Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-17 Room:105 Time:May 19 16:15-16:35

Evolution of small bodies: The role of collision

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Collisions change the mass distributions of small bodies. When two small bodies collide, they will become bound to form a bigger body, lose mass by fragmentation and ejection, or be disrupted into smaller pieces. It has been recognized that larger rocky bodies are weaker due to a larger probability of relatively weak cracks. However, observational data indicate that small bodies have various porosities suggesting that they have experienced various degrees of thermal metamorphism and aqueous alteration. We conducted laboratory collisional disruption experiments for rock and homogeneous porous targets by changing the size scale of the target and projectile. Our porous target showed no obvious size dependence in the disruption threshold, in contrast to a size-dependent disruption threshold for the rock targets. If this tendency can be applied to the evolution of small bodies, it could be that mass distributions with different thermal metamorphism stages or different degrees of aqueous alteration evolved along different evolutional tracks or different timescales.

Collision modifies the structure of small bodies. Collisions initiate and promote crack growth and consequently reduce the strength of the small bodies. Collisions make the small bodies more compact and reduce the porosity. They also increase the temperature of a body and cause it to lose porosity and gain strength via thermal evolution. Collisional disruption and re-accumulation can even change a continuum body into a granular, rubble-pile body.

Collision changes the surface material of small bodies. Mature surface materials exposed to interplanetary space are ejected by collision, refreshing the surface. Collision brings exotic material to the surface as seen on the surface of Asteroid 4 Vesta and the spatial variation of surface material. Vibration produced in a rubble-pile body by collision induces migration and segregation of grains on the surface. Eventually, it may modify the reflectance spectrum and thermal emission of the surface.

Here we discuss our current understanding of the above three roles of collision in small body evolution and discuss this alongside recent results of laboratory experiments.

Keywords: small bodies, collision, evolution