# MAPPING THE EXTENT AND TIMING OF WATER TRACK FORMATION WITH HIGH TEMPORAL RESOLUTION SATELLITE IMAGERY OF THE MCMURDO DRY VALLEYS IN ANTARCTICA: CAN SUBSURFACE MELT CONDITIONS BE DEDUCED FROM ORBITAL IMAGERY OF RSL-ANALOGS?

L. Kuentz[1], J. Levy[1], M. Salvatore[2] [1]Colgate University Department of Geology, Hamilton, NY 13346, lkuentz@colgate.edu,, [2]Northern Arizona University Department of Astronomy and Planetary Science

**Introduction:** The cold desert ecosystem of the McMurdo Dry Valleys exhibits a variety of seasonal meltwater features [1], including water tracks [2], that may be analogs for past or present shallow groundwater or brine flow features on Mars including recurring slope lineae [3,4]. Water tracks are stretches of soil that exhibit high moisture content in the summer as meltwater and solutes flow downslope above the ice table. In satellite imagery, they stand out from dry soils as dark patches that develop into linear tracks and branching networks. Thaw [5], solute transport [2], weathering [6], and microbial metabolism [7,8] rely on the presence of meltwater and solutes in water tracks. However, the duration and extent of water track thaw remain incompletely constrained [9]. Examining the hydropattern of these cold desert features informs when and where biogeochemically active groundwater flows occur, what its sources are, and under what environmental conditions it is available. In particular, our goal was to determine whether water track thaw initiates due to snow melt (when ground surface temperatures reach 0˚C) or whether subsurface melt or solute-driven freezing point depression determine the timing of thaw (when ground surface temperatures can remain well below freezing).

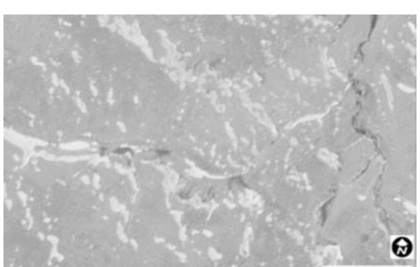
**Image Analysis:** We used Planet PlanetScope 8-bit visual images (RGB and RGBIR) at ~3 m/pixel to identify water track features on a sub-weekly to sub-daily timescales from November-February 2018-19. Observations were gathered at ten sites across the MDV. To confirm the presence of water track activity at each site, a terrain correction method [10] was utilized that removes the effects of differential illumination on surfaces. The resulting images show intrinsic surface reflectance, allowing us to attribute the dark, linear features in the images to water track activity.

**Results and Discussion:** We find that water tracks on north-facing sites initiate not at the onset of surface temperatures exceeding 0°C, but rather when temperatures at 10 cm depth reach 0°C. This suggests thaw of ground ice and wicking of moisture to the surface to initiate water track-related albedo change. Although the six sites exhibiting water track activity show a range of salinities [11], our results suggest that freezing point depression and early (sub-0°C) thawing is not a significant occurrence.

Furthermore, the initiation of water track activity at north-facing sites begins in late November, which extends the previously understood hydroperiod of water tracks [2,9], implying a greater duration for solute transport, weathering, and microbial metabolism. The connection between water track activity and seasonal climate forcing results in a recurring groundwater feature that shares morphological and temporal characteristics with RSL on Mars. The demonstration of this water track formation mechanism suggests that remote sensing observations complement on-the-ground temperature measurements for understanding the composition, origin, or hydrology of potential martian groundwater flows where freezing point depression and evaporative inhibition from hypersaline soils allow or allowed shallow groundwater bodies to exist.

**Acknowledgements:** This work is supported by award NNX17AG70G and ANT-1847067 to JSL. Image data provided via the NASA-Planet contract.

**References:** [1] Gooseff, M., et al. (2016). *Geomorphology*. doi:10.1016/j.geomorph.2016.04.024. [2] Levy, J. S. et al. (2011) *GSA Bul.*, 123, 2295–2311. [3] McEwen, A. S. et al. (2011) *Science* 333, 740–743. [4] Levy, J. (2012) *Icarus*, 219, 1–4. [5] Levy, J. S. & Schmidt, L. (2016) *Ant. Sci.,* 28, 361–370. [6] Levy, J. S. et al. (2013) *Ant. Sci.*, 26, 153–162. [7] Rummel, J. D. et al. (2014) *Astrobio.*, 14, 887–968. [8] Ball, B. A. & Levy, J. S. (2015) *JGR-Biogeo.*, 120, 270–279. [9] Langford, Z. L., et al. (2012) *Ant. Sci.*, 27(2), 197–209. [10] Salvatore, M. (2020) Personal communication. [11] Toner, J.D. et al. (2013) *Geophys.*, 118, 198-215.



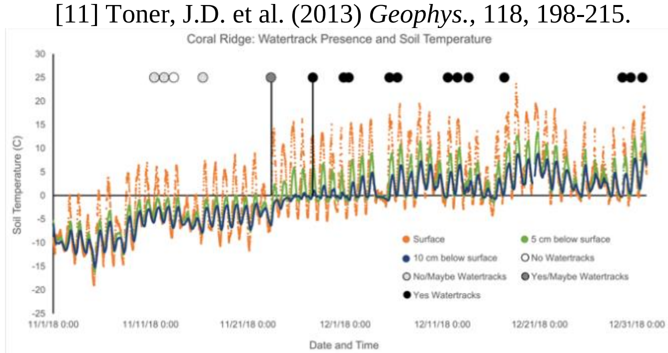



**Figure 1:** Image processing example and thermal analysis. Left, terrain-corrected image with topographical shading removed. Right, analysis of ground thermal regime in the satellite image footprint over the spring melting season.