EPSC Abstracts
Vol. 12, EPSC2018-245-1, 2018
European Planetary Science Congress 2018

Gully activity in Sisyphi Cavi, Mars

Jan Raack (1), Susan J. Conway (2), Meven Philippe (2), Thomas Heyer (1), Dennis Reiss (1) and Harald Hiesinger (1)
(1) Institut für Planetologie, Westfälische Wilhelms-Universität Münster, Germany, (2) Laboratoire de Planétologie et Géodynamique, Université de Nantes, France (jan.raack@uni-muenster.de)

1. Introduction

We present preliminary results of our study regarding recent gullies and their ongoing activity/modification within the Sisyphi Cavi region on Mars. Recent studies have shown gully activity in this region [1, 2], in which Raack et al. [1] proposed a potential formation process for one active gully: dry flows of sandy/dusty material over a sublimating translucent seasonal CO_2 slab ice.

In the same region numerous dark spots [3, 4] and dark flows [5, 6] can be found on dunes as well as on slopes of the pits during spring. It is thought that this activity is most likely triggered by basal sublimation of seasonal CO_2 ice followed by degassing through small cracks in the ice crust, carrying darker sand and dust to the surface [4]. On sloping surfaces, these lofted materials can move downslope leading to dark flows [5, 6]. The morphological similarity between dark flows within a gully in the northern region of Sisyphi Cavi [1] and the dark spots and flows in the same region during spring leads us to the hypothesis of a similar formation mechanism. Furthermore, dark flows have also been proposed to form via jets through the CO_2 ice slab [6, 7]; comparable to the proposed formation mechanism for the active gully [1].

By extending our survey area to the whole Sisyphi Cavi we want to test our hypothesis that the near-polar gullies and the dark spots and flows have similar formation mechanisms.

2. Methods

2.1 Study Region

Sisyphi Cavi is a pitted terrain in the south polar region of Mars. Our study region (20°W to 10°E and 66° to 76°S) comprises all of the pits of Sisyphi Cavi (Figure 1). The steep slopes of numerous pits hold several recent gullies with ongoing present-day activity [1, 2]. Within the pits and on the slopes of the pits, numerous dark spots and dark flows can be observed in spring. The depth of the pits is up to ~1 km [1]. It is proposed that the pits were formed by the basal melting of volatile rich material by subglacial volcanos [8]. During southern winter the complete region is covered in centimeter to decimeter thick seasonal CO_2 slab ice with contaminations of H_2O and dust [1].

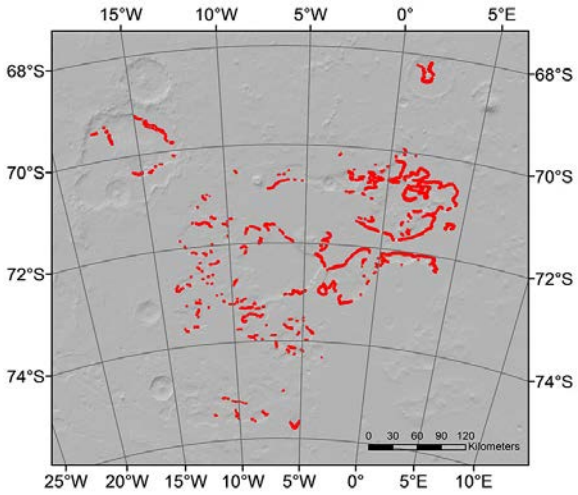

Figure 1: Preliminary map, showing gullies and gully-like structures within Sisyphi Cavi based on CTX images. Background MGS MOLA DEM hillshaded relief.

2.2 Proposed working plan

Here the presented work is preliminary and ongoing, we will:

1) Map all of the gullies in the Sisyphi Cavi region and analyze their orientation and slope angles (if suitable data are available) based on CTX images (preliminary results shown in Figure 1), and MOLA/HRSC/CTX elevation data.
2) Identify the activity of gullies over the last few martian years (MY) based on HiRISE images. This work will be carried out with the Multi-Temporal Database of Planetary Image Data (MUTED) [9, 10]. Activity will

be then narrowed down to the smallest time range for each MY.

3) Identify and map the dark flows and dark spots in the region.
4) Investigate identified activity in detail with spectral and thermal datasets to identify possible triggering mechanisms of the dark flows inside and outside gullies.

2.3 Data

Our mapping of gullies is based on CTX images. Until now for our preliminary results we have used numerous single CTX images, but for the final study it is planned to use a part of the global CTX-Mosaic by Dickson et al. [11]. We will also use all of the 479 HiRISE images which are available in our study region for detailed analysis. For the identification of current activity of our observed geomorphological features, MUTED [9, 10] is a perfect tool to not only identify the multi temporal coverage of HiRISE images, but also for the search for adequate thermal and spectral datasets. Based on MUTED, 345 HiRISE images have a multi temporal coverage in this region.

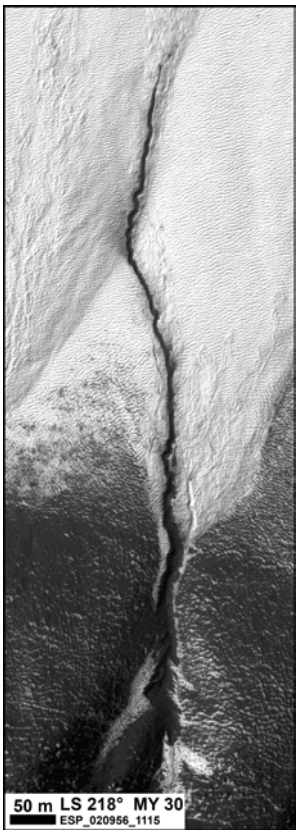

Figure 2: Active gully in Sisyphi Cavi. A dark flow is visible during spring within the gully alcove and channel. The dark material flows over the apron and new deposits are visible later in the spring. North is up, flow direction is from south to north. Modified after [1].

3. Results of recent studies

As described shortly in the introduction, in 2015 a previous study about present-day activity of one specific gully (1.44°E, 68.54°S) within the Sisyphi Cavi region was published [1]. This detailed work comprised a multi-temporal analysis of the gully on the basis of 36 HiRISE images, as well as spectral data acquired by CRISM and OMEGA and thermal datasets acquired by TES [1]. The active gully has very similar dimensions, slope angle and orientation to the adjacent gullies. Therefore activity of only one gully was difficult to explain. The multi-temporal part of this study showed that activity occurred between solar longitudes (L_S) ~218° and ~226° in MY 29-31 [1]. At this time of year surface temperatures rise rapidly and CO_2 and H_2O surface frost sublimate. Spectral modelling has shown that the annual surface frost is translucent CO_2 slab ice with H_2O contamination [1]. Raack et al. [1] proposed that dry material was eroded due to the sublimation of the seasonal slab ice at the steep slopes of the gully apron and channel and accumulated within the gully channel, which was still covered with ice. The ongoing sublimation of this ice triggered the movement of this dry material on top of the ice down the gully to the apron. Such a mechanism was previously proposed by [12].

4. Preliminary results

During our preliminary study we have identified activity within additional gully channels, which are comparable to the activity identified by Raack et al. [1]. Furthermore, activity occurs at the same time as the appearance of dark spots and flows on dunes, which supports our working hypothesis that a similar formation mechanism forms both features.

5. References

[1] Raack, J. et al. (2015) Icarus 251, 226-243.
[2] Dundas, C.M., Diniega, S., McEwen, A.S. (2015) Icarus, 251, 244-263.
[3] Cantor, B., Malin, M., Edgett, K.S. (2002) JGR 107, E3, 5014.
[4] Piqueux, S., Byrne, S., Richardson, M.I. (2003) JGR 108, E8, 5084.
[5] Kereszturi, A. et al. (2009) Icarus 201, 492-503.
[6] Gardin, E. et al. (2010) JGR 115, E06016.
[7] Pilorget, C., Forget, F. (2016) Nat. Geosci. 9, 65-69.
[8] Ghatan, G.J., Head, J.W. (2002) JGR 107, E7, 5048.
[9] Erkeling, G. et al. (2016) PSS 125, 43-61.
[10] Heyer, T. et al. (2018) PSS, accepted.
[11] Dickson, J.L. et al. (2018) LPSC, 2480.
[12] Cedillo-Flores, Y. et al. (2011) GRL 38, L21202.