SEDIMENT SORTING AND ROUNDING IN A BASALTIC GLACIO-FLUVIO-AEOLIAN ENVIRONMENT: ÞHÓRISJÖKULL GLACIER, ICELAND.

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Introduction: Sediments and sedimentary rocks preserve a rich history of environment and climate. Identifying these signals requires an understanding of the physical and chemical processes that have affected sedimentary deposits [1]. Such processes include sorting and rounding during transport and chemical alteration through weathering and diagenesis. Although these processes have long been studied in quartz-dominated sedimentary systems [2], a lack of studies of basaltic sedimentary systems limits our interpretations of the environment and climate where mafic source rocks dominate, such as on Mars [3,4].

As part of the SAND-E: Semi-Autonomous Navigation for Detrital Environments project [5], which uses robotic operations to examine physical and chemical changes to sediments in basaltic glacio-fluvial-aeolian environments, this research studies changes in sorting and rounding of fluvial-aeolian sediments along a glacier-proximal-to-glacier-distal transect in the outwash-plain of the Þórisjökull glacier in SW Iceland (Fig. 1)

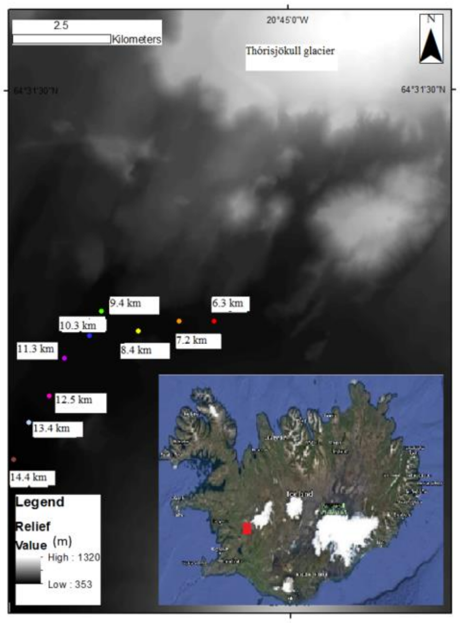

Figure 1: Field location SW of Þórisjökull glacier, Iceland. Sample locations are given in km downstream from the glacier and are approximately 1 km apart. The red box on the inset map of Iceland shows location of the field site (Google, 2019).

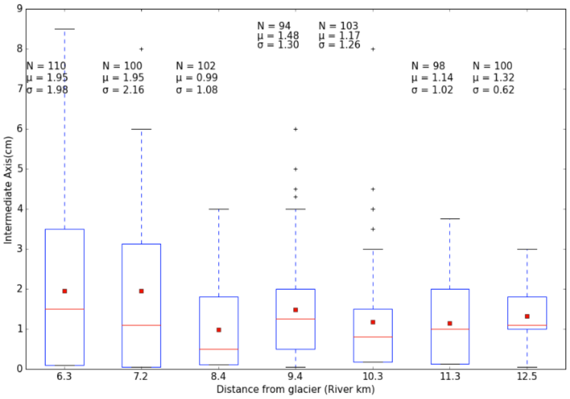

Figure 2: Boxplot of the size of the intermediate axis of sand, pebbles, and cobbles for 7 locations. N is the sample size, μ is mean (red square) and σ is the standard deviation of the mean.

Methods: Data were collected every ~1 km along a ~8 km transect (9 stops), which started 6.3 km from the base of Þórisjökull glacier (Fig. 1). A cobble count was performed at each stop, which consisted of measurements of the intermediate and long axes of 100 randomly chosen samples. The aspect ratio was used to assess shape change. Bulk sediment samples of the finer (e.g., pebble-sized and smaller) fractions were collected and their sizes and sphericity were determined using the Retsch Camsizer.

Results: Minor variations in sediment size exist across the transect as determined from both the cobble count method and Camsizer analysis. The cobble count data show a decrease in the length of the intermediate axis from the proximal to the distal site (Fig. 2). The decrease is most prominent in the first 1 km of the transect and varies less across the last 6 km. Changes in the smaller size fractions determined from the Camsizer are not as apparent for either the fluvial or aeolian sediments. Fig. 3 shows the cumulative size distribution curves for three (A) fluvial and three (B) aeolian samples at 6.3 km, 10.3 km, and 14.4 km from the glacier. No clear trend exists, though overall, the grain sizes of the fluvial samples are more widely distributed than the aeolian samples.

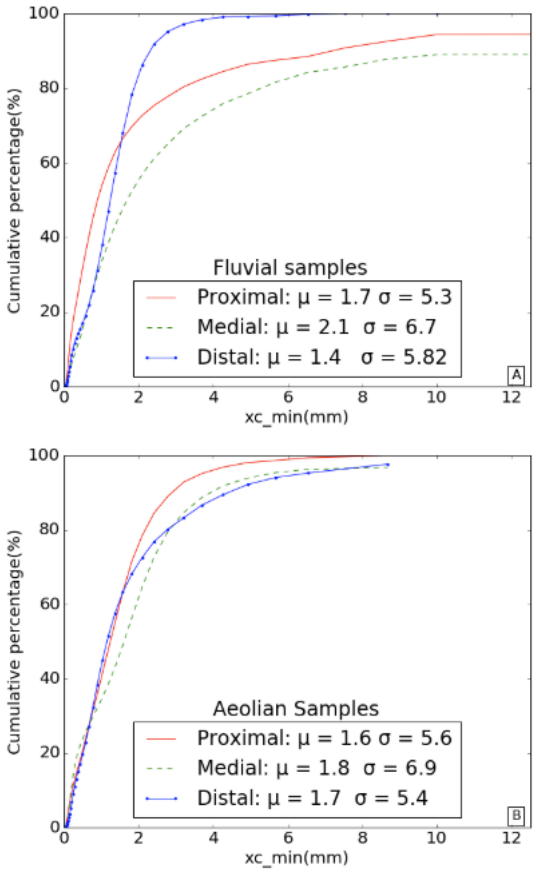

Figure 3: Cumulative distribution curve of paticle size. Samples were selected from the Proximal (6.29 km), Medial (11.26 km) and Distal (14.4 km) field sites, named in accordance with their distances from the glacier. A: fluvial. B: aeolian.

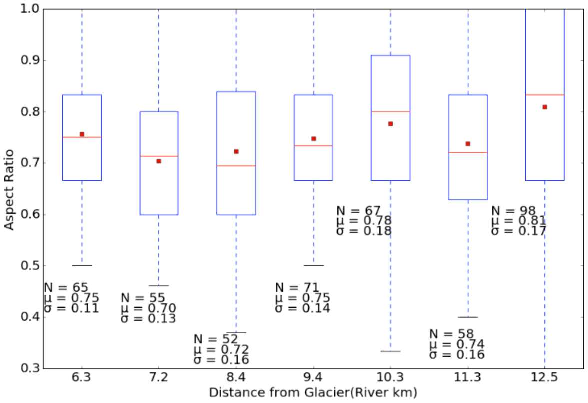

Figure 4: Aspect Ratio calculated at first 7 stops. The last 2 stops were not manually measured due to small size of samples. Orange horizontal line represents median and the red box represents the mean, μ. N is the sample size and σ is the standard deviation of the mean.

Discussion: Though variations exists throughout the transect, some trends stand out and align with expectations of transport distance and physical processes. The decrease in cobble size from the proximal to distal sites matches expectations that the coarser fractions are sorted out due to loss of river competence with a downstream decrease in river slope. The aspect ratio increased away from the glacier, as expected for particle rounding processes [6]. The lack of a significant rounding trend emerging from the data may be due to the short overall transport distance from the source and the addition of new particles sourced along the transect. The lack of size variation in the smaller fractions may highlight that the competence remains high enough to maintain a poorly sorted pebble-to-sand sized sediment population. The lack of size variation among the fluvial and aeolian sediments is surprising and may signal both sampling bias due to the limited samples analyzed thus far and the capacity of the winds to move the available population of sand-sized grains from the fluvial system. Bulk sediment samples collected by scooping sediment likely did not isolate aeolian-transported only grains, which may have been limited to a surface veneer of grain-scale reorganization. Thus, these aeolian samples may comprise a similar distribution as the fluvially transported sediments.

Conclusions:

- A decrease in grainsize and an increase in the aspect ratio occurs along a 8 km source-proximal-to-source-distal fluvial transect.
- No significant difference in grainsize variation exists between bulk aeolian and fluvial sediment samples.
- Lack of variation in samples may be due to sampling bias, length of transect, and fluvial and wind transport capacity.

References: [1] Tucker M. E. (2003) *Sedimentary Rocks in the Field.* [2] Nesbitt, H.W. et al. (1996) *Sedimentology 43.2:341-358.* [3] Thorpe, M.T. et al. (2019) *Geochimica et Cosmochimica Acta 263 :140-166.* [4] Fedo C. et al. (2015) *Earth and Planetary Science Letters, 423*, 67 -77. [5] Ewing et al. (2019), SAND-E: Semi-Autonomous Navigation for Detrital Environments First Results, *AGU Fall Meeting Abstract EP24A-05.* [6] Szabó, T. et al (2015). Reconstructing the transport history of pebbles on Mars. *Nature Communications*, 6, 8366.