



Asteroidal space weathering due to solar wind bombardement

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Abstract

A comparison of the laboratory reflectance spectra of meteorites with observations of asteroids revealed that the latter are much redder, with the spectral difference explained by space weathering, though the actual processes and timescales involved have remained controversial. Here we show that space weathering must be a very rapid process—the final color of a silicate-rich asteroid is acquired shortly after its ‘birth’ (within 10^6 years of undergoing a catastrophic collision). This rapid timescale favors solar wind implantation as the main mechanism of space weathering, as laboratory experiments have shown that it is the most rapid of several competing processes. We further demonstrate the necessity to take account of composition when evaluating weathering effectiveness, as both laboratory and asteroid data show an apparent dependence of weathering on olivine abundance. The rapid color change that we find implies that color trends seen among asteroids are most probably due to compositional or surface-particle-size properties, rather than to different relative ages. Apparently fresh surfaces most frequently seen among small near-Earth asteroids may be the result of tidal shaking that rejuvenates their surfaces during planetary encounters.