Water-rich S-type asteroid Itokawa

ZILIANG JIN[1] AND MAITRAYEE BOSE[1]

[1]Center for Isotope Analysis, School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287-6004. Ziliang.Jin@asu.edu

Asteroid 25413 Itokawa is an S-type rubble-pile asteroid, and Hayabusa I successfully collected more than 1500 particles in 2011 from this object [1]. It has been argued to be the parent body of ordinary chondrites [2], common in our meteorite collections. The high abundance of water in inner solar system bodies such as Earth, Moon, and Mars [e.g., 3], is thought to be a result of a late bombardment by water-rich asteroids and comets. We measured the water contents and D/H isotope ratios in Itokawa minerals to verify if S-type bodies could account for the water in the terrestrial planets.

We measured the water contents and D/H ratios of two low-calcium pyroxene (LPx) grains within particles RA-QD02-0057 and RA-QD02-0061 by using the NanoSIMS at Arizona State University. The estimated water contents were corrected for the contributions from galactic cosmic rays spallation. RA-QD02-0057 LPx grain has a water content of 971±50 ppm (2σ), while RA-QD02-0061 LPx grain contains 683±50 ppm water (2σ). The δD values of the LPx grains RA-QD02-0057 and RA-QD02-0061 normalized to D/H_{SMOW} (1.55×10^{-4}) are -61±16 ‰ (2σ) and -35±12 ‰ (2σ), respectively.

The effects of terrestrial contamination and solar wind implantation are negligible. Dehydration due to thermal metamorphism and impact events on Itokawa parent body was simulated assuming a size (50 km diameter), temperature (600-900 ºC) and time-scales of the metamorphic event (0-10 Ma), and proved to be less likely to change the water content (< 20 ppm) and δD values (< 1 ‰) of the tested pyroxenes. Therefore, the reported values represent the original composition of pyroxene grains, when they first condensed and accreted to form the Itokawa parent body. Based on the pyroxene proportion in Itokawa [1], the estimated water content of Itokawa parent body ranges from 330 to 870 ppm. We thus infer that the S-type asteroids are probably water-rich. Finally, the δD values of the pyroxene grains are within the range of terrestrial samples and indistinguishable from ordinary chondrites, carbonaceous chondrites, and meteorites from Vesta and Mars [3]. Based on this work, we speculate that S-type asteroids could potentially have provided water to the inner planets.

[1] Tsuchiyama (2014) *Elements* **10 (1)**, 45-50. [2] Nakamura et al. (2011) *Science* **333**, 1113-1116. [3] Sarafian et al. (2014) *Science* **346**, 623-626.