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

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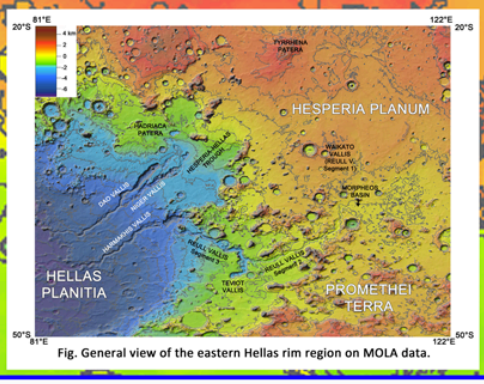
In this work, we compare our preliminary results of age determinations based on the CTX and HiRISE datasets of MRO. We investigate the evolution history of the outflow systems in the eastern Hellas impact basin by mapping and dating. This work has also revealed information on the benefits and limitations 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]. The channels cuts the sedimentary and volcanic deposit suites mostly postdating their emplacement [1,4,5].

Now we have estimated the cratering model ages for the units on the floor of the channels, using established methologies [e.g. 6–10]. The age determinations were conducted using the Mars Reconnaissance Orbiter Context Camera (CTX) and High Resolution Imaging Science Experiment (HiRISE) datasets.



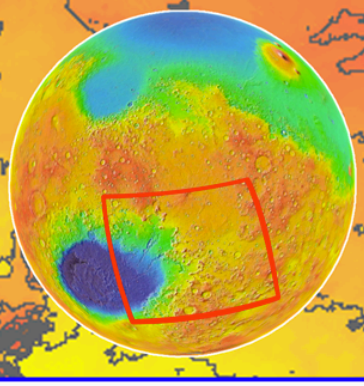


Fig. General view of the eastern Hellas rim region on MOLA data.

2. Why to use high resolution data?

The role of secondary impact craters and their usability for age determination on terrestrial planets have been discussed in many papers [11–14]. Usually the small impact craters have been excluded from the crater counts because of the uncertainty of their origin (primary or secondary crater). Thus, on the old surfaces, it may be impossible to use small craters for the age determinations because of the number of postated secondary crater forming impacts.

On the young surfaces, we can expect that small craters are unaffected by distal secondaries, because they mostly postdate the latest secondary-forming impacts. High spatial resolution is also necessary when we are dating the young surfaces, where there are only few large craters. However, the availability of the very high resolution HiRISE images usually varies (resolution 0.3-0.5 m/px, swath wide ~6 km) and particularly on the eastern Hellas region, most of them focus on the wall of the channels only. The CTX images cover the entire channel systems (resolution ~5m/px, swath wide ~30 km).

In our work, the obvious clusters of secondary craters were identified and excluded from the counts and the areas showing signs of recent large impact craters were avoided for minimizing the error.

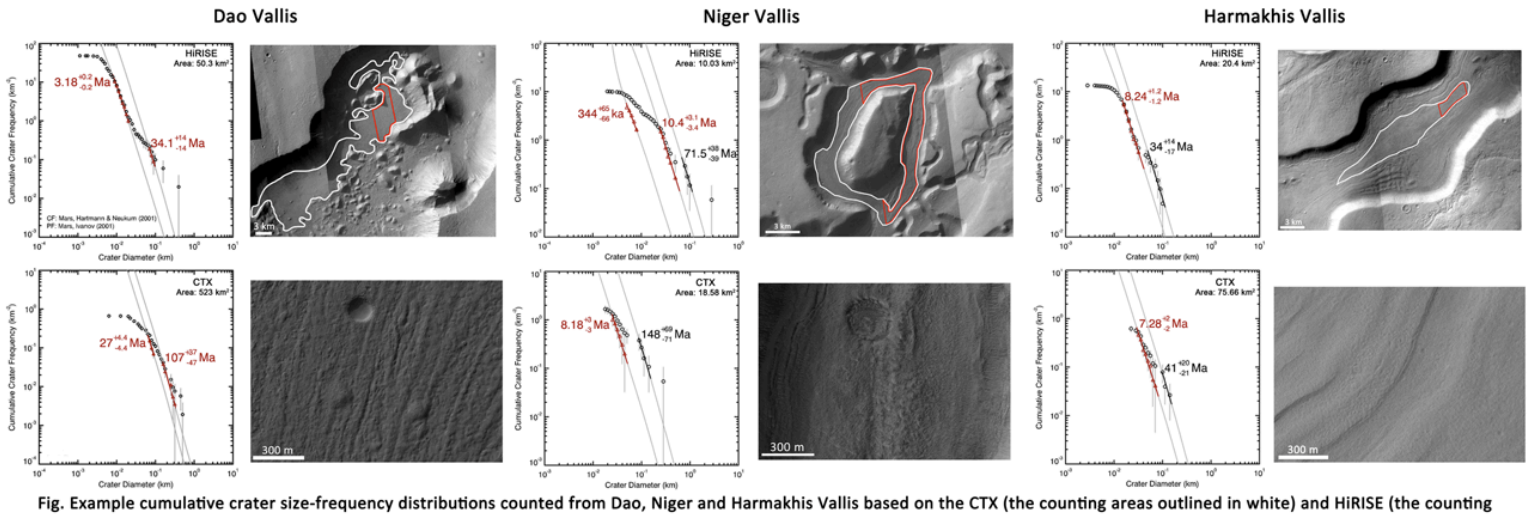


Fig. Example cumulative crater size-frequency distributions counted from Dao, Niger and Harmakhis Vallis based on the CTX (the counting areas outlined in white) and HiRISE (the counting area outlined in red) data. The detail HiRISE images show the examples from the counted surfaces. The plots were constructed by using Craterstats, developed by G. Michael. The used correction for the resurfaced surface has been developed by [15]. The corrected model age marks the end of the period of a significant resurfacing event.

3. Results

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. Even most of the large impact craters are covered or eroded. Thus the formation age of the channels cannot be measured directly.

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. The cratering model ages from the HiRISE images show also the younger unit, which is e.g in Niger Vallis only ~350 ka old. 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.

4. 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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