ZIRCON-BADDELEYITE-BEARING SILICA+K-FELDSPAR GRANOPHYRIC CLASTS IN KREEP-RICH LUNAR BRECCIAS NORTHWEST AFRICA 4472 AND 4485. S. M. Kuehner[1], A. J. Irving[1], R. L. Korotev[2], G. M. Hupé and S. Ralew (kuehner@u.washington.edu) [1]Earth & Space Sciences, University of Washington, Seattle, WA 98195, [2]Earth & Planetary Sciences, Washington University, St. Louis, MO 63130.

Discovery: Two separate 64.3 gram and 188 gram meteorites found in Algeria in summer 2006 are paired specimens of lunar basaltic breccias containing unusual Si-K-Zr-rich granophyric intergrowth clasts. Bulk compositions are KREEP-rich and resemble "LKFM".

Figure 1: NWA 4472 cut main mass (© Greg Hupé).

Figure 2: Part slice of NWA 4485 (© Stefan Ralew).

Petrology: Both specimens consist predominantly of clasts of ophitic to quench-textured basalts and related debris composed of various low-Ca and high-Ca pyroxenes, olivine ($Fa_{26.3\text{-}63.6}$, FeO/MnO = 91-121), calcic plagioclase ($An_{86.9\text{-}97.5}Or_{0.6\text{-}0.2}$), ilmenite and rare baddeleyite. Pyroxenes range from orthopyroxene ($Fs_{18.9\text{-}29.9}Wo_{4.6\text{-}3.7}$, FeO/MnO = 60.5-89) to pigeonite ($Fs_{37.0}Wo_{10.1}$, FeO/MnO = 61.9), subcalcic augite ($Fs_{48.9\text{-}52.6}Wo_{26.7\text{-}39}$, FeO/MnO = 59.3-72.2) and Al-Cr-rich pigeonite ($Fs_{27.0}Wo_{17.1}$, FeO/MnO = 51.1, Al_2O_3 = 5.85 wt.%, Cr_2O_3 = 1.48 wt.%).

Sparse granophyric clasts (see Figure 3) consist of "ribbon-like" subparallel intergrowths of silica and barian K-feldspar ($Or_{80.9\text{-}55.6}Ab_{15.3\text{-}30.2}Cn_{0.6\text{-}6.3}$) with accessory baddeleyite and rare tranquillityite. Other clasts are rich in fayalite ($Fa_{90.2}$, FeO/MnO = 80-92) with associated glass, silica, K-feldspar and merrillite (see Figure 4). Mineral clasts include silica, zircon, baddeleyite, merrillite, Ti-chromite, fayalite, ilmenite (with baddeleyite inclusions), metal (both kamacite and taenite), troilite and schreibersite. Spherical to ellipsoidal glass objects (up to 60 μm across) and very fine grained, quench-textured clasts composed of glass and fine microlites also are present (see Figure 4).

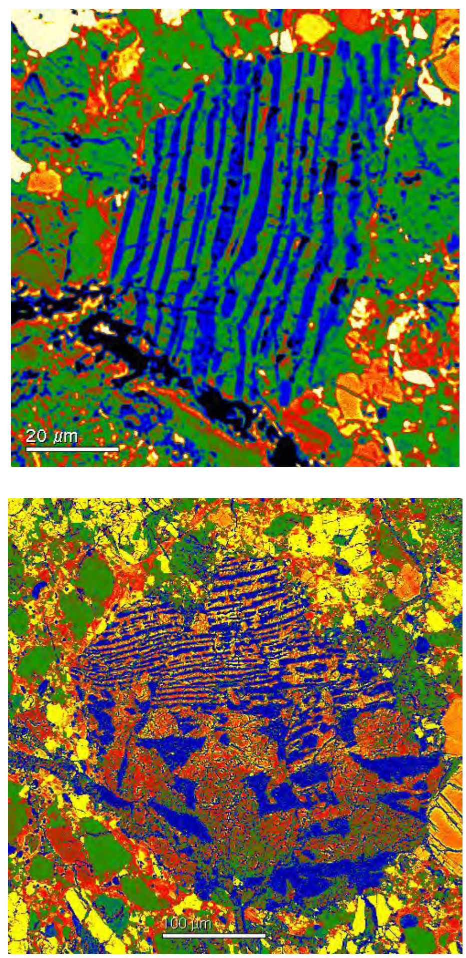

Figure 3: BSE images of lamellar intergrowth clasts in NWA 4472 (above) and NWA 4485 (below) - silica (blue), K-feldspar (green to red).

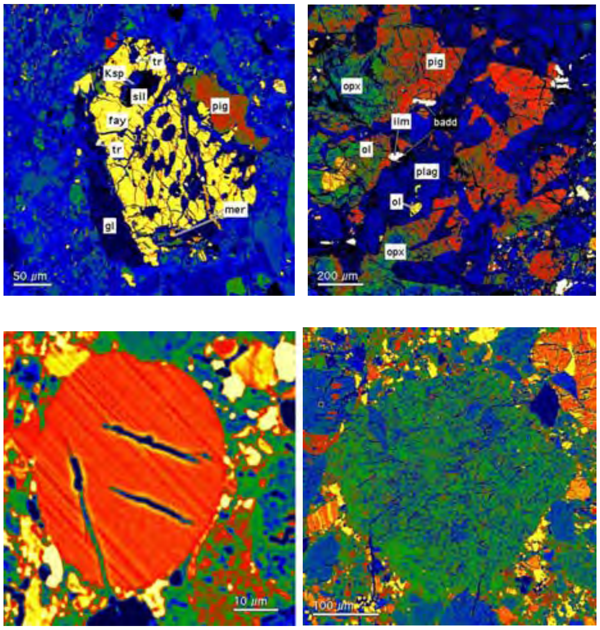

Figure 4: BSE images. **A.** NWA 4472 fayalite-rich clast. **B.** NWA 4485 basalt clast. **C.** NWA 4472 glass sphere. **D.** NWA 4485 quenched clast composed of glass (green) and plagioclase microlites (blue).

Bulk Composition: Based on INAA of 17 separate ~35 mg subsamples of both specimens, these two meteorites are essentially identical in bulk composition. Preliminary mass-weighted mean abundances are: Na_2O 0.60 wt.%, FeO 9.27 wt.%; in ppm, Sc 21.3, Zr 441, Hf 11.3, Ba 488, Th 6.9. REE abundances are elevated (see Figure 5), with large negative Eu anomalies (chondrite-normalized Sm/Eu and Tb/Eu are both >3.5), implying significant loss of plagioclase and/or K-feldspar in the evolution of one or more lithologies.

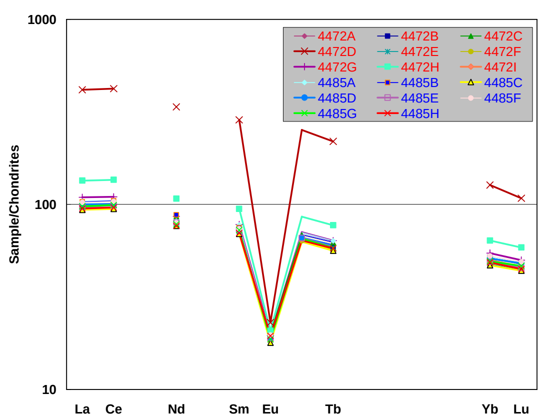

Figure 5: Chondrite-normalized REE abundances of NWA 4472 and NWA 4485 subsamples (very enriched subsample probably contains abundant phosphate).

These two specimens differ significantly from all other lunar meteorites and most Apollo/Luna samples [1]. Although bulk FeO is within the range for 'mingled' lunar breccias, the incompatible element abundances are much higher, and approach levels in KREEP-rich specimen SaU 169 (see Figure 6).

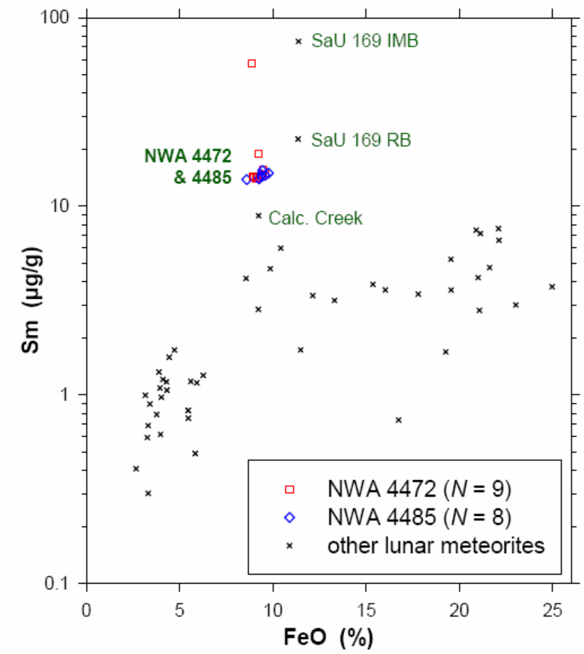

Figure 6: Semilog plot of bulk FeO and Sm abundances for lunar meteorites.

Discussion: The distinctive silica+K-feldspar intergrowth clasts in NWA 4472 and NWA 4485 resemble the granophyre regions in some Apollo samples, such as 14161 [2]. They appear to represent silicic liquids enriched in K, Zr, P and other incompatible elements that were generated by protracted fractional crystallization of mafic magmas, in the same way as icelandites are thought to be formed from basalts on Earth. Although bulk compositions permit a small mare basalt component, the predominant materials are non-mare and decidedly KREEP-rich, and the overall composition is similar to those of Apollo mafic "LKFM" impact melt breccias [3]. The prevalent K-rich and Zr-rich phases in these specimens present a special opportunity for multi-isotopic age determinations utilizing especially Ar-Ar and Pb-Pb techniques (as in [4]).

References: [1] Korotev R. L. (2005) *Chemie Erde* **65**, 297-346 [2] Jolliff B. L. et al. (1999) *Amer. Mineral.* **84**, 821-837 [3] Korotev R. L. (2000) *J. Geophys. Res.* **105**, 4317-4345 [4] Meyer C. et al. (1996) *MAPS* **31**, 370-387.