Quantifying Recurring Slope Lineae in Space and Time

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5 Second Summary

We're quantifying RSL behavior in detail and working to answer the question, "What does an RSL life cycle look like?"

30 Second Summary

- **Recurring slope lineae (RSL) are narrow linear features that recur seasonally on warm martian slopes and may be caused by flow of brine or liquid water. [1,2]**
- **We are mapping the detailed evolution of ~100 RSL at Tivat crater across three active seasons.**
- **Based on this mapping, we are making dozens of quantitative measurements for each RSL and tracking the evolution of each RSL (its "life cycle") across each active season.**
- **We will use these measurements and tracking to test competing hypotheses for the RSL formation mechanism using physical models.**

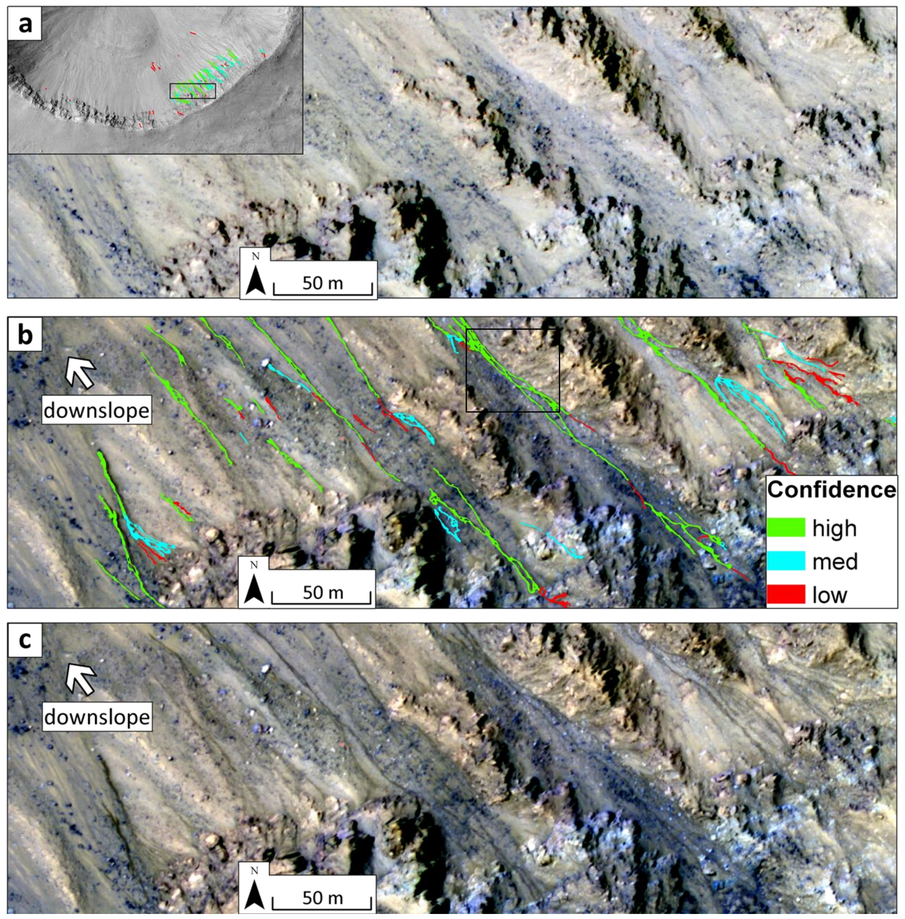

Fig. 1. Southern Tivat crater (45.93° S, 9.53° E, in Noachis Terra).

a) Spring (Ls 250.6), before RSL activity in MY 30. Inset shows full extent of RSL mapped at Tivat. Black rectangle is extent of main figure. Part of HiRISE image ESP_021628_1335.

b) Mapped confidence (positional accuracy + scientific confidence) indicated by colored outlines overlying part of HiRISE image ESP_013624_1335 (Ls 290.3, MY 29).

c) Same as figure (b), but not annotated.

Early Results, Discussion

	MY 29	MY 30		
	Ls 290.3	Ls 250.6	Ls 257.8	Ls 278.5
# of RSL	98	0	13	106
areal extent (m^2)	10,221	*N/A*	661	3,674
RSL length (m)	13,506	*N/A*	741	4945
mean:	169	*N/A*	57	47
median:	61	*N/A*	55	23
growth rate (m/sol)				
mean all RSL:	--	*N/A*	5.04	1.04
mean extended[1] RSL:	--	*N/A*	--	3.49
median extended[1] RSL:	--	*N/A*	--	2.48
mean inherited[2] RSL:	--	*N/A*	--	1.61
mean new[3] RSL:	--	*N/A*	--	1.10

[1]new in Ls 257.8 + grew in 278.5 [2]new in Ls 257.8 [3]new in Ls 278.5

- In MY 30, at Ls 250.6, no RSL are observed, but 13 RSL form and grow to ~55 m by 11 sols later (Ls 257.8), an "inter-image growth rate" of ~5 m/sol. By 32 sols later (Ls 278.5), 93 new RSL have formed but their inter-image growth rate over this longer interval is ~1.1 m/sol. Also, only 5 of the earlier RSL continue to grow during the interval, at an observed rate of ~2.5-3.5 m/sol.
- The anticorrelation between inter-image growth rate and inter-image interval suggests that RSL grow fastest when they initially form. Earlier forming RSL also *may* grow faster on average, but this inference is complicated by the week-scale inter-image intervals.

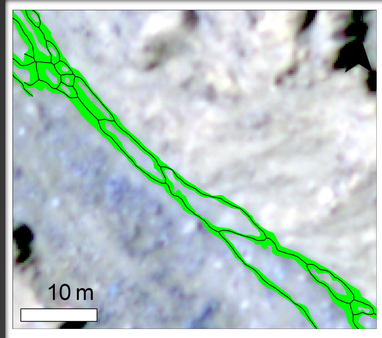

Fig. 2. Example of "skeletal" linear representation automatically derived from manually mapped RSL polygon. From top center of Fig. 1b (box).

Motivating Questions and Methods

Question 1: At the site level, what are the statistics of flow dimensions and growth? How do these vary in space and time?

- Importance:
  - Such characteristics reveal gross, site-level behavior, and are therefore useful for suggesting and testing general hypotheses for RSL activity and recurrence [e.g., 3-4]
  - Detailed quantitative measurements could reveal subtleties and trends (e.g., interannual variability)
- Methods:
  - We are mapping all ~100 RSL at Tivat crater across 14 HiRISE [5] images spanning 3 active seasons (MY 29-31) (**Fig. 1**)
  - We combine these maps with high-resolution digital terrain models [6] to generate a large suite of metrics, including 3D lengths, longitudinal profiles, areas, sinuosities, etc.

Question 2: How do flows evolve throughout an active season? How do local effects influence this "life cycle?"

- Importance:
  - Such characteristics effectively reveal the behavior of the flow itself, and therefore represent a powerful tool for discriminating between competing RSL hypotheses
  - With local context, such as slope and temperature information, this tool becomes even more powerful
    - for example, different RSL hypotheses predict different sensitivities to slope change
- Methods:
  - We are carefully tracking each RSL across each active season, including through coalescence events (when RSL merge)
  - Our analyses include 3D longitudinal profiles, which provide local topographic context, and we will later add thermal modeling to include local thermal effects

Question 3: How much does ambiguity affect the results, and how can this effect be minimized?

- Importance:
  - There is some ambiguity in every mapping project, but its effect is often not quantified
  - RSL are near the ~1 m HiRISE resolution limit, further complicating interpretation
- Methods:
  - We are using a variety of automated methods to enhance objectivity and consistency (e.g., **Fig. 2**)
  - We are also using ancillary information, such as confidence (**Fig. 1**), to quantify how different interpretations affect the results

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