An Icelandic aeolian system as an analogue for Mars

E. Martin Lund[a,b,c], Mike J. Zawaski[b], Ryan C. Ewing[b] and Ívar Ö. Benediktsson[d]

[a]Department of Geosciences, University of Oslo, Oslo, Norway, e.m.lund@geo.uio.no; [b]Department of Geology & Geophysics, Texas A&M University, College Station, Texas, USA, zawaski@tamu.edu, rce@exchange.tamu.edu; [c]Department of Geology, Lund University, Lund, Sweden; [d]Institute of Earth Sciences, University of Iceland, Reykjavík, Iceland, ivarben@hi.is

Aeolian systems are among the most prevalent systems encountered on planetary bodies in the solar system (e.g., Lorenz et al. 2006, Rubanenko et al. 2022), despite significant differences in physical parameters. The presence of these systems over such different settings suggests commonalities in processes forming ripples and dunes on these planetary bodies. Planetary missions have been vital for our understanding of processes forming the surface of planetary bodies (e.g., Ewing et al. 2017, Squyres et al. 2004). However, these missions are costly endeavours, and take many years from initiation to conclusion. Terrestrial analogue studies offer a resource and time efficient compliment to planetary missions, where sites on Earth can help us understand landscape evolution on other planets, such as Mars. One popular terrestrial analogue for Mars is Iceland, where many recent analogue studies have been conducted (e.g., Ehlmann et al. 2012, Sánchez-García et al. 2020).

In 2022 we conducted fieldwork at a mafic cold climate aeolian system in Iceland. The field site is situated next to the headland Ingólfshöfði, and is part of the easternmost extent of the Skeiðarársandur glacial outwash plain. Aeolian processes are active in the area, forming bedforms and also causing dust storms. Surface samples were collected along a 2 km transect, including cover sand, ripples, and protodunes, as well as nearby sand sources (i.e. beaches and creeks). The composition of the samples was measured using a µXRF, and no major variations in major and minor elements were found along the transect, or between different grain sizes. This indicate that there is minimal heterogeneity between source rocks, or that any potential heterogeneity is lost on this glacial outwash plain. This might be due to mixing during the glacial abrasion and transport, during stream migration, longshore drift, flooding events and a bimodal wind regime. This is contrasted by other studies finding a noticeable sorting by density and grain size in systems with less variable transport (cf. Pye and Tsoar, 1990). The degree of sorting is strongly dependent on the directionality and interactions between sedimentary systems. This study shows how sedimentary transport processes, on chemically similar rocks, leads to homogenisation, which has implications for understanding the provenance of deposits on Earth and Mars.

References

Ehlmann, B. L. et al., 2012: Mineralogy and chemistry of altered Icelandic basalts: Application to clay mineral detection and understanding aqueous environments on Mars. *Journal of Geophysical Research: Planets, v. 117*, no. E11.

Ewing, R. C. et al., 2017: Sedimentary processes of the Bagnold Dunes: Implications for the eolian rock record of Mars. *J Geophys Res Planets, v. 122*, no. 12, p. 2544-2573.

Lorenz, R. D. et al., 2006: The Sand Seas of Titan: Cassini RADAR Observations of Longitudinal Dunes. *Science, v. 312*, no. 5774, p. 724-727.

Pye, K. & Tsoar, H., 1990: Aeolian sand and sand dunes. *Springer*.

Rubanenko, L. et al., 2022: A distinct ripple-formation regime on Mars revealed by the morphometrics of barchan dunes. *Nature Communications, v. 13*, no. 1, p. 7156.

Sánchez-García, L. et al., 2020: Fingerprinting molecular and isotopic biosignatures on different hydrothermal scenarios of Iceland, an acidic and sulfur-rich Mars analog. *Scientific Reports, v. 10*, no. 1, p. 21196.

Squyres, S. W. et al., 2004: The Opportunity Rover's Athena Science Investigation at Meridiani Planum, Mars. *Science, v. 306*, no. 5702, p. 1698-1703.