Basalt Related to Lunar Mg-Suite Plutonic Rocks: A Fragment in Lunar Meteorite ALH81005.

A. H. Treiman[1], and J. Gross[2]. [1]Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston TX 77058, USA. treiman{at} lpi.usra.edu. [2]American Museum of Natural History, New York NY, USA.

Mg-suite plutonic rocks are inferred to have developed in bodies of magnesian basaltic magma, emplaced before the mare basalts [1]. Few pre-mare basalts are known [2,3] and only one may be related to the Mg-suite [4]. Here, we report on a basalt clast, in meteorite ALH81005, which appears also to be from Mg-suite magma.

Description: Clast U is a 750x350µm fragment in section -,9 [5]; it consists of plagioclase An_{91-96} (~40% area), pigeonite $\sim En_{83}Wo_{04}$ (~30%), olivine Fo_{82} & Fe/Mn≈75 (~15%), and augite $\sim En_{50}Wo_{35}$ (~15%), with minor FeS, Fe metal (3.8% Ni, 0.13% Co), apatite, TiO_2, ZrO_2 (~0.3% area), SiO_2, and Zr-Ca-armalcolite [5]. Compositions of pyroxenes and olivine are consistent with equilibration of Fe-Mg but not Ca; pigeonite is zoned from Ca-poor to Ca-rich; Ca-rich pigeonite is intergrown with augite. Grains of major minerals are up to ~200µm long in a subophitic texture (mafic minerals occupying patches among plagioclase grains). Minor minerals are concentrated along boundaries between plagioclase and pyroxenes.

Interpretation: Clast U's mineralogy, texture, and Fe/Mn imply it is a fragment of lunar basalt. Nothing in its texture suggests that it is a cumulate (e.g., large aligned grains) or a quickly cooled impact melt (e.g., dendrites). The metal composition is consistent with a lunar or chondritic (i.e. impact melt) origin [6].

Clast U is unlike mare basalts and more like Mg-suite norites [7] in having: high Mg# (81 vs. 60-35 [8]); abundant plagioclase of $An_{>88}$; more low-Ca pyroxene than augite; low-Ca pyroxene crystallizing prior to augite; Ca-Zr armalcolite, rutile, and baddeleyite; and little or no ilmenite [7]. Clast U was interpreted [5] as an impact melt, based on the composition of its metal. However, such metal need not be meteoritic [6], and nothing else about the clast signals an impact origin.

Implications: It seems reasonable that clast U is from an erupted magma related to Mg-norites. Density constraints imply that Mg-suite magmas should have erupted if they were generated at depths > 20 km [9], as is generally inferred [10]. The rarity of Mg-suite volcanic rocks in the Apollo collections could be explained with the fact that Mg-norites are pre-Imbrian in age (~4.3 Ga [7]). Had Mg-suite basalt been common on the (now) lunar nearside, the Imbrium impact would have destroyed some and buried much of the rest. However, the absence or rarity of Mg-suite basalts in lunar meteorites [11] suggests that they were rare across the whole Moon.

References: [1] Shearer C.K. et al. 2006. Ch. 4, *New Views of the Moon*. [2] Taylor L.S. et al. 1983. *Earth Planetary Science Letters* 66:33-47. [3] Terada K. et al. 2007. *Nature* 450:849-853. [4] Arai T. et al. 2006. Abstract #2387. 37th Lunar & Planetary Science Conference. [5] Treiman A.H. & Drake M.J. 1983. *Geophysical Research Letters* 10:783-786. [6] Papike J. J. et al. 1991. Ch. 5, *Lunar Sourcebook*. [7] James O.B. & Flohr M.K. 1983. *Proc. 13th LPSC, JGR* 88:A603-A614. [8] Taylor S.R. 1982, *Planetary Science, A Lunar Perspective*. [9] Prissel T.C. et al. 2013. Abstract #3014. 44th Lunar & Planetary Science Conference. [10] Elardo S.M. et al. 2011. *Geochimica et Cosmochimica Acta* 75:3024-3045. [11] Robinson K.L. et al. 2012. *Meteoritics & Planetary Science* 47, 387-399.