Asteroid Ryugu's parent body and its properties inferred from Haybusa2 multi-band imaging observations

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JAXA’s Hayabusa2 has conducted global observations of Ryugu and revealed many important properties of Ryugu, such as Cb-type average spectrum, the lack of a strong 0.7-um absorption, very low 0.55-um geometric albedo (4.5+/-0.2) %, and very young (< a few Myr) crater retention age for small craters (>10m).

The Cb-type spectrum of Ryugu is consistent with Eulalia and Polana families in the inner main belt, which are dynamically most probable source families. This agreement between the prediction from dynamic calculations and spectral observations suggests that one of the two asteroids is likely Ryugu’s parent body. These families are among the most widely dispersed C-complex families in the inner main belt, allowing to deliver family members at very high flux rate to the resonance zones (nue6 and 3:1) at both inner and outer boundaries of the inner main belt, which are the dominant source of near-Earth objects (NEOs).

Furthermore, high abundance of boulders are found on Ryugu. Evidence for mass wasting indicates mechanically unconsolidated surfaces, allowing surface boulders to move easily. The morphologies of impact craters on Ryugu are consistent with gravity-regime formation, in which impact events produce large ejecta masses. These suggest that large mass of boulders and pebbles can be ejected from Ryugu to space over time.

Consequently, a large mass of Ryugu-like macroscopic objects would enter Earth’s atmosphere, suggesting the presence of counterparts in our meteorite collection. Among such candidates is moderately dehydrated carbonaceous chondrites, which have both very low albedo and flat spectra. They are also found with high abundance in Antarctica, which may represent the long-term average flux of infalling meteorites on Earth. Another is interplanetary dust particles (IDPs), which also have low albedos and account for large influx of extraterrestrial materials to Earth. Although a decisive conclusion may not be obtained before the analysis of Ryugu samples returned to Earth, currently available observational evidence, such as high boulder abundance on Ryugu, favors that its composition may be similar to moderately dehydrated carbonaceous chondrites. This would further suggest that Ryugu’s relatively low abundance of hydrated minerals may be due to partial dehydration on Ryugu’s parent body.

Keywords: Hayabusa2, Ryugu, The evolution of the solar system