ITOKAWA: A GLOBAL SHACKEN AND FRACTURED ASTEROID WITH BRAZILIAN NUT EFFECT.

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Introduction: The aim of this work is to discuss the morphological evolution and origin of the rubble pile asteroid 25143 Itokawa, destination of the Hayabusa mission in 2005.

The current model considers Itokawa as a disruption of a parent asteroid by collision with another object that later regroup following a rubble pile scheme. Based on the dynamical history of this asteroid along with the analyzed data from Hayabusa spacecraft, we conclude that the morphology presented corresponds to a global shacked asteroid. Due to its present low inclination and possible source region in the inner asteroid belt [1], the asteroid has suffered frequent collisions which produce a seismic shaking of the entire body. Global shaking by non-disruptive collisions over long periods of time seems to activate the so-called Brazilian Nut Effect, acting as the major modeling process upon Itokawa's structure. This process is known to segregate the particles of different their sizes under the influence of a gravity field. Large particles tend to rise to regions of high potential while small particles tend to sink to regions of lower potential.

As a first look at the images, it was suggested that the material covering Itokawa's surface was distributed with a particular pattern. Rocks and boulders piled over certain areas whereas small grains covered a very specific location. It seems that there is a correlation between the size distribution of rocks, pebbles or small grains and their location over the surface of the asteroid. For instance, it was desirable to compute an accurately surface gravity potential in order to pursuit a more clear relation concerning the displayed features of Itokawa.

Making use of the available shape model of Itokawa, the total volume and surface gravity potential, including its rotational term, were computed along with the geometrical spacecraft-asteroid configuration for each image used, the later by means of implementation of SPICE routines and the kernels developed for this mission. The potential results agree with the model presented by Fujiwara A. et al.[2].

Following a rigorous image composition it was clear that there was an evident correlation between the surface gravity potential zones and the size of the material (rocks, pebbles and grains), covering them. Larger particles concentrate in regions of high potential while the small particles are found in the low-potential regions.

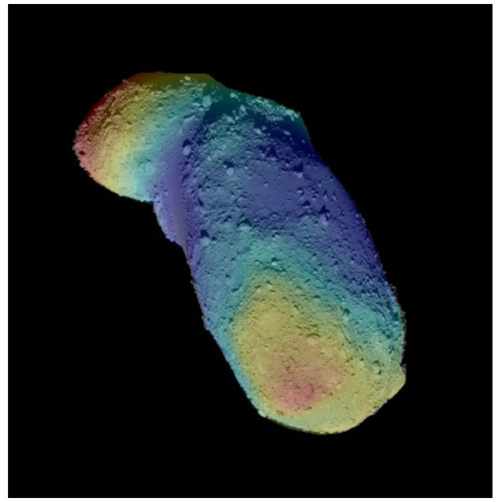

Figure1: Gravity potential mapped over Itokawa's surface combined with an image taken by Hayabusa. Red and yellow colors correspond to high potential while white and blue to low potential.

As a confirmation of this qualitative comparison we obtained the cumulative size distribution of rocks in different areas of the surface. We manually counted several thousand boulders of different sizes in far and close range images in regions of the “head”, “tail” and central “neck” of the asteroid. The size distributions confirm our previous analysis.

We conclude that the redistribution of boulders is a global effect and it is not a simple surface process that moves the particles along surface slopes [3]. The asteroid must then be considered as a completely fractured rubble pile body where the seismic shaking has produced a segregation of rocks in a global scale.

This conclusion has important implication regarding the deflection mechanism that could be applied to a NEA like Itokawa.

References:

[1] Yoshikawa M. & Mitchel P. (2006) *Research Note A&A 449, 817820.* [2] Fujiwara A. et al. (2006) *Science, 312, 1330.* [3] Miyamoto et al. (2007), *Science, 316, 1011.*