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Origins and Implications of the Apollo 16 Breccia Noble Gas Suite

Mark C. Nottingham[1], Natalie M. Curran[2], John Pernet-Fisher[1], Ray Burgess[1], and Katherine H. Joy[1]
[1]Department of Earth and Environmental Sciences, The University of Manchester, UK
(mark.nottingham@manchester.ac.uk)
[2]NASA Goddard Space Flight Center, 8800 Greenbelt Rd, Greenbelt, MD 20771, United States

The Apollo 16 landing site is dominated by regolith breccias; consolidated regolith palaeo-soils [5,7,8]. Each regolith soil (and, by extension, each regolith breccia) is composed of fragments of rock sourced from different impacts and lithological units [e.g. 2,3]. Because of this, these samples probe the impact history of the lunar surface across a wide range of time. McKay et al. (1986) reported the trapped argon isotope ratios (i.e., $^{40}Ar/^{36}Ar_{Tr}$) values of regolith breccias and used these values to semi-quantitatively model breccia formation ages [see also 4]. Two groups of regolith breccias were identified at the Apollo 16 landing site: (i) the 'ancient' group, lithified immature regolith (i.e., <30 I_s/FeO), and (ii) a 'younger' group that generally have higher levels of maturity. Joy et al. (2011) used the $^{40}Ar/^{36}Ar_{Tr}$ ratios to model that: (i) the ancient samples closed from soils to breccias between ~3.8 and 3.4 Ga, consistent with regolith developed and consolidated after the Imbrium basin-forming event, and during a time of declining basin-forming impacts, and (ii) that the young breccias were assembled in the Eratosthenian period between ~2.5 and 1.7 Ga, providing insight into post-basin bombardment impact processes.

A third set of regolith breccias identified by Jerde et al. (1987, 1990), (the soil-like breccias), have no reported noble gas or exposure age information. Joy et al. (2011) inferred that these samples were likely consolidated into breccias in the last 2 Ga (based on their I_s/FeO maturity being similar to the Apollo 16 soils). They, therefore, may extend the current archive of impact and regolith processes into the Eratosthenian and Copernican periods.

Whole-rock samples were laser step heated and the extracted gases were measured using a Thermo Scientific Helix-MC noble gas magnetic sector mass spectrometer. Preliminary analysis of our data shows these breccias are dominated by a solar wind composition component, with minor spallation and radiogenic contributions. The concentrations of evolved gases suggest the samples are more similar in terms of noble gas budget to the present day Apollo 16 soil samples (based on analysis using data collated by Curran et al. 2020), than the ancient gas-poor Apollo 16 regolith breccias (McKay et al. 1986). Thus, these noble gas data are consistent with the petrological characterisation and Is/FeO classification [5,6] of these breccias being comparable to present day Apollo 16 soil samples. Solar wind composition gas concentrations comparable to present day soil samples suggest these new breccias represent consolidated regolith of comparable maturity, perhaps suggesting these soil-like breccias were formed around the same time period as the

'younger' group.

References: [1] Curran, N.M., et al., 2020, PSS, 182, 104823. [2] Donohue, P.H., et al., 2013, 44th LPSC, A#2897.; [3] Fagan, A.L., et al., 2013, GCA, 106, 429-445.; [4] Fagan, A.L., et al., 2014, Earth Moon Planets, 112, 59–71.; [5] Jerde, E.A., et al., 1987, J. Geophys. Res., 92(B4), E526– E536.; [6] Jerde, E.A., et al., 1990, EPSL, 98(1), 90-108.; [7] Joy, K.H., et al., 2011, GCA, 75(22), 7208-7225.; [8] McKay, D.S., et al., (1986), J. Geophys. Res., 91(B4), 277– 303.