Electrostatic removal of fine-grain regolith on sub-km asteroids.
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Introduction: Surfaces of the asteroids Itokawa, Ryugu, and Bennu, the targets of recent sample return missions, are dominated by boulder fields without the presence of fine-grain regolith, indicating an active regolith removal process at work (1-6). Here, based on recent laboratory and space experimental results, we show that, at 1AU heliospheric distance, asteroids smaller than 1 km in radius experience a net loss of surface fine-grain material (Hsu et al., submitted). This is because the regolith loss driven by electrostatic dust lofting (7) dominates the production from fragmentation caused by thermal fatigue and meteoroid impacts, mainly because of the low-gravity environment of these small bodies. Sub-kilometer Main Belt Asteroids likely become regolith-free Near Earth Asteroids as they migrate inwards. The electrostatic regolith removal is expected to be coupled to the orbital and rotational evolution of small bodies driven by thermal radiation processes. In conjunction with rotation, space weathering, and other processes, electrostatic regolith size-sorting and removal affects the surface properties of small asteroids, contributing to the spectral diversity among asteroids.

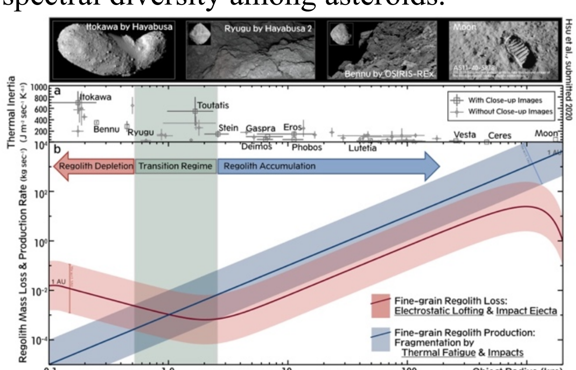

Figure 1. Surface thermal inertia and regolith mass production and loss rates as a function of object radius. (a) Surface thermal inertia of airless bodies. (b) The regolith loss (red) and production (blue) rates as a function of object size based on our model calculation. It shows that, at 1AU, objects will radii < 1 km experience net regolith loss dominated by electrostatic ejection, providing a physical explanation to the size-surface thermal inertia relation (8,9) and the lacking of fine-grained regolith on asteroids Itokawa, Ryugu, and Bennu visited by recent missions (2,4-6).

Reference: (1) A. Fujiwara et al., *Science* 312, 1330 (2006) (2) H. Yano et al., Science 312, 1350 (2006) (3) M. Riner et al., Icarus 198, 67 (2008) (4) D. S. Lauretta et al., Nature 568, 55 (2019) (5) Grott et al., Nature Astronomy (2019) (6) R. Jaumann et al., Science 365, 816 (2019) (7) X. Wang et al., Geophys. Res. Lett. 43, 6103 (2016) (8) Delbo et al., Icarus 190, 236 (2007) (9) Delbo et al., Asteroid Thermophysical Modeling in Asteroids IV (2015).