SEASONALITY AND SURFACE PROPERTIES OF SLOPE STREAKS AT ACHERON FOSSAE. K. M. Primm[1], R. H. Hoover[2], H. H. Kaplan[3], T. I. Michaels[4], and D. E. Stillman[2], [1]Planetary Science Institute, 1700 East Fort Lowell, Suite 106 Tucson, AZ 85719, USA (kprimm@psi.edu).[2] Dept. of Space Studies, Southwest Research Institute, 1050 Walnut St. #300, Boulder, CO 80302. [3]NASA Goddard Space Flight Center, Greenbelt, MD. [4]SETI Institute 189 Bernardo Ave, Suite 200 Mountain View, CA 94042.

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 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, [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, [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. However, recently a thorough High Resolution Imaging Science Experiment (HiRISE) study concluded that a dry dust avalanche origin fit best [11]. That study only performed analyses on HiRISE images, though, rather than on multiple datasets.

Motivation: Combining multiple properties of slope streaks 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 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. 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: The HiRISE continues to acquire images at numerous slope streak sites that help further our analyses. At Acheron Fossae (37.315°N, 229.122°E) we use these data to study the fading rate of slope streaks, Compact Reconnaissance Imaging Spectrometer (CRISM) data to evaluate the mineralogy of slope streaks and the surrounding terrain, and mesoscale atmospheric modeling to study any atmospheric role(s).

To analyze the fading of the slope streaks, we calculated the Mars Year (MY) each slope streak would fade. To do this, we used a technique by [12] to collect the digital number (DN) from the HiRISE image of a slope streak and ratio it with the DN of nearby flat and sloped areas(with no slope streaks) within the same image. We then calculate the difference in the two ratios and use the best-fit line to this data. With this, we can calculate the MY when this slope streak is expected to fade completely.

We analyzed the CRISM data for this site and used the Map-projected Targeted Reduced Data Record (MTRDR), which has been corrected for illumination conditions, atmospheric gas absorptions, and spectral smile. Visible-near-infrared (VNIR) and infrared (IR) datasets have been co-registered to provide a continuous spectrum from ~0.4 to 3.9 µm. We ratioed the slope streak spectra to a background spectrum from within the same image to emphasize spectral variations. For backgrounds, we chose multiple regions of interest on the slope (without slope streak), and in dusty regions at the top and bottom of the slope.

The Mars Regional Atmospheric Modeling System (MRAMS) [13,14] was used to investigate the contemporary surface environment (e.g., wind speeds and directions, temperatures) for Acheron Fossae at multiple seasons. The MRAMS runs used multiple telescoping grids and blended MOLA/HRSC

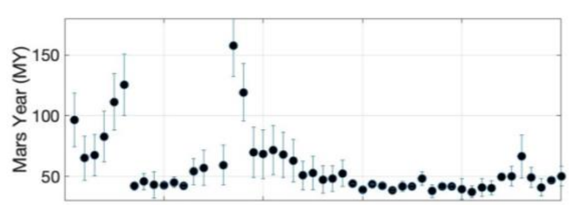

Figure 1. The estimated MY that each slope streak completely fades.

topography to achieve a finest grid spacing of <= 1 km at the target sites.

Results: Fig. 1 shows results of the relative albedo analysis performed on 50 slope streaks to determine the MY they would completely fade at Acheron Fossae. It shows the wide range of MY the slope streaks could fade at. We then counted the new slope streaks formed and plotted those versus MY (Fig. 2). Between MY33 and MY34 there is a huge increase in the number of new slope streaks formed. Note that this number starts from the original 50 analyzed and there are ~500 in the image in total. However, we counted all newly formed sloped streaks that could be visually identified. The slope streaks formed at L_s 187.2° which is consistent with when [9] recorded the most slope streak formation.

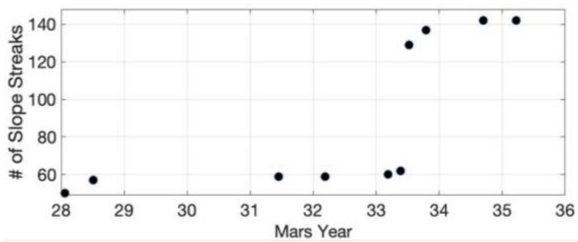

Figure 2. Number of slope streaks formed per MY. Count starts after the 50 in the earliest HiRISE image.

MRAMS climate modeling was then performed at this site at L_s 190° to assess the atmospheric condition when the most slope streaks formed. Figure 3 shows the wind speed and wind direction. The red line in the wind direction subplot shows the direction that the wind would have to come from to push material downslope to create the observed slope streaks. Here we see that there are relatively strong winds (especially in the daytime), but not often in the direction the slope streaks are oriented. Currently, we are unsure what event may have occurred in MY33 that could have caused such an increase in slope streaks, but it could be a rare stochastic enhancement of the strong wind pulse around 23:00 in Fig. 3.

Slope streak spectra within the CRISM image plotted in Figure 4 are shown with the continuum removed between 0.4 and 1.05 µm to show differences in VNIR absorption. These features fall within one of two categories that are sequestered spatially. The northern slope streaks have a weak feature near 0.57 µm and are relatively flat out to 1 µm. Similar spectral features are associated with slope streaks near Olympus Mons and have been suggested to arise due to a transparent coating (such as Si) or an increase in Fe oxides [10]. The second spectral type observed in Acheron Fossae has a feature at 0.475 µm, a stronger feature at 0.57 µm, and a broad absorption centered at ~0.86 µm. These spectral features may be consistent with fine-grained hematite (Fig. 4). The southern slope streaks lack significant spectral features.

Conclusions: Slope streaks are more dynamic than originally reported in the literature [2] and may be seasonally triggered or only started by rare events. Thus, increased research is needed to determine slope streak mechanisms. Analyses are ongoing to understand the spectral distinction of the two types of slope streaks found within this image and sudden increase in slope streak formation in MY33. It is possible that the spectral distinction is due to a difference in underlying composition, a particle size effect, a weathering rate effect or a difference in mechanism for slope streak formation. We will test these theories with future analyses at more sites and with Digital Terrain Models (i.e., slope angles). In particular we will look for other large increases in the formation of slope streaks midway through MY33 in nearby slope streak monitoring areas. This broad study will help to reveal if the trends we see are global or depend on regional conditions, such as temperature. Given the number of variables we are analyzing we will also be able to better determine the role of these variables in slope streak formation to better understand formation mechanisms.

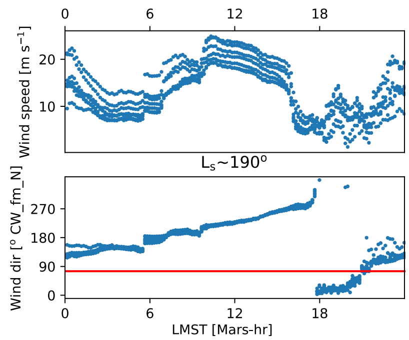

Figure 3. MRAMS wind results for Acheron Fassae.

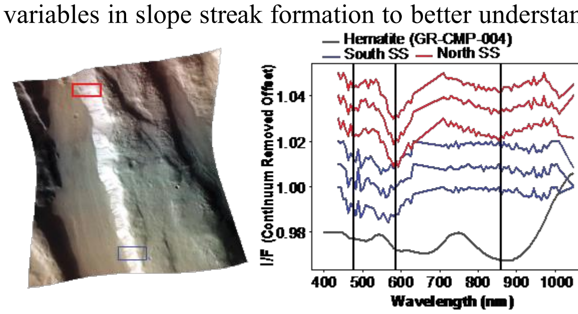

Figure 4. Slope streak spectra from CRISM image FRT-000059B3. Hematite spectrum is a <56 µm particle size sample and shows similar absorptions to the North SS

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