PETROGRAPHY, GEOCHEMISTRY, AND PAIRING RELATIONSHIPS OF BASALTIC LUNAR METEORITE MILLER RANGE 13317.

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Introduction: Miller Range (MIL) 13317 is a 32 g lunar meteorite collected during the 2013-2014 ANSMET field season. It was initially described [1] as having 25% black fusion crust covering a light- to dark-grey matrix, with numerous clasts ranging in size up to 1 cm; it was tentatively classified as a lunar anorthositic breccia. Here we present the petrography, geochemistry, and possible pairing relationships of MIL 13317.

Methods: The petrography described here is based on optical, electron, and x-ray microscopy of polished thin sections MIL 13317,6 and MIL 13317,13. We have obtained bulk-composition data by instrumental neutron activation analysis of eight subsamples of MIL 13317,9 (266 mg total).

Petrography: Lunar meteorite MIL 13317 has a fine-grained glassy matrix that contains abundant lithic and mineral clasts. Basalt clasts are the most common lithic clast type, but several large feldspathic impact-melt clasts (up to ~1 cm) are also observed. Many smaller granulitic clasts (typically magnesian and feldspathic, but compositionally variable) are found, as are abundant small symplectite clasts. Shock-melt veins are observed within the sample and much of the plagioclase in the sample has been partially or completely shocked into maskelynite. A vesicular glassy fusion crust is observed: 0.8 wt% TiO_2; 0.5 wt% Na_2O; 10.5 wt% FeO; Mg' = 52.

Most basalt clasts consist predominantly of large (up to 2-3 mm) zoned pyroxene grains, elongate zoned plagioclase and silica grains (up to ~3 mm), and fine-grained mesostasis areas containing minor amounts of K,Si-rich glass, ilmenite, fayalite, RE-merrillite, Cl-bearing apatite, and FeS. The pyroxene grains have cores of subcalcic augite and pigeonite (Mg' 40-60), trending toward rims of near endmember pyroxferroite. Pyroxene grains are rarely exsolved (~1 μm), with both pigeonite hosting augite and vice versa. Large plagioclase grains are typically zoned from cores of An_{90} to rims of An_{80-75}, although mesostasis plagioclase extends the compositional range observed to ~An_{65}. Medium- and fine-grained basalt clasts and symplectite clasts are less commonly observed; the observed mineral assemblages and compositions fall within the same ranges as the coarse-grained basalt clasts. Feldspathic impact melt clasts have a few large plagioclase clasts set in a fine grained matrix of calcic plagioclase an low Ca pyroxene in nearly equal proportions; minor amounts of more calcic plagioclase, and rare occurrences of FeS and FeNi metal are also observed. Granulite clasts are typically small, fine-grained, and magnesian.

The most common mineral clasts are pyroxene and plagioclase, with less abundant clasts of olivine, ilmenite, silica, and glass also observed. FeNi metal and FeS clasts are rarely observed in the matrix. A single HASP glass clast (~100 μm in diameter; up to 55 wt% Al_2O_3) was found. The composition of the mineral clasts is largely representative of the minerals seen in the major lithic clasts, though a small subset of very magnesian (Mg' > 80) pyroxene and olivine mineral clasts not observed in a lithic clast is observed.

Geochemistry: MIL 13317 is compositionally distinct from other lunar meteorites [2-3]. Comparison of MIL 13317 subsamples to subsamples of the other five MIL brecciated lunar meteorite stones show MIL 13317 to be more mafic and ITE-rich. Unlike for Calcalong Creek, NWA 4472/4485, and NWA 6687, subsamples of MIL 13317 increase in Sm and Na concentration with increasing Sc and Fe, suggesting MIL 13317 is not related to previously observed KREEPY lunar meteorites. Moreover, this trend suggests that MIL 13317 is a mixture of (1) a regolith which itself is a mixture of mare basalt and some KREEPy lithology (as are the Apollo 12 soils [4]), and (2) feldspathic material (the melt breccias and granulites) with compositions broadly similar to the MIL 07006 and paired stones MIL 090034/70/75. The mafic component cannot be just mare basalt because extrapolation of the FeO-Na_2O trend to 20% FeO, a typical value for mare basalt, leads to a absurdly high Na_2O concentration, 1.06%.

Discussion: The predominance of lithic and mineral clasts of an obvious basaltic origin, coupled with the presence of regolith components such as a HASP glass means that MIL 13317 is a basaltic regolith breccia. The basalt is a VLT basalt based on the modal abundance of ilmenite and composition of the fusion crust. While not necessarily a good measure of bulk major- element composition, FeO and Na_2O concentrations in the fusion crust do match the whole-rock INAA data. The paucity of FeNi metal and impact-glass clasts suggests that the regolith from which this meteorite was formed was immature.

References: [1] Satterwhite C. and Righter K. (2015) *Antarctic Meteorite Newsletter*, **Vol. 38**, No. 2. [2] Korotev R. L. and Irving A. J. (2016) *LPSC* **47**, abstract #1358. [3] Zeigler R. A. and Korotev R. L. (2016) *LPSC* **47**, abstract # 2554. [4] Korotev R. L. et al. (2011) *GCA* **75**, 1540–1573.