CHARACTERISATION OF THE SILICON ISOTOPE COMPOSITION OF THE LUNAR MANTLE

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Introduction: There have been a number of high precision studies comparing the silicon (Si) isotopic compositions of terrestrial mantle samples with those of meteorites (both achondrites and chondrites) [1-4]. These studies report that Si in the terrestrial mantle is heavier than meteorites as the result of metallic–silicate liquid partitioning during terrestrial core formation.

Currently there are only limited high precision Si isotope data for lunar samples [1, 5-6], however they do show that the Moon is similar to the Earth's mantle in its Si composition and unlike meteorites. In this study, we aim to extend the dataset of high precision Si isotope analyses with the ultimate goal of characterizing the isotopic composition of the lunar mantle.

Results: We carried out bulk rock analyses on a range of lunar rock types including high-Ti basalts, anorthosites, glasses and olivine-normative basalts, covering all the Apollo landing sites. We also analysed mineral separates from both high and low Ti-basalts. Limited variation was observed among the lunar samples but did not appear to be systematic with lithology. No inter-mineral fractionation was seen in either basalt type. The mean lunar δ^{30}Si = -0.30±0.07‰ (2SD) measured in this study is in excellent agreement with the published data for four lunar basalts (δ^{30}Si = -0.31±0.06‰ (2SD)) [1]. There is no resolvable difference between the terrestrial mantle Si composition (δ^{30}Si = -0.29±0.08‰ (2SD)) [7] and that of the lunar samples.

Conclusions: These new Si isotope data find that lunar rocks have, like the Earth's mantle, a limited range of Si compositions. There is no evidence of any effects from magmatic differentiation or the existence of distinct source regions for Si isotopes. The Si isotope composition of the lunar mantle is identical to the Earth's mantle, but distinct from that measured in meteorites [1,6]. These results imply that the lunar Si composition is not that of the impactor, which, from our knowledge of the Si isotope composition of Mars and Vesta, would likely have a light, chondritic composition. Our new results support scenarios where Si became homogenized in the aftermath of the lunar-forming giant impact [8], but with no significant Si isotope fractionation during the associated volatilisation and condensation processes.

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