SEASONALITY OF VALLES MARINERIS RECURRING SLOPE LINEAE (RSL) SUGGESTS MULTIPLE WATER SOURCES. D. E. Stillman[1], T. I. Michaels[2], R. E. Grimm[1], and J. Hanley[3], [1]Dept. of Space Studies, Southwest Research Institute, 1050 Walnut St. #300, Boulder, CO 80302 (dstillman@boulder.swri.edu), [2]SETI Institute, [3]Lowell Observatory

Introduction: Recurring slope lineae (RSL) are narrow (0.5–5 m), low-albedo features that incrementally lengthen down steep slopes during warm seasons [1-4]. All RSL sites have steep slopes, outcropping bedrock, and lower albedo (relatively dust-free) than average for Mars. Evidence of surficial material transport associated with RSL activity has not been observed, but rare slumping events that are much bigger than RSL have been observed on the same slopes. The hydration of surficial salts changes seasonally, suggesting that RSL are caused by water [5]. Dry and wet origins have been suggested, but water-based hypotheses best match observations that correlate incremental lengthening with higher surface temperatures [1-4,6-8]. The mechanism by which RSL annually recharge water and salt (if needed) remain enigmatic. Estimated RSL water budgets are large (>1 m^3 per m of headwall) and imply a groundwater source [4,8-9], as no other known mechanism (i.e., atmospheric recharge) appears to be capable of replacing this volume of water (and salt) without producing surficial material transport. However, the presence of aquifers feeding RSL is scientifically challenging to support (unknown subsurface thermal and vapor-diffusion barriers must exist, as well as a source of hydraulic head). Atmospheric water recharge via perchlorate deliquescence has also been suggested [10], supported by the widespread presence of RSL in hydrologically challenging locations (Coprates Montes). However, deliquescence does not support the estimated water volumes.

Over 250 candidate and confirmed RSL sites have been discovered, primarily within the southern mid-latitudes (SML), in and around Valles Marineris (VM), equatorial highlands (EQ), and in northern Chryse Planitia and southwestern Acidalia Planitia (CAP). The seasonality of RSL sites within SML (except for Hale crater) and CAP sites are similar. SML RSL have a much shorter duration of activity compared to CAP RSL (100 vs 370 sols [3,4]). Thus SML RSL flow only at much higher temperatures, and we conclude [4] that SML RSL are much less salty then CAP RSL. Here we give the distribution and seasonality of VM RSL and discuss what the freezing temperature of VM RSL may be.

Methodology: We analyzed hundreds of HiRISE images taken over steep slopes in and around Valles Marineris to determine if RSL were present. We analyzed each pair of chronologically adjacent images to determine if RSL were lengthening, static, or had faded away. This analysis was done as a function of slope orientation, as the seasonality of tropical RSL sites varies with slope orientation [2,9]. Each RSL site was then classified by the number of RSL characteristics (recurrence, incremental lengthening, and fading) it had (**Fig. 1**).

Observations: Currently, VM RSL account for ~50% of all RSL sites on the planet. This may be because of the great abundance of low albedo (relatively dust-free) outcropping bedrock on steep VM slopes. RSL cover the slope-and-gully terrain of many valleys and ridges (**Fig. 1 -** labels 4,5,6), interlayer deposits (ILD; **Fig. 1 -** 1,2,3), craters on the floor (**Fig. 1 -** 7,8), and in inselbergs rising out of sand sheets (**Fig. 1 -** 9,10). However, RSL are not found on every steep, low-albedo slope, as evidenced by the lack of detections in numerous HiRISE images on the North and South (east of 295°E) walls of Coprates Chasma.

Interpretations: We compared the seasonality and slope orientation of VM RSL activity (**Fig. 2**), we found that the majority of VM RSL sites follow the same seasonal patterns. Our thermophysical modeling [e.g., 4,9] suggest that typical VM RSL have a freezing temperature of 245-263 K. However, RSL activity can be disrupted by local dust storms [2] that typically cause RSL to stop lengthening and fade. RSL emanating from two inselbergs in the deepest part of Juventae Chasma (**Fig. 1 -** label 10) are anomalous in that they start lengthen in every slope facing direction much later than all the other VM RSL sites (**Fig 2**). Our confidence in this interpretation is strong, as this site has 33 repeat images (the most of any VM RSL site) spanning 4 Mars-years. This suggests that Juventae Chasma RSL come from a different, less briny water source than the majority of the other VM RSL sites.

Conclusions: Different slope orientations allow VM RSL to flow year-round. RSL sites are widespread in VM, indicating that many more sites will likely be discovered as HiRISE data coverage increases. Furthermore, additional HiRISE temporal coverage of candidate and confirmed RSL sites will allow better characterization of further anomalous behavior, better answering whether groundwater in VM is compartmentalized.

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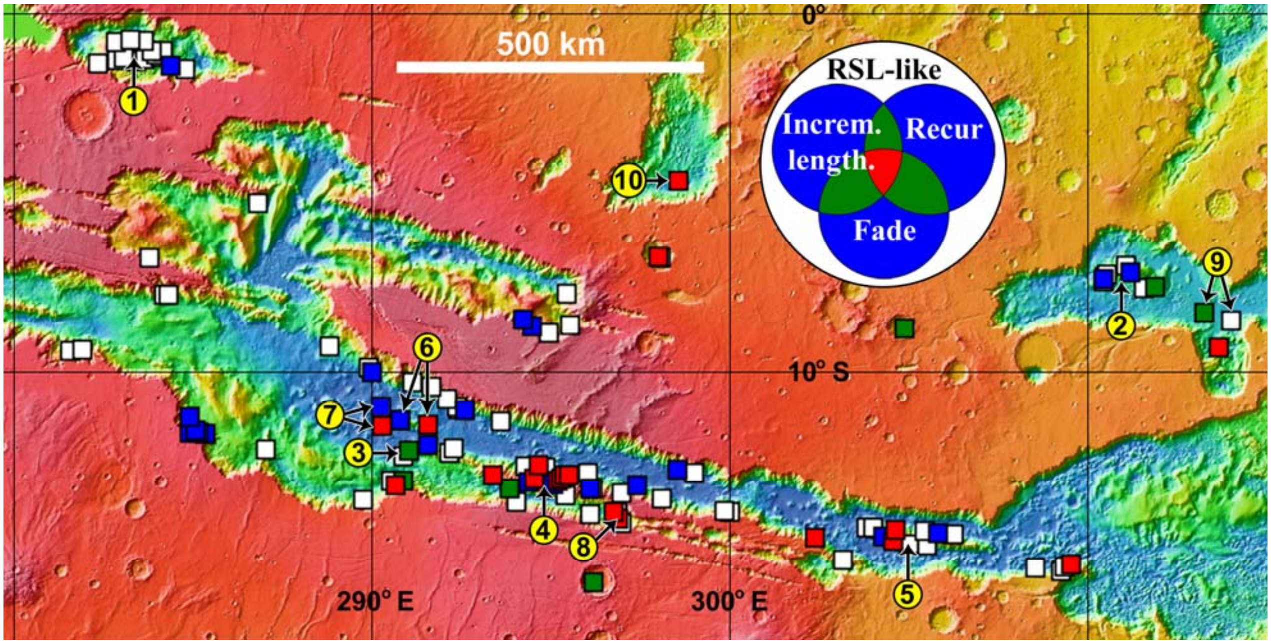

Figure 1. Candidate and confirmed (red) VM RSL sites. Numbered labels demonstrate the diversity of RSL sites in VM. Labels 1, 2, and 3 highlight candidate RSL sites from the ILD within Hebes, Ganges, and E Melas Chasma, respectively. Labels 4, 5, and 6 highlight RSL sites from Coprates, Nectaris, and an unnamed Montes, respectively. Labels 7 and 8 highlight craters. Labels 9 and 10 highlight inselbergs rising out of sand sheets in Ganges and Juventae Chasma, respectively.

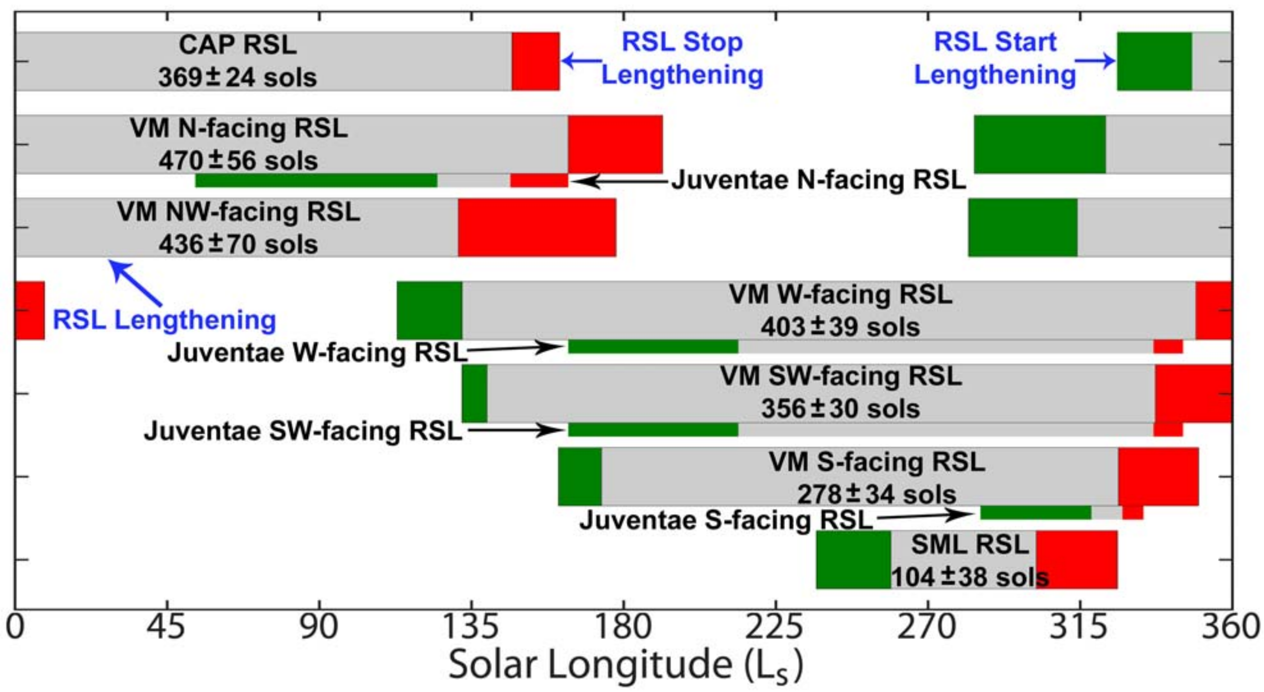

Figure 2. Seasonality of all RSL regions and Juventae Chasma RSL (shorter bar beneath the regional). Error bars for about when RSL start and stop lengthening are due to the gap between consecutive images. VM RSL also occur on SE-, E-, and NE- facing slopes, but we do not have enough images showing lengthening to constrain these.