Vanadium isotope composition of lunar basalts

SEAN S. HOPKINS[1*], JULIE PRYTULAK[2], JANE BARLING[1], SARA S. RUSSELL[3], ALEX N. HALLIDAY[1]

[1]Depart. of Earth Sciences, University of Oxford, UK
[2]Depart. Earth Sci. & Engineering, Imperial College, UK
[3]Depart. Earth Sciences, Natural History Museum, UK
[*]corresponding author: *sean.hopkins@stx.ox.ac.uk*

The Moon is thought to have formed in a Giant Impact between the proto-Earth and another planet [1,2]. However, geochemical predictions from dynamic models are hard to reconcile with the isotopic compositions recorded in lunar samples. Vanadium (V) isotopes offer a new constraint because the silicate Earth's composition (BSE), which appears distinct from that of other Solar System objects, might also be found for lunar samples if the Moon-forming material were derived from the Earth. Vanadium is of interest due to its refractory nature, multiple valence states, and systematic partitioning relationship with oxygen fugacity [e.g., 4]. The BSE is estimated as $\delta^{51}V = -0.7\pm0.2$‰, which is heavier than most meteorites by ~1‰ and most martian meteorites by ~0.4‰ [5-7]. Preferential irradiation of early-formed meteorite components and enrichment in ^{50}V due to early solar winds has been suggested as a cause of the isotopic difference between the Earth and meteorites [8]. Such material could then be heterogeneously distributed through the Solar System. Recent determination of light $\delta^{51}V$ of ~ -4‰ in calcium-aluminium-rich inclusions (CAIs) support a role for irradiation [9].

We analysed a suite of normal and high Ti lunar basalts from Apollo 11, 12, 14, 15 & 17, chosen for their pristine nature and range of compositions and localities. The $\delta^{51}V$ for these samples span the range between meteorites and terrestrial basalts [5-7], with no $\delta^{51}V$ difference between high-Ti and other lunar basalts. The reason for the isotopic diversity is being investigated further and deriving a primary lunar composition will enable us to further test theories of lunar origin and subsequent differentation.

[1] Hartmann, WK & Davis, DR (1975) *Icarus* **24**, 504-515 [2] Cameron, AGW and Ward, WR (1976) *Proc. Lunar Planet. Sci. Conf.* **7**, 120-122 [3] Armytage, RMG et al (2012), *GCA*, **77**, 504-514 [4] Canil, D (1997) *Nature* **389**, 842-845 [5] Prytulak, J et al. (2013) Earth Planet Sc Lett 365, 177-189 [6] Nielsen, SG et al. (2014) *Earth Planet Sc Lett* **389**, 167-175 [7] Nielsen SG et al. (2017) *LPSC* **XLVIII**, 1225 [8] Shu, FH et al. (1997) Science 277, 1475-1479 [9] Sossi, PA et al. (2017) *Nature Astronomy* **1** 0055