MAGNESIUM ISOTOPIC COMPOSITION OF THE MOON: IMPLICATION FOR ITS ORIGIN AND EVOLUTION

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Magnesium, a slightly volatile and major element in the Earth and the Moon, with large relative mass differences of 4-8% between its three stable isotopes (^{24}Mg, ^{25}Mg, and ^{26}Mg) can potentially produce large isotopic fractionation during low-temperature processes. Magnesium isotope fractionation has been also detected during high-temperature processes such as chemical and thermal diffusion [1]. Therefore, studies of Mg isotopic composition of the Earth and the Moon not only are important for understanding their geochemistry and evolution but also can be used to study of the accretion of the early solar system. It has been used in estimating the relative contribution of chondrule objects to the formation of the planetary objects [2, 3]. However, to date, the Mg isotopic composition of the Moon and its fractionation during the lunar magmatic differentiation and lunar-forming giant impact are still poorly constrained [3, 4]. There has also been debate on whether the Earth and chondrites have the same Mg isotopic composition or not and uncertainty in the magnitude of Mg isotope fractionation at mantle temperatures [3-9].

Here, we studied lunar samples to estimate the Mg isotopic composition of the Moon, to understand the Mg isotopic variation during the lunar-forming giant impact and lunar evolution and to constrain the extent of chondritic origin of the Moon. Our samples include all major types of lunar samples: lunar mare basalts, highland rocks, breccias soils and regolith.

Regardless of diverse origins and chemical compositions, Mg isotopes of these lunar samples display a narrow range, with δ^{26}Mg ranging from -0.29 to -0.17, identical within our long-term external precision (~ ± 0.07, 2SD). Our data suggest that little Mg isotope fractionation occurred during lunar differentiation, consistent with the insignificant Mg isotope fractionation during terrestrial magmatic differentiation [7-9]. Overall, Mg isotopes of these samples indicate identical Mg isotopic compositions similar to those of the Earth and chondrites, suggesting a homogenous nebular reservoir for the solar system.

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