小惑星リュウグウにおける表面赤化と層序
REDDENING PROCESS OF THE RYUGU SURFACE BASED ON THE CRATER SIZE-FREQUENCY DISTRIBUTION

*諸田 智克[1]、長 勇一郎[2]、金丸 仁明[3]、本田 理恵[4]、亀田 真吾[5]、巽 瑛理[2]、横田 康弘[6]、神山 徹[7]、鈴木 秀彦[8]、山田 学[9]、坂谷 尚哉[6]、本田 親寿[10]、早川 雅彦[6]、吉岡 和夫[2]、松岡 萌[6]、道上 達広[11]、宮本 英昭[2]、菊地 紘[2]、逸見 良道[2]、平林 正稔[12]、平田 直之[13]、平田 成[10]、Ernst Carolyn[14]、Barnouin Olivier[14]、澤田 弘崇[6]、杉田 精司[2]
*Tomokatsu Morota[1], Yuichiro Cho[2], Masanori Kanamaru[3], Rie Honda[4], Shingo Kameda[5], ERI TATSUMI[2], yokota yasuhiro[6], Toru Kouyama[7], Hidehiko Suzuki[8], Manabu Yamada[9], Naoya Sakatani[6], Chikatoshi Honda[10], Masahiko Hayakawa[6], Kazuo Yoshioka[2], Moe Matsuoka[6], Tatsuhiro Michikami[11], Hideaki Miyamoto[2], Hiroshi Kikuchi[2], Ryodo Hemmi[2], Masatoshi Hirabayashi[12], Naoyuki Hirata[13], Naru Hirata[10], Carolyn Ernst[14], Olivier Barnouin[14], Hirotake Sawada[6], Seiji Sugita[2]

1. 名古屋大学、2. 東京大学、3. 大阪大学、4. 高知大学、5. 立教大学、6. 宇宙航空研究開発機構、7. 産業技術総合研究所、8. 明治大学、9. 千葉工業大学、10. 会津大学、11. 近畿大学、12. オーバーン大学、13. 神戸大学、14. ジョンズホプキンス大学
1. Nagoya University, 2. The University of Tokyo, 3. Osaka University, 4. Kochi University, 5. Rikky University, 6. JAXA, 7. AIST, 8. Meiji University, 9. Chiba Institute of Technology, 10. The University of Aizu, 11. Kindai University, 12. Auburn University, 13. Kobe University, 14. Johns Hopkins University/Applied Physics Laboratory

The Hayabusa2 has acquired the high-resolution images and spectra of the Ryugu surface. Although the Ryugu surface has almost homogeneous reflectance and color at the macro scale, the regional variation in the spectral slope is observed by the telescopic optical navigation camera (ONC-T). The redder materials of the Ryugu surface seem to cover bluer materials. Some small craters excavate the red materials on the surface and penetrate the underlying blue materials, suggesting that the craters are younger than the reddening of the surface (space weathering or deposition of red materials). In this study, we performed the crater size-frequency measurements on the Ryugu surface using the ONC image data to constrain the surface age of the Ryugu and the age of reddening event or the timescale of reddening process of the Ryugu surface.
To identify the craters excavating the red materials we used the b-x slope images calculated from multi-band images obtained in the Mid-altitude operation. We identified 15 craters excavating the red materials. These craters have diameters from 10 to 50 m, suggesting that the thickness of the red material layer is less than 1 m.
The cratering chronology models of asteroids have been numerically calculated from the collision rate with other asteroids and scaling laws for crater formation. In this study, we used the intrinsic collision probabilities Pi for the main belt and the NEAs, the population models of the main belt asteroids and NEAs, the mean impact velocities for the main belt (5.3 km/s) and the NEAs (18 km/s), and the new Pi–scaling law developed by Tatsumi and Sugita to develop the cratering chronology model of Ryugu. Because little is known about the bulk strength of materials on Ryugu, we examined two cases (i) the strengthless target (Y = 0 MPa) and (ii) the strength for dry soil (Y = 0.18 MPa).
The density of large craters (D>100 m) on Ryugu is lower than the empirical saturation level and its slope is steeper than that of the saturated distribution, suggesting that craters larger than 100 m are not saturated and the size distribution reflects the crater production function. However, craters smaller than 100 m are significantly under-saturated, suggesting that some crater erasure processes such as seismic

shaking and armoring effect are active on the Ryugu surface. Based on cratering chronology model for the main belt, the surface age of Ryugu is estimated to be 5–200 Ma from the size–frequency distribution of craters larger than 100 m.
The observed frequency of craters penetrating the underlying blue materials is ~1/50 of that of craters found on the whole Ryugu. The model age of the reddening is estimated to be 0.1–4 Ma based on the main-belt chronology model and 4–160 Ma based on the NEA chronology model. The NEA model age is roughly close to the median dynamical lifetime of NEAs (~10 Ma), suggesting that the reddening of the Ryugu surface may have some connect with the orbital transition from the main belt to near Earth orbit.

キーワード：はやぶさ２、小惑星リュウグウ、クレータ
Keywords: Hayabusa2, Ryugu, crater

