MARTIAN ANALOG DUST DEVIL STUDIES IN NEVADA – FINDING THE ATMOSPHERIC LINK. S. Metzger[1], L. Fenton[2], S. Scheidt[3], T. Michaels[2], T. Dorn[4], B. Cole[5], O. Sprau[5] and L. Neakrase[6], [1]Metzger Geoscience Consulting <metzgergeosci@gmail.com>, [2]SETI Institute, [3]Planetary Science Institute, [4]UCLA Earth, Planetary and Space Sciences, [5]St. Lawrence University Geology, [6]New Mexico State University Astronomy.

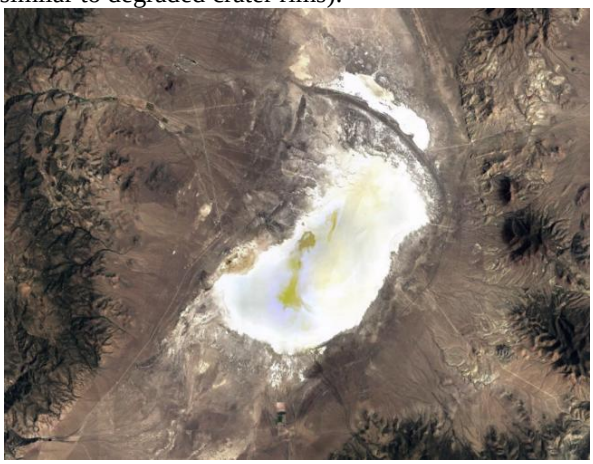
Introduction: While dust devils are a common arid region feature, they are by no means a certainty. The goal of this project is to understand the relationship between dust devil formation and physical characteristics, and atmospheric activity at the regional and local scales. In turn, such an understanding will hopefully enable use of surface dust devil images as indicator proxies of the lower atmosphere's structure, especially the Planetary Boundary Layer (PBL). If that relationship is reliably defined, years of archived Mars lander surface images can be utilized to reconstruct atmospheric conditions in the lower Martian atmosphere.

This introductory report presents initial site characterization results of our first field campaign, intended to represent a Martian crater or canyon. Colleagues with similar interests and experience are invited to share their insights prior to our next deployment in early summer 2020.

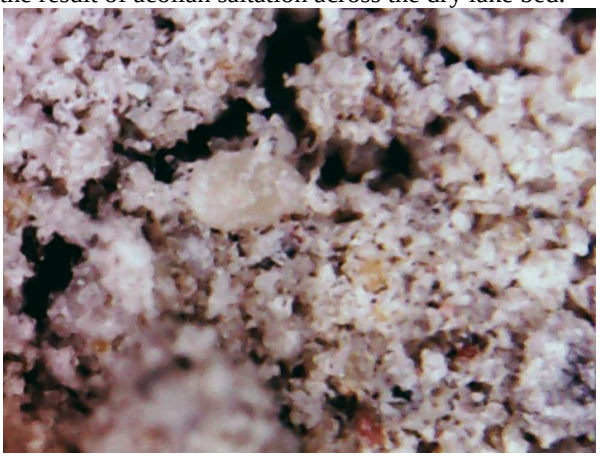
Field Program Design: In order to characterize the weather and resultant dust devil activity, three instrument clusters were chosen to 1) probe PBL conditions, inversions and dust plumes using a Vaisala CL51 Ceilometer lidar, 2) characterize the near surface meteorologic environment using a Campbell Scientific 10m profiling tower with eddy correlation and soil heat flux sensor suites, supplemented by four Kestrel 5500 micro weather stations, and 3) record daily dust column behavior over a broad playa area using four Canon 7D MkII DSLRs integrated into a spatially precise 3D photogrammetric time series, supplemented by trail cam and manual surveys. A contextual geomorphic field survey was performed on four radial transects of the transition from medial alluvial plain onto playa.

Analog Site Selection: The field program is designed to study two Mars analog settings; confined crater/canyons, and wide open plains. Since the first setting ("crater floor") required nearby topographic relief, Nevada's Basin and Range Province was screened with GIS for size, land ownership and terrain. In May 2019, Fenton and Metzger toured prospective sites in Central Nevada to examine surface materials, dryness conditions, and logistical considerations. The Smith Creek Playa Field Site, west of Austin NV, was chosen for the 2019 June campaign because its surface was sufficiently indurated to support vehicles, dry (although ponding persisted into midsummer along the southwestern margin), and known to generously produce dust devils (as per Land Sailing hobbyists). While still providing weather and soil conditions comparable to this first season, Southern Utah is being considered for the upcoming field season's analogue site of the Mars Northern Lowlands.

Geomorphic Setting: The Basin and Range Province is a Horst and Graben system, and as an ephemeral lake the Smith Creek Playa is biased eastward due to more recent subsidence along the eastern flank. The perimeter alluvial plain basin exhibits low relief and is covered by <1m bushes and sparse grasses. A nestled series of stranded recessional shorelines provide arcuate minor relief (1-4m) on the northern bounds of the playa (perhaps aerodynamically similar to degraded crater rims).

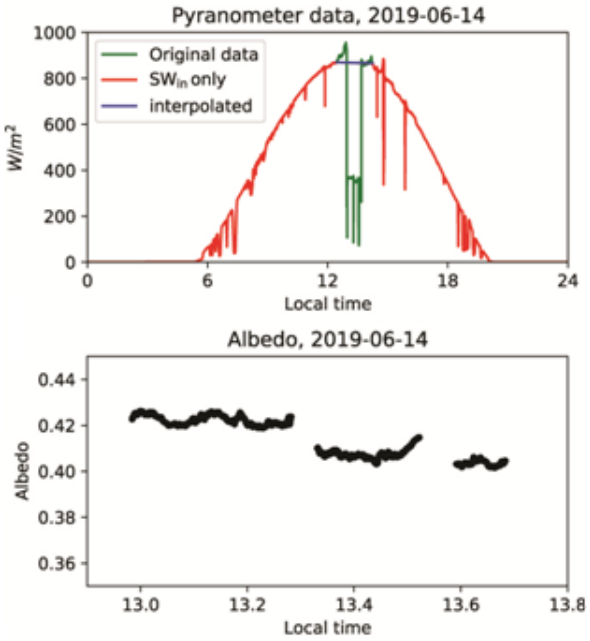


The playa's surface consists predominantly of angular well-sorted coarse silt (0.04mm) and clay, nearly devoid of larger grains except the occasional rounded, frosted quartz fine sand (0.2mm), probably the result of aeolian saltation across the dry lake bed.

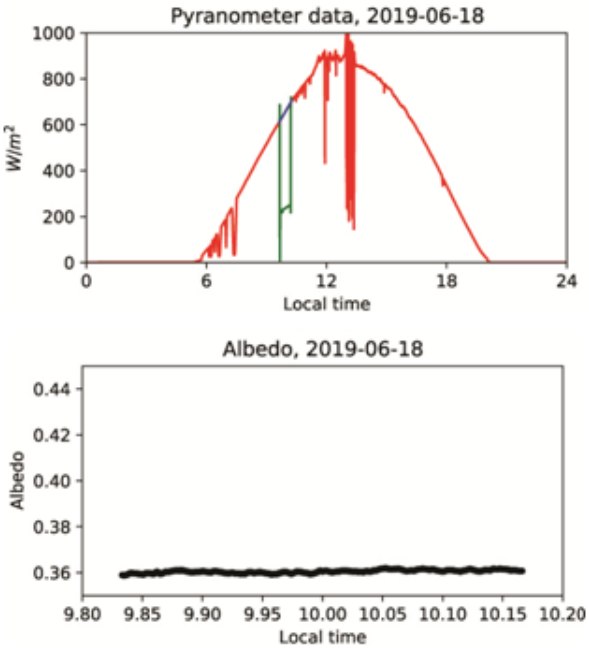


And while Nevada is often subject to SW winds, coincidentally generally parallel to most basin trends, our field season experienced a wide range of wind regimes, showers, hot days and cold mornings. Dust devils occurred across the entire valley on most days, often soon after rain showers, but mostly closer to and on the playa. Their particulates were surprisingly fine grained, lacking the sand blasting deluge experienced in most dust devil encounters.

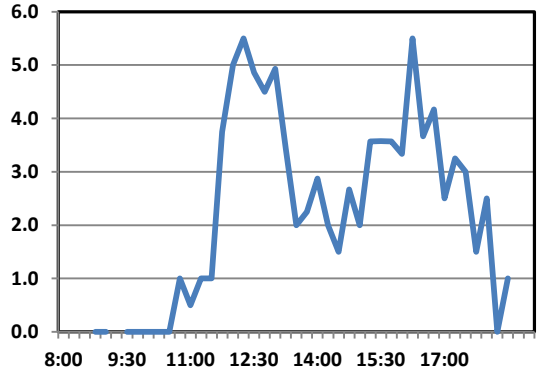
Playa Albedo: The meteorology tower was installed on this uniform material. Using a Kipp and Zonen pyranometer, initial analysis indicates playa albedo to be 0.36 to 0.40 (rain showers had influence). Calculating the albedo involves flipping the pyranometer so that for a time it measures broadband sunlight (0.3-2.8 μm) reflected from the surface (SW_{out}), rather than that directly incoming from the sun (SW_{in}). The albedo is simply the ratio of SW_{out}/SW_{in}. During the time the pyranometer is flipped, it's not measuring SW_{in}, so this value must be interpolated from measurements before and after the pyranometer was flipped. Results suggest a late morning "flipping time" is optimal.




June 13 Dust Storm



Dust Devil Activity Survey: The automated 3D camera survey will be compared to results from manual inspection of the images, and a trail cam time lapse series overseeing the same area. Concurrently, a visual survey of observable dust devils around the valley was manually conducted over 8 days. Bimodal activity peaks occurred around noon, and then late afternoon. Record numbers of dust devils formed on June 13 leading up to an intense dust storm haboob, interrupting the visual survey and base camp observations; one of several encounters with a passing thunder cell.



Next: Results from the five meteorology stations will be integrated vertically and horizontally, providing heat flux and erosion potential insights. Eventually, dust devil behavior statistics will be compared to that of the near surface atmosphere & PBL.

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