MORPHOLOGY AND MEASURMENT OF FRACTAL DIMENSION OF BOULDERS ON RYUGU. R. A. Parekh[1], R. Jaumann[1,2], N. Schmitz[1], S. Schroeder[1], K. Otto[1],K. Krohn[1], K. Stephan[1], K.-D.Matz[1], R. Wagner[1], S. Elgner[1], F. Preusker[1], F. Scholten[1], T. Roatsch[1], F. Trauthan[1], A. Koncz[1], T-M. Ho[1], [1]German Aerospace Center, Institute of Planetary Research, Rutherfordstraße 2, 12489, Berlin, Germany, mail: rutu.parekh@dlr.de, [2]Freie Universität Berlin, Planetary Science and Remote Sensing, Malteserstr. 74-10012249, Berlin, Germany

Introduction: Hayabusa 2 is a descendant mission of the asteroid sample return mission Hayabusa carried out by JAXA. The objective of Hayabusa 2 is to aid the understanding of the origin and evolution of the parent body of near Earth asteroid (162173) Ryugu. The spacecraft carried the lander MASCOT (Mobile Asteroid Surface Scout) developed by DLR in cooperation with CNES [2]. MASCOT successfully landed on the asteroid surface on October 3rd,2018. The lander carried four scientific instruments including a wide angle imager (MasCam), a thermal radiometer (MARA), a magnetometer (MasMag) and a hyperspectral infrared microscope (MicrOmega). MasCam was built to conduct in situ observations of surface materials during day and night.

Studies suggest that Ryugu belongs to the C-type asteroid family [1] with traces of volatiles[10]. The thermal inertia of Ryugu is less than that of Itokawa which indicates a boulder rich surface on the asteroid [3,10]. Based on the telescope observation of Ryugu's surface, the best possible meteorite analogue is thought to be heated CM or CI [9], however it is still under debate. Our aim is to contribute to this discussion by using high resolution Mas-Cam datasets onboard the MASCOT lander.

MasCam data: The MASCOT lander separated from the Hayabusa 2 spacecraft and landed on the surface of Ryugu at approxi-mately 4:03 (CEST) on Oct. 3rd 2018. After facing several bounce around 4.034 (CEST) MASCOT started taking measurements with its onboard instruments including MasCam. MASCOT has been designed to hop to reach dif-ferent places at the surface of Ryugu. During these hops MasCam took almost 120 images. The resolution of these images are highly variable. Out of the 120 images aprox. 66 images showed the surface in the field of view. These observations unfold some of the most extraordinary surface characteristics of Ryugu. Based on MasCam images a variety of boulder morphologies were observed.

MasCam data analysis: Figure 1 is one of the studied region. During the descent, MasCam has covered four different views, one of them is shown here. It is a high resolution MasCam image which shows that the asteroid surface is covered by boulders varying from millimeter to meter in size [8]. Based on the visual interpretation we have differentiated two types of boulders: (1) boulders with sharp and angular edges, relatively smooth surface texture, non-chondritic fractures and bright in appearance (highlighted in red, Fig.1); (2) boulders with rough and crumble surfaces, dark in brightness, rough in texture, and cauliflower like fractures (highlighted in blue, Fig.1). The distribution of these two types of boulders seems to be uniform at this stage [4].

Further, the roughness of the boulder surfaces has been measured by means of their fractal dimension D. It de-scribes the extension of difference in curve, surface or a volume from a line, cube or plane, respectively[6]. Through this variable it is possible to quantify the roughness profile in terms of difference in height and length [6]. One of the most reliable methods to derive the fractal dimension is the H-L method [7], which recently has been updated by [6], to minimize the error in measurement.

$$D = \frac{\log 4}{\log\left(2\left(1+\cos\left(\tan^{-1}\left(\frac{2H}{L}\right)\right)\right)\right)}$$

where H is the average height and L is the average length.

At this stage, we have measured the fractal dimension of a number of boulders on Ryugu. According to studies, the peak stress of two parallel sheared rock surface increases with increasing fractal dimension of the shear sur-faces[9]. The fractal dimension will help us to understand the regolith surface properties of Ryugu's rocks and provide information on the mechanical behavior of the regolith.

Conclusion: We derived the fractal dimension of multiple rock surfaces imaged by MASCOT's MasCam during descent and on the surface of asteroid Ryugu. We were able to derive the fractal dimension on various scales and show that smooth as well as rough surfaces are present on Ryugu. Based on the primary analysis our understanding is that Ryugu is possibly comprised of two different materials.

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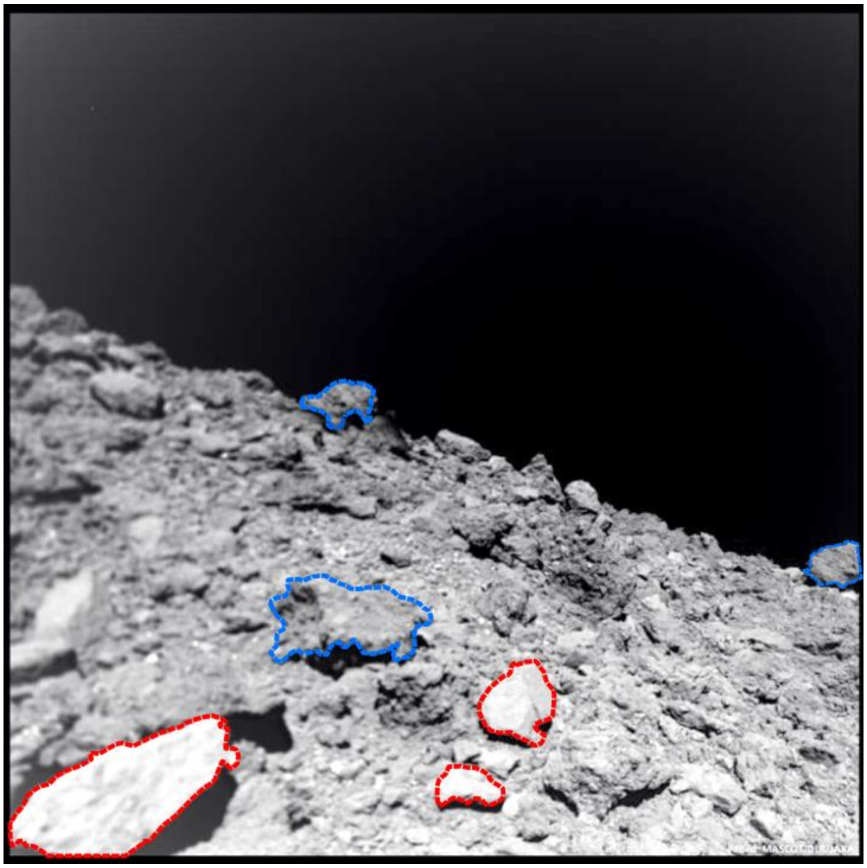

Fig.1 The high resolution image is part of Ryugu surface captured by MasCam during its operational period. The surface of Ryugu is covered with variety of boulders. In the above image few boulders' edges are clearly visible, which are highlighted in two color, denotes two different types of boulders morphology.

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