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Space Weathering and Surface Gardening on Mercury

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Space weathering is a proposed process to explain spectral mismatch between lunar soils and rocks, and between asteroids (S-type) and ordinary chondrites. Most of lunar surface and asteroidal surface show darkening of overall reflectance, spectral reddening (darkening of UV–Vis relative to IR), and weakening of absorption bands. Recent asteroid observations (including asteroid Itokawa by Hayabusa spacecraft) strongly support that space weathering occurred not only on the moon but also on asteroids. Hapke et al. (1975) proposed the formation of nanophase metallic iron particles in soil coatings from the deposition of ferrous silicate vapor. High-velocity dust impacts as well as sputtering by solar wind would be responsible for vapor formation. Mercury is also an airless body and its surface should be affected by these processes. We succeeded in reproducing the spectral change expected in space weathering, using nano-second pulse laser irradiation simulating high-velocity dust impacts. We also confirmed the formation of nanophase iron particles. Since impact flux and velocity of dust particles on Mercury would be much higher than those on the moon and asteroid, spectral darkening and reddening on Mercury would be faster Although Mariner 10 and recent ground observation show the surface reddening on Mercury, there are many impact craters associate with bright ejecta and rays. Impact process should have excavated underlying unweathered material, but Mercury has more craters with brighter rays/ejectra than the moon has. This might not imply rapid surface weathering. One possibility is that high surface temperature would grow nanophase iron leading to decreasing optical effect. The other possibility is lower abundance of Fe. But probably the most significant effect is an impact gardening process which would have dilute the surface maturity. Higher impact flux and velocity of impacting meteoroids would stir the surface regolith more effectively than on the moon, which may moderate observed spectral change. Spectral obaervation of Mercury by Messenger and BepiColombo would clarify the space weathering rate in comparison with relative crater density age. Also detailed surface imaging may provide information on surface impact process. MDM (Mercury Dust Monitor) on board BepiColombo will clarify flux and velocity of dust causing space weathering.