FELSITE "FRENZY" IN LUNAR METEORITE BECHAR 009: CONSTRAINING THE ROLE OF SILICATE LIQUID IMMISCIBILITY (SLI) ON LUNAR FELSITE PETROGENESIS

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Introduction: Lunar felsites, highly evolved lithologies on the Moon (i.e. granitoids), have been suggested to have crystallized from either 1) high-Si melts formed by silicate liquid immiscibility (SLI) [1-5], or 2) felsic melts formed by fractional crystallization of a partially melted crustal source [6-7]. Occasionally found alongside felsites are high-Fe clasts, which are inferred to have crystallized from the complementary high-Fe melt formed during SLI [1-3]. Owing to the scarcity of lunar felsites and high-Fe clasts in existing Apollo samples [8] and lunar meteorites [9], this raises the question as to whether SLI is the primary mechanism in forming felsites. Further study of felsite and high-Fe clasts would provide additional constraints on the role of SLI on felsite petrogenesis, most notably the role of SLI on generating large volumes of magma capable of producing silicic volcanic domes on the lunar surface [7]. Here, we report on preliminary chemical analysis of felsite and high-Fe clasts from Bechar 009, a lunar polymict breccia containing >32 identified felsite clasts/clast fragments, and >7 identified high-Fe clasts/clast fragments.

Petrography: Felsite clasts are heterogeneous in texture (Fig. 1A-B); most felsite clasts display graphic/granophyric textures consisting of intergrowths between alkali feldspar and silica. Silica grains display noticeable fractures that resemble a "hackle fracture pattern" [8]. Plagioclase feldspar is present as either tabular/blocky grains toward the edges of felsite clasts, or within clasts enclosed by alkali feldspar. Accessory phases include merrillite, troilite, ilmenite, and zircon. High-Fe clasts (Fig. 1C-D) exhibit fine-grained, granular textures composed of Fe-rich olivine, augite, and minor silica, along with accessory ilmenite, troilite, and merrillite. Some high-Fe clasts are found attached to felsite clast fragments, with some olivine/silica grains elongated perpendicular to the boundary line.

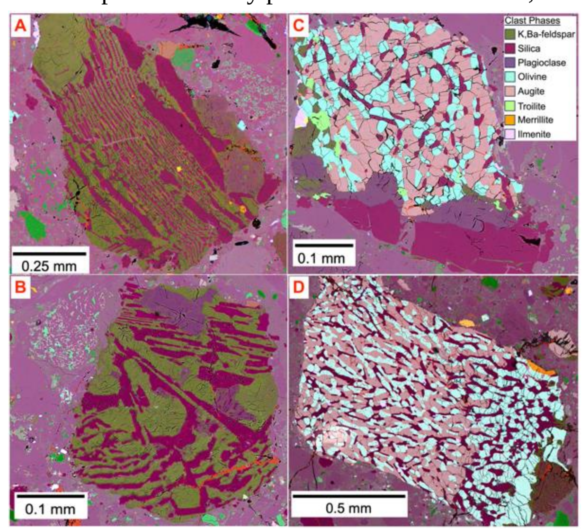

Fig. 1. False color EDS+BSE chemical maps of felsite (A-B) and high-Fe (C-D) clasts.

Geochemistry: Alkali and plagioclase feldspar compositions vary amongst felsite clasts (K,Ba-feldspar: An6.4±4.3 Or70.8±8.6 Ab20.0±6.9 Cn2.7±1.3, n=50; Plagioclase: An38.7±6.3 Or4.1±3.7, n=36), some felsite clasts display irregular zoning trending to intermediate compositions (An34.1±8.5 Or47.0±20.1, n=10). Olivine and augite grains in high-Fe clasts are equilibrated (Olivine: Fa85.5±0.9, Fe/Mn=101±4, n=32; Augite: Fs40.8±0.9 Wo38.7±0.6, Mg#=33.4±1.4, Fe/Mn=73±6, n=24). Silica grains are compositionally similar across both felsite and high-Fe clasts (TiO2 (wt. %) = 0.2±0.1, FeO (wt. %) <0.1, n=65). Bulk composition (in wt. %) of felsite clast (Fig. 1B) and high-Fe clast (Fig. 1C) estimated by modal recombination: Felsite (SiO_2~77, Al_2O_3~12, Na_2O~1.5, K_2O~6, CaO~1.3, TiO_2~0.1, MgO~0.2, FeO~0.1); high-Fe (SiO_2~47, Al_2O_3~0.6, Na_2O~0.2, K_2O~0.1, CaO~9, TiO_2~0.4, MgO~6, FeO~37).

Discussion: Compared to previously identified lunar felsites [1-3], the similarities in texture, mineral chemistry, and bulk chemistry of the felsite clasts in Bechar 009 are consistent with being derived from an SLI model [4-5]; felsite/high-Fe clast pairs best signify incomplete separation between immiscible high-Si,K and high-Fe melts. Although the observed "hackle fracture pattern" of silica grains in felsite clasts combined with their TiO_2 contents has been suggested to indicate rapid cooling and inversion of a high temperature silica polymorph (tridymite or cristobalite) to quartz following crystallization [8], the presence of felsite/high-Fe clast pairs containing fractured silica with similar TiO_2 contents indicates high temperature crystallization at depth, likely followed by impact exhumation and shock deformation, forming the fractures. Ongoing EBSD analysis of the clasts will prove resourceful in characterizing the degree of shock deformation and identifying the silica polymorph present in each clast.

References: [1] Warner R. D. et al. (1978) *Proceedings of Lunar and Planetary Science Conference* 9:941-958. [2] Taylor G. J. et al. (1980) *Proceedings of Lunar and Planetary Science Conference* 339-352. [3] Jolliff B. L. et al. (1999) *American Mineralogist* 84:821-837. [4] Roedder E. and Weiblen P. W. (1970) *Science* 167:641-644. [5] Hess P. C. et al. (1975) *Proceedings of Lunar and Planetary Science Conference* 6:895-909. [6] Ryder G. et al. (1975) *Proceedings of Lunar and Planetary Science Conference* 6:435-449. [7] Hagerty J. J. et al. (2006) *Journal of Geophysical Research* 111:E06002. [8] Seddio S. M. et al. (2015) *American Mineralogist* 100:1533-1543. [9] Fagan T. J. et al. (2003) *Meteoritics & Planetary Science* 38:529-554.