RECURRING SLOPE LINEAE AND THE PRESENCE OF CHLORIDES IN THE SOUTHERN HEMISPHERE OF MARS. J. Mitchell[1] and P. Christensen[1], [1]Arizona State University (201 E. Orange Mall, Tempe, AZ 85281, julie.l.mitchell@asu.edu)

Introduction: The presence of liquid water on the surface of Mars has substantial geologic and astrobiological implications. Potential sources of liquid water are therefore high-priority targets of study; the most likely candidates for liquid water on the surface of Mars are Recurring Slope Lineae (RSL). RSL are seen on steep slopes in both equatorial and southern mid-latitudes of Mars, appearing as streaks that extend down-slope. In the southern hemisphere, RSL appear, grow, and fade in HiRISE high-resolution imagery during the summer only (Ls 270°-0°), reaching lengths of 10s to 100s of meters and widths less than 10m. Previous studies have classified RSL according to their annual growth patterns; "confirmed" RSL are those whose growth has been observed in the same locations over multiple years. [1]

Thermal infrared (TIR) data from the Thermal Emission Imaging System (THEMIS) [2] have allowed the temperature conditions under which RSL form to be constrained. While a small number of RSL are visible at temperatures above the freezing point of water, most are not, and many appear at temperatures as low as 230K [3]. Under these cold conditions, a brine of $Fe_2(SO4)_3$ or $CaCl_2$ is the most likely mode of RSL formation [4]. Because chlorides lack distinct absorption features, they must be identified by their effect on spectral slope. Osterloo et al. (2008) developed a chloride-detection method using THEMIS TIR decorrelation stretch (DCS) products [5]. Their global map of chlorides on Mars shows strong parallels between the latitudes of southern hemisphere RSL and large-scale chloride deposits. The purpose of this study is to assess the colocation of small-scale chloride deposits and confirmed RSL. If a positive correlation is detected, it will provide strong evidence for $CaCl_2$ brine flow as the mechanism behind RSL formation.

Methods: Ojha et al. reported the most recent catalog of confirmed RSL in early 2014, which included a list of the associated HiRISE imagery and THEMIS products used for RSL temperature estimates [3]. Using the Java Mission Analysis and Remote Sensing (JMARS) software, regions where RSL have been confirmed were mapped in representative HiRISE images from the Ojha et al. catalog [6]. All RSL on a given slope were mapped as a single unit, with multiple RSL units typically appearing within a single HiRISE image (**Figure 1**). **Table 1** lists the confirmed RSL, selected HiRISE images, and their corresponding THEMIS products.

Table 1. Confirmed RSL and associated imagery for which THEMIS coverage and DCS products were available.

Nearest Named Crater	HiRISE ID	THEMIS ID
Palikir	ESP_022267_1380	I34263004
Tivat	ESP_013624_1335	I17599005
Pickering (SW)	ESP_022820_1415	I17966002
Raga	ESP_023004_1315	I17541004
Corozal	ESP_022440_1410	I07847004
Asimov	ESP_016156_1320	I17699007
Lohse	ESP_022908_1365	I43131002
Horowitz	ESP_022678_1475	I17919002
Rabe	ESP_022682_1360	I34456002
Huggins (SE)	ESP_022783_1275	I23609005
Triolet	ESP_022808_1425	I34201002

Three DCS products, including THEMIS bands 8, 7, and 5, bands 9, 6, and 4, and bands 6, 4, and 2 are required for chloride detection. Chloride deposits appear blue in 875, turquoise in 964, and yellow-orange in 642; the RSL unit outlines were then overlain on each DCS product. Because THEMIS' highest spatial resolution is 100 m/px, most individual southern hemisphere RSL fall within a single THEMIS pixel. The focus of this study was not to pinpoint specific RSL, therefore, but to search RSL slopes for both local- (100s of m) and regional-scale (up to 1 km) evidence of colocated chlorides. For this reason, isolated RSL clusters that were smaller than 10m in length and net width were not mapped.

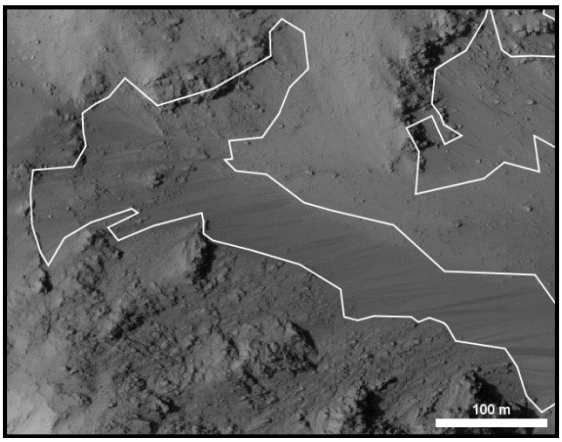

Figure 1. RSL (outlined in white) mapped on HiRISE image of Horowitz Crater.

Results: Confirmed RSL were mapped at each location listed in **Table 1**. Palikir Crater was the most distinct locale, showing local evidence of chlorides in areas where RSL were most densely located (**Figure 2**). This locale has also shown periodic evidence of ferric iron in the near-infrared [7], perhaps indicating the presence of a mixed ferric sulfate and calcium chloride brine. However, for Palikir and all other RSL, DCS chloride signatures did not correlate to the presence of RSL on the regional scale. In some cases, such as Triolet Crater, neither local- nor regional-scale evidence of chlorides was observed (**Figure 3**).

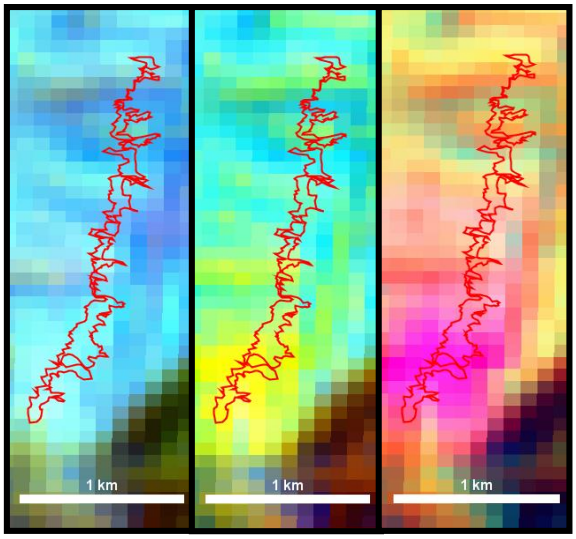

Figure 2. Outline (red) of RSL region of study in Palikir Crater. From left to right: DCS 875, 964, and 642 basemaps.

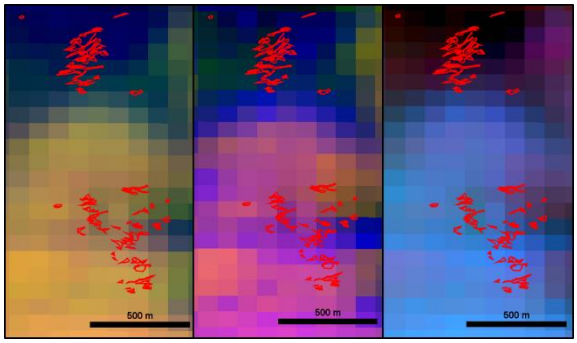

Figure 3. THEMIS DCS imagery and RSL in Triolet Crater. From left to right: DCS 875, 964, and 642 basemaps, with RSL outlines (red).

Discussion: The lack of chloride signatures could be the result of one of three scenarios. First, RSL may not contain chlorides, either because they a) are not aqueous flow features or b) are not chloride-based brines. This scenario has the greatest astrobiological implications, especially if RSL are water-lubricated granular versus liquid water flows, as some have hypothesized [7]. Second, steep slopes (where all RSL are located) could affect the appearance of RSL in THEMIS DCS. Several locales are dominated by the distinct steep-slope signature identified by Bandfield [8]; the fact that the many RSL occur on the steep crater walls supports this scenario (**Figure 4**). Third, the concentration of chlorides could be non-zero, but below the detection limits of THEMIS. If this is indeed the case, any chlorides present at or near the RSL are masked by the TIR properties of the surrounding terrain.

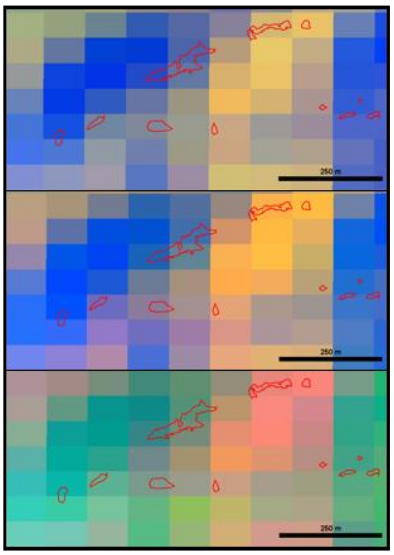

Figure 4. Southeast of Huggins Crater, showing spectral slopes indicative of steep terrain [8]. From top to bottom: DCS 875, 964, and 642 basemaps, with RSL outlines (red).

An analysis of larger (100s of meters long) RSL, such as many at equatorial latitudes, is the logical next step in assessing a correlation between RSL and chlorides. While most confirmed chloride deposits are in the southern mid-latitudes, a small number were detected just south of Valles Marineris, where the equatorial RSL population is located [9]. If there is a correlation between chloride deposits and RSL in the Valles Marineris region, the likelihood of each of the above scenarios can be more accurately understood.

References: [1] McEwen, A. et al. (2011) *Science, 333*, 740. [2] Christensen, P., et al. (2004) *Space Sci. Reviews, 110*, 85-130. [3] Ojha, L., et al. (2014) *Icarus, 231*, 35-376. [4] Chevrier, V. and Rivera-Valentin, E. (2012) *GRL, 39*, L21202. [5] Osterloo, M. et al. (2008) *Science, 319*, 1651. [6] Christensen, P., et al. (2009) *AGU*, Abstract #IN22A-06. [7] Ojha, L., et al. (2013) *GRL, 40*, 5621-5626. [8] Bandfield, J. (2009) *Icarus, 202*, 414-428. [9] McEwen, A., et al. (2014) *Nature Geoscience, Vol 7.*