

Does the Brazil nut effect work on small asteroids?

*Koji Wada¹

1. Planetary Exploration Research Center, Chiba Institute of Technology

Previous asteroid exploration missions, including Hayabusa2, have revealed that asteroid surface layers tend to be covered with relatively large rocks and poor in small particles. This is thought to be due to the so-called "Brazil nut effect (BNE)," with which larger particles rise and smaller particles sink in the surface layer due to vibration and flow, and is considered to be evidence that the asteroid's surface layer is active. However, it is not obvious whether the BNE effectively works or not for asteroids with extremely low gravity, because the inter-particle adhesion force is not negligible and the fluidity of particle layers is expected to be decreased.

If we conclude that the BNE does not work on asteroids, the presence of many relatively large rocks (with few small particles) in the surface layer may suggest that the asteroid was composed of relatively large particles since its formation rather than being a consequence of surface evolution. This may constrain the formation process of the asteroids. If the BNE is at work, it would also constrain the inter-particle adhesion forces, which in turn would be expected to constrain the asteroidal materials and the mechanical strength of the asteroid. Such a discussion is expected to lead to a deeper understanding of the formation process of asteroids, and thus the origin and evolution of solar-system bodies. Therefore, in order to quantitatively discuss the asteroid surface evolution process, it is important to clarify whether the BNE is effective in the asteroid surface environment where inter-particle adhesion is dominant, and whether a critical adhesion force can be specified for the BNE.

In this presentation, I will introduce an effort in numerical simulations using the distinct element method to clarify the dependence of the BNE on parameters such as inter-particle adhesion forces for understanding the asteroidal surface evolution.

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