THE DISTRIBUTION OF CRATER MORPHOLOGIES ACROSS RYUGU. C.M. Ernst[1], Y. Cho[2], T. Morota[3], M. Kanamaru[4], O. S. Barnouin[1], Naoyuki Hirata[5], Naru Hirata[6], S. Sugita[2], S. Watanabe[3], R. W. Gaskell[7], E. E. Palmer[7], P. Michel[8], R. Honda[9], S. Kameda[10], E. Tatsumi[2], Y. Yokota[11], T. Kouyama[12], H. Suzuki[13], M. Yamada[14], N. Sakatani[11], C. Honda[6], M. Hayakawa[11], K. Yoshioka[2], M. Matsuoka[11], H. Sawada[11], [1]Johns Hopkins Applied Physics Laboratory, [2]University of Tokyo, [3]Nagoya University, [4]Osaka University, [5]Kobe University, [6]University of Aizu, [7]Planetary Science Institute, [8]Observatoire de la Côte d'Azur, [9]Kochi University, [10]Rikkyo University, [11]ISAS/JAXA, [12]National Inst. of Advanced Industrial Science and Technology, [13]Meiji University, [14]Chiba Institute of Technology

Introduction: The Hayabusa2 spacecraft arrived at asteroid Ryugu in late June 2018. Optical Navigation Camera (ONC) images revealed dozens of craters and crater candidates across the surface [1,2]. We use ONC images and the Hayabusa2 stereophotoclinometry shape model [3] to investigate the morphologies of 68 crater candidates. These identification of craters and measurements of crater morphologies are being conducted independently to those performed by [1], but ultimately will be compared to results from that study.

Methods: Eight profiles were taken across high-resolution digital terrain models of each crater candidate measured. Average values for depth, diameter, and rim height were recorded, using multiple methods: profile (combinations of individual profiles were used to measure these parameters) and plane (depth was measured with respect to a plane defined by the circle fit to the crater rim). Measurements were taken with respect both to geometric height and to elevation (defined relative to a reference gravitational potential equivalent to a "geoid"). Between 2 and 8 of the taken profiles were used to measure each crater—some profiles were ruled out due to modification by subsequent craters, severe surface slopes, difficulty identifying a crater rim, or the presence of large blocks.

Preliminary Results: To date, we have made measurements of 21 of 68 crater candidates. The craters of Ryugu are more difficult to measure than those typically measured on larger asteroids and other planetary surfaces. The blocky surface, degraded nature of many of the craters, and significant slopes/curvature make measurements and even identification of craters difficult. Table 1 summarizes our measurements thus far. As not all crater candidates have been measured, and the results are likely biased to larger d/D values, as larger and more certain craters were measured first. Figure 1 shows a sample of the measurements that have been made.

Next Steps: The remaining crater candidates will be measured to enable an analysis of the population as a whole. Results will be compared to those of [1] to assess the sensitivity of these measurements to technique and observer. The distribution of d/D will be assessed across Ryugu to determine whether any relationships can be determined (see also [1]). For example, seismic shaking on Ryugu has played a detectable role on the removal or degradation of small craters, as has been suggested by [2] and has been proposed for Eros [4]. On Eros, a correlation was found between radial distance from Shoemaker crater, the largest young crater on Eros, and both a dearth of small craters and the degree of degradation of large craters. Such radial correlations are consistent with the removal of small craters and the modification of large craters by seismic shaking caused by the Shoemaker impact, and not with burial by Shoemaker ejecta. We will compare our findings from Ryugu to Eros and assess the effects of seismic shaking on the modification of craters on Ryugu.

References: [1] Cho, Y. et al., this meeting; [2] Morota, T. et al., this meeting. [3] Hirata, N. et al., this meeting. [4] Thomas, P.C. and Robinson, M.S. (2005) *Nature*, 436, 366–369.

Table 1. Crater morphology measurements.

	d/D profile geometric height	d/D plane geometric height	d/D profile elevation	d/D plane elevation
all 21 measured	0.13 ± 0.02	0.10 ± 0.03	0.15 ± 0.02	0.13 ± 0.03
>100 m diameter	0.10 ± 0.02	0.09 ± 0.02	0.14 ± 0.02	0.13 ± 0.02
<100 m diameter	0.15 ± 0.02	0.12 ± 0.03	0.15 ± 0.02	0.13 ± 0.03

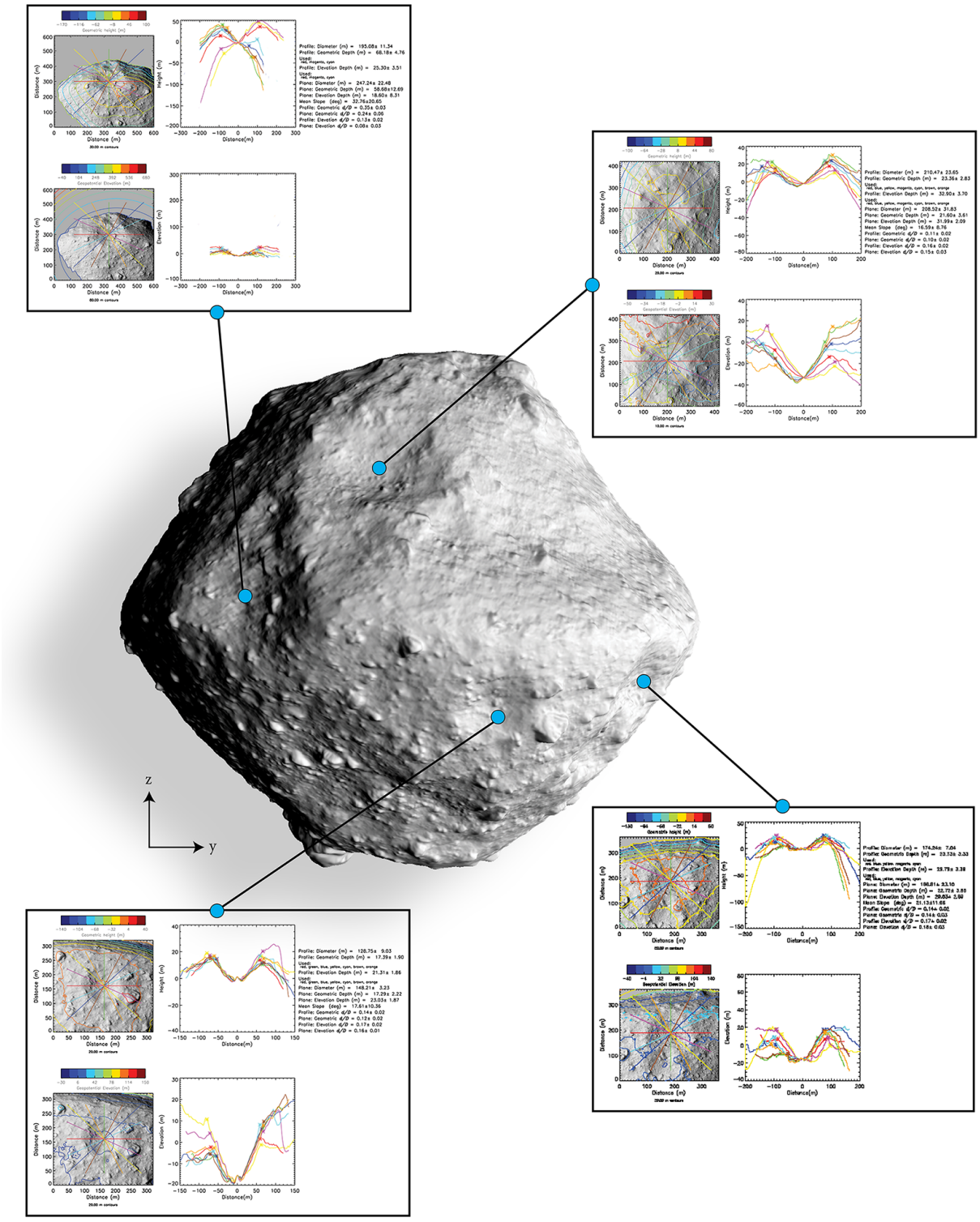

Figure 1. Examples of some of the crater candidate measurements made for Ryugu. The call-out rectangle shows the local digital terrain model (left) with 8 profiles overlain, and the geometric height (top) or elevation (bottom) versus distance for those profiles. Data are recorded at upper right for the four methods detailed in the text.