VOLCANICLASTIC AEOLIAN SYSTEMS ON EARTH AS ANALOGUES FOR MARS: A CASE STUDY FROM THE BLACK ROCK DESERT, UTAH.

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Introduction: Aeolian landscapes are present throughout the solar system. They have been observed on Venus [1], Mars [2], Titan [3], and Pluto [4]. The presence of familiar landscapes over such diverse planetary bodies implies similarities of processes, but also challenges our understanding of processes due to the vast differences in planetary boundary conditions (e.g., atmospheric density, sediment composition, gravity) [5, 6, 7]. Terrestrial analogue studies play a key role in understanding how boundary conditions shape planetary aeolian landscapes.

The volcaniclastic aeolian systems on Earth have received relatively little attention, but are ideal analogues for martian and venusian aeolian systems. Edgett and Lancaster [8] published a review paper in the early nineties concerning terrestrial mafic aeolian systems and their potential use as martian analogues. To our knowledge no review concerning volcaniclastic aeolian systems has been published since, despite advancements in the field of planetary aeolian research in the last few decades, including an unprecedented number of planetary data sets available for us to compare with terrestrial analogue sites. Our aim is to expand the work of Edgett and Lancaster and present an updated review of terrestrial mafic aeolian landscapes. As part of this updated inventory of volcaniclastic aeolian systems on Earth we visited the Black Rock Desert Dunes in Utah.

The Black Rock Desert Dunes are situated within the Black Rock Desert volcanic field, located within the Basin and Range tectonic province [9]. The volcanic field has been active for 6 Ma, primarily during the last 2.5 Ma. The area was covered by the palaeolake Lake Bonneville during the Pleistocene [10, 11], thus lacustrine deposits are ubiquitous in the area.

The Black Rock Desert Dunes dune field is situated in the centre of the basin and covers an area of approximately 1 km^2. The expected volcanic source rock is the Pahvant Butte tuff cone. Volcaniclastic sediments from Pahvant are detectable in aeolian bedforms throughout the area. The quartz sands have a number of potential source areas; the nearby Sevier River channel, from Lake Bonneville deposits, or from alluvial fans entering the desert from the nearby Wasatch Range. The dune field has a striking mix of light and dark minerals (e.g., quartz, feldspar, carbonates, glassy mafic fragments), something that is particularly clear from aerial imagery (Fig. 1). The dune field mainly consists of unvegetated barchan and barchanoid dunes.

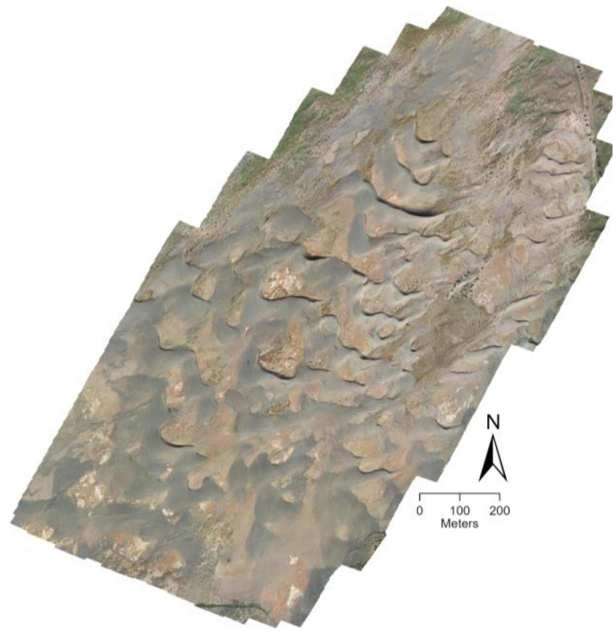

Fig. 1. Orthomosaic of the Black Rock Desert Dunes, Utah.

Methods: The aerial imagery was collected using a DJI Mavic 2 Pro and DroneDeploy, the imagery subsequently processed in Agisoft to create a DTM and orthomosaic (Fig. 1). Several different sediment samples were retrieved from the Black Rock Desert Dunes; (i) surface samples consisting of only the top 1-2 mm of sediment close to the dune crest, (ii) double-sided tape affixed to wooden tongue depressors were used to collect the surface layer of grains across individual ripples, (iii) bulk samples taken across the dune field and individual dunes. The surface samples and the bulk samples were analysed for grain size distribution using a Retsch Technology CAMSIZER®. Depressor samples were analysed for elemental composition and abundance using a Bruker M4 Tornado Plus µXRF.

Initial findings and perspectives: Across the dune field, from the upwind south-western part towards the downwind north-eastern part, the sand size decreases as does the abundance of mafic and carbonate grains (Fig. 2). The surface samples at the upwind part of the dune field display median grain size values of ~550 µm, while the downwind dunes display median grain sizes of 200-300 µm. A similar trend is noted for the crest bulk samples, where the upwind median grain size is 400-500 µm, while the downwind is 200-300 µm. The windward bulk samples have a more varied median grain size upwind, ranging between ~300-800 µm, while the downwind samples display median values of 200-300 µm. The leeside bulk samples display more fine sediments, ~200-350 µm upwind, and ~150-200 µm downwind. Some samples vary from this trend.

Along the dune field, the abundance of elements associated with mafic grains (i.e., Fe, Mg, Ti, Cr), zircons (as Zr), and chemical sedimentary rocks (i.e., carbonates (as Ca) and phosphates (as P)) decreases, while the felsic portion (i.e., Si and K) increases. We hypothesize that the mafic grains may be sequestered as a lag or are mechanically broken down and lost as loess. Zircon should be a lag in the proximal dunes. The Ca- and P-rich grains could be mechanically broken down and blown away or, if deposited, failed to be collected.

Although the mineral composition is not purely mafic, it still offers many benefits as a martian analogue site. The contrast in mineral types affords the opportunity to examine sorting and abrasion of different minerals during aeolian transport and in dune processes (e.g., grainflows and grainfall). The presence of quartzose sand provides an ideal environment to test exposure dating methods, including developing optically stimulated luminescence dating for mafic environments (a subproject within our project). This particular analogue site is easily accessible by car 2 hrs drive from Salt Lake City, Utah, which hosts a major airport.

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References: [1] Greeley R. et al. (1992) *JGR Planets, 97*, 13319-13345. [2] Cutts J.A. and Smith R.S.U. (1973) *JGR Planets, 78*, 4139-4154 [3] Lorenz R.D. et al. (2006) *Science, 312*, 724-727. [4] Telfer M.W. et al. (2018) *Science, 360*, 992-997. [5] Bridges N.T. et al. (2012) *Geology, 40*, 31-34. [6] Lapotre M.G.A. et al. (2017) *JGR Planets, 122*, 2489-2509. [7] Ewing R.C. et al. (2017) *JGR Planets, 122*, 2544-2573. [8] Edgett K.S. and Lancaster N. (1993) *Journal of Arid Environments, 25*, 271-297. [9] Johnsen et al., (2010) *UGA, 39*, 109-150. [10] Benson et al., (2011) *Quaternary International, 235*, 57-69. [11] Oviatt, (2015) *Quaternary Science Reviews, 110*, 166-171.

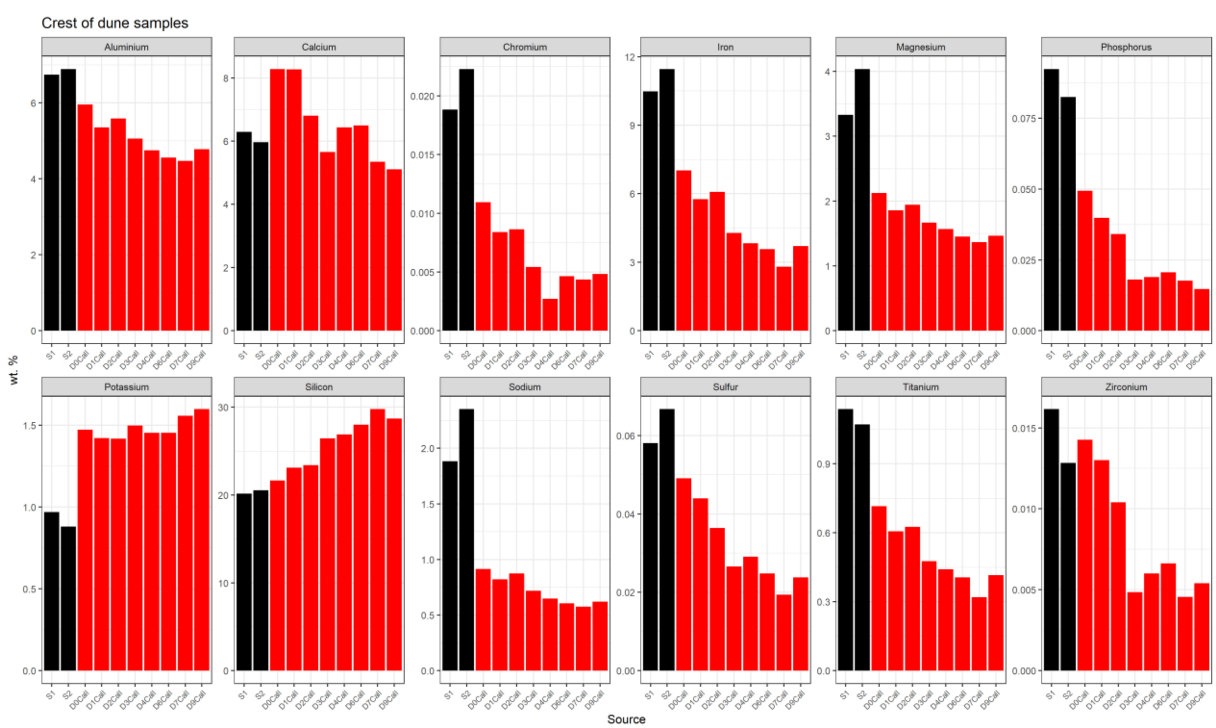

Fig. 2. µXRF measurements. The black S1 and S2 samples are from the Pahvant Butte source area, while the red samples are from the Black Rock Desert Dunes. D0 is the most upwind dune while D9 is the most downwind dune.