Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SCG59-P02 Room:Convention Hall Time:May 27 18:15-19:30

Granular convection and its application to asteroidal resurfacing timescale

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Recently, planetary explorations by space probe have observed various surface geomorphologies that are covered with regolith and boulders on the asteroids. In particular, landforms resulting from the regolith fluidization and sorting by impact-induced global seismic shaking were found on the asteroid Itokawa [1]. As a possible mechanism for the regolith fluidization, granular convection was proposed [1]. In addition, the regolith migration and resurfacing resulting from the granular convection might be consistent with the relatively young surface age (1 ? 8 Myr) of Itokawa [2, 3]. In fact, when the granular matter such as regolith is subjected to the vertical vibration, the granular convection can be readily generated (e. g. [4]). Although the gravity dependence of the convective velocity has to be investigated to discuss the possibility of regolith convection under the microgravity condition such as asteroid Itokawa, only a few researches concerning this problem have been performed so far [5].

We performed systematical experiments of the granular convection with glass beads under the steady vertical vibration. Although the direct control of gravity is quite difficult in laboratory experiments, we instead employ the scaling approach to figure out the gravity dependence of the granular convective velocity. As a result, we found that the granular convective velocity is almost proportional to the gravitational acceleration [6]. This experimental result suggests that the convective velocity would be very low under the microgravity condition. The low convective velocity would result in the long timescale of regolith migration. In order to examine the feasibility of the regolith convection on Itokawa, the resurfacing timescale induced by regolith convection should be compared with the surface age or the lifetime of Itokawa. In this study, we aim at developing a model of resurfacing process induced by granular convection. The model allows us to estimate the resurfacing timescale not only Itokawa but also on the general asteroids covered with regolith.

In the model, we divide the resurfacing process into three phases as follows:
1. Impact phase: An impactor intermittently collides with a target asteroid.
2. Vibration phase: The collision results in a global seismic shaking.
3. Convection phase: The global seismic shaking induces the regolith convection on the asteroid.

For the impact phase, we estimate the frequency of impact events per year by using the model of impactors' population in the main belt asteroids (MBA) [7]. To compute the vibration strength induced by each impact, we utilize the global seismic shaking model [8] for the vibration phase. For the convection phase 3, we use the scaling of the granular convective velocity [6] in order to relate the vibration strength and the regolith convective velocity. Combining these three phases, we compute the resurfacing timescale T as a function of the diameter of target asteroid D_a.

We assume the specific parameter values based on previous work [1, 7, 8] to compute T. As a result, we find T= 9 Myr for the Itokawa-sized asteroid, and this value is comparable to the surface age of Itokwa measured by the returned sample (1 ? 8 Myr) [2, 3]. In addition, T= 9 Myr is much shorter than the mean collisional lifetime of Itokawa (about 170 Myr [7]). This indicates that the regolith convection is able to resurface the asteroid almost within its lifetime.

[1] H. Miyamoto et al., Science **316**, 1011 (2007).
[2] K. Nagao et al., Science **333**, 1128-1131 (2011),
[3] M. M. M. Meier et al., LPSC abstract #**1247** (2014).
[4] A. Garcimartin et al., Physical Review E **65**, 031303 (2002).
[5] C. Gutteler et al., Physical Review E **86**, 050301 (2013)
[6] T. M. Yamada and H. Katsuragi, Planetary and Space Science **100**, 79-86 (2014).
[7] D. P. O'Brien and R. Greenberg, Icarus **178**, 179-212 (2005).
[8] J. E. Richardson Jr. et al., Icarus **179**, 325-349 (2005)

Keywords: granular convection, regolith fluidization, asteroid, resurface