A GLOBAL DATABASE AND ANALYSES OF (4) VESTA CRATERS. Z. Liu[1], Z. Yue[1], G. G. Michael[2], S. Gou[1, 3], K. Di[1, 3], S. Sun[4], and J. Liu[5], [1] State Key Laboratory of Remote Sensing Science, Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, Beijing 100101, China. [2] Institute of Geological Sciences, Freie Unversitaet Berlin, Malteser Strasse 74-100, Haus D, Berlin 12249, Germany. [3] Lunar and Planetary Science Laboratory, MUST — Partner Laboratory of Key Laboratory of Lunar and Deep Space Exploration, CAS. [4] Sichuan Remote Sensing Geoinformatics Institute, Chengdu 610100, China. [5] Institute of Geochemistry Chinese Academy of Sciences, Guiyang, China 550002.

Introduction: Asteroid (4) Vesta is the second most massive object in the asteroid main belt, and it has long been a target of scientific interest because of its geologic diversity [1, 2] and the discovery that Howardite, eucrite, and diogenite meteorites are very likely samples excavated from Vesta [3, 4]. It was also the first target of the Dawn mission, during which (4) Vesta was mapped at spatial resolutions of ~260 m/pixel, ~60 m/pixel, and ~20 m/pixel, respectively [5, 6]. These data sets are very important for the study of the surface properties of (4) Vesta, and have been used for geologic study both regionally [7] and globally [8, 9].

Impact craters have been confirmed as the major landform on the surface of the (4) Vesta at all scales [10]. Craters are very important to the gelogic studies of (4) Vesta, not only because the cratering itself can contribute to investigations of the properties of the surface or subsurface materials, but also because crater populations can provide valuable information for regional or global geologic studies [11, 12]. However, a global crater database including a variety of important attributes, such as the crater positions, diameters, and depths has not yet been developed. In this research we aim to accomplish this work with newly available HAMO global mosaic and DEM of (4)Vesta.

Methodology: With analyses of the characteristics of the craters on the surface of (4) Vesta, 18 attribute fields are created in this crater database, including the diameter, depth, major axis, minor axis, ellipticity, etc. Among these parameters, crater depth is directly measured from the DEM data, while other parameters are derived through circle or elliptical fittings with the identified rim points. The errors for these parameters can be derived through error propagation laws.

Crater rim was first manually identified in image data with the CraterTools [13]. More accurate crater rim points are then searched based on the above initial rims, during which eight profiles crossing the circle center are created evenly with a 22.5° angular difference between neighboring profiles. A local maximum of the topographic curvature in each profile is subsequently found within 10% of the diameter on both sides of the initial crater rims. And they are used for circle or elliptical fittings to derive the above mentioned parameters.

Results and analyses: Fig. 1 shows the global distribution of the 11,605 mapped craters with D ≥ 0.7 km in this research. Fig. 1a shows fitted circles overlaid on the HAMO global mosaic, and Fig. 1b shows their spatial density, i.e., the number of craters per 10^4 km^2, by averaging over the 100 × 100 km rectangle centered at the current pixel. It is obvious that the area around Crater Marcia (20.24 °W, 9.72 °N, *D* = 56.70 km) is less populated (Fig. 1b), which we interpret to be because its ejecta covered over or destroyed previously existing craters.

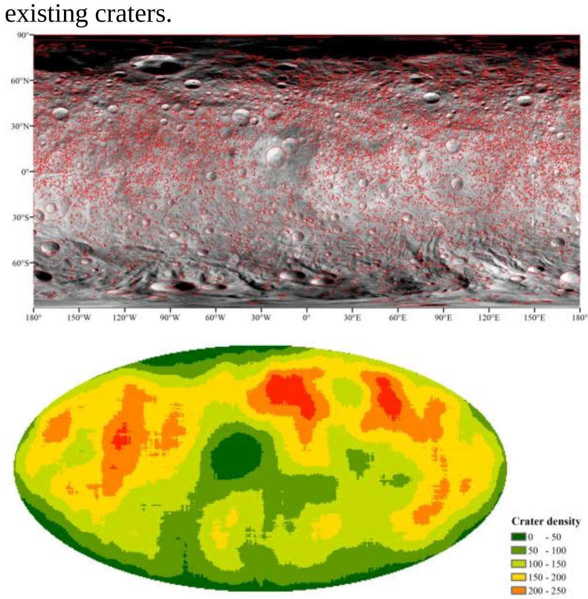

Fig. 1. Global distribution of craters on the (4) Vesta surface. (a) Top panel: global crater distribution in simple cylindrical projection; (b) bottom panel: the density map of all craters with a D ⩾ 0.7 km in Mollweide projection (in number of craters per 10^4 km^2), which ensures that the crater density was calculated over the same area at different latitudes.

Fig. 2 shows a plot of the number of craters with depths > 0.1 km in which the crater depths are binned every 0.1 km. There are 4,637 craters included in the analyses. Among these craters, 4,406 craters (~95.0%) are less than 1.0 km in depth. Crater Tarpeia is the deepest with a depth of ~5.0 km. Fig. 2 also indicates that the trend in the number of craters deeper than 1.0 km fluctuates, and this is more evident for the deeper craters.

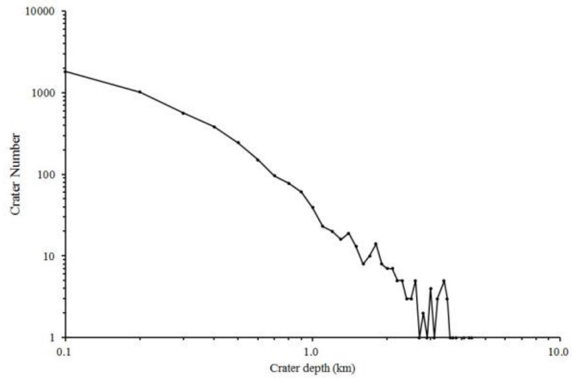

Fig. 2. Global distribution of craters with $d \geq 0.1$ km on the (4) Vesta surface. Craters are binned from 4.5 km to 0.1 km every 0.1 km, and the crater depth refers to the left border (the smaller value) of the bin.

For the 4,637 craters with $d \geq 0.1$ km, the mean value of d/D is 0.065 $\pm$0.023. The peak of the distribution is between 0.05 and 0.06, and there are 4,225 craters (91.1%) with a d/D of less than 0.10. Fig. 3 shows the variation in d/D of craters with a particular diameter. The d/D of craters less than 40 km in diameter varies from 0.02 to 0.16 with a mean value of 0.065 ±0.02; however, for the larger craters, this value clearly decreases.

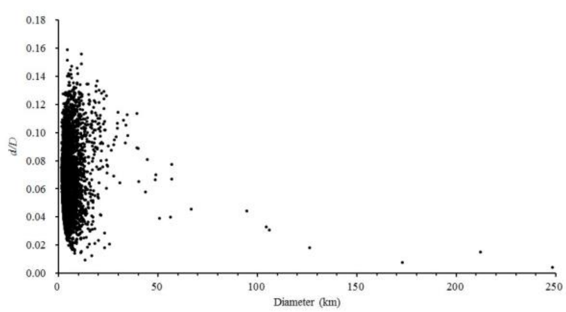

Fig. 3. Variation in d/D of craters with diameter of the 4,637 craters ($d > 0.1$ km) on the (4) Vesta surface.

To obtain a reliable statistic for the ellipticity of the craters, we first removed the results with large relative errors in the ellipse fitting, and we further removed craters for which fewer than 10 points were used to fit the ellipse. Finally, we only selected craters larger than 2.0 km and ellipticity greater than 1.12. As a result, 742 craters are included in the calculation. Fig. 4 shows the distribution of the parameter ellipticity with respect to crater diameter. It can be seen that craters with an ellipticity larger than 1.2 are those craters less than 50 km in diameter. For small craters less than 20 km in diameter, the ellipticity varies greatly.

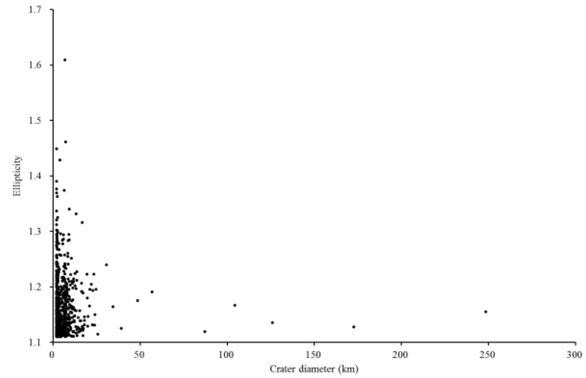

Fig. 4 Variations in ellipticity of the selected 742 craters with diameters.

Conclusions: A database for craters larger than 0.7 km in diameter is created for (4) Vesta, and there are totally 18 fields of the parameters, such as diameter, depth, d/D, ellipticity, and azimuth of the Vestan craters are derived. Generally, Vestan craters are much shallower than those on the Moon and Mars. Our globally consistent crater database has many potential applications for future studies such as geologic mapping and surface age dating.

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