Pb-Pb DATING OF APOLLO 67016 AND MIL 090034 LUNAR IMPACT BRECCIAS

A. Bouvier[1], S J. Romaniello[2], M. Wadhwa[2], R. Korotev[3], W. K. Hartmann[4]. [1]University of Minnesota. E-mail: abouvier@umn.edu, [2]Arizona State University. [3]Washington University in St Louis. [4]Planetary Science Institute.

Introduction: Lunar impact breccias in the Apollo and meteorite collections are products of the evolution of the lunar crust. Most are polymict, hosting clasts of a variety of rock types. Consequently, they are complex rocks to study for their chronology, and application of multiple radiochronometers with different closure temperatures, such as Ar-Ar and U-Pb, can potentially provide better constraints on their thermal histories. Since impact breccias from the Apollo collection were collected at specific locations on the Moon, studying lunar meteorite breccias can extend our understanding of the lunar surface impact history.

Samples: The Apollo 67016 sample is a feldspathic fragmental breccia from the Descartes terrain. The MIL 090034 (MIL34) Antarctic meteorite is an anorthositic regolith breccia containing dark glassy melt, but having no compositional hint of a KREEP component [1]. We selected several chips of individual cm-sized feldspathic clasts (67016,407 and MIL34,34), finely recrystallized matrices (67016,405) and dark glassy melt (MIL34,36) from each of these two breccias. The petrological study of 67016 thin sections showed that the matrix was finely crystallized throughout the breccia. We processed a bulk fraction and a pyroxene-rich fraction from 67016,405, and two plagioclase-rich fractions from 67016,407 (each ~20-30 mg), as well as bulk fractions of MIL34 sub-samples (each ~30-40 mg) from a large plagioclase-rich inclusion with glass veins (,34), and from a dark melt lithology (,36) for Pb-Pb dating. Acid-washing procedures using 3 to 4 steps were used to efficiently remove common Pb and to achieve progressive dissolution of the silicates. Lead extraction and isotopic analyses were carried out at ASU following procedures described in [2]. The Pb-Pb ages were calculated using $^{238}U/^{235}U$ =137.80 and the Pb isotope compositions of residues, and the third and fourth step leachates.

Results & Discussion: We find a Pb-Pb age of 4187±1 Ma for 67016,405 that is older than the Ar-Ar assembly age of 3866 ± 9 Ma for this feldspathic fragmental breccia [3]. However, this Pb-Pb age is similar to Ar-Ar ages of 67016 melt breccia clasts that yielded apparent plateau ages of 4.0–4.2 Ga ages for the high-T fractions [3]. The feldspathic clast 67016,407 has a much older Pb-Pb age of 4411±23 Ma suggesting that Pb isotope systematics were not disturbed by the later brecciation event. For MIL34, the Pb-Pb age of our feldspathic clast (,34) is 3859±7 Ma. This is similar, within the errors, to the Pb-Pb age of 3894±39 Ma for the dark melt lithology (,36). These Pb-Pb ages for MIL34 impact lithologies are systematically older, but nevertheless agree within the errors with the Ar-Ar age of MIL34 clasts of 3.23 ± 0.31 Ga [4]. The apparently older Pb-Pb ages when compared to Ar-Ar record suggest that melt-matrix creation events took place earlier than the ubiquitous 3.9 Ga ages found in Apollo samples, and that the Ar-Ar systematics were more intensely affected than Pb-Pb by later impact event(s) recorded in these breccias.

References: [1] Korotev R. L. et al. 2011. *42nd LPSC*, Abs. #1999. [2] Bouvier A. and Wadhwa M. 2010. *Nature Geoscience* 3:637-641. [3] Norman M. D. et al. 2010. *GCA* 74:763-783. [4] Park J. et al. 2013. *44th LPSC*, Abs. #1719.