SEASONALITY AND SURFACE PROPERTIES OF SLOPE STREAKS. K. M. Primm, R. H. Hoover, H. H. Kaplan, and D. E. Stillman, Dept. of Space Studies, Southwest Research Institute, 1050 Walnut St. #300, Boulder, CO 80302, USA (kprimm2@gmail.com).

Background: Slope streaks are large (up to 200 m wide, up to a few km long), relatively low-albedo streaks that occur in the dustiest locations on Mars [1]. They are one of the few currently active and widespread geologic processes on the surface of Mars. Many slope streaks have persisted for >15 Mars years and others have been observed to form, but many fewer have been seen to completely fade/disappear (e.g., [2]). This inconsistency leads us to believe hypothesize that slope streaks might have different formation and fading mechanisms depending on their environment.

There have been several studies of slope streaks that examine a combination of parameters: slope angles [1,3], mineralogy [4-6], environmental factors, and seasonality [2,7,8] but none have combined all four to discern the mechanism(s) involved in their formation, maintenance, and fading. For example, Schorghofer et al. [8] found that slope streaks form in regions where there is low thermal inertia, steep slopes, and temperatures above 275 K. Mushkin et al. [6] investigated the mineralogy of two slope streaks near Olympus Mons and found that the slope streak spectrum is enhanced in ferric oxides and proposed a formation mechanism whereby the slope streaks were formed in association with transient brines, which left behind a (dry) ferric surface coating [6]

Using CTX images and modeled insolation and large-scale wind velocities, Heyer et al. [9] showed that the formation rate of slope streaks is seasonal and could be formed by multiple mechanisms. Similarly, Bhardwaj et al. [10] reviewed several papers discussing wet and dry hypotheses and also concluded that a combination of wet and dry processes best explains the current observations of slope streaks.

Motivation: Combining multiple properties of slope streaks (i.e., seasonality, mineralogy, slope angle, surface temperature, and wind velocities) using multiple remote-sensing data sets and modeling tools has yet to be done for a wide variety of slope streak sites, and thus formation and fading mechanisms are not well-defined. The uncertainties in slope streak properties and the lack of parameter correlation leads us to revisit the formation and fading mechanism(s) of slope streaks using more data and tools, for more study sites. This will help better determine if these features are dry or could be caused by other processes that may involve liquid water, water vapor, dust, and/or CO_2 frost. In the end, a better understanding of the formation and fading processes of slope streaks may also help us better explain other features like gullies and RSL.

Methods: We used images from the High Resolution Imagining Science Experiment (HiRISE) to study the fading rate of slope streaks, Context Camera (CTX) to create Digital Terrain Models (DTMs) to study the slope angles, and lastly the Compact Reconnaissance Imaging Spectrometer (CRISM) to evaluate the mineralogy of slope streaks and the surrounding terrain.

Results: Preliminary observations show that within one area (within a few kms), there are slope streaks that completely fade within 1 Mars Year and some that form within that same time frame (Fig. 1). The green circles in Fig. 1B shows the newly formed slope streaks and the red circle show the areas where the slope streaks have completely disappeared. This finding has led us to continue our investigation of the formation and fading rates of slope streaks.

Figure 2 (A-C) shows an example of the relative albedo analysis performed on one slope streak in Arabia Terra. Here we show that this slope streak seems to visually change, but to remove visual bias, we calculated the ratio of slope streak apparent albedo to flat terrain (red traces), ratio of sloped adjacent terrain to flat area (blue trace) and the difference between these two numbers (green trace). To better understand if the slope streak is changing or not, we calculate the difference in the two ratios, so that if it is decreasing with time the slope streak is fading, and if it is increasing the slope streak is getting darker. Using the best-fit line for the relative albedo difference data, we can calculate the MY when this slope streak is expected to fade completely. At this rate, this slope streak would potentially fade completely in MY 40.3, ~5 MYs from now.

The slope angle of the same slope streak is analyzed using CTX DTMs (Fig. 2D). This DTM shows that the slope streak is in the region of sloping section with higher slope angles.

Fig. 2E-F shows CRISM spectra of the same slope streak (2) compared to a spectrum of nearby faded slope streaks and surrounding material (4), showing an iron absorption (decrease from 0.4 to 0.7 µm, as observed by [6]) that decreases in strength as the slope streaks fade and brighten (1⇒3).

Conclusions: Slope streaks are more dynamic than originally reported on in the literature [2] and may be seasonally triggered. Thus, increased research is needed to determine slope streak mechanisms.

We plan to analyze more slope streaks in other regions on Mars (e.g., Olympus Mons Aureole and

Tooting Crater, etc.) in addition to this study site at Arabia Terra. This broad study will reveal if the trends we see are global or depend on regional conditions, such as temperature, . Given the number of variables we are analyzing (e.g., slope, atmospheric composition, and mineralogy), we will also be able to better determine the role of these variables in slope streak formation to better understand formation mechanism.

References: [1] Sullivan et al. (2001) JGR E: Planets 106, 23607-23633. [2] Schorghofer et al. (2007) Icarus 191, 132-140. [3] Brusnikin et al. (2016) Icarus 278, 52-61. [4] Amador et al. (2016) 47th LPSC. [5] Bhardwaj et al. (2017) Sci. Rep., 1-14. [6] Mushkin et al. (2010) GRL 37, 1-5. [7] Heyer et al. (2018) 49th LPSC. [8] Schorghofer et al. (2002) GRL 29, 41-1–41-4. [9] Heyer et al. (2019) Icarus 323, 76-86 [10] Bhardwaj et al. (2019) Rev. Geophys. 1-30.

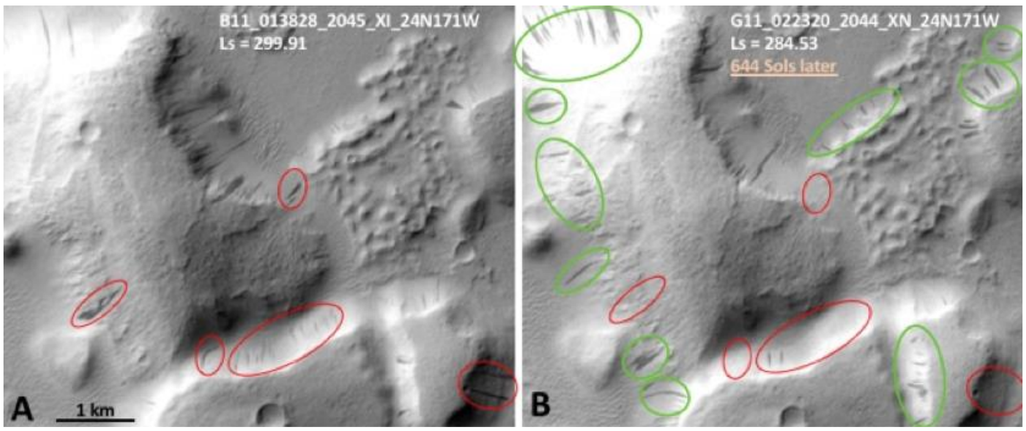

Figure 1. Images of Marte Vallis (11.35°N, 181.0°E). Red circles (A and B) are places where slope streaks disappear completely within one Mars Year (MY), or 644 sols. Green circles in (B) are all the slope streaks that have also formed within a similar time frame. It is unclear why within the same MY, some slope streaks disappear completely while others form.

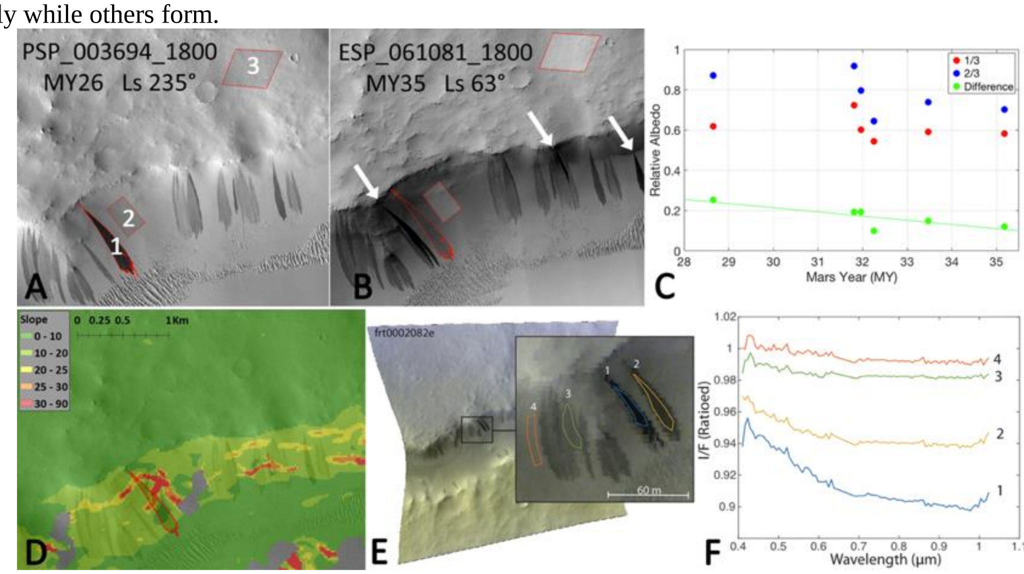

Figure 2. A) and B) show the first and last CTX image of the Arabia Terra (0.089°N, 37.938°E) study site, outlining (1) slope streak, (2) sloped adjacent terrain, and (3) flat nearby terrain areas. The white arrows in **B** show newly-formed slope streaks. **C)** Relative albedo plot vs. time, where the slope streak (red) and sloped adjacent terrain (blue) are normalized by the flat terrain. The difference between 1/3 and 2/3 (green) shows the change in relative albedo. **D)** The CTX DTM slope angle (°) for this region. **F)** A CRISM spectrum of the same slope streak (2) compared to a spectrum of nearby faded slope streaks and surrounding material (4).