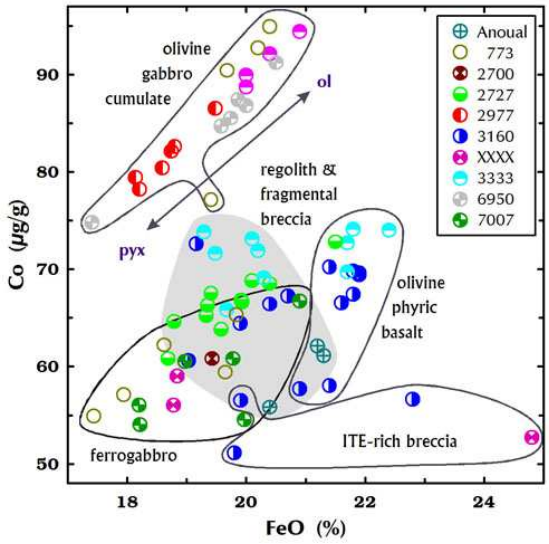
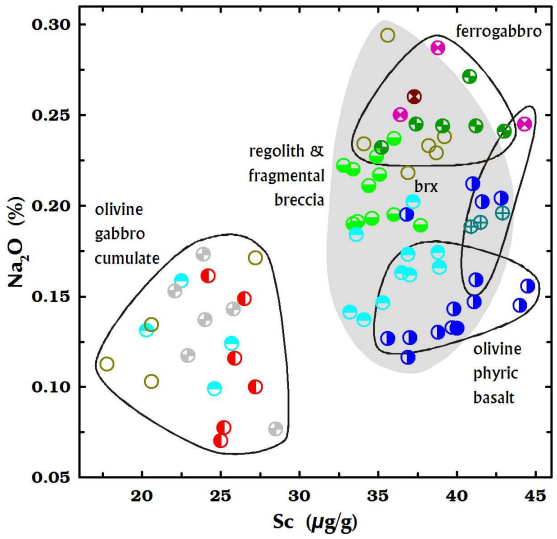


Figure 5 (A, above; B, below). *FeO-Co and Sc-Na_2O variation for bulk subsamples of stones of the "NWA 773 clan", showing the distinctions among the various lithologies.*



Conclusion: The petrologic and chronologic history of the "NWA 773 clan" materials (which have no counterpart among returned lunar specimens) may be much more complicated than previously thought.

References: [1] Fagan T. et al. (2003) *MAPS* **38**, 529-554 [2] Zeigler et al. (2006) *Lunar Planet. Sci.* **XXXVII**, #1804 [3] Bunch T. et al. (2006) *Lunar Planet. Sci.* **XXXVII**, #1375 [4] Jolliff B. et al. (2007) *Lunar Planet. Sci.* **XXXVIII**, #1489 [5] Nishiizumi K and Caffee M. (2010) *73rd Meteorit. Sci. Mtg.*, #5377 [6] Shaulis B. et al. (2012) *This conference* [7] Nyquist L. et al. (2009) *72nd Meteorit. Sci. Mtg.*, #5347 [8] Zhang A. et al. (2010) *Meteoritics Planet. Sci.* **45**, 1929-1947. **Website**:
http://meteorites.wustl.edu/lunar/moon_meteorites.htm