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Resurfacing events on the Harmakhis Vallis channel, Mars: results of mapping and dating.

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Abstract

In this study, we outline our results of mapping and dating the geologic activity on the Harmakhis Vallis floor. We focus especially on the large-scale flow units which are possibly ice-facilitated and cover the channel floor almost entirely, and investigate when the processes that formed these units occurred.

1. Introduction

Harmakhis Vallis is one of the four large-scale outflow channels which cut the volcanic, sedimentary and mixed material on the northeastern Hellas rim region of Mars (e.g., [1]). It starts as a broad and deep depression without any other fluvial features around the head, and thus it has been suggested to have formed when the subsurface ice melted and the water was released due to the volcanic heat from the activation of the nearby volcanoes (e.g., [1–3]).

One of the most significant characteristics of Harmakhis Vallis is that instead of being a continuous channel, its head depression and main channel are separated by the ~ 80 km long and topographically higher (> 0.4 km) "barrier surface" [4] (Figure 1a) which possibly represents the non-collapsed but partially sunken part of the channel.

In this study we present our results of mapping and crater counting [5–7] of the floor units of Harmakhis Vallis (see also our previous studies [8–10]). The used data consist of a full resolution CTX mosaic (~ 5 m/pixel) and separate HiRISE images (~ 0.3 – 0.5 m/pixel). In the case of mapping, images of MGX's MOC (~ 1.5 – 12 m/pixel), Mars Express' HRSC (~ 50 m/pixel) and Mars Odyssey's THEMIS infrared (day and night) camera were also used.

2. Results and discussion

Mapping on Harmakhis Vallis shows that the channel has suffered several later modifying processes, such as mass movements and wall collapses. However, the most significant resurfacing events have been the formation of the still visible viscous flow units, which cover the channel almost entirely. The varying texture of the flows indicates that they might be ice-facilitated. On the channel head depression, the flows originate from the interior walls and the surrounding pitted plains and debris aprons. On the barrier surface and the main channel, on the other hand, the flows seem to originate from the interior walls only.

The crater count results (Figure 1b–e) show that all of the flow units on the Harmakhis floor are relatively young. The oldest cratering model ages were found on the head depression and near the end of the main channel, and these ages are only ~ 1 Ga. Otherwise, the oldest ages of the flow units are mainly between ~ 100 Ma – 1 Ga, except a unit at the beginning of the main channel (the oldest preserved age is ~ 70 Ma) and a unit near the end of the channel (the oldest age is ~ 15 Ma). In addition to these, all of the units show evidence of 1–3 resurfacing events, the ages of which correlate with each other on different units. This might indicate that several channel-scale resurfacing processes have occurred on the channel, varying only in intensity and duration.

It is still unclear why the age of ~ 100 Ma – 1 Ga is totally disappearing from some flow units. Because the resurfacing ages of the flows seem to correlate throughout the channel and almost all of the craters on the channel floor seem to have suffered erosion processes only (not deposition), it is implausible that the oldest ages (< 100 Ma) found on some units are the formation ages of these units, even though the measured crater size-frequency distributions in these cases do not show evidence of older surface ages. One reason for this might be that the crater erosion rate caused by ice sublimation (due to the ice-facilitated nature of the flows) has varied in different parts of the channel and caused, together with the later resurfacing processes, the lack of some crater populations in the crater size-frequency distribution.

There could be a similar explanation for why some of the resurfacing ages are disappearing from some units.

3. Summary and conclusions

The original floor of the Harmakhis Vallis channel seems to be totally modified by later processes which are now seen mainly as the large-scale viscous flows that are possibly ice-facilitated. The oldest measurable cratering model age of these flow units varies from ~ 100 Ma – 1 Ga, which may be, however, only the youngest limits for the formation age of the flows due to their ice-facilitated nature. All of the flow units also have several resurfacing ages which mainly correlate with each other, and which can be roughly divided in three phases.

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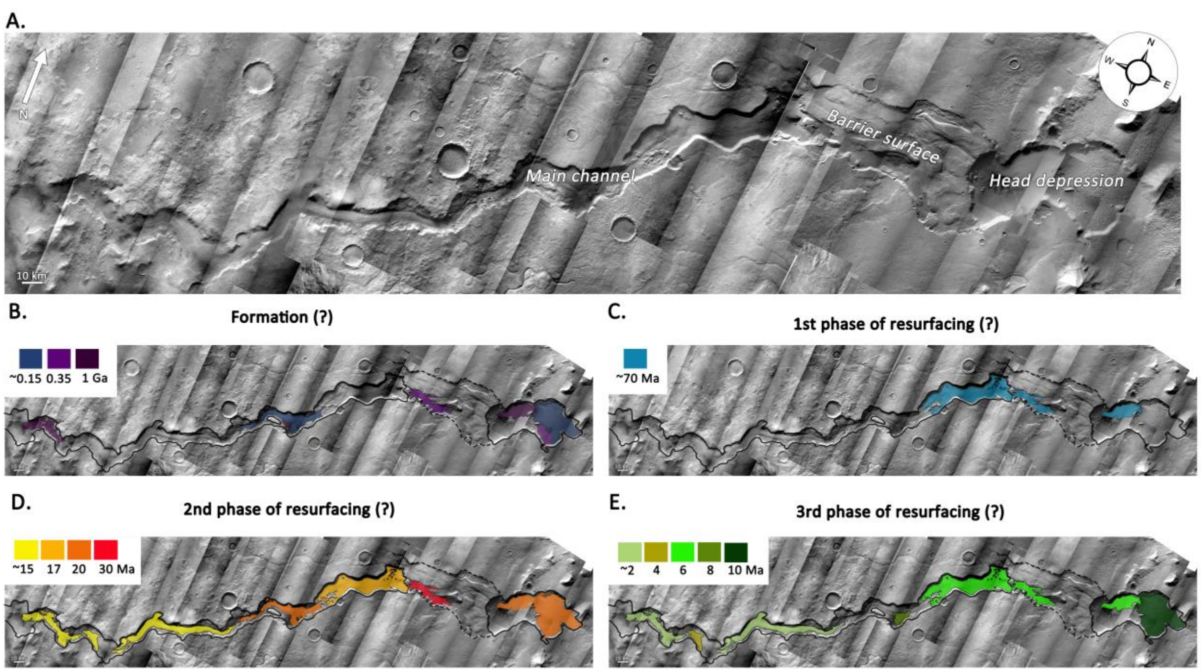

Figure 1: A) A CTX mosaic of Harmakhis Vallis shows that the channel is covered almost entirely by the flows whose morphology may indicate that they are ice-facilitated. B–E) An overview of the crater counting results for the flow units on different parts of the Harmakhis floor. The dashed lines indicate the location of the barrier surface. Based on the crater counting, the channel-covered flow units seem to have suffered three separate resurfacing events after their formation.