PRESENT DAY ACTIVITY OF SOUTH POLAR GULLIES ON MARS. J. Raack[1], D. Reiss[1], O. Ruesch[1] and H. Hiesinger[1], [1]Institut für Planetologie, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany, jan.raack@uni-muenster.de

Introduction: Here we report on the first clearly identified seasonal changes of gullies in the south polar region on Mars. Seasonal activity of gullies were observed within the last two martian years (MY) on slopes of a polar pit. The polar pit has a depth of ~1000 m and is located in a filled crater (diameter ~54 km) north of Sisyphi Cavi at ~68.5°S and ~1.5°E. The source material of the gullies appears to be relatively fine grained with enclosed large boulders of about 5 m in diameter.

With new high resolution imaging, temperature and spectral data we analyze the exact timing of changes of gullies and detect the possible medium (CO_2, H_2O or dry) and mechanism which initiate present day gully activity in the last martian years.

Background: Seasonal activity of gullies under current climatic conditions on Mars were observed by [1-4]. These observations were made on mountain and/or crater slopes [1,2] or on dune slopes at mid-latitudes [3,4]. The suggested mechanisms to form new gully deposits are melting of H_2O-ice [1,3] or sublimation of CO_2 [2,4].

Active polar gullies in the southern polar region were analyzed by [5]. On the basis of observations made with Mars Orbiter Camera (MOC) and Thermal Emission Spectrometer (TES), gully formation was proposed to result from sublimation of CO_2 in spring, triggering debris avalanches [5].

Data: Our investigation is based on multiple data sets, including High Resolution Imaging Science Experiment (HiRISE) data with 25 and 50 cm/pxl resolution. The study region is covered by 17 images within the last two MY (29 and 30). All images of the study region were acquired in spring and summer. Brightness temperature data of the study region were derived by TES (~3 km/pxl). Near infrared spectral data are based on the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) (18 and 36 m/pxl) and on the Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité (OMEGA) spectrometer (1.5-4.8 km/pxl).

Results: *Imagery results:* Two locations in the study region with clear modifications of the gullies were identified within these two MY. Region 1 (68.48°S/1.23°E) shows new deposition of dark material between L_S 226° and L_S 247° (MY 29) (Fig. 1a,b) and the formation of a new small apron (width: ~20 m) between L_S 218° and L_S 249° (MY 30) (Fig. 1c,d). In region 2 (68.54°S/1.44°E) dark material within the channel (Fig. 1e) leads to the formation of new dark deposits (Fig. 1f) between L_S 209° and 226° (MY 29). At L_S 247° deposition of material on the apron shortens the channel by about 40 m (Fig. 1g). Also in MY 30 dark material in the channel is observable at L_S 218° (Fig. 1h) forming new deposits within the channel of about 30 m at L_S 249° (Fig. 1i). No erosional processes in channels or/and in alcoves were observed.

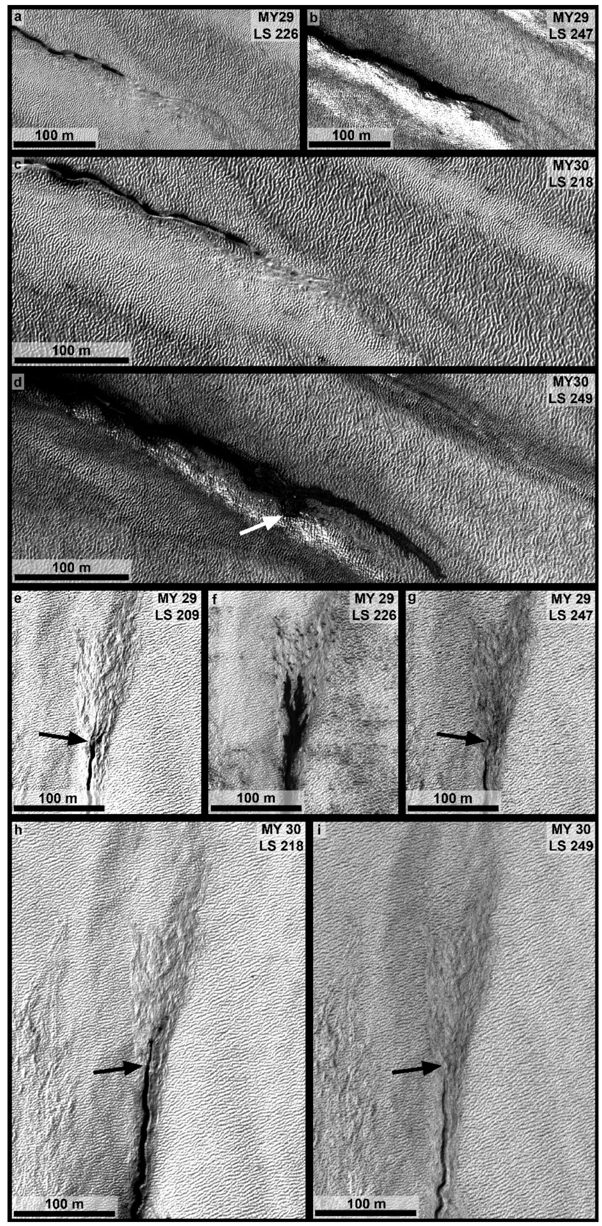

Figure 1. (a)-(d) Region 1 with changes of the apron in MY 29 and 30 (white arrow). (e)-(i) Region 2 with changes of the channel and apron in MY 29 (black arrows) and 30 (black arrows).

Temperature results: TES data indicate that in the study region temperatures in autumn and winter are below ~150 K. In early spring (L_S ~220°) temperatures increase rapidly due to solar insolation. TES data show maximum temperatures in early summer between L_S ~270° and ~310° with temperatures up to ~285 K (Fig. 2).

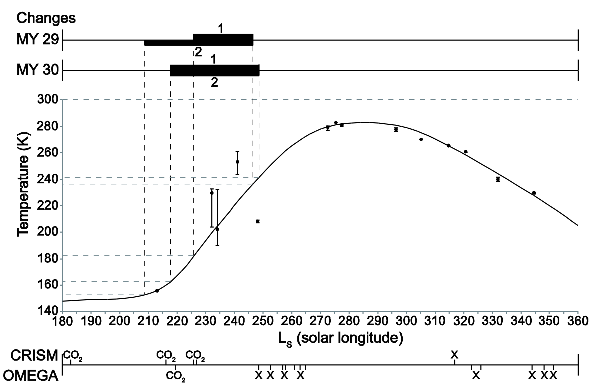

Figure 2. Changes of gullies in region 1 and 2 in MY 29 and 30 (first two lines) and the associated temperature-profile (points represent TES-measurements with their variance) in spring and summer. The line below shows the identified spectral composition of the study region with CRISM and OMEGA (X stand for no CO_2 or/and H_2O-cover).

Spectral results: Spectral data show a CO_2-cover of the complete study region in early and mid-spring (Fig. 2 and 3). At 1.43 µm there are strong absorptions of CO_2-ice (Fig. 3). Spectral evidence for CO_2-ice cover in the study region is found until L_S 227°. CO_2-ice free surface are spectrally observed for the first time at L_S 249°. H_2O was not spectrally detected in the study region and a mixture of CO_2 and H_2O as presented in [6] can not be clearly detected (Fig. 3). Unfortunately, there are no spectral data available between L_S 227° and 249°.

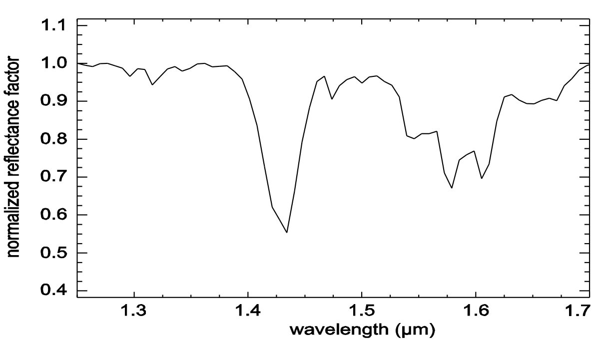

Figure 3. Near infrared spectra (CRISM) of gullychanges in region 1 at L_S 227°. The CO_2-absoption band is at 1.43 µm. A lower reflectivity at the 1.5 µm band is also visible, but it is not clear if it represents the 1.5 µm H_2O-absorption band.

Discussion: New small deposits on the gully apron and transport of dark material in gully channels implies seasonal volatile activity. The activity can be narrowed down to occur between L_S 226° and 247°. Erosion in gully alcoves or channels were not observed. Spectral data show a CO_2-ice cover until L_S 227° and an ice-free surface after L_S 249°. Within this time range, the activity of gullies occurs. TES data show temperatures of about 180 and 240 K within this time range in both regions. This is also in the range of temperatures where CO_2 sublimates back into the atmosphere. Based on the temperature range, the most likely candidate for the observed new deposits are processes related to the sublimation of CO_2. It is possible that the new deposits on gully aprons were initiated by CO_2/dust avalanches as proposed in [5,7].

An alternative possibility might be that the new deposits were initiated by briny flows (liquid H_2O, melting point lowered due to salts) [8]. Small amounts of seasonal deposited H_2O could be present beneath a later (at higher L_S) deposited seasonal CO_2-layer in the study region. Temperatures are very variable in the time of the observed activity (Fig. 2, large variance of TES-data) and exceed temperatures of 260 K. Some brines have eutectic temperatures down to ~201 K [9], hence brines can remain liquid under temperatures below the H_2O freezing point [8]. CRISM and OMEGA data do not cover the study region between L_S ~230° and ~245°, where the activity occurs.

Conclusion: Based on our analysis, seasonal changes of gullies in a south polar pit were clearly identified during springtime. Sublimating of CO_2 is the most likely candidate to initiate these changes, but involvement of small amounts of H_2O(-brines) can not be ruled out. We are currently expanding our investigations to other regions with polar gullies (south of the study region). CRISM data between L_s ~230° and ~245° could help to constrain if the changes are initiated by sublimation processes of CO_2 or by melting of H_2O-brines.

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