Age & chemical diversity of basaltic particles in the Apollo 12 regolith

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Background The Apollo 12 (A12) landing site sampled lunar mare basalt lava flows in Oceanus Procellarum. Most of these lavas are ~3.1-3.2 Ga [1]. We examined small fragments (<1 cm, typically <2 mm) of A12 soil to (i) characterise the relationship between the surficial regolith and underlying local lava flows, (ii) better understand the magmatic origins of these lavas and the chemical diversity of the lunar interior, and (iii) identify and characterise any fragments that are exotic to the A12 landing site, which may originate from previously unsampled lava flows.

Methods Regolith particles from soil samples 12003,308 and 12023,155 were divided into two portions. One half of each chip was petrographically examined [2-4]. The other portion was analysed using laser step heating and the MS1 or a Thermo Argus VI MC noble gas mass spectrometer at the University of Manchester. We validated our approach using chips of previously well studied hand specimen sized mare basalts (12022, 12038).

Results Our argon isotope age spectra and apparent ages of 12022 and 12038 mare basalt samples are similar to that measured by other labs, and ages measured by other isotopic systems. Twenty two regolith particles have been studied: of these, 1 is a granulitic breccia; 2 are lithic (fragmental) breccias; 18 are sourced from olivine, pigeonite, or ilmenite lava flows, which are typical of the local Apollo 12 region; and 2 are sourced from a feldspathic lava flow. Argon isotopes are variable from chip to chip: (a) The granulite has a corrected $^{40}Ar/^{39}Ar$ age of ~4.083±0.029 Ga (2σ weighted mean) [4]. (b) The fragmental breccias have corrected argon-release dates of ~3.299±0.016 Ga (2σ) and 2.96±0.64 Ga (2σ), where the younger sample has more implanted solar wind than the older one [4]. (c) The basaltic chips have variable impact shock disturbance histories, solar wind exposure, and corrected ages that mostly cluster around 3.1-3.33 Ga, consistent with the eruption ages of A12 lava flows.

[1] Snyder *et al* (2007) *GCA* **61**, 2731-2737 [2] Alexander *et al* (In Press) *MAPS* [3] Snape *et al* (In Press) *MAPS* [4] Snape *et al* (2014) *LPSC XLV*, #1974(Abstr).