Tracing the sources of lunar volcanism with Pb isotopes

J. F. SNAPE[1], A. A. NEMCHIN[2], J. J. BELLUCCI[1], M. J. WHITEHOUSE[1]

[1]Department of Geosciences, Swedish Museum of Natural History, Box 50007 SE-104 05, Stockholm, Sweden. E-mail: joshua.snape@nrm.se

[2] Department of Applied Geology, Curtin University, Australia.

Following the methodology of a recent study [1], precise crystallisation ages (2σ errors < ±15 Ma) and initial Pb isotopic compositions for a range of lunar basalts have been determined using *in situ* Secondary Ion Mass Spectrometry (SIMS). The samples investigated here include, low-Ti basalts from the Apollo 12 and 15 missions, high-Ti basalts from Apollo 11 and 17, and basaltic clasts in the anorthositic breccia meteorite MIL 13317.

The ages determined for the Apollo basalts are broadly consistent with previous work, but the improved precision of these new ages permits a stricter evaluation of the timing and nature of lunar basaltic volcanism. For example, the sequence of basaltic flows sampled by the Apollo 12 mission has now been refined to a ~60 Ma period beginning with ilmenite basalts at 3187±6 Ma and ending with the pigeonite basalt, 12039, at 3129±10 Ma. By combining these new Pb-Pb isochron ages, initial Pb compositions and existing Rb–Sr and Sm–Nd data, this combined data set may be used to construct a coherent model describing the generation of mantle sources for lunar basalts following crystallization of the lunar magma ocean.

The basaltic clasts in MIL 13317 yield Pb-Pb isochron ages of ~4330 Ma. Petrologic evidence suggests that these clasts may have been subjected to impact metamorphism. As such, the Pb-Pb isochron is interpreted as providing a minimum estimate for the crystallisation of the basalts, while a slightly older ^{207}Pb-^{206}Pb age (4342±5 Ma) determined for several zircon grains in the brecciated meteorite matrix may be more representative of the original crystallisation of the basaltic material. These ages are comparable with the ancient age determined for the Kalahari 009 meteorite [2,3], placing the MIL 13317 clasts amongst the oldest known lunar basalts. Furthermore, an estimate for the initial Pb composition of the basaltic material is consistent with the most recent model of lunar Pb isotope evolution [1].

[1] Snape et al. (2016), *EPSL* **451**, 149-158. [2] Terada et al. (2007), *Nature* **450**, 849-852. [3] Sokol et al. (2008) *GCA* **72**, 4845-4873.