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Crater Counting Using the High-Resolution Images: Case Study of Martian Outflow Channels in Hellas Region

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Abstract

Due to the availability of the new high resolution images obtained by the CTX and HiRISE cameras onboard MRO, the crater size-frequency distributions have been extended to smaller craters, providing new insights into the erosional and depositional histories of the surfaces. In this work, we compare our preliminary results of age determinations based on the CTX and HiRISE datasets. We investigate the evolution history of the outflow systems in the eastern Hellas impact basin by mapping and dating. This work has also revealed information on the benefits and limitations of high resolution imagery used in age determination studies.

1. Introduction

The Hellas impact basin is one of the largest known impact structures on Mars. The northeastern rim region of the basin is characterized by several channel features, of which the most prominent are the large outflow systems of Dao, Niger, Harmakhis and Reull Valles [1–3].

Dao, Niger and Harmakhis Valles are located within a large smooth-surfaced depression (Hesperia–Hellas trough, HHT, [4, 5]; SW trough in [6]), which connects Hesperia Planum and the Hellas basin. The channels extend for over 1000 km down into the floor of the Hellas basin. Reull Vallis does not connect to the basin, but instead it ends abruptly close to the source area of the Harmakhis Vallis channel.

We have estimated the cratering model ages for the units on the floor of the channels. The general morphology of the channels' floors suggests that the regional geologic history has been complex. All of the channels are covered by several distinct viscous flow units which clearly postdate the channel formation indicating lateral glacial-like activity in the channels. Preliminary results of mapping and dating from the Dao Vallis head have been presented in [7]. In the case of the upper part of Reull Vallis, we have also made age determinations on Hesperia Planum and the Morpheos basin [8, 9].

The age determinations were conducted using the Mars Reconnaissance Orbiter Context Camera (CTX) and High Resolution Imaging Science Experiment (HiRISE) datasets. In general, the HiRISE imagery has a better spatial resolution, 0.25–0.5 m/px, which is important factor on the young surfaces, where there are few large craters. On such terrain, we can also expect that small craters are unaffected by distal secondaries, because they mostly postdate the latest secondary-forming impacts. However, the availability of the HiRISE images varies and on the eastern Hellas region, most of them focus on the wall of the channels only. The CTX images cover the entire channel systems and part of the Morpheos basin and Hesperia Planum with the resolution ~5m/px.

2. Results

The crater size-frequency distributions based on the CTX images show that viscous flow units on the floors of the channels have been modified by at least two distinct resurfacing events. For example, for the viscous flows on Dao Vallis we get an age of 200–900 Ma with the resurfacing events occurring at 60–110 Ma and 15–35 Ma (Figure 1a). No younger ages can be detected due to the resolution limit of the CTX imagery.

The cratering model ages from the HiRISE images, in turn, show the unit of 15–35 Ma and also a younger unit which is only 3–7 Ma old (Figure 1b). On the crater size-frequency distributions based on the HiRISE images, the older crater populations are missing or they are insufficient for fitting the isochrones, due to the limited area of images and thus the limited number of the largest craters.

Correspondingly, the crater data based on the HiRISE data from the floors of Niger, Harmakhis and Reull Valles show only the youngest surface units (on Niger Vallis the units of ~4 Ma and 12–15 Ma, and on Harmakhis and Reull Valles the units of ~2-3 Ma) whereas the crater counts from the CTX imagery indicate that the floors of the channels also consist of older surface (40–80 Ma). However, there seems to be regional differences. We compared the crater data from the HiRISE imagery with the CTX images from Hesperia Planum and the Morpheos basin, we noted that there is no missing older crater population in the HiRISE data so the results are not always as straightforward.

6. Conclusions

Crater countings on high resolution and high quality HiRISE images are a useful way to estimate the resurfacing histories on the young surfaces. However, the small areas of the high resolution images may limit the rate of the observable crater populations. On the small areas, the effect of the resurfacing processes increase and this may lead to incorrect results if any other reference data do not exist.

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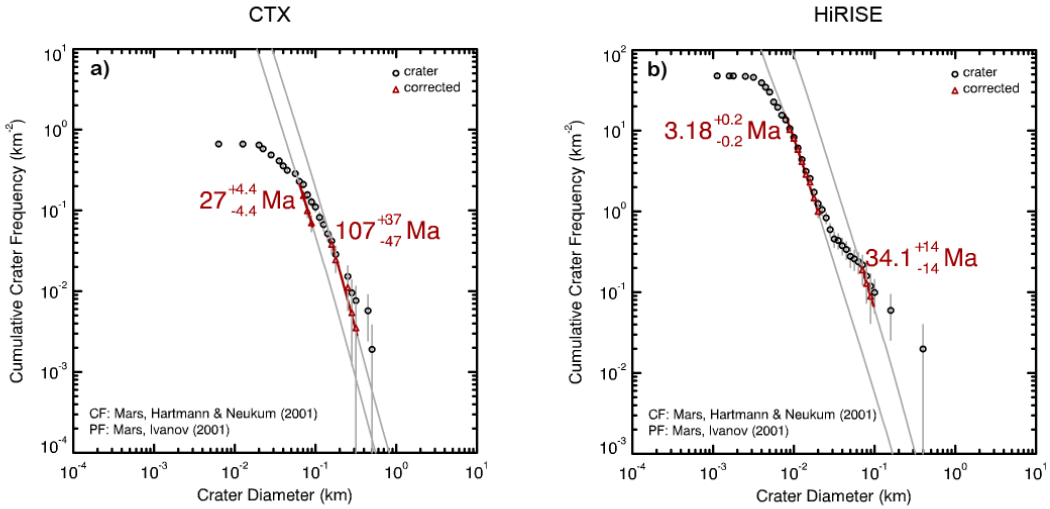

Figure 1: Cumulative crater size-frequency distributions from Dao Vallis based on the a) CTX data and b) HiRISE images (produced with Craterstats). The crater size-frequency distribution based on the CTX images (the counting area is ~520 km^2) shows that the floor on the Dao Vallis head consists of two units with ages of 107 Ma and 27 Ma. No younger units can be detected due to the resolution limit of the CTX images. The cratering model ages for the same unit from the HiRISE images (the counting area is ~50 km^2) show the unit of 34.1 Ma, but also the younger unit with an age of 3.18 Ma. The resurfacing correction used here has been developed by [10].