Ultraviolet irradiation experiments on olivine and the Murchison CM2 chondrite: Implications for space weathering on asteroids

Hiroshi Kaiden[1], Takahiro Hiroi[2], Keiji Misawa[1], Hirokazu Tanaka[3], Sho Sasaki[3],
Kevin M. Robertson[2], Ralph E. Milliken[2], Hiroshi Masai[4] and Jun Terao[4]
[1]*Geoscience Group, National Institute of Polar Research*
[2]*Department of Earth, Environmental and Planetary Sciences, Brown University*
[3]*Department of Earth and Space Science, Osaka University*
[4]*Department of Basic Science, The University of Tokyo*

Introduction: Various investigations have been conducted to simulate space weathering in laboratories. Ion irradiation (e.g., Brunetto, 2009) and pulse-laser irradiation (e.g., Sasaki et al., 2001) experiments were carried out to simulate the alteration of asteroid surfaces by the solar wind and by micrometeorite impacts, respectively. In this study, ultraviolet (UV) irradiation experiments on olivine and the Murchison (CM2) chondrite were performed to investigate possible mechanisms of space weathering on asteroid surfaces.

Materials and Methods: Pressed pellet samples of powdered (<75 μm) olivine ($Fa_{11–15}$) and the Murchison chondrite were placed in a vacuum chamber (~10^{-4} Pa) and irradiated with focused (5.0 mm in diameter) UV light in the wavelength range of 250–385 nm emitted from a 300 W xenon arc lamp housed in the Asahi Spectra MAX-303 at the University of Tokyo. The duration of UV irradiation was 312 and 624 hours for olivine and that for Murchison was 63 and 312 hours. The duration of UV irradiation for 312 hours with the xenon light source is estimated to be equivalent to that for 2–3 years with the Sun at 1 AU. Bidirectional UV–visible–near-infrared (VNIR) diffuse reflectance spectra of the unirradiated and the irradiated samples were obtained using a Bunko Keiki DRS-25 UV-VNIR spectrometer at Osaka University.

Results and Discussion: Reflectance spectra of the olivine and the Murchison pellet samples before and after UV irradiation are shown in Figure 1. The spectra of olivine became darker and redder with increasing the duration of UV irradiation. The spectral changes are consistent with those of space weathering of S-type asteroids (Sasaki et al., 2001). The spectra of Murchison also became darker with increasing the duration of UV irradiation. The spectral changes both for olivine and Murchison occurred very rapidly, i.e., equivalent to <10 years of UV irradiation by the Sun at 1 AU. We will continue the UV irradiation experiments and investigate the mechanism of the spectral changes for a better understanding of space weathering on asteroids.

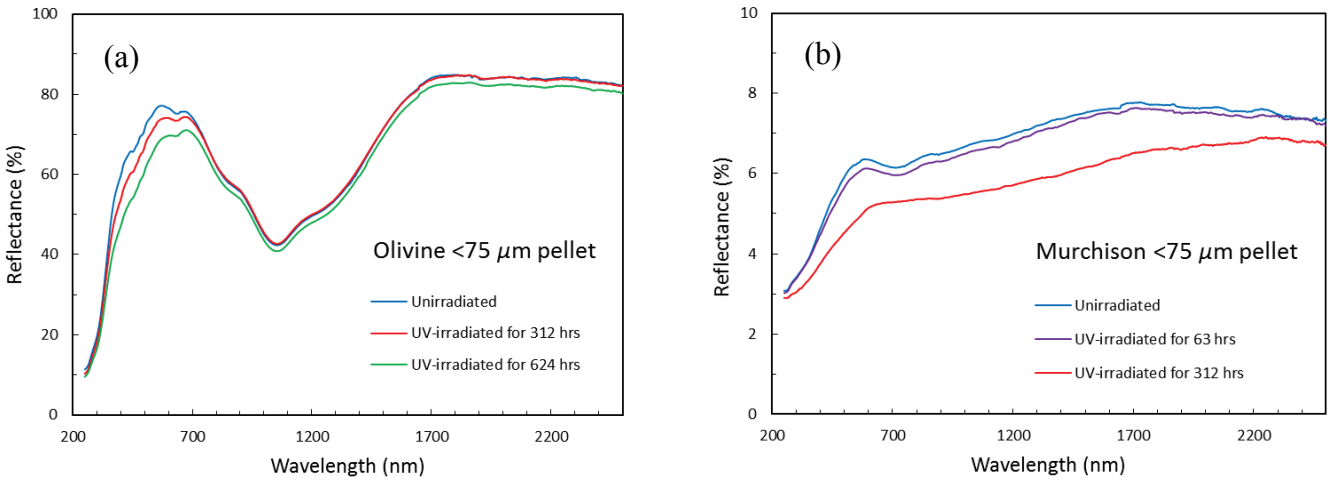

Figure 1. UV-VNIR spectra of (a) olivine and (b) Murchison pellet samples with different duration of UV irradiation.

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References

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