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Mapping and dating the resurfacing events on the Harmakhis Vallis channel, Mars

S. Kukkonen, V. -P. Kostama, A. I. Rauhala and J. Raitala
Astronomy, Department of Physics, University of Oulu, P.O. Box 3000, 90014 Oulu, Finland (soile.kukkonen@oulu.fi)

Abstract

The purpose of this study is to outline the events which formed the geologic features and units observed in the Harmakhis Vallis region, and by doing so, provide further understanding of channel evolution. The work is part of our ongoing project [1–3] where we are looking into the eastern Hellas fluvial systems 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.

1. Introduction

Harmakhis Vallis is one of the four major outflow channel systems that cut the eastern Hellas rim region of Mars. It is located ~450 km south of Hadriaca Patera and only ~40 km north of Reull Vallis terminus. Due to the proximity of volcanic features, the channel is suggested to have been formed by the mobilization and release of subsurface volatiles by volcanic heat [4–7]. After formation, Harmakhis Vallis has been modified by the different geologic processes such as wall collapse, mass movements and surface flows.

The channel has now been mapped and dated by using data from MRO´s CTX (~5m/px) and HiRISE (~0.3-0.5 m/px) cameras, MGS's MOC (~1.5-12m/px) and Mars Express' HRSC (~50m/px). In the case of mapping, also the images of Mars Odyssey's THEMIS infrared (day and night) camera have been used.

2. Characteristic of the channel

Harmakhis Vallis resembles the other nearby outflow channels (Dao and Reull Valles) in many aspects. It is deep (0.3-1.6 km), relatively wide (~9-25 km) and morphologically prominent feature along its entire extent. However, unlike the other channels, Harmakhis Vallis is not a continuous valley. Based on the morphologic characteristics, Harmakhis Vallis can be divided to four segments: the channel head depression (*H*), the barrier surface (*B*) the main channel (*M*) and the terminus (*T*) (Fig. 1).

2.1 The head depression

Harmakhis Vallis head depression is about 38 km wide, 90 km long and in places even 1.6 km deep collapse structure. Due to the lack of fluvial features around the head depression, the depression is apparently the source area for the Harmakhis Vallis system [7]. On the other hand, due to the proximity (~40 km) of the Reull Vallis terminus, it is also suggested that there might be a connection (on-surface or subsurface) between Reull and Harmakhis Valles [i.e., 8]. However, due to the later debris aprons which cover the area, there is no evidence left of the possible connection channel.

Also the head depression has experienced a later modification. Except of the few blocks which might be remnants of the original depression collapse, the surface is covered by at least three lateral, possibly ice-facilitated flows, which originate from the interior walls and in places from the surrounding pitted plains and debris aprons. The age of the covering flows varies from 179 Ma to 1.12 Ga, which are (due to the ice sublimation and thus the craters' erosion) the younger age limits for the formation of these features. All of the units have also suffered from later resurfacing processes.

2.2 The barrier surface

After well-defined head depression, Harmakhis Vallis ends abruptly and starts again ~83 km to the southwest. This barrier surface [9], which separates the head depression from the main channel, differs clearly in topography from the other parts of the channel; the elevation difference varies from 400 m to even 1 km. Thus the connection between the head depression and the main channel is suggested to be

mainly subsurface [9]. However, the small and shallow valleys (from 1 km to 10 km wide) which cut the barrier surface indicate that there may have been also on-surface connection. These valleys are also mainly covered by a viscous flow. We dated an age of 353 Ma for this flow and at least two resurfacing events were found.

2.3 The main channel

The Harmakhis Vallis main channel starts as a ~0.8 km deep and ~27 km wide valley. The channel's walls have collapsed place-to-place making the floor hard to recognize. For the main channel, we mapped four larger scale flow-units which originate from the channel walls, but flows exist also parallel to the channel. These units seem to be clearly younger than the units in the head depression or the barrier surface. In places, the biggest craters do not fit to the isochrones at all, but where they fit the oldest observed age is only 75 Ma. In addition to this, two resurfacing period were dated.

2.4 The channel terminus

Harmakhis Vallis becomes further shallower and wider upon reaching the Hellas basin floor. Eventually it disappears in the topography. The units on the floor are clearly smoother and there are no similar kinds of large scale viscous flows that were found on the other parts of the channel.

3. Summary and conclusions

The Harmakhis Vallis fluvial system has been modified throughout by later geological events, which are now seen as channel covered ice-facilitated viscous flows. However, the age of these flows clearly varies in different parts of the channel. On the head depression and barrier surface, the flows are systematically older (>170 Ma) than the flows in the main channel (<70 Ma). This does not necessarily mean that the flows have formed in different times or due to the different events, but also that the duration of ice sublimation processes, and thus the crater erosion rate, has varied. Instead, the ages of resurfacing processes seem to be the same throughout the channel.

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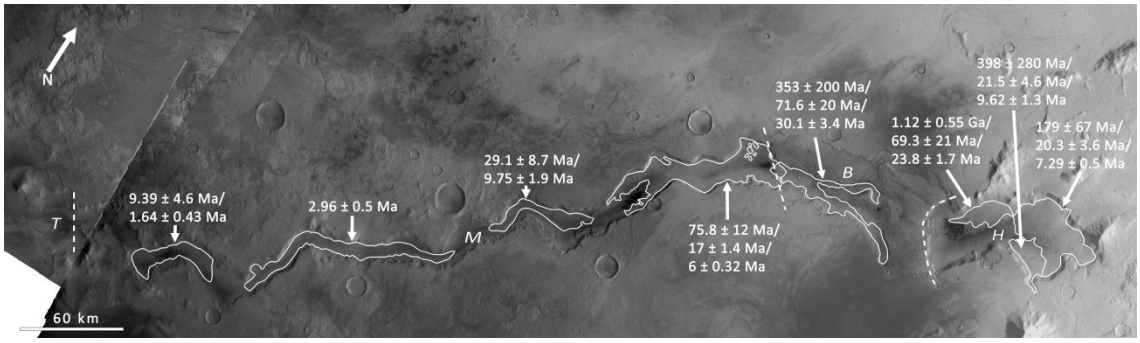

Figure 1: A HRSC-mosaic shows Harmakhis Vallis and its four parts with the mapped flow-units and the summary of crater counts.