WEATHERING EFFECTS OF SOLAR WIND PLOTONS ON SPECTRAL SHAPE OF SILICATE MINERALS.
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Introduction: HAYABUSA2 was launched on December 3, 2014 (JST) from Tanegashima Space Center and started the new juarny. It would carry the asteroidal samples to us in 2020. The target of HAYABUSA2 is C-type asteroid which is thought to contain water and/or organics. We must decide the sampling site using characterization of mineralogical and textural heterogeneities on the asteroid surface by remote sensing data.

The reflectance spectra of asteroidal surface have information of surface composition, but the surface spectra was changed by weathering effects which contain the micro-impacts and the implantation of solar wind ions and cosmic ions. The space weathering effects change the surface color of airless bodies. The S-type asteroids spectra show the redding and darking, and the C-type asteroids show the bluing and darking[1].

A lot of experimental approaches tried to reproduce the weathering effects. *Sasaki et al.* simulated space weathering of the S type asteroid well [2]. On the other hand, the simulation of implantation using H^+ and He^+ ions at keV emergies [3] and MeV energy protons implantation [4] show only small changes in visible and near infrared spectra. For the luna analogs, the weathering simulation of solar wind protons is well stading[e.g. 5].

The weathering simulation for the carbonaceous condrite using puls laser shows that the irradiated spectra trend bluing and darking [6]. However the influence of the solar wind proton on minerals contained in C-type asteroids is not studied well. Here we report on a laboratory simulation of the implantation of the solar wind protons in the minerals contained in CI and CM chondrite.

Samples: We prepared three samples which would be contained in C-type asteroids, Olivine (San Carlos, Arizona), Antigorite (Sangencyaya, Kyoto), Saponite (synthetic: Kunimine Industrie Co., Ltd.). They were heated for 24 houres at 423 K. Olivine was sieved between 75 μm - 105 μm and antigorite and saponite were sieved between 50 μm and 75 μm. The samples were packed into Cu cups and pressed. Then they were formed pellets.

Experiment: We simulated the weathering effect of irradiation of solar wind protons using ion implantation device at the Wakasa Wan Energy Research Center (WERC), Fukui. This device can irradiate H_2^+ beam with 10 keV. The irradiation chamber was drew vacuum under 1×10^{-5} Pa. The total amount of H_2^+ was about 10^{18} ion/cm^2. After irradiation, we measured reflectance spectra.

Discussion: The spectra of olivine which contained in moon and S-type asteroids was changed by irradiation. It shows redding and darking very well (Fig. 1-a). This trend has not been seen in the irradiation experiment of high energy protons [4]. The trend of rapid redding and darking is required by observation of asteroidal families [8] and consistent with bulk silicate-rich rocks [9]. The amount of irradiated protons corresponding to time scale shorter than 10^6 years.

On the other hand, alterated spectra of antigorite and saponite show only small changes (Fig. 1-b, 1-c). The irradiated spectrum of antigorite shows about 5 % darking (Fig. 1-b). Furthermore, the absorption feature at 0.7 μm region remain after irradiation. This feature relative with Fe^{2+} and Fe^{3+}. This feature of CM chondrite was disappeared by heating and laser irradiation [6, 7]. Therefore it suggests that the tempareture of sample was not raised like laser irradiation.

The 1 μm band slope defined as the slope of the tangential line continuum of a reflectance spectrum scaled to 1.0 at 0.55 μm showed difference between minerals[10]. Before irradiation, the spectral slopes showed 0.042 (olivine), 0.13 (antigorite) and 0.075 (saponite). After irradiation, they showed 0.31 (olivine), 0.11 (antigorite) and 0.095 (saponite). It suggests that the change in spectral slope of hydrated silicate minerals was less than unhydrated silicate minerals.

Conclusion: We simulated the space weathering effect of solar wind protons. The irradiated spectrum of olivine which is major mineral of moon and S-type asteroids shows rapid redding and darking. However the irradiated spectra of antigorite and saponite which are contained carbonaceous chondrites did not show big changes. Furthermore, 0.7 μm feature of antigorite was not changed by proton irradiation. The influence of proton irradiation on hydrated silicate minerals is more difficult to be observed than unhydrated silicate minerals.

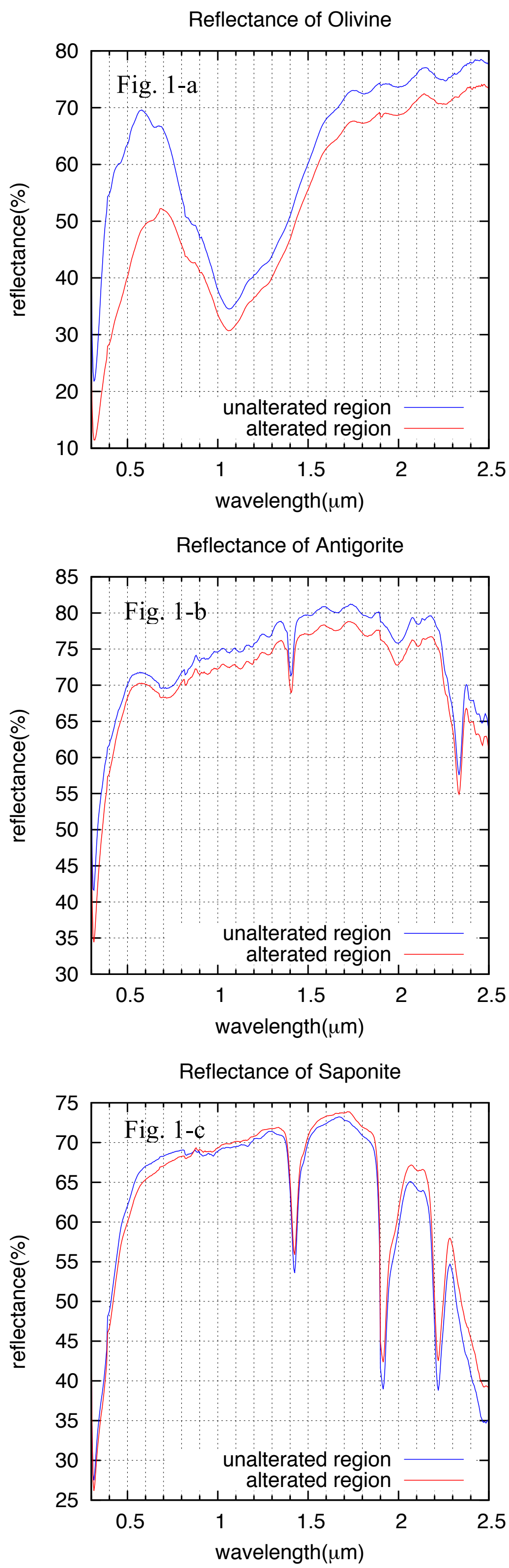

Fig. 1) The reflectance spectra of samples: Blue line : The spectrum of unirradiated sample. Red line : The spectrm of irradiated sample. The irradiated ion was H_2^+ with 10 keV and total fluence was about 10^{18} ion/cm^2. a) The sample is olivine, San Carlos. b) The sample is antigorite, sangencyaya. c) The sample is saponite, synthetic.

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