

μXRF INVESTIGATION OF GEOCHEMICAL AND PHYSICAL GRAIN CHARACTERISTICS IN A GLACIO-FLUVIAL-AEOLIAN CATCHMENT IN SOUTHWEST ICELAND.

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Introduction: Iceland has a unique, basaltic landscape that has been modified by glacial, fluvial and aeolian processes. The island is covered by 20,000 km² of sandy deserts dominated by basaltic materials [1]. The cold, yet humid climate and similar geology of Iceland provides a promising analog to study paleo-martian landscapes. Studying geochemical variability and sorting is important to determine how geologic environments change with increasing distance and time. The weathering of many quartzofeldspathic landscapes have been studied in depth, whereas studies of basaltic transport pathways are lacking [2]. By studying Iceland's basaltic landscape, we can gain a better geochemical and sedimentological understanding of past and present Mars.

This project uses μXRF to examine how geochemical variability, sorting, grain shape and size along the Þórisjökull transport pathway change with increasing distance from the glacier. Samples for this study were collected in the Summer of 2019 for the SAND- E: Semi-Autonomous Navigation for Detrital Environments project. This project investigated the geochemical, mineralogic, and physical grain changes along a martian analog transport pathway using autonomous rover and drone system operations [3].

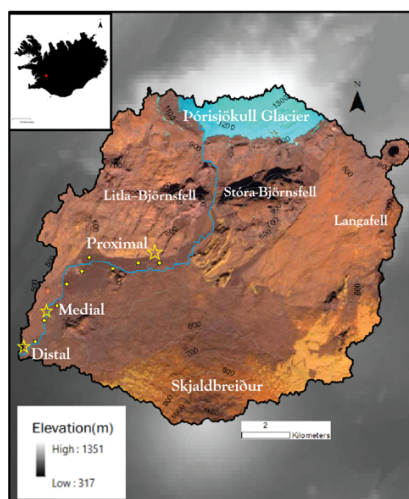


Figure 1. Map of field area for the 2019 SAND-E expedition. Field sites are labeled with stars along the fluvial transect. Subglacial eruptions are also labeled [4].

Geologic Field Area: The 2019 field season took place in the Skjaldbreiður volcanic field below the Þórisjökull glacier. Three sites were selected along the fluvial transport pathway to understand geochemical variability and sedimentologic variability with increasing distance from the glacier. The proximal site (P) is 6.3 km from the glacier, medial site (M) is 11.3 km, and distal site (D) is 14.4 km, making this transport pathway an 8.1 km traverse.



Figure 2. (Top) Sample layout of a plexiglass sheet, with sieved grain sizes for μXRF analysis. The orange crosses depict the Ti tape used for correlation on optical images. (Bottom) An optical image of sample: Medial Aeolian 2019.

Methods: There are a total of 6 samples for this study. Three samples were taken from an aeolian deposit (ripple crests), and three samples were taken from a fluvial deposit (channel bed). Aeolian and fluvial samples were collected from each of the three field sites along the transect.

All samples were dried at the Texas A&M University lab to ensure no alteration in samples from moisture. Each sample was sieved into 5 grain sizes: (5) 1 mm-710μm, (4) 710-250 μm, (3) 250-125 μm, (2) 125-63 μm, and (1) <63 μm. Grains larger than 1 mm were excluded from analysis due to risk to the μXRF. Each grain size was stuck to double sided tape and a plexiglass sheet and analyzed by the Bruker M4 Tornado Plus μXRF (Fig. 2). This μXRF can detect

elements as light as carbon. A 20 μm probe head was used at 1 accumulation for each sample. The total time for 1 sample, a total of 5 grain size fractions, is approximately 7 hours. Due to the high resolution, only 1 accumulation is necessary. While this study uses a 20 μm probe head, a 100 μm probe head is most comparable to the PIXL instrument on NASA's Perseverance rover [5].

Results and Discussion: The most significant trends in the fluvial μXRF data include changes in the stoichiometric weight abundances of Ca, Fe, Mg, and Ti with field areas and grain sizes.

We found that Ca decreases with increasing grain size in the proximal field site. At the medial and distal sites, Ca decreases in the fine fraction, then increases in the coarse. The 125-250 μm grain size fraction contains the least Ca (Fig. 3). In the finest 3 grain size separates, Ca decreases in weight percentage with increasing distance from the source, meaning the proximal site possesses the greatest amount Ca.

Fe increases in weight percentage with increasing grain size up to the 710 μm size fractions. Fe also increased in weight percentage in every grain size with increasing distance from the glacier, meaning the distal site contains the greatest amount of Fe. This trend could result from sorting or mixing of new sediment sources. Mg decreases in weight percentage with increasing grain size, which may indicate olivine is not strongly associated with coarser grain sizes.

Ti decreases with increasing grain size in the medial and distal field sites. Ti increases in weight percentage in every grain size with increasing distance from the glacier, similar to Fe. Thus, the coarsest grain sizes contain the least Ti, and the distal site carries the most Ti in each grain size. Although Ti is a relatively immobile element, there is evidence of fluctuation of weight percentages through grain sizes and distance from the glacier. This trend could result from fluvial transport and/or mixing of different volcanic sources. Al and Si do not show any significant trends with grain sizes in each of the field sites. At this time, no aeolian trends have been analyzed.

μXRF elemental maps show multimineralic grains in the coarser grain size fractions, >125 μm (Fig. 4). The finer grain sizes are dominated by monomineralic grains. The dominance of the monomineralic grains in the fine fractions could be a result of the parent multimineralic coarser fractions weathering into the monomineralic constituents through transport and sorting [6]. Further investigation of abundances of multimineralic grains across the transect of study and within different depositional environments will be conducted.

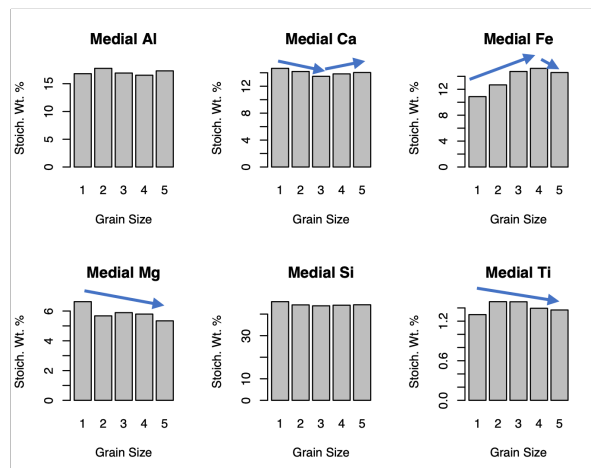


Figure 3. Bar plots of 2019 medial fluvial μXRF stoichiometric weight percentages of elements Al, Ca, Fe, Mg, Si, Ti. Notable trends are depicted by a blue arrow.

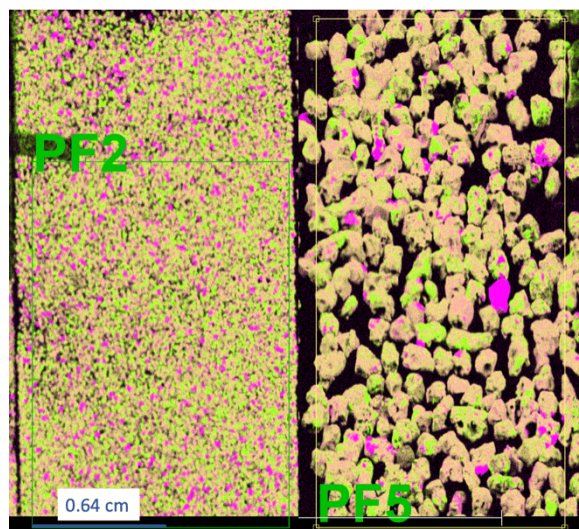


Figure 4. μXRF element map displaying proximal fluvial (PF), grain size 2 & 5. Mg is pink and Ca is green. PF5 has many multimineralic grains, whereas PF2 has many, individual monomineralic grains.

References: [1] Arnalds O. et al. (2001) *Journal of Arid Environments* 47.3, 359-371. [2] Thorpe M. et al. (2019) *Geochimica et Cosmochimica Acta* 263, 140-166. [3] Ewing R. et al. (2019) *AGU Fall Meeting Abstract*, EP24A-05. [4] Mason K. et al. (2021) *LPSC 2021*, Abstract #1752. [5] Allwood A. et al. (2020) *Space Science Reviews* 216.8, 1-132. [6] Champion et al. (2021) *LPSC 2021*, Abstract #2429.