

Magnesium isotopic composition of the Moon

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The origin of chemical heterogeneity and differences between differentiated planetary bodies and chondrites in elements, elemental ratios and isotopic ratios has not been well-understood yet. The core formation and disk-related processes are the most widely considered planetary processes to explain these heterogeneities. However, the extent to which the planetary disk material was homogeneous and similar to chondritic materials is not clear.

Magnesium is slightly volatile and one of the most abundant elements in the Earth and the Moon. Large relative mass differences of (~8%) between its three isotopes can potentially produce large isotopic fractionation during low-temperature processes and high-temperature thermal diffusion and chemical diffusion processes. Mass-dependent Mg isotope variations among planetary materials have been used to study the accretion of the early solar system [1]. However, to date, Mg isotopic compositions of the Earth, chondrites, especially the Moon, are still not well constrained and are highly debated [1, 2].

We reported high-precision Mg isotopic data for over 30 lunar samples that cover all major types of lunar rocks to: 1) estimate the Mg isotopic composition of the Moon, 2) understand its variation during the lunar evolution and magmatic differentiation, 3) constrain the extent of chondritic origin of the Moon, and 4) evaluate the effects of lunar-forming giant impact on the compositional evolution of the Moon and Earth. Regardless of diverse origins, Mg isotopic compositions of these lunar samples display a narrow range, with $\delta^{26}\text{Mg}$ ranging from -0.29 to -0.17, identical within our long-term external precision ($\sim \pm 0.07$, 2SD). Our data suggest that little Mg isotope fractionation occurred during lunar differentiation, consistent with the insignificant Mg isotope fractionation during terrestrial magmatic differentiation [2]. Overall, the Moon has an average Mg isotopic composition indistinguishable from the Earth and chondrites, suggesting a homogenous nebular reservoir for the Moon, Earth and chondrites.

[1] Wiechert & Halliday (2007) *Earth Planet. Sci. Lett.* **256**, 360–371. [2] Teng *et al.* (2007) *Earth Planet. Sci. Lett.* **261**, 84–92.

Experimental study of TiO₂ nanoparticle adhesion to silica and Fe(III) oxide-coated silica surfaces

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With the rapid expansion of industrial nanotechnology applications, engineered nanoparticles are being introduced into the environment before we fully understand the controls on their fate and mobility. In this study, we measured the adhesion of TiO₂ nanoparticles onto silica and Fe (III) oxide-coated silica surfaces as a function of pH, nanoparticle concentration, and nanoparticle size.

Batch TiO₂ adhesion experiments were conducted at pH 3–8 and 0.01 M NaClO₄ with TiO₂ concentrations ranging from 10–200 mg/L. Three TiO₂ size fractions, each containing a range of particle sizes, had initial average diameters of 16, 26, and 50 nm. Silica grains, both uncoated and coated with Fe (III) oxide, were used as the geosorbents.

The extent of TiO₂ nanoparticle adhesion increased with increasing nanoparticle concentration, and both pH and nanoparticle size exerted strong effects on the adhesion behavior of the nanoparticles onto the uncoated silica particles. Below pH 6, the expected nanoparticle pH_{zpc} , TiO₂ nanoparticle adhesion increased with increasing particle size and pH; at pH 6 and above, adhesion occurred independently of pH and particle size. Within a given size fraction, preferential adhesion of the larger TiO₂ particles was observed below pH 6, and preferential adhesion of the smaller TiO₂ particles occurred at and above pH 6.

Experiments with the Fe-coated silica grains were conducted only with the 26 nm TiO₂ nanoparticles, and, except at pH 6 where we observed significantly enhanced adhesion to the Fe-coated silica relative to the uncoated silica, the extents of nanoparticle adhesion onto the two geosorbents were the same within experimental uncertainty. The similarity in adhesion behaviors onto solids with such different surface chemistries suggests that the properties of the TiO₂ nanoparticles, such as aggregation, and not of the mineral surfaces, are primarily responsible for governing adhesion.