MICROSCALE CHARACTERISTICS OF PARTICLES DEPOSITED BY THE 1996 SKEI∂ARÁRSANDUR JÖKULHLAUP: A POTENTIAL TERRESTRIAL ANALOG TO MARS. R. A. Yingst[1] and K.R. Kuhlman[2], [1]University of Wisconsin-Green Bay (2420 Nicolet Dr., Green Bay, WI 54311; yingsta@uwgb.edu), [2]Planetary Science Institute (1700 E. Fort Lowell, Suite 106, Tucson, AZ 85719).

Introduction: The application of microscale imaging to martian surface materials has revolutionized our understanding of past and present surface processes (e.g., [1-4]). Images at this scale form a crucial suite of data, the importance of which is demonstrated by the use of handlenses by terrestrial field geologists to identify depositional processes and environments from grain attributes and sedimentary structures. Analysis of geologic materials at the microscale — where we use the term "microscale" to refer to features resolved approximately by a handlens — has proved a powerful strategy to maximize the information gleaned from limited samples, such as at Mars. However, discrimination between processes that leave behind similar traces requires enlightened comparison to well-characterized analogs. As part of our effort to characterize and create a database of important martian analogs at the microscale [5-7], we here report on the characteristics of particles deposited by the 1996 Skei∂arársandur jökulhlaup (subglacially-generated outwash flood). Our goal is to provide a standard terrestrial analog of the microscale characteristics of such particles for use in the interpretation of martian geologic features.

Geologic Setting: At 1300 km^2, Skei∂arársandur is Iceland's largest glacial outwash plain, extending from the lobate outlet glacier Skei∂arajökull to the North Atlantic [8-14]. The largest jökulhlaups in this region result from eruptions beneath the parent Vatnajökull ice cap that raise and then catastrophically drain a subglacial lake within the Grimsvötn caldera [15]. The jökullhlaup that occurred in 1996 was one of the largest across Skei∂arársandur in 100 years [16,17], and was characterized by very high peak discharge (5x10^4 m^3/s) and maximum localized stream power (4x10^4 W/m^2) [18]. Composition of the proximal deposits include a mix of basalt fragments (85%) and more friable hyaloclastics (10-15%). Distal deposits are almost exclusively basalt.

Data Collection: Beginning less than 1 km from the terminus of the glacier, we sampled the morphology and texture of sandur deposits laterally at six points separated by 2-4 km. We followed the traverse shown in Figure 1, a path that minimizes changes in longitudinal topography. Measurements were taken up to the point where traversability in the field vehicle was impossible.

Context images were taken of each sample site at the surface. To reveal potential vertical structure, and to access less weathered particles relatively free of organics, a 30 cm deep trench was dug and samples were taken from the bottom of the trench. The trench site and interior were imaged and then samples were extracted and imaged at approximately MAHLI resolution (10 μm/pxl) [19]. Samples from site SS4 are shown in Figure 2.

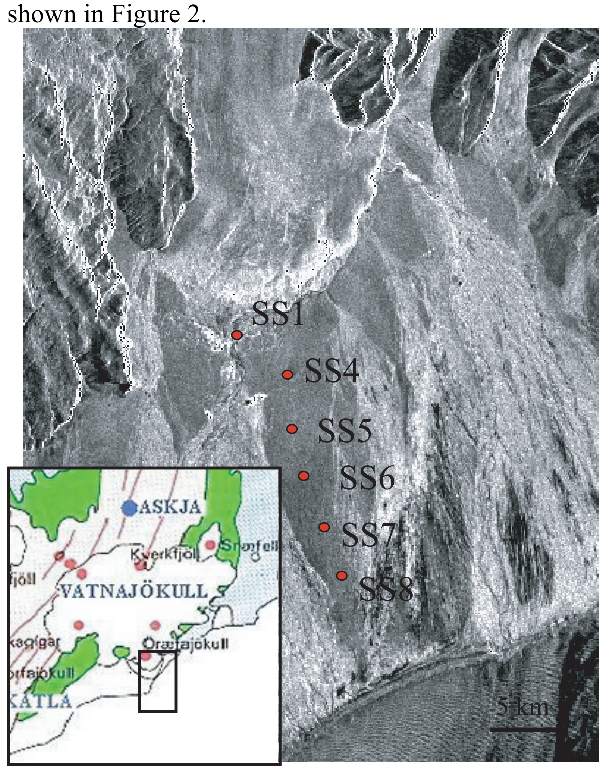

Figure 1. Map of field area in SE Iceland (inset) and Nov. 7, 1996 ESA/TSS image of field site, with sample collection sites noted.

We utilized the methodology of [20] to calculate size, shape (sphericity and elongation) and roundness (sharpness of particle corners). Texture, or how a particle surface varies from a perfectly flat surface at scales smaller than the corners and angles of the particle, was classified qualitatively, following the methodology and nomenclature of [21].

Results: *Particle morphology and appearance.* Particle morphology at each site is primarily blocky, though vesicular particles are more common proximal to the glacier and make up ~20% of the population at field sites SS1 and SS4. Hyaloclastic fragments (red circle in Figure 2) comprise ~5-15% of the population at these sites as well, though they are rare at SS4 and disappear entirely in the more distal samples. Average particle roundness ranges from angular to sub-rounded, with roundness increasing with distance from the glacier. However, the increase is subtle, and is more evidenced by the absence of angular particles in the more distal samples, rather than the significant rounding of the entire population at each site.

Figure 2. Sample from site SS4.

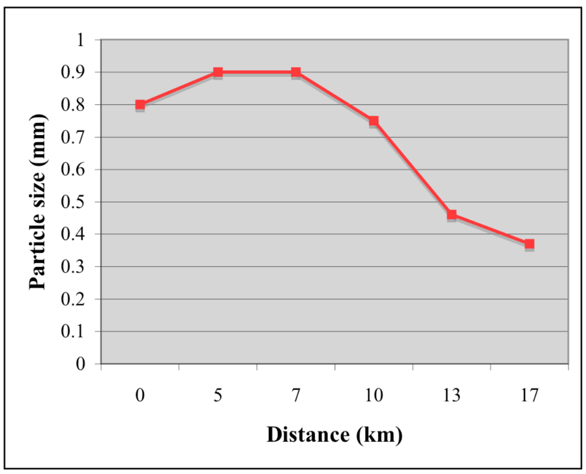

Figure 3. Particle size as a function of distance from the glacier terminus.

Texture. Blocky, dull grains similar to Type 3 of [21] predominate (yellow circle in Figure 2). Type 3 displays flat facets ending in sharp to rounded irregular edges. A few somewhat glassy particles exist at sites SS1 and SS4 (black circle in Figure 2).

Particle size and sorting. Average particle size decreases with distance from the source, as shown in Figure 3. The range of sizes present narrows with distance as well; by 7 km distance (SS5) paticles larger than 5 cm fall out of the sampling and particles are highly uniform in size.

Color. Grey-colored grains make up 85-95% of each sample, with the percentage increasing with distance from the glacier. Tan or buff-colored grains also appear. Near the source are reddish (hyaloclastic) grains, disappearing downflow of sample SS4.

Discussion: Based upon these observations, the distinctive microscale characteristics of a recently-formed jökulhlaup that can be determined by a MAHLI-class instrument [19] include (1) little change in angularity with distance, unlike particles affected by more persistent flow [20, 22-24]; (2) decrease in size with distance from the glacier terminus, in this case, most evident at > 10 km distant; (3) increased sorting with distance, evident as a dropout of larger (cm-scale) particles; and (4) an increased percentage of basalt particles with distance from the source. If observed on Mars, this combination of characteristics for mm- to cm-scale particles could provide one indicator that volcanically-driven, subglacially-generated outwash flooding had occurred. In follow-on work, we will compare these results with grain morphology for other types of flooding, to determine if they can be differentiated based on particle morphology.

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