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Present-Day Seasonal Gully Activity in a South Polar Pit (Sisyphi Cavi) on Mars

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Seasonal activity of gullies under current climatic conditions on Mars was observed by [1-7]. Dundas et al. [2] reviewed the present-day activity of classical gullies (including the gully presented in this work), dune gullies, and other mass wasting processes in the southern hemisphere on Mars. Recent polar gullies in Sisyphi Cavi were also analyzed by [8], who estimated ages of about 20 ka to 20 Ma for the gullies.
In this study we focus on a single gully in Sisyphi Cavi, located in the south polar region at 1.44° E and 68.54° S. The gully occurs on the gullied equator-facing slope of an isolated polar pit within an infilled impact crater. Multi-temporal high-resolution image data analyses show new deposits at the terminus of the gully channel and on the gully apron within spring (after solar longitudes of 236°) of martian years (MY) 29 and 31. In MY 29 deposition of material shortens the channel by about 40 m; in MY 31 a new deposit at the western flank of the gully apron with approximately 300-600 m3 of material is visible [3].
Our morphological investigations show that the identified new deposits were formed by dark flows through the entire gully deposited on top of the apron between LS ∼218° and ∼226°. Thermal data show a temperature increase between solar longitudes (LS) ∼218° and ∼226°. Near-infrared spectral data show relatively constant band strengths of CO_2 ice and H_2O ice in this time range. After the formation of the dark flows (after LS ∼226°), temperatures increase rapidly from ∼180 K to >∼270 K at LS ∼250°. At this time, spectral data indicate that all volatiles on the surface sublimated. However, an earlier beginning of sublimation when the dark flows were observed (between LS ∼218° and ∼226°) is likely, due to the fact that the instruments can only show the last phase of sublimation (decrease of volatile band strengths) [3].
Spectral modeling shows that from winter to mid-spring, the surface of the studied area is covered by CO_2 slab-ice contaminated by minor amounts of H_2O ice and dust. Furthermore, our spectral modeling indicates that the dark material most likely flows on top of the CO_2 slab-ice cover [3]. Three different scenarios were proposed to explain the identified dark flows, including (1) flows supported by liquid H_2O, (2) flows supported by CO_2 gas, and (3) dry flows supported by continued sublimation of CO_2 ice [3]. On the basis of our study we find that scenario (1) is unlikely because of the very low temperatures [3]. While scenario (2) is consistent with the observed beginning of CO_2 ice sublimation in the study area, it is unlikely because of the limitation of the activity to only one gully compared to surrounding gullies that share the same morphologies, slope angles, and volatile contents [3]. Thus, we propose that scenario (3), dry flows possibly supported by the continued sublimation of CO_2 ice within the gully [9], is the most plausible scenario, when the observed active gully comprises different source material than the surrounding gullies, i.e. a higher content of probably sand-sized material from an outcrop located in the alcove [3].

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