CRATER COUNTS BY USING SMALL IMPACT CRATERS OF THE CTX AND HIRISE IMAGES: RESULTS FROM THE HARMAKHIS VALLIS CHANNEL, MARS. S. Kukkonen and V.-P. Kostama, Astronomy and Space Physics, P. O. Box 3000, FI-90014 University of Oulu, Finland (soile.kukkonen@oulu.fi).

Introduction: The usability of small (deca/hectometer scale) impact craters in the crater count age determination has been under discussion since MRO's very high-resolution images allowed us to extend crater size-frequency distributions to small impact craters. In theory, small impact craters offer valuable information about surface history, especially about recent or small-scale geologic processes, which are not necessarily available for detection in crater size-frequency distributions if only large impact craters are counted. However, originally small impact craters were excluded from crater counts. The main reason for this was the uncertainty of their origin (primaries or secondaries). In addition, because earlier we usually wanted to estimate only the formation age of the surface, it wasn't even necessary to use the smallest craters for dating.

After the new crater production studies [1–5] it become clear that it is also possible to utilize small craters in age determinations if obvious secondary craters and clusters are excluded from the counts and the areas showing signs of recent large impact craters are avoided. This makes it possible to extend age determinations to the young and small surface units too as well as to the small-scale and multi-stage geologic processes, and study only the youngest parts of the geologic history of the surface unit.

In this work we compare the crater count results based on MRO's CTX and HiRISE datasets obtained from the floor units of the Harmakhis Vallis, one of the northeastern Hellas outflow channels (see also our previous works [6–8]). In addition to the evolution studies of the Harmakhis channel, the work reveals information on the benefits and limitations of using very high-resolution imagery and small impact craters in age determinations.

Data and methods: The cratering model ages of the Harmakhis floor units were estimated based on MRO's CTX and HiRISE datasets by using the established crater count methods (e.g. [9–12]). The CTX data (~5 m/pixel) cover the entire channel system, but the availability of the higher resolution HiRISE imagery (~0.3–0.5 m/pixel) is, however, still limited, and many of them focus on the wall of the channel only.

All the image data were imported onto a GIS environment, where the floor units of Harmakhis were mapped and dated [6–8]. The crater model ages were measured using the Craterstats2 software [12].

Results and discussion: The surface of Harmakhis Vallis has experienced significant recent modification and degradation. It has resurfaced almost entirely by the flow-like depositions, the varying texture of which indicates that they may be ice-rich [13]. The small number and diameter of the superposed impact craters on the flows suggests that the units are relatively young. This means that the craters are not yet saturated and that most of them can be assumed to be primaries, as their formation has to mainly postdate the latest secondary-forming impacts. Thus, Harmakhis Vallis is suitable for small crater studies.

On the other hand, the Harmakhis Vallis region is very challenging because the size of the craters on the floor units is relatively small compared to the resolution of the CTX data (~5 m/pixel). In addition, many of the craters are modified and eroded due to the ice-related nature (and thus the ice flow and sublimation) of the flow units and other later partial resurfacing processes. Because the size of the craters also mainly correlates with the scale of the pits, depressions and other topographic variations, which are typical features in the ice-rich material, craters are difficult to detect and many of the pits and depressions are also easily mistaken for craters. This effect is especially pronounced in the CTX images.

The dating results of Harmakhis Vallis show that the crater count data based on the HiRISE images mainly complement the data of the lower–resolution CTX images (Figure 1). However, we found also cases in which some cratering model ages are missing in either one of the data sets (Figure 2).

In the case of the CTX images, the main reason for the missing ages is the resolution limit of the data set. Due to the lower resolution compared to the HiRISE images, the CTX data naturally reveal information only about those events whose crater size-range modified by these events is distinguishable. This means that, for example, two nearly simultaneous partial resurfacing processes may be seen as a single event in the crater size-frequency distribution based on the CTX images, whereas in the HiRISE-scale crater distribution these events are distinguishable.

In the case of HiRISE-scale dating, some ages may be missing if the size of the counting area is too small to get a reliable age determination for older units (on small units, old ages are more difficult to detect). However, it is also possible that the unit, which seems to be homogenous in the CTX scale, actually consists of several units in the HiRISE scale. Thus the geologic nature of the HiRISE-scale counting area may differ from the main geologic unit of the counting area in the CTX scale. Correspondingly, there can be local differences in resurfacing intensities or scales, which may have caused crater populations to be erased in places.

Conclusion: Small (deca/hectometer scale) impact craters are very useful and often even the only way to get information about multi-stage, small-scale or young geologic processes of surfaces. Although in many cases the crater count data based on the HiRISE images correlate and complement the data of the lower resolution CTX images, it is good to be careful when only single HiRISE images are used for age determination of larger units. All the results obtained from a specific counting area always primarily represent the results of that area – not the whole mapped unit. However, together with the CTX images, the HiRISE images are a very valuable tool for providing unique information about the local surface processes.

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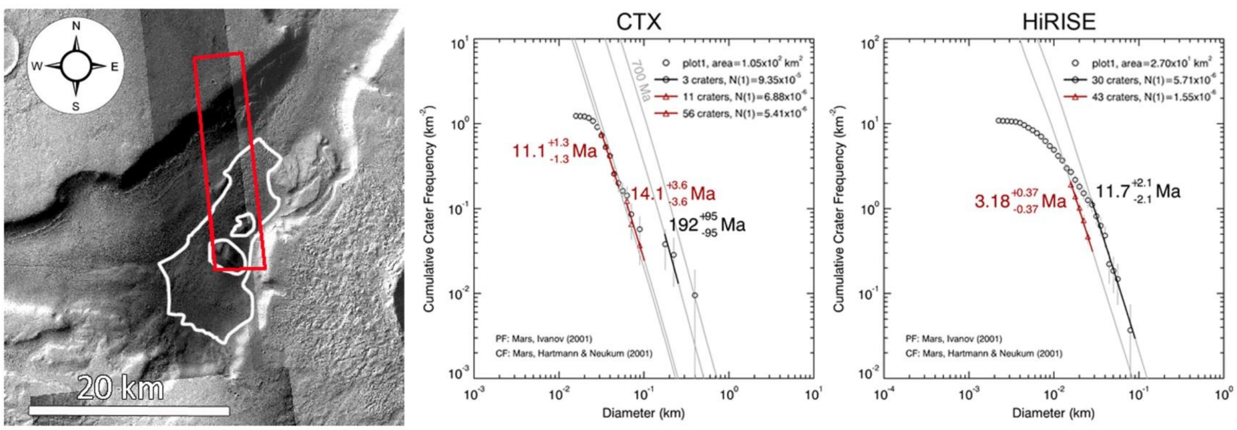

Figure 1: An example of the crater size-frequency distributions for the small unit in the middle of the Harmakhis main valley. In this case the HiRISE-based crater counts complement the CTX results even though the size of the HiRISE counting area (location of the HiRISE image is outlined in red) is ~26 % of the CTX counting area (outlined in white). Due to the smaller size of the HiRISE counting area, the oldest ages of the CTX results, 192 Ma and 14.1 Ma, are not recognizable in the HiRISE scale.

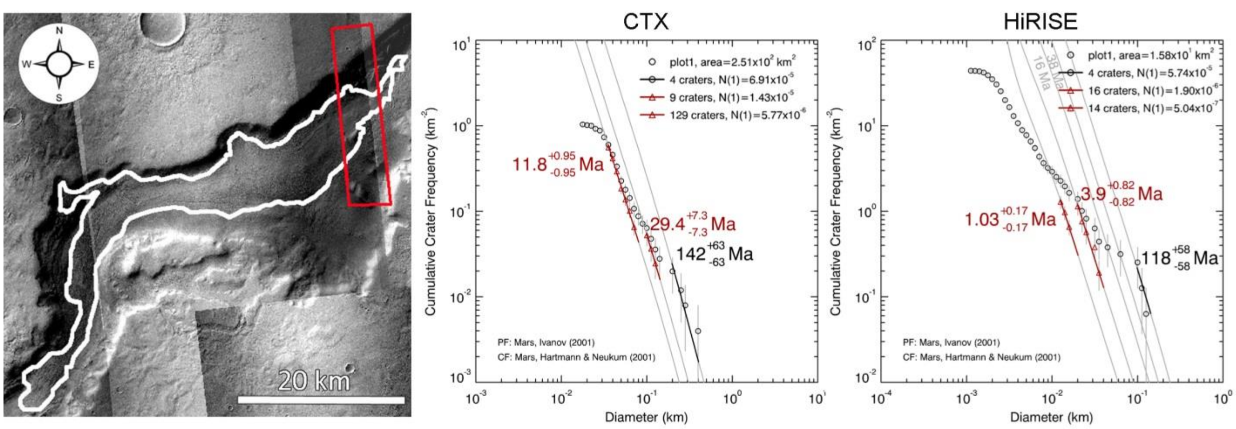

Figure 2: The crater count results from the flow unit on the Harmakhis main valley. The crater size-frequency distribution based on the CTX scale dating (area outlined in white) shows three ages, 142 Ma, 29.4 Ma and 11.8 Ma, whereas the HiRISE scale dating (HiRISE image outlined by red) shows only the age of 118 Ma and two extra ages outside the CTX scale. The reasons for the lack of the ages in the middle might be the small counting area of the HiRISE image (only ~6% of the CTX area) together with the geological diversity of the region in the HiRISE scale.