REMOTE SENSING TECHNIQUES TO INVESTIGATE POTENTIAL RECENT EXPOSURE ON MARS FOR HIGH BIOSIGNATURE PRESERVATION POTENTIAL. J.M. Williams¹, T.P. Nagle-McNaughton¹, H.E. Newsom², Z.E. Gallegos¹, H.A. Wilkie¹, D.C. Martinez¹, L.A. Scuderi¹, ¹University of New Mexico, Albuquerque, NM 87131, USA (jwilliams4@unm.edu).

Introduction: The Jezero crater has been selected to be the destination for the Mars 2020 rover in early 2021. One of the primary goals of the Mars 2020 mission is to identify locations within or near the landing ellipse that could have high biosignature preservation potential. The rover would then seek these locations and cache samples for return and analysis on the Earth. It is therefore vital to locate areas near or in the landing ellipse utilizing orbitally derived imagery. Solar and cosmogenic radiation destroys organic molecules after prolonged exposure at the Martian surface, however fresh outcrops (<100 ma) re-exposed by aeolian dominated erosion provide potential sites where biosignatures could have been protected and made recently available for sampling. This and previous work [1] tests the parallel scarp retreat model that would expose fresh outcrops. Previous work on analyzing aeolian dominated erosion by mapping meter-scale scarp orientation [1] returned a distribution of scarp orientations not significantly different from random, and bearing little correspondence with the wind directions elsewhere interpreted for these regions from long- and short-term indicators. However, coupled with further study of possible scarp retreat indicators such as a detailed analysis of boulders shedding, [2] and Infrared Red Blue (IRB) color stretch analysis [1] might help yield locations with relatively fresh outcrops that were previously shielded from solar and cosmogenic radiation and may be useful to identify samples with potential biosignatures.

Scarp Orientation in Jezero: Williams, J. M. et al. [1] utilized 25cm/pixel imagery obtained from the HiRISE instrument onboard the Mars Reconnaissance Orbiter (MRO) to map scarp orientations found in and near the landing ellipse within the Jezero crater. Scarps were mapped using this imagery to investigate (1) if scarp orientations aligned normal to eroding wind direction indicating that scarp orientations are perpendicular to that of the formative wind stepped back uniformly or (2) scarps become parallel to the formative eroding winds, (3) scarps orient in bimodal distributions of parallel and perpendicular to the formative winds, and (4) scarp orientation does not correlate with wind direction [1]. Unfortunately this investigation did not yield a statistically significant result and therefore meter-scale scarp orientations in Jezero do not appear to correlate with erosive wind directions and therefore cannot help to predict locations of active or most active erosion.

Boulder Identification and Quantifying positions in Jezero: We developed an automated methodology [2] for identifying boulders in and near the landing ellipse at Jezero crater utilizing images from the HiRISE instrument. Parallel scarp retreat; softer material below erosion resistant bedforms within a scarp is removed through aeolian processes allowing the erosion resistant layer(s) to fail, creating cleaved blocks or boulders. This process repeats over time causing the scarp to retreat and step back in the direction of the scarp face. Scarps with abundant boulder shedding could indicate increased erosion. These scarps could be eroding quickly enough to allow boulders to accumulate without being destroyed by erosion. This procedure was applied to the Jezero delta/fan and surrounding areas (~64km²) (Fig. 1) and correlated with the manually digitized scarps [1] (Fig. 1) covering the southern portion of the Jezero delta/fan. Over 440,000 were identified correlating with boulder-like features over 170,000 meter-scale scarps on the western delta/fan formation (Fig. 1, 2). The density on the western delta/fan was heterogeneous and varied by three orders of magnitude [2]. The Jezero delta/fan elevation histogram (Fig. 2) shows a clustering of boulders at the -2400 m to -2435 m.
Enhanced Hues in HiRISE IRB: Martian dust (red) contains Nanophase ferric-oxide usually covering silicate-bearing bedrock and sand [3, 4], the latter appearing more neutral or “blue” when exposed in HiRISE false-color images. This study utilized HiRISE false-color infrared-red-blue (IRB) (observation ESP_046060_1985_COLOR) imagery of the eastern portion of the Jezero west delta/fan. This region was used to help identify scarp faces with relatively little dust-cover, which may indicate ongoing aeolian abrasion [5]. Many portions of the western/delta distal end with bluer hues also coincided with large amount of boulders shedding. Portions of the western delta/fan showing scarps with a redder hues, indicating less active modern aeolian erosion appear to have less accumulation of boulder below, however this is not always the case along the western delta/fan.

Discussion: Prior to landing the Mars 2020 rover mission will be completely dependent on remote sensing analysis to assess point of interests within the mission area. The scarp orientation study did not reveal scarp orientation patterns or preferential orientations indicative with retreating scarps related to eroding winds. This indicates that the erosive wind directions are either not the driving force behind scarp evolution or that the combined formative winds occurred at a multitude of different directions. However, there clearly is scarp retreat, exposing newly unshielded terrain that will be suitable for sampling. The boulder study within the western delta/fan yielded a multitude of boulders in close proximity to scarps associated with the delta/fan complex. These scarps are assumed to be derived from a silica indurated channel floor and would be a good astrobiologic target. With further study a correlation between these scarps and boulders could help identify scarps that could be more actively eroding than others found in the area. This would be useful for identifying locations that could have recently exposed surface materials and therefore help to identify locations with high biosignature preservation potential. The largest populations of boulders are between -2400 m to -2435 m elevations, this appears as orange on the color coded DEM (Fig. 2) and are almost entirely located on top of the delta/fan. This could be due to erosion shelters from high standing terrain found on the delta/fan. The IRB HiRISE imagery gives a possible snapshot of the modern erosive wind regimes in Jezero. This also aids in the search for freshly exposed surface materials.

A strong correlation between scarp orientation, scarp boulder shedding, and color analysis might provide a critical insight into the erosion mechanism and relative ages of exposed Martian surface material in the Jezero delta/fan.

Further Study: Boulder analysis, TARs and small Crater identification and statistics to help infer relative ages: Further work will be done to correlate stretched IRB color images of scarp faces and boulder accumulation utilizing ArcMap and python scripts within the Jezero west delta/fan area. This will allow a statistical analysis to check if there is a relationship between them. Relic aeolian landforms including Transverse Aeolian Ridges (TAR’s) appear to be surrounding the Jezero delta/fan complex, and to some extent, the heavily cratered mafic crater floor material. TARs are extremely prevalent west (up drainage) and east across the crater (down drainage) and therefore could be helpful in constraining post-aqueous evolution. Analysis of the TAR formation [6] could yield wind dynamics in the area during the relative formation age of the TARs. The interdune playas may also represent areas that have only been intermittently unshielded from cosmic rays, further study on the location of the TARs relative to the scarps on the western delta/fan could provide insight on which scarp segments have gone through more extensive erosion compared to others. Small crater statistics and dating of the mafic crater floor could also help to narrow the relative ages of these morphologic features.