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Shape and Distribution of Craters on the Asteroid Ryugu

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The telescopic optical navigation camera (ONC-T) on board the Hayabusa2 spacecraft has been acquiring images of the asteroid 162173 Ryugu. Impact craters on this asteroid provide fundamental information on the asteroidal surface, including surface ages, physical properties, and crater degradation processes. Here we report the shape and the spatial distribution of craters found on the asteroid Ryugu.

We conducted stereoscopic analyses to find circular depressions, using images obtained from altitudes of 20 km, 5 km, and 3 km. Spatial resolution of the images were 2, 0.5 and 0.3 m/pix, respectively. A shape model and the Small Body Mapping Tool (SBMT) were used to measure the dimension and location of craters.

As a result of global observation campaigns, 70 crater candidates larger than 10 m have been found on Ryugu. Observed morphological features of the craters include a possible slump on the southeastern wall of the largest crater Urashima (D$\sim$300 m); slightly darker material exposed at the bottom of this crater; lack of obvious ejecta deposits around the craters larger than 50 m; possible ejecta deposits observed near a few craters as small as $<$ 10 m; craters forming clusters; varying number density of boulders on crater floors; and potentially buried craters suggestive of infilling by surface materials.

The overall d/D ratio of all crater candidates was measured to be 0.07 $\pm$ 0.03, which is comparable to that reported for Itokawa. The craters larger than 100 m yield a d/D of 0.11 $\pm$ 0.02, while smaller ones have a shallower d/D of 0.07 $\pm$ 0.02. Urashima, the largest crater on Ryugu, exhibits a d/D of 0.14. The largest circular depressions on Ryugu are shallower than those reported for another C-type asteroid Mathilde (0.12-0.25), but the difference in the crater size range (1-5 km for Mathilde) would account for the apparent shallower nature of the craters on Ryugu. Moreover, the craters in the mid-to-high latitudes are more degraded than those in the equatorial region. This result strongly suggests the presence of processes that preferentially degrade craters at mid-to-high latitudes, and/or different material properties that better preserve craters in the equatorial region.

We also examined the spatial distribution of craters. First, a factor of 2.5 enhancement in crater number density was observed in the western bulge (180-300°E), supporting the presence of longitudinal dichotomy between the western bulge and the eastern hemisphere. Our results also indicate that the circular depressions are more densely distributed on the equatorial region than on the middle-to-high latitudes. This result supports the efficient crater erasure process on the mid-to-high latitudes and/or different material properties there, consistent with other morphological evidence described above.