Vanadium isotope composition of lunar basalts

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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 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 δ⁵¹V = -0.7±0.2‰, 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 ⁵⁰V 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 δ⁵¹V 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 δ⁵¹V for these samples span the range between meteorites and terrestrial basalts [5-7], with no δ⁵¹V 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 differentiation.

[1] Hartmann, WK & Davis, DR (1975) Icarus 24, 504-515