THE ORIGIN OF STRIPE-LIKE PATTERNS ON MARTIAN GULLY SLOPES; USING SVALBARD ADVENT VALLEY AS A MARS ANALOGUE.

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Introduction: Stripes are a common slope features in polar regions on Earth were active layer processes (freezing/thawing and gelifluction) occur [1] (Fig. 1). Their origin is most likely polygenic and closely related to frost crack plygons and sorted circles with the addition of a gravitational component. Stripes are either sorted or unsorted. Features resembling stripes have been observed on slopes on Mars with or without association with polygons [2,3]. Due to the current temperature and pressure regime on Mars soil moisture and active layer processes are not likely to occur [4]. However, in recent HiRISE images stripe-like patterns can be observed in proximity to gullies (Fig. 2). Stripe width typically ranges from ~50 cm to 1.5 m, and their orientation is consistently down slope, although it can not be excluded that it sometimes slightly deviates from the steepest topographic gradient.

In our study we have examined sorted and non-sorted stripes on slopes in Svalbard in order to test the working hypothesis of an cryoturbation origin for the martian stripe-like patterns. In doing so we compare their morphological characteristics, settings, and slope to those on Mars.

Study Area: Our study area is located in the Adventdalen valley near Longyearbyen (78°13'0"N, 15°38'0"E) in Svalbard. The bedrock consist of Mesozoic sandstones and shales [5]. The present climate is arctic, with low mean annual air temperatures and very low precipitation, mostly as snow [6]. Svalbard is in the zone of continuous permafrost with an active layer thickness of approximately 1 m.

Data and methods: The analysis of stripes on Svalbard is based on high resolution imagery with the airborne High Resolution Stereo Camera (HRSC-AX) [7] (Fig 3a). The HRSC-AX is a digital pushbroom (linear array CCD) scanner with 9 channels for nadir panchromatic, stereo panchromatic and color imaging like its planetary counterpart HRSC on Mars Express [8]. For comparison we use satellite imagery of Mars obtained by the High Resolution Imaging Science Experiment (HiRISE) [9] which has a similar spatial resolution of 25 cm/pxl to the terrestrial HRSC-AX (Fig 3b-c). HiRISE data is implemented in ArcGIS for measurements.

Aerial imagery are complemented by field work for ground truth (Fig 3d). Parameters measured are slope, width of each individual stripe at eight 30x30 m sample areas covering different types of parent soils. Additionally profiles were digged and soil samples taken for grain size distribution analysis (degree of sorting). This is on-going work so grain size analyses are currently on its way.

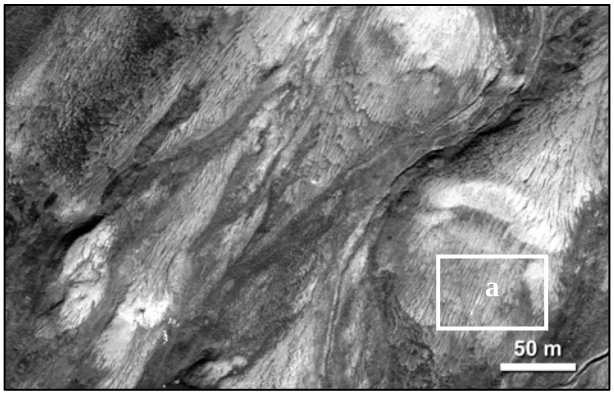

Figure 1. Slopes in Svalbard showing numerous stripes. Subset of HRSC-AX coverage, north is up.

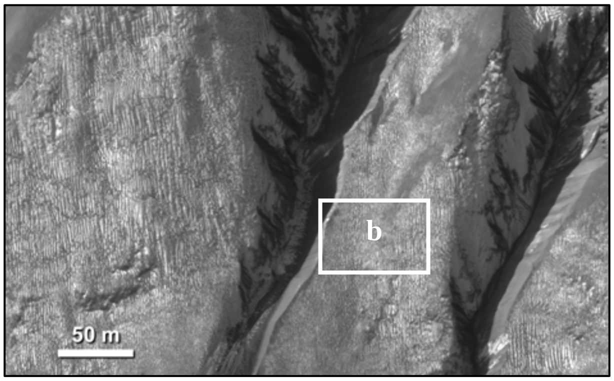

Figure 2. Subset of HiRISE image PSP_001684_1410, 38.9°S/196°E, showing abundant stripe-like surface expressions.

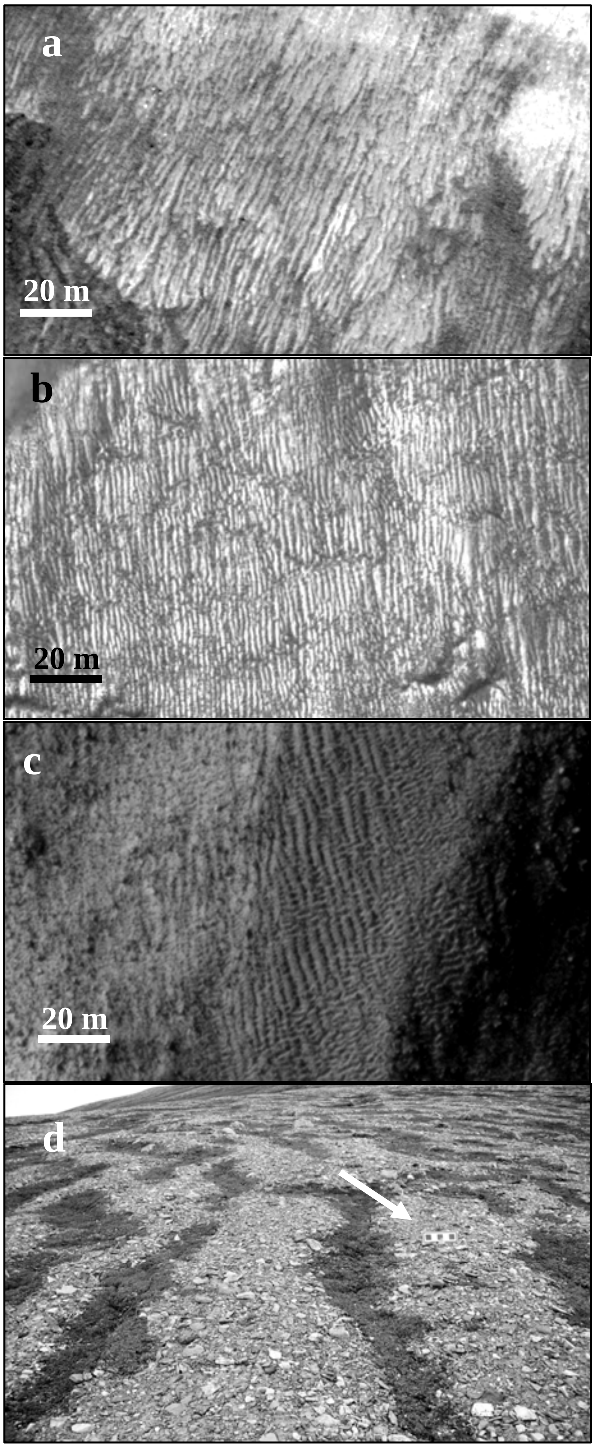

Figure 3 a-d. a-b) Sub sets of fig. 1-2. c) Stripe-like features in HiRISE image PSP_007143_1370. d) Close up on stripes in Adventdalen. Scale bar is 30 cm.

Observations and discussion: The occurrence of stripe-like features on martian gully slopes raise the question if they are periglacial or eolian in origin, or are there any alternative explanations? If they are periglacial do they have any functional linkage to the gully formation or not? Previous studies have identified several landforms with a moist active layer affinity, such as gelifluction lobes, hill slope stripes [2] and sorted polygons [10]. The presence of an moist active layer requires the surface layers ice content to be recharged as ice is continuously lost by the progressive desiccation of the ground. However, seasonal thaw may have existed in microenvironments such as the interior of craters or on hillslopes. In recent models crater floors [11] or poleward facing slopes [12] have been identified as specific locations for water ice stability and deposition of ice. [13] proposes a model were liquid water in the ground could be stable for enough time before being sublimated. In this case the winter CO_2 frost may protect ground ice from sublimation before thawing [14].

One plausible mechanism for recharge is top-down melting of snow packs [15], which could be a viable mechanism to supply moisture for active layer processes to occur on an annual freeze and thaw cycle. If that is the case the stripe-like patterns could be linked to the formation of gullies since both landforms would be favored by similar conditions. However, the investigated gullies alcoves and channels seems to cut the stripe features which would point to an older age of the stripes.

The presence of slope stripes on Mars might be an indicator of cryoturbation processes. An alternative model would be an eolian origin with slope parallel wind-abraided narrow furrows with alternating lighter deposits. This process would need an explanation also.

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