EVOLVED-LITHOLOGY CLASTS IN LUNAR BRECCIAS: RELATING PETROGENETIC DIVERSITY TO MEASURED WATER CONTENT.

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Introduction: Studies of the inventory and distribution of water in lunar rocks have recently begun to focus on alkali suite samples as possible water repositories, particularly the most highly evolved granitoid lithologies [1,2]. Although H analyses of feldspars in these rocks have so far pointed to 'low' (<20 ppm) H_2O contents [1,2], there is sufficient variability in the dataset (e.g., 2-20 ppm [1,2]) to warrant consideration of the petrogenetic factors that may have caused some granitoid-to-intermediate rocks to be dryer or wetter than others. Given that all examples of these rocks occur as clasts in complex impact breccias, the role of impact and other factors in altering water contents established by primary igneous processes becomes a major factor. We are supporting our ongoing SIMS studies of water in evolved lunar lithologies with systematic SEM and EPMA observations. Here we report a synthesis of the observations as part of developing discriminating factors for reconstructing the thermal, crystallization and shock history of these samples as compared with their water contents.

Samples and Methods: Clasts of true granite to quartz monzodiorite (QMD) to K-feldspar-bearing alkali basalt were characterized in mm- to sub-mm sized rock fragments from lunar breccias 12013, 14303, 14321, and 15405 [1,2]. We have reported SIMS analyses of H (as H_2O) in feldspars from selected assemblages in clasts from all of these samples [1,2]. SEM imaging/element mapping and EPMA microanalyses were performed on samples in indium SIMS mounts and on epoxy thin sections.

Results. Microstructural and mineral composition criteria were qualitatively used to sort the clasts according to: 1) their likelihood of being melt-derived assemblages un-processed by shock or other effects, 2) the chemically-evolved character of their parent melt, and 3) their relative sub-liquidus thermal histories. The criteria were selected with particular emphasis on factors likely to affect feldspar water contents before, during and after crystallization. Based on these criteria, for example, our 2 ppm water content measurements [2] on the 14321 granite clast described by [3] would correspond to a relatively un-processed, highly evolved, igneous microgranite/rhyolite. By comparison, similarly evolved, but more highly processed/altered assemblages are represented by complex fine-grained felsic aggregates distributed in the matrices of 14303 and 12013. Few of these aggregates are un-equivocally igneous, and many suggest re-processing by shock with re-distribution of alkali cations by partial melting or other processes. Between these extremes are microgranophyres in 12013 and 15405 and K-feldspar-bearing basaltic clasts in 14303 and 15405. The microgranophyres are paradoxical melt-derived assemblages whose microstructures are suggestive of rapid cooling, but whose An-rich alkali feldspar compositions record possibly the highest liquidus temperature of any lunar felsite. At the same time they contain up to 2.5-3.0 mole % $BaAl_2Si_2O_8$ consistent with their parent liquids being incompatible element enriched. Our initial water-content values of 9-20 ppm for the granophyre feldspars exceeds the 2 ppm value measured in feldspar from the nominally more slowly-cooled 14321 microgranite/rhyolite.

Discussion. We find that for the current samples, identification of igneous or melt-derived clasts that would appear to be good candidates for water measurements is generally not difficult. (However, microstructural/compositional evidence for melt derivation does not guarantee that an assemblage is truly igneous as opposed to being impact melt.) The significant fraction of felsic clast material with an enigmatic origin due to shock or other processes, far from being a negative, actually presents an opportunity to systematically examine how water may be lost/gained or redistributed after primary igneous crystallization. The K-feldspar-bearing basaltic-textured clasts in 14303 and 15405 are likely related to the lunar alkali basalt suite, possibly including the very-high-K Apollo 14 basalts in the case of the 14303 clasts [4,5]. As such the K-feldspar and other phases in these clasts are excellent candidates for future water measurements, because the clasts are relatively pristine melt-derived assemblages, less evolved than the granitoids clasts, but still incompatible-element enriched.

References: [1] Mills, R. D. et al. (2017) *Geochem. Persp. Let*. 3, 115-123, [2] Simon, J. I. et al. (2017) 48th LPSC 48, abstract # 1248. [3] Warren, P. H. et al. (1983) *EPSL* 64, 175-185. [4] Shervais, J. W. et al. (1985) *Proc. Lunar Plan. Sci. Conf.* 16, JGR 90, D3-D18, [5] Roberts S. E. and Neal C. R. (2015) 46th LPSC, abstract # 1297.