

# Space Weathering: A Lesson from Itokawa

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Reflectance spectra of S-type asteroids are different from those of ordinary chondrites. There are also spectral differences between lunar rocks and soils of the similar composition. These spectral mismatches are explained by the so-called “space weathering”. S-type asteroids exhibit more overall depletion and reddening of spectra, and more weakening of absorption bands relative to ordinary chondrites. Formation of nanophase metallic iron particles due to high velocity dust impacts as well as sputtering by solar wind would be responsible for the spectral change. We succeeded in reproducing the spectral change expected in space weathering, using nano-second pulse laser irradiation on silicates simulating high-velocity dust impacts. We confirmed the formation of nanophase iron particles using TEM (Sasaki S., et al. (2001) *Nature*, **410**, 555-557). We considered regolith-like surface condition is essential for space weathering, since evaporated materials may condense with nano-iron particles on the surfaces of other particles. The size-dependent transition from Q-type (ordinary chondrite-like) objects to S-type objects also suggested that regolith is scarce (abundant) on objects smaller (larger) than the transition size (Binzel R. P. et al. (2004) *Icarus* **170**, 259-294).

In 2005, Hayabusa spacecraft rendezvoused an S-type asteroid (25143) Itokawa (with size of 550m) and performed a color imaging by onboard camera AMICA. Approximately 80% of Itokawa’s surface is rough and boulder-rich but it has a somewhat weathered spectrum on average. Optically, the surface of Itokawa is divided into darker (and redder) (boulder-rich) areas and brighter (and bluer) areas. High resolution images indicate that boulders are firmly covered with weathered fine particles or boulders’ surface are optically weathered.

In order to check the possibility that the rock surface could be weathered, we irradiate pulse laser on meteorite fragments with cut flat surface. We irradiated on relatively fresh meteorites NWA1794 (LL5) and Bencour (LL6), because spectral similarity of Itokawa with LL5 /LL6 chondrites. We found that rocky meteorite surface is darkened and reddened by weathering simulation, although the weathering degree is weaker than powder-like surface. We consider that the darker boulder-rich zone of Itokawa consists of dark boulders with weathered coating, which is also suggested from highest resolution image. Small (sub-km) less-regolith asteroids with silicate composition may also change its brightness and color by space weathering, although their weathering degree would be weaker than regolith-covered asteroids.