GEOLOGICAL MAPPING OF ASTEROID RYUGU: PROGRESS REPORT. G. Komatsu[1,2], T. Ruj[3], H. Kikuchi[4], R. Hemmi[5], L. M. Vincent[3,6], A. Ray[3,7], H. Miyamoto[8], S. Sugita[9,2], the Hayabusa2 science team, [1]IRSPS, Università d'Annunzio, Italy (goro.komatsu@unich.it), [2]PERC, Chiba Institute of Technology, Japan, [3]IPM, Okayama University, Japan, [4]Gakushuin University, Japan, [5]ISAS, JAXA, Japan, [6]Dept. of Earth Sciences, Utrecht University, Netherlands, [7]Dept. of Geology, Presidency University, India, [8]Dept. of Systems Innovation, University of Tokyo, Japan, [9]Dept. of Earth and Planetary Science, University of Tokyo, Japan.

Introduction: Geological mapping is a fundamental tool in geoscience investigation of planetary surfaces. There is a long history of geological mapping for terrestrial planets and also moons including those of gas giant planets in the Solar System [e.g., 1, 2]. These planetary bodies are in general very large (over 1000 km in diameter), and the mapping has been done based on divided quadrangles alongside a global map (with equatorial and polar projections). Mapping of dwarf planet Ceres (~940 km diameter) follows this scheme since it is mostly spherical [3].

The situation for geological mapping of much smaller planetary bodies (diameters less than 100 km) with non-spherical shapes differs from those of larger bodies. This is because such shapes do not allow assumption of mapping over near-flat surfaces. Interpretation of surface features on small planetary bodies and their responsible geological processes is conducted with consideration not typical of larger bodies. General characteristics such as the lack of atmosphere and internal heat source, and their complex orbital and collisional histories, all contribute to production of their unique surface features that are different on larger bodies. Furthermore, small gravity and fast rotation on irregular topography make the dynamic gravity significantly complex, hence mass movement follows peculiar trajectories.

The geological mapping of small planetary bodies is becoming more important in recent years due to many space missions visiting them including 67P/Churyumov-Gerasimenko (comet) [4], 486958 Arrokoth (KBO) [5] and 101955 Bennu (asteroid) [6]. Some of them have been mapped in detail, and geological maps are presented to the planetary community [e.g., 7].

162173 Ryugu: The Hayabusa2 mission to the asteroid 162173 Ryugu (**Fig. 1**) was successful for its detailed investigation of the surface and returning its samples to the Earth for laboratory analysis. Ryugu is a small (1004 m × 876 m) carbonaceous asteroid (Cb-type) spinning-top shape with a prominent equatorial ridge [8, 9]. Large boulders on the surface, low density and high porosity of the asteroid body indicate a rubble pile composition. Hydrated minerals such as phyllosilicates, carbonates and organic compounds are found on the surface [10].

A preliminary map depicting major geological elements was included in the initial publication [9], but no formal geological map has been presented to date.

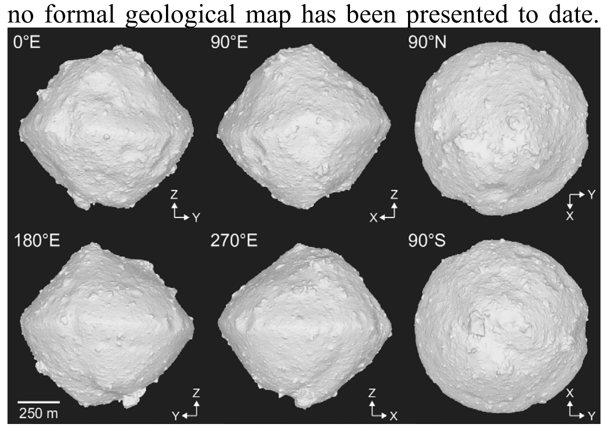

Fig. 1. Equatorial and polar views of Ryugu.

Data and mapping procedure: We prepared equator- and polar-projected mosaics based on ONC images. The mapping was conducted on an ArcGIS platform. 2018 and 2019 ONC images [9, 11], processed Digital Elevation Model (DEM), and thermal images obtained from Hayabusa2 [12] were considered for mapping. The highest resolution data had a pixel scale of approximately 0.25 m.

Geological units and structures: After an initial assessment of the Ryugu surface incorporating also previous studies, we decided to map the following geological units and features as presented in **Figure 2**: 1) Equatorial ridge, 2) depressions (non-crater), 3) craters with variable confidence (levels 1, 2, 3), 3) large boulders, 7) low boulder density zones, 8) possible mass wasting features, 9) lineaments. Craters with high confidence (level 1), potential craters with moderate confidence (level 2), and circular features that are possibly large old craters (level 3) are identified. Low-lying areas are identified as well as the equatorial ridge. The Western Bulge [9, 13] is recognized from the DEM based on the presence of surrounding troughs, and then compared with the previous work. This comparison shows that the Western Bulge, relative to the rest of Ryugu, exhibits deviations in boulder and crater diversities and spectral variance.

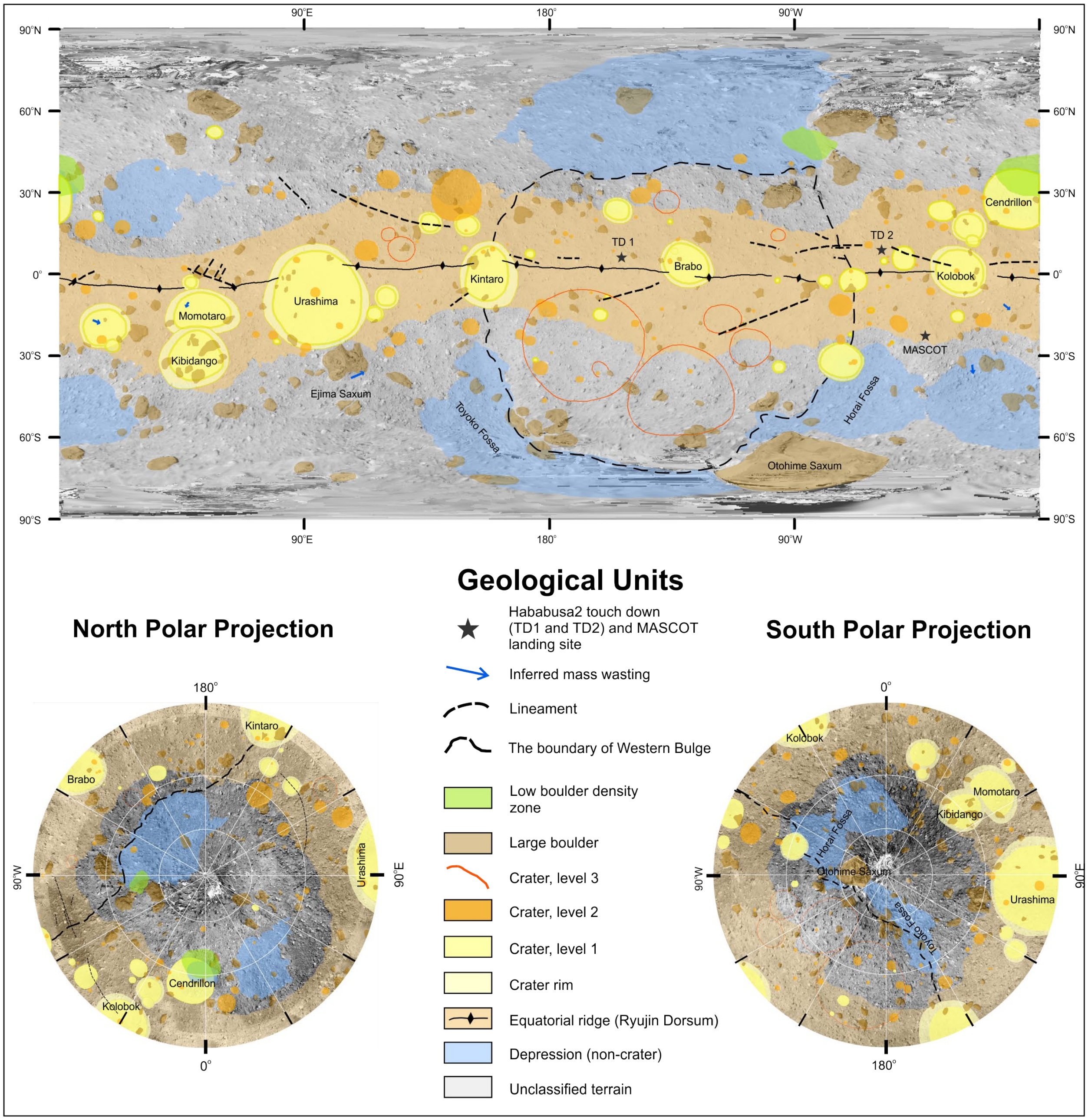

Fig. 2. Geological map of Ryugu (in progress)

Future work: A plan is in progress for completing the geological map. Some important observations regarding the units emerged from the mapping, which will be reported in future separate works in more detail.

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