DATING THE RESURFACING EVENTS OF THE HARMAKHIS VALLIS SOURCE REGIONS, MARS: PRELIMINARY RESULTS. S. Kukkonen and V.-P. Kostama, Astronomy, Department of Physics, P.O. Box 3000, FI-90014 University of Oulu, Finland (soile.kukkonen@oulu.fi).

Introduction: Harmakhis Vallis is one of the four major outflow channel systems that cut the eastern Hellas rim region of Mars (Fig. 1). It is ~800 km long and located ~450 km south of Hadriaca Patera starting close to the end of another valley, Reull Vallis. Due to the close position to the volcanic features, the channels are suggested to have been formed by the mobilization and release of subsurface volatiles by volcanic heat [1–5]. Because Harmakhis Vallis cuts the surrounding massifs of the cratered terrains, it is clearly one of the youngest features in the region [6, 7].

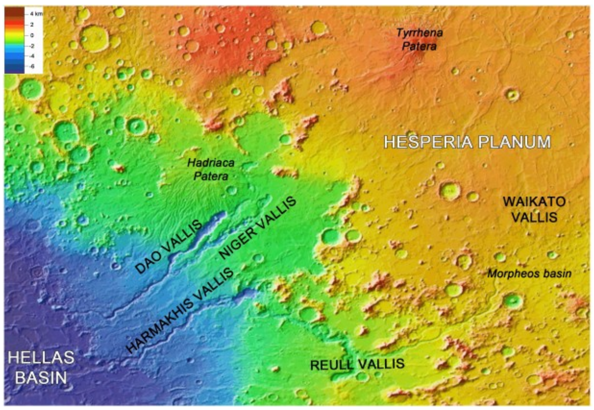

Figure 1. Mola gridded topography for the eastern Hellas rim region. Harmakhis Vallis is located about 450 km south of Hardriaca Patera. The center of the image is at ~32°S, 97°E.

Purpose of this work: The previous works on the region of Harmakhis Vallis have been mostly focused on different geological events [e.g., 5, 8–10] or only on a limited region [i.e., 11]. In this work, we present some of our preliminary results of mapping and crater counting within the head depression region of Harmakhis Vallis based on the CTX (resolution ~5m/px, swath width ~30 km) and HiRISE (resolution 0.3-0.5 m/px, swath width ~6 km) images.

The work is part of an ongoing project where we are looking into the eastern Hellas fluvial systems as a whole to form a detailed picture of the drainage system evolution within the larger region, and to relate them to changes in the Martian climate history.

Crater counting method. The crater countings have been conducted by using established methodologies [12–14]. Because of using very high resolution data, the distribution of small impact craters is significant. The role of small impact craters and their usability in crater counting have been discussed in many papers [e.g., 15–17]. Usually they have been excluded from the crater counts because of the uncertainty of their origin (primary vs. secondary crater). However, small craters accumulate to the surface more quickly than larger ones, and thus the high spatial resolution is necessary in dating younger surfaces or small units where there are only few large craters. In the case of Harmakhis Vallis, the region has experienced significant recent modification and degradation, and thus, we can assume that the small crater population mostly postdates the secondary craters forming larger impacts located in the older regions. Therefore, only the obvious clusters of secondary craters were excluded from the counts.

The crater counting regions are shown in Fig. 2a. The regions have been defined based on the quality of the images available. The initial results are presented in Table 1.

Crater size-frequency distributions: The head depression of the Harmakhis Vallis channel is characterized by a 3.84×10^3 km^3 [18] steep-walled depression, which is believed to be a similar kind of collapse area as on the head of Dao Vallis. The depression is covered by the younger, about 179 Myr old (Area 1, resurfacing age ~24 Myr) ice-related materials which originate from both the interior walls of the depression and from the surrounding pitted plains and debris aprons. The material consists of coherent blocks, rounded knobs, and unconsolidated material, and the texture varies from smooth to mottled [18]. Between the head depression and main valley Harmakhis Vallis has a "barrier surface" [11] indicating a possible subsurface channel.

Because there is no evidence of fluvial features on the surface around the head depression, the depression is apparently the uppermost portion of the system [4]. On the other hand, due to the close location (~40 km) of the terminus of Reull Vallis Segment 3, it is suggested that there might be a connection (on-surface or subsurface) between Reull and Harmakhis Valles [i.e., 15]. An unusual, sudden termination of Segment 3 of Reull Vallis favours the connection, because unlike the other outflow channels in the eastern Hellas rim region, Segment 3 of Reull Vallis shallows [19] as it nears its terminus without an obvious terminal depositional area. We measured for the terminus (Area 4) an age of 1.2 Gyr (and the resurfacing age ~35 Myr). However, at least two different episodes of debris aprons (Areas 2 and 3) with the ages of 381 Myr and 101 Myr (the resurfacing ages are ~46 and ~20 Myr) cover the terminus of Reull and the area between Reull and Harmakhis Valles, so all the evidence of the connection or the end wall of Reull Vallis seem to have been buried.

When looking at the HRSC DTM topographic map (Fig. 2b) of the area, we note that the map does not show any evidence of the connection channel under the debris aprons. Around the debris aprons the topography is even lower (~3.2 km level) than the elevation level (~-3.1 km) of the terminus of Reull Vallis. In [8], this unit has been mapped as an outwash channel based on its low albedo. For this surface (Area 5) an age of 3.64 Gyr (the two resurfacing ages are ~156 Myr and ~35 Myr) was measured.

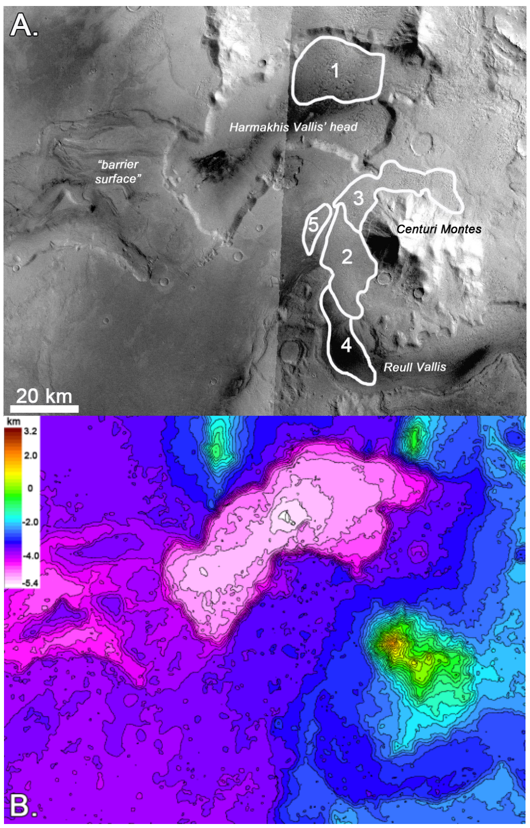

Figure 2. a) HRSC mosaic shows the crater counting areas (1=ice facilitated flow features inside the Harmakhis Vallis head depression, 2=first phase of debris aprons from the eastern side of Centauri Montes, 3=second phase of debris aprons from the northern side of Centauri Montes, 4=floor of the terminus of Reull Vallis Segment 3, 5=possible shallow outwash channel); and b) HRSC DTM topography map of the Harmakhis Vallis head depression region with the 200 m contours.

Discussion: Because of the lateral mass wasting processes which cover both Segment 3 of Reull Vallis and the head depression of Harmakhis Vallis, the degree of the preservation of the primary features is limited. Even though in the crater counts the old craters (eroded and buried) were also counted, the potential older surface units were not found, which might indicate that the layers formed due to lateral processes are thick enough to cover the craters on the original surfaces.

The resurfacing ages of the units (20-46 Myr) that almost correlate, may be evidence of the regional processes (e.g. an episode of significant erosion). The age of 156 Myr found from Area 5, in turn, might be due to events of contemporary climate conditions, which are related to the formation of the ice-related material in the head depression of Harmakhis Vallis (Area 1) and the debris aprons (Area 2 and 3).

Table 1. Results of the crater counting based on the production function of [16] and the chronology model of [17]. The crater counts are conducted based on the CTX data.

Unit	Area (km^2)	Age1	Age2 (resurfacing)	Age3 (resurfacing)
1	570	179 (+88-10)My	24 (+6.6-6.8)My	-
2	175	381 (+170-210)My	45.6 (+9.1-9.8)My	-
3	310	101 (+48-50)My	19.6 (+9-9)My	-
4	240	1.20 (+0.72-0.85)Ga	34.9 (+82-85)My	-
5	60	3.64 (+0.12-2.7)Ga	156 (+82-85)My	35.9 (+11-11)My

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