Space Weathering on Mercury: Laboratory Simulation of Plagioclase Weathering

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The surface optical property of airless silicate bodies such as the Moon, Mercury and asteroids should change in time. Typical characteristics of this change, "space weathering", are darkening, spectral reddening, and attenuation of absorption bands in reflectance spectra. The space weathering is caused by the formation of nanophase metallic iron particles in amorphous surface coatings of regolith grains from the deposition of ferrous silicate vapor, which was formed by high velocity dust impacts as well as irradiation of the solar wind ions. Experimental studies using pulse laser showed the formation of nanophase ion particles on the surface should control the spectral darkening and reddening [1].

Mariner 10 and MESSENGER spacecraft showed that Mercury has more impact craters associated with bright rays than the Moon. The space weathering rate on Mercury's surface might be slower than that of the lunar surface, although dust flux and solar wind flux causing the weathering should be one order of magnitude of greater on Mercury than on the Moon [2]. MESSENGER-MASCS spectra show variation in the slope, which can be explained by lunar-like maturity trend due to the difference of space weathering degree. Absorption in the UV range shows that the ferrous oxide (Fe^{2+}) content in average surface/subsurface material is as low as a few weight percent. This could explain apparent low weathering rate on Mercury.

The difference of space weathering between the Moon and Mercury might be also due to the compositional effect. Mercury surface is considered to be plagioclase-rich like the highland of the Moon. We started experimental simulation of space weathering on Mercury (and the Moon) using anorthite samples. Although pure anorthite is in lack of iron, addition of iron-bearing material could alter the anorthite reflectance. Our experiments show that laser irradiation on pure anorthite should not alter its spectrum largely. The addition of small amount of pyroxene can change the anorthite reflectance upon laser irradiation (darkening/reddening of visible spectrum). Addition of 5% ilmenite can enhance the spectral change (darkening/reddening) drastically.

Keywords: Mercury; Space Weathering; Plagioclase; Anorthite; Reflectance spectrum; pulselaser; laboratory simulation.

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