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Dating the resurfacing event of Morpheos basin (upper Reull Vallis), Mars: Implications for the extent of the basin

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1. Introduction

The eastern rim of Hellas basin has several large channel features which are characteristic to this region. One of these, Reull Vallis, has been studied in great detail by earlier works [i.e. 1, 2]. However, the new data from Mars Express (HRSC) and MRO (CTX and HiRISE) gives a possibility to still add more details to the general view of the evolution of the larger Reull fluvial system. We were able to find new age constraints for the upper parts of this system through crater size-frequency distributions using the available images of CTX, HiRISE and HRSC and compared them with the previous results from MDIM images [2]. We also mapped the Morpheos basin depression and the confining region in CTX resolution.

2. Reull Vallis and Morpheos basin

As has been observed before, the Segments 1 and 2, [1] of Reull Vallis are not connected [i.e. 1]. In between locates a closed, flat-floored topographic depression, the Morpheos basin [2,3,4]. The deepest parts of this basin are at about 450 m, about 50 m deeper than the level of the floor at the beginning of the Segment 2 of Reull Vallis [2]. The rugged surface of the cratered terrains surrounds the smooth basin.

A hypothesis of a transient reservoir of water that existed in the western portion of the Morpheos basin has been suggested [2,3,4]. In this hypothesis, the reservoir was filled by a flow or flow events from Reull Vallis Segment 1 and it served as the source of water that later carved Segment 2. In this approach, it was noted, that this reservoir may have formed quite rapidly and it may not have been a long-lived feature [2].

Morpheos basin question was also addressed when a volumetric re-analysis of the Reull Vallis fluvial system was completed with the MOLA DEM and GRIDVIEW [5]. In this study, Capitoli [5] determined that the previously proposed level of filling of the Morpheos basin at 600-650 m [2] was too high due to the limit of the volume of the Segment 1. We agree, as the proposed level in our earlier work was in fact thought to be the absolute maximum of possible filling. However, Capitoli and Mest [6] proposed that if multiple pulses of water from Segment 1 were released, a level of 550 m at the Morpheos basin could still be reached.

3. SFDs of the study areas

In our first study [2] the MDIM derived crater retention age for the Morpheos basin floor was noted to be indistinguishable from the general age of the Hesperian ridged plains. This result was now tested with the availability of more detailed images of both Morpheos basin and Hesperia Planum surface.

Several areas were used for crater counts within the Morpheos basin and within Hesperia Planum in order to get comparative results. Interestingly, the calculations within one study area of Morpheos basin (1: HiRISE, ESP_016719_1425_RED, resolution of 50cm/pix) resulted in the surface age of ~3.69 Ga, which was actually comparable to the new results we measured from the study areas of Hesperia Planum (1: CTX, B16_015928_1501_XN_29S254W, 5.13m/pix; 2: CTX, P19_008280_1519_XN_28S251W, 5.1m/pix; HRSC, 3: H1876_0000_ND3, 23.5m/pix; 4: H2660_0001_ND3) with the ages of ~3.69 Ga, ~3.84 Ga, ~3.68 Ga, and 3.69 Ga, respectively. However, the counts from the other areas of interest within Morpheos basin (2: CTX, P04_02531_1438_XN_36S246W, 5.08m/pix; 3: CTX, P20_008794_1430_XI_37S245W, 5.16m/pix; 4: CTX, B17_016542_

1433_XN_36S246W) resulted in ages of ~3.52 Ga, ~3.45 Ga, and 3.49 Ga, respectively.

The reason for this interesting result is due to the locations of the study regions, they differ by their altimetry: The areas 2 and 3 are located within the surface area confined by the contour level of 500 m and area 1 of Morpheos basin is located next to the Segment 2 channel head at around 550 m. The separation of study area 1 from the actual identified Morpheos basin is also supported by the geologic mapping of the region.

6. Summary and Conclusions

The new SFD calculations using the high resolution data of the new Mars missions show the age difference between the previously indistinguishable [2] Hesperia Planum and Morpheos basin surface ages. The deepest parts of the basin show clearly a younger surface age.

These new observations and measurements support the proposition by Capitoli [5] of a smaller extent of the basin in this location. According to our observations and measurements it is very likely that the limit of the Morpheos basin filling is in fact near the 500 m contour level, as the areas of calculation outside this contour level of the basin gave the same age results as the general Hesperia Planum areas and areas within the lower basin show the younger age. This limit is also supported by the mapping of the basin from the CTX mosaic where the identified basin floor units locate in general below the 500 m contour.

In general, the SFDs derived from the Morpheos basin imply that the region has experienced variable erosional and depositional processes. The calculations clearly show that between ~3.4-3.5 Gyr ago the surface of the Morpheos basin, below the identified contour level of 500 m was modified along with the cratering record by a resurfacing event that affected the whole basin floor. This may be explained by an outflow event and subsequent filling of the basin with water from the Segment 1, forming a reservoir within the Morpheos basin depression.

The geological observations of the Morpheos basin floor support this hypothesis. Many of the craters appear to have been covered by sediments and are now being exhumed. Also, the general characteristics of the impact craters and other structures imply at least some presence of ice-rich materials within the 500 m contour derived basin.

The small difference of above and below 500 m contour counts and the signs of even older aged surface seen in some of the areas of calculation, seem to hint to the direction that the length of the Morpheos basin phase in the evolution sequence may have been quite limited.

According to the results of this study, the crater size-frequency distribution calculations with higher resolution images may be used in order to investigate the more subtle changes or differences of surface units.

Acknowledgements

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