Ion irradiation experiments to olivine: Comparison with space weathering rims of Itokawa and lunar regolith particles

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Surface morphologies of regolith particles of asteroid Itokawa recovered by the Hayabusa missions have important imformation about phenomena on the surface of an airless celestial body. In previous studies, space weathering rims were found on Itokawa particles by TEM and STEM [1, 2]. Especially, vesicles were identified in thick space weathering rims probably caused by solar wind He^+ implantation [2]. Blister structures corresponding to the vesicles were also observed on the particle surfaces by FE-SEM [3].

In this study, we carried out ion irradiation experiments to olivine particles (Fo_{70}) at the Wakasa Wan Energy Research Center and Institute of Low Temerature Science in order to understand relationship between space weathering processes and surface nano-morphological changes of Itokawa paricles. The fragments were irradiated by H^+, H_2^+ and He^+ ions at 4 to 50 keV with fluences of 1×10^{16} to 1×10^{18} ions/cm^2. Irradiated samples were observed by FE-SEM. Ultra-thin sections of the samples prepared by FIB were observed by TEM and STEM. Lunar regolith particle surfaces were also observed by FE-SEM for comparison. Blister structures and numerous bubbles, which have silimar structures to the Itokawa particles, were observed on the irradiated olivine samples. The blister structues were also observed on the lunar particles. The mean size and number density of blisters on lunar and Itokawa regolith particles are within almost the same range, suggesting that blisters formed on lunar and Itokawa particles by the same process.

[1] Noguchi *et al*. (2011) *Science*, ***333***, 1121-1125. [2] Noguchi *et al*. (2013) *Met. Planet. Sci. accepted*. [3] Matsumoto *et al*. (2013) *LPSC XLIV,* 1441.

Improved understanding of sources and processes of metal mobilization from sulfidic mine wastes through the application of post-transition stable isotopes

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The generation of metalliferous mine waters can result in potentially harmful impacts on environmental receptors. We conducted a 30 week lab-scale humidity cell test with sulfidic tailings from the Kidd Creek massive sulfide deposit, Canada. In 7-day cycles, the mine waste was exposed to three days of dry and moisturized air to accelerate sulfide-mineral oxidation. On day seven, metals were mobilized through flushing with deionized water. For the first time, we combined this prediction technique with a detailed study on the fractionation of stable zinc isotopes to i) identify principal metal sources and ii) improve understanding of the geochemical processes leading to metal mobilization. The dissolution of secondary and tertiary oxyhydroxisulfates at the beginning of the study led to considerable changes in zinc isotope ratios, potentially indicating kinetic fractionation of zinc isotopes. Thereafter, zinc was primarily mobilized through the oxidation of primary sulfide minerals with little or no change in $\delta^{66}Zn$ values. The limited isotope fractionation observed may assist in the use of zinc isotopes as a tracer of anthropogenic, metal mine sources in future studies.

www.minersoc.org
DOI:10.1180/minmag.2013.077.5.13