

Estimation of space weathering timescale using the number of mottles on the boulder in Hayabusa/AMICA images

*Sunho Jin¹, Masateru Ishiguro¹

1. Seoul National University

The remote-sensing images of the Hayabusa mission target asteroid (25143) Itokawa (Sq-type) indicates the coexistence of both matured terrains by space weathering and fresh regions with newly exposed materials. Several resurfacing mechanisms (e.g., tidal interaction with terrestrial planets) [1] are proposed to explain the formation of these regions. The estimation of space weathering timescale is essential to constrain the possible mechanisms to rejuvenate the asteroid.

Note that there is an unignorable discrepancy between the timescale derived from different techniques. The timescale estimated from the solar flare track density and the weathered rim thickness of regolith samples acquired by Hayabusa spacecraft range from 10^2 to 10^4 years [2][3], while those estimated from laboratory simulations range from 10^4 to 10^6 years [4][5]. Besides, there are inherent insufficiencies of these age estimation methods. Since evidence of regolith migration is found on the surface of Itokawa [6], particles on the very surface would be rejuvenated by granular convection. Meanwhile, laboratory experiments are indirect stimulations of the space weathering process, which would have possibilities to be different from the actual process present in the asteroid. Thus, we focus on estimating the surface exposure age using bright mottles on the large boulders, where the materials are insusceptible to the regolith migration. These mottles are expected to be formed by impacts of mm to cm-sized interplanetary particles.

In this work, we used three AMICA (Asteroid Multi-band Imaging Camera) v-band images. These images were taken on November 12th, 2005, during the close approach to the asteroid. First, we masked boulders large enough to detect mottles. Then, we determined the size distribution of these mottles. We also derived theoretical size distribution with various timescales of space weathering with the well-known size distribution of interplanetary dust particles (e.g., Grün, 1985 [7]). By comparing these two distributions, we estimated the time needed to form mottles before becoming dark again by space weathering.

As a result, we found surface exposure timescales of these boulders are an order of 10^3 – 10^4 years, consistent with those previously estimated from laboratory simulation with light ions, such as Hydrogen and Helium. We also plan to discuss possible resurfacing scenarios to expose fresh materials during such short time intervals at this meeting.

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