

TRANSIENT SLOPE LINEAE ON MARS: OBSERVATIONS BY HiRISE L. Ojha¹, A. McEwen¹, C. Dundas¹, S. Mattson¹, S. Byrne¹, J. Wray² ¹LPL, U. Arizona (luju@email.arizona.edu), ²Cornell. U.

Introduction: Transient Slope Lineae (TSL) are relatively dark albedo markings with sharp margins, extending downhill on steep slopes, that are narrow (typically up to 2 m wide) and have lengths up to 100s of m (Figure 1). They are also transient—forming and fading over time periods of less than a Mars year. Hundreds of images of steep slopes acquired by the High Resolution Imaging Science Experiment (HiRISE) onboard the Mars Reconnaissance Orbiter (MRO) were examined to find examples of TSL. Our search indicates that TSL are mostly found on rocky, generally north-facing slopes in the mid-southern latitudes (latitudes -32 to -48; Table 1). Where repeat imaging is available, TSL are observed to appear or grow during southern summer (extending into early fall in one case) and to fade or disappear in other seasons.

In this abstract we describe the observations of TSL, while discussion and interpretations are in a companion abstract [1].

Geologic Setting: TSL occur in the classical dark regions of Mars, which have moderate thermal inertias ($\sim 200\text{--}340 \text{ Jm}^{-2}\text{s}^{-1/2}\text{K}^{-1}$) [2], but TSL are concentrated at or just below the rockiest portions of steep slopes that are not resolved by TES and must have higher thermal inertias. The slopes with TSL appear geologically very recent, with no impact craters, and are often found on “fresh” (very well-preserved) impact craters.

TSL sometimes occur on slopes covered by many small (few meters wide) channels, or they form on slopes that lack HiRISE-resolved channels. They are rarely associated with the much larger martian gullies (really ravines). In a few cases (e.g., in Horowitz crater) the TSL occurrence and lengths provide such an exact match to that of the fine channels that a genetic connection seems likely.

The seasonal, latitude, and slope aspect distributions of TSL and the fact that they do not occur in regions with high dust index distinguishes them from slope streaks [3]. Small transient slope lineaments are also seen on high-latitudes dunes during late winter and spring, as the seasonal CO_2 frost is sublimating [4]. Although it has been proposed that these defrosting dune streaks are due to brines [5], they have not been observed in the summer when temperatures are most favorable for brines.

Observations: TSL were first discovered using high resolution (1m/post) Digital Terrain Models (DTMs) and their associated orthorectified images created from HiRISE images [6]. Change detection algorithms employed on a pair of orthorectified images

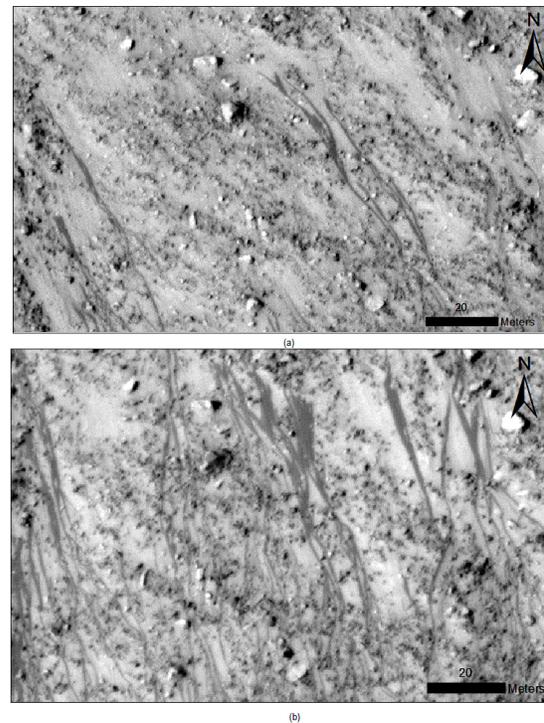


Figure 1. (a). HiRISE observation ESP_0013189_1330, (Ls: 269.2, acquired 20/05/2009) showing TSL on a NW facing slope in Asimov crater. (b) ESP_0013835_1330, (Ls: 300.2, 09/07/2009). TSL formation and growth occurred between the dates of these two observations.

revealed flow-like features that had formed between the acquisition dates of the two images. Following the initial discovery, HiRISE images were examined for more examples of TSL. We initially examined images in all latitudes, but soon focused on mid-northern and mid-southern latitudes from all seasons. A strong correlation of TSL to latitude and season was observed (Table 1). Confirmed TSL (changes over time seen) have been found to date only within 32S-48S latitude; no longitudinal constraint has been established. They are mostly seen on equator facing, steep, rocky slopes, although they are also common on west and east-facing slopes, and a few examples of pole-facing TSL have been observed. TSL extend down the topographical gradient ($>20^\circ$ slopes), often diverting around topographic obstacles rather than over-topping them like the slope streaks on dust-mantled slopes. The individual lineae may split or merge. Wherever repeat imaging is available, TSL are observed to grow or fade. There are often hundreds of these features on a slope.

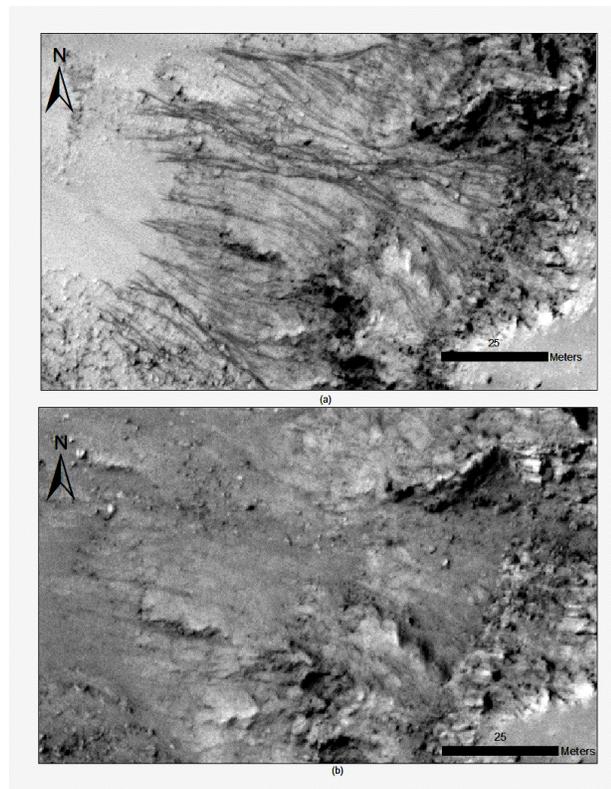


Figure 2. (a). HiRISE observation PSP_005943_1380, (Lat: 41.6S, Ls: 340.9) showing TSL on a NW facing slope. (b) HiRISE observation ESP_0011428_1380, (Ls: 184.7). TSL have faded/disappeared in the later (ESP) observation.

The timing of the growth (daily?) cannot be resolved at present. Where repeat images are available in subse-

quent Mars years, the features fade or disappear (Figure 2).

Possible Formation Mechanisms: The strong seasonal, latitudinal, and slope aspect distributions strongly suggest that these features require relatively warm temperatures. Temperature alone cannot explain the formation of these features because equatorial regions get just as warm as mid-southern equator-facing slopes; however, no definitive examples of TSL have been observed in the equatorial region. The latitudinal distribution as well as temperature dependence implies that TSL are triggered or driven by volatiles in some way. The expected temperatures at shallow depths are consistent with brines as the driving volatile [7]. The possible origins of these features are discussed in more detail in [1].

Future Work: HiRISE and CRISM will plan intensive monitoring of key TSL sites over the upcoming southern summer. At 18 m/pixel CRISM cannot resolve individual flows, but they can be quite dense, covering up to ~50% of resolvable areas. It is difficult to acquire repeat observations more often than about once per Earth month with MRO in the middle latitudes, but that can provide ~5 time steps over the summer.

References: [1] McEwen, A. et al., this conference. [2] Putzig, N.E., and Mellon, M.T. (2007) *Icarus* 191, 68-94. [3] Baratoux, D. et al., (2006) *Icarus* 183, 30-45. [4] Hansen, C. et al. (2010) *Icarus* 205, 283-295. [5] Kereszturi, A. et al. (2010) *Icarus* 207, 149-164. [6] Kirk, R.L. et al. (2008) *JGR* 113, E00A24. [7] Ulrich, R. et al. (2010) *Astrobiology* 10, 643-650.

Table 1. Confirmed TSL (seen to change)

Lat	Lon (E)	Setting	Image IDs	Slope Aspect	Activity (Ls limits)
-48.1	242.5	Fresh 4-km crater	ESP_14011_1315, ESP_14288_1315	N, NE	308-321
-47	4 - 6	Troughs in Asimov crater	many images	N, E, W	265-19
-45.9	9.5	Fresh 4-km crater	ESP_12991_1335, ESP_13624_1335	N	259-290
-43.7	34.1	scarp in Rabe crater	PSP_004024_1360, PSP_005646_1360	N, E	252-328
-43.5	35	scarp in Rabe crater	PSP_005514_1360, ESP_014401_1360	N	323
-42.3	201.8	Crater in Newton basin	PSP_004163_1375, PSP_005877_1375	N	259-338
-41.6	202.3	Fresh crater in Newton basin	PSP_005943_1380, ESP_011428_1380, ESP_16808_1380	N	184-341
-39.4	202.7	Crater in Newton basin	PSP_004176_1405, PSP_005587_1405	NW, W	259-326
-39	223.7	Fresh crater	PSP_005929_1405, ESP_016438_1410	N, W	340
-38.8	159.5	Impact crater	PSP_006261_1410, ESP_014093_1410	N, W	354
-38.1	224	Fresh crater	ESP_014038_1415, ESP_016583_1415	N	310
-37.4	229	Fresh 7.5-km crater	PSP_003674_1425, PSP_005942_1425	NW	340
-37.1	192	Impact crater	PSP_003583_1425, PSP_005706_1425, PSP_006629_1425	N	330
-34.1	134.5	Fresh 6.6-km crater	PSP_005985_1455, ESP_013817_1455	NW	343
-32	140.8	Horowitz crater central peaks	PSP_005009_1480, PSP_005787_1475, PSP_007857_1475, PSP_0010006_1475	N, E, W fewer on S	300-334