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Crater depth statistics: constraining obliteration rates from secondary clusters of Mojave crater

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Abstract

Crater statistics based on size frequency distribution have been correlated with the age of planets' surfaces. We propose to widen statistical analysis of craters using not only diameter but also crater depths. We briefly present a calibrated method that quickly measures the depth of craters and provide a dataset that is large enough to perform statistical analyses. We use this method to study the evolution for depth of several secondary clusters of the Martian crater Mojave. Our method shows that the depth to diameter ratio (D/d) is not constant but varies with the diameter. This brings a new perspective on crater depth distribution.

1. Introduction

Impact craters are found on all terrestrial bodies. Their wide repartition have made them a key to understand planetary surfaces evolution. The most common use of craters is to date planetary surfaces. The known influx of impactors acts as a clock that adds craters as time is going. Since Apollo sample-return missions, a correlation has been established between the crater size-frequency distribution and absolute ages of the terrestrial planets surfaces. However, size-frequency distribution can be influenced by surface processes. Hence the idea that crater size-frequency distributions can be used to constrain surface processes. But increasing the complexity of the models requires new parameters. Crater morphology can be used to do so, especially crater depth as it is closely linked with crater infilling and erosion. Crater D/d has been widely exploited to tackle issues such as characterizing the depth of fresh craters and estimating obliteration of craters. Most of the time those studies interpret small datasets. Morphology measures are time consuming and there is no established method to interpret crater depths statistically. Here, we propose a workflow that allows systematic extraction of depth in a crater map. Secondary clusters are formed simultaneously after a huge impact. Studying their depth in different regions may provide key clues on the evolution of craters under different climatic conditions [1].

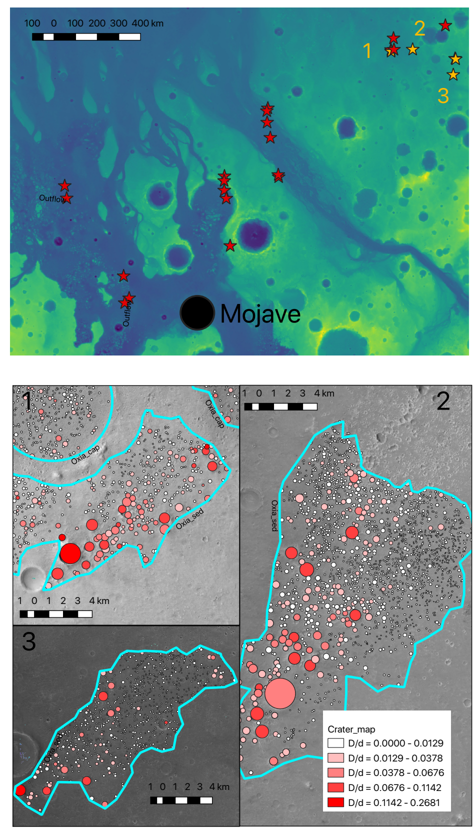

Figure 1: Map of Mojave and its surroundings, stars represent the mapped clusters. Yellow stars locate cluster represented in figure 2 (top). Details of mapped clusters (1,2 and 3).

2. Crater mapping and depth measures

Mojave is a crater of about 58 km diameter located at the outlet of Valles Marineris. We look for secondary clusters in a radius of 1000 km around Mojave on CTX. Secondary clusters that are oriented toward the primary source and with a CTX stereo-pair coverage, are selected for mapping. The depth of each crater is measured from the crater map and a co-registered DEM using GRASS raster statistics-tool. This tool retrieve 95th and 4th percentiles, depth is measured as the difference between those two values. Craters depth are plotted relative to their diameter. In order to clearly display crater density, we convoluted each crater by a gaussian function corresponding to the error [2][3].

3. Results

Figure 2 represents the crater distribution on three clusters located on a sedimentary layer on Oxia Planum [4]. Crater diameters range from 100 m to km scale. We clearly note that D/d strongly depends on crater diameter and on the studied cluster. Small craters present wider range of depths. In cluster 2 we observe a shallower trend than on site 1 and 3. We still need to investigate if this depletion can be linked to local characteristics. Our measure of D/d shows no trend relative to the distance to the source primary. However significant differences can be observed when looking at different geologic units. In our range of distance to the primary, the mean D/d seems to change according to the local geology and/or climate more than according to the distance to the source.

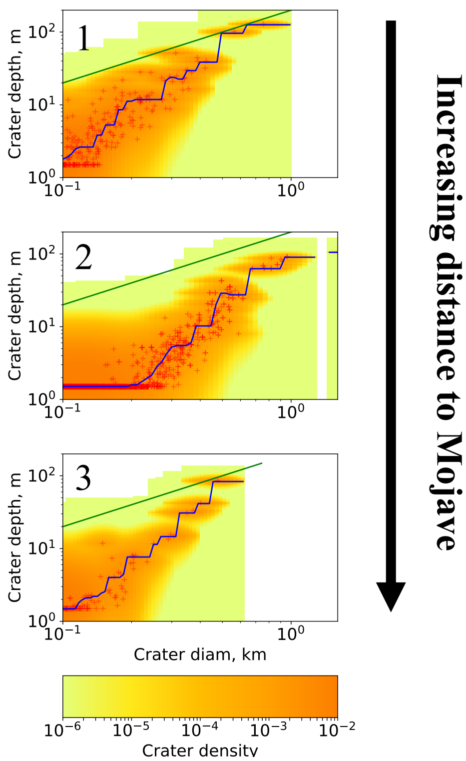

Figure 2: Representation of the mapped clusters in the depth/diameter space. Each red cross represent a measured crater. The colormap represent the crater frequency. Blue line is the mean depth value. Green line represent a D/d = 0.2 which is expected for pristine secondary craters above 160 km [1].

4. Summary and Conclusions

We identified and mapped secondary clusters originating from Mojave. We extensively measured the depth of the craters within these clusters. We represent our data in an original formalism that emphasize crater frequency variations on a depth-diameter space. We identified differences between mapped clusters, although we still need to interpret those differences in term of surface properties and processes. This multiparameter statistical approach can better constrain age of a planetary surface and surface processes. We are developing other usage of this data such as characterisation of fresh crater depth.

Acknowledgements

All image processing are done using MarsSI Web facility [5].

References

[1] W. A. Watters *et al.*, “Dependence of secondary crater characteristics on downrange distance: High-resolution morphometry and simulations,” *J. Geophys. Res. Planets*, vol. 122, no. 8, pp. 1773-1800, 2017.

[2] S. J. Robbins *et al.*, “Revised recommended methods for analyzing crater size-frequency distributions,” *Meteorit. Planet. Sci.*, vol. 41, 2018.

[3] S. Breton *et al.*, “Automatic crater morphometry extraction,” *submited*

[4] Quantin *et al.*, “Oxia Planum”,*4th Landing site selection workshop Exomars200, ESTEC, Netherland,* march 2017

[5] C. Quantin-Nataf *et al.*, “MarsSI: Martian surface data processing information system,” *Planet. Space Sci.*, vol. 150, pp. 157–170, 2018.