

**Comparison of morphological parameters of boulders > 1m on Ryugu and 67P.** J.-B. Vincent<sup>1</sup>, R. Jaumann<sup>1</sup>, N. Schmitz<sup>1</sup>, S. Schröder<sup>1</sup>, <sup>1</sup>DLR Institute of Planetary Research, Berlin, Germany, jean-baptiste.vincent@dlr.de

Considering dark small bodies of our Solar System, carbonaceous dust appears to be the dominant contributor to their spectrophotometric properties, especially for objects likely to have been formed beyond the snow line, from about 2.7 AU out to the Trojan region and beyond (asteroids classes C, Cg, D, and JFC comets) [1]. The increasing darkness/redness is thought to result from organic coating, with comets being potentially richer in organics than asteroids [2]. Remote sensing observations already lead to significant advances in quantifying the physical properties of such material [e.g. 3, 4, and 5] but its exact nature still remains to be determined, and will be one of the key measurements to be performed by sample return missions such as Hayabusa 2 and OSIRIS-REX.

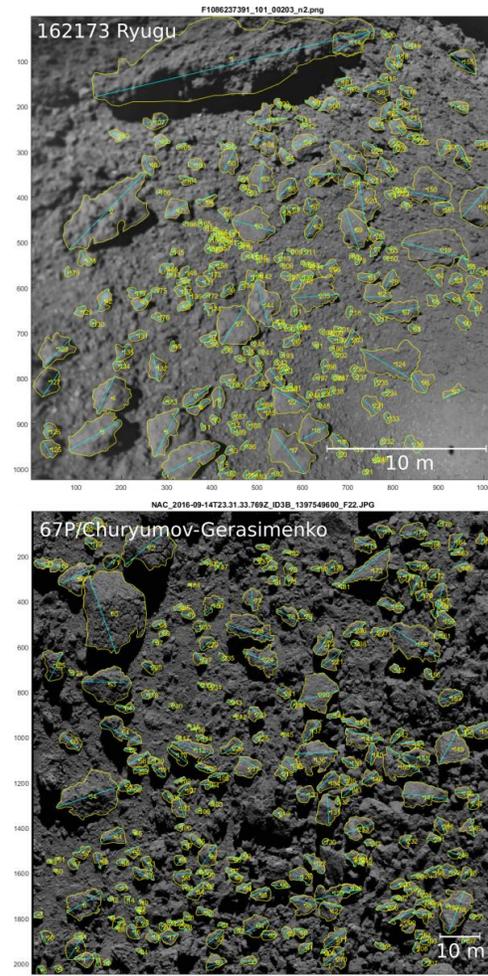
Nonetheless, if most small bodies in our Solar System are coated with organics, this layer will introduce variations in the physical properties of those objects as a function of the heliocentric distance at which they are formed. E.g. one may expect a different tensile strength of thermal conductivity in objects that present a thicker coating.

We investigate this question by comparing morphological parameters of boulders observed on two small bodies: asteroid Ryugu as seen by the MASCAM [6] camera on board the MASCOT lander (JAXA's Hayabusa 2 mission) and comet 67P as observed by the OSIRIS cameras [7] on board ESA's Rosetta mission. While Ryugu and 67P are very different objects in terms of composition, size, and density, they both share a very dark surface and a flat, slightly red spectrum which may indicate a similar type of surface coating. In addition, both objects have a comparable range of effective surface gravity, an important parameter for the building of boulders and topographic features.

In this study we focus on rough terrains on both objects, in areas littered with blocks > 1m, and visually similar. We quantify this similarity by measuring a series of morphological identifiers for a set of 500 boulders (250 per object). We use primarily the size distribution, axis ratio, circularity, solidity, compactness, of boulders. Those parameters provide dimensionless quantifiers for each set of boulders, which can then be compared with similar measurements performed on other surfaces, and with formation mechanisms [8, 9]. They are equivalent to a measure of the boulders roughness at several scales.

This paper will present the full set of statistics obtained on both objects, and report a detailed comparative analysis of material properties on comets and asteroids.

Overall, it appears that boulders on both small bodies share several properties, although Ryugu's larger boulders tend to be rougher and less compact than their cometary counterparts, which may be indicative of longer exposure to erosional processes such as thermal fatigue. Our statistics also suggest at least two types of blocks on Ryugu, aggregate-like and monolithic-like, with the first type being closest to what has been observed on comet 67P.



Set of 500 boulders for which we measured morphological parameters on Ryugu and 67P. Credits: MASCOT/DLR/JAXA and ESA/Rosetta/MPS for OSIRIS Team (MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA)

**References:**

- [1] Hartmann W. et al (1987), *Icarus*
- [2] Cruikshank D. et al (1992), *Exobiology in Solar System Exploration*
- [3] Sandford S. et al (2006), *Science*
- [4] Naraoka H. et al (2011), *MetSoc proceedings*
- [5] Goesmann F. et al (2015), *Science*
- [6] Jaumann R. et al (2016), *SSR*
- [7] Keller H. U. et al (2007), *SSR*
- [8] Yingst R. et al (2007), *JGR*
- [9] Cambianica et al (2019), *submitted to A&A*