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Seasonal Activity of Gullies in South Polar Pits

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Seasonal activity of gullies under current climatic conditions on Mars was observed by [1-6]. These observations were made on mountain and/or crater slopes [2-4], on dune slopes at mid-latitudes [2,5,6], and on slopes of polar pits [1,2]. The suggested mechanisms to form new gully deposits are melting of H_2O ice [3,5] or sublimation/removal of CO_2 ice [2,4,6].
With high-resolution imaging, temperature, and spectral data we analyzed gully changes in a polar pit north of Sisyphi Cavi at ∼68.5°S and ∼1.5°E. One investigated gully shows dark material within the channel in martian years (MY) 28, 29, and 30. The dark material results to the formation of new dark deposits (dark flow-like features) at LS ∼223° in MY 28, between LS 209° and 226° (beginning of spring) in MY 29, and between LS 218° and LS 249° in MY 30. We observed a new deposition of material at the channel termini, which shortens the channel by about 40 m in MY 29.
Maximum surface temperature data of the area indicate that temperatures in autumn and winter are ∼150 K. In mid-spring (between LS ∼220° and ∼250°) temperatures increase rapidly up to ∼270 K due to solar insolation and ice sublimation.
To better understand the temporal evolution of H_2O and CO_2, we processed near infrared spectral data and analyzed the strengths of absorption bands caused by these volatiles (ices). These investigations show that CO_2 and H_2O ices sublimate between LS ∼225° and ∼240°. This is also the time range when temperatures rise rapidly and when gully changes occurred. More detailed analyses show that the spectral signatures of ice are generally lower on the dark flow features within the gully channel / above the gully apron compared to the surrounding terrain.
Our investigations either imply 1) a generally lower value of volatiles within gully channels due to non uniform volatile deposition on the slope, 2) a faster sublimation of volatiles within gully channels, or 3) deposition of debris above ice from the upslope regions by mass wasting.
1) The slope angle of the polar pit is very homogenous and numerous gully channels with comparable shapes and sizes can be found there. The only gully channel with lowered ice band strength is the gully with the dark flow. A non uniform deposition of volatiles in only one gully channel seems implausible. 2) If the volatiles sublimate faster within gully channels, we would also expect lowered ice band strengths in other gully channels on the polar pit slope, which is not the case. 3) Deposition of material by mass wasting seems to be the most plausible scenario. Our investigations show small dark spots and flows throughout the gully channel and alcove at the beginning of spring with lowered ice band strengths compared to the surroundings. This seems to be the source of material, which is deposited further downslope later in mid-spring as the large dark flow. The temporal occurrence of gully changes, temperature data and seasonal behavior of volatiles imply that mass wasting is linked to, and probably caused by, defrosting of CO_2 and/or H_2O ice.

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