THE PERSISTENCE OF FLUVIAL FEATURES ON CLASTS: RESULTS OF WIND TUNNEL ABRASION EXPERIMENTS

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Introduction: Ground-based remotely sensed images returned from Mars indicate that aeolian abrasion is effective at modifying boulder surface morphology. [1]. Viles et al [2] have pointed out the importance in planetary studies of determining the extent to which in-situ rock breakdown (*e.g.* aeolian abrasion) masks signatures of earlier geomorphic transport processes (*e.g.* fluvial transport or crater ejecta). This has not been determined for rock surfaces on Earth or for other planets. We have conducted a series of wind tunnel experiments to test the persistence of signatures of fluvial transport on clasts (*e.g.* percussion marks, incipient cones, ring fractures, terminations, roundness, etc. [3]) in an abrasive aeolian environment. Here we present an outline of the innovative techniques we apply to understanding feature persistence. In addition we present our preliminary results.

Experimental Design: Our experimental design tests the persistence of fluvial features following aeolian abrasion. Future work will test the persistence of features produced in weathering and aeolian environments.

Step 1: Identify signatures of fluvial transport. We undertook a detailed survey of boulders and cobbles recently transported by fluvial processes. Sample sites included Oak Creek Canyon, Arizona, Cunene River, Namibia and the Channeled Scablands in eastern Washington. Where possible, we restricted our sampling to basalt lithology. Our survey has identified eleven signatures of fluvial transport [3] (Fig. 1).

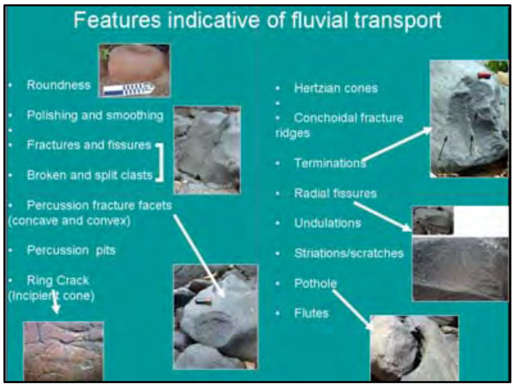

Figure 1 Signatures of fluvial transport [3].

Step 2: LIDAR scanning of selected facets. Basalt cobbles with representative fluvial features were collected in the field. Selected facets were scanned using a Minolta 900 "triangulation type" laser scanner (LiDAR) to characterize surface morphometry at high-accuracy, high precision, and high resolution. The scans have a resultant model resolution of 0.23-0.40 mm (see Fig. 2). Similar scanning techniques have been used in wind tunnel [4] and field studies [2, 5, 6]. The digital models were sliced and tabs inserted in the back for stabilization in the wind tunnel.

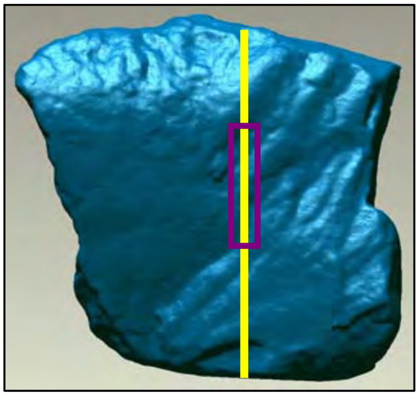

Figure 2 DEM of scanned basalt cobble (target 1). Yellow line indicates location of sample profile where data on abrasion were collected. Purple box indicates location of Figure 4.

Step 3: Rapid prototype printing of targets.

Figure 3 Image of the field sample of vesicular basalt cobble (left) and the printed model of target (right).

Rapid prototype printing provides a way to create physical, 3-D models of virtually any CAD with precise detail It has not been previously used for wind abrasion experiments. We used a Zcorporation 3D Zprinter 310 to print the scanned cobbles. The models are composed of a gypsum powder and binding agent. The printer deposits layers 0.01016 mm thick that gradually build up the rock model. For example one of our samples has 779 layers and took two hours to print. Settling of the printed model in the X, Y and Z is estimated to be 0.018 mm.

Step 4: Wind tunnel abrasion experiments. Experiments were conducted in the ASU's Planetary Geology Wind Tunnel facility. 100 µm quartz sand was placed in a hopper 4 m from the target array. Targets were located 20 cm above the tunnel floor. The eleven targets were subjected to three or four runs, each at 30 m/sec wind velocities. Each run lasted about 45 minutes.

Results: Targets were re-scanned following each wind tunnel run. Iterations of each sample were exported into a single file for analysis using SolidView software. Profiles were plotted and measurements taken of the amount of material eroded at several points within given features. While these simple linear measurements are useful to identify fluvial features that are sensitive to abrasion, we are assessing additional analysis techniques for the DEM data such as fractal analysis and geomorphometry [2, 5-7].

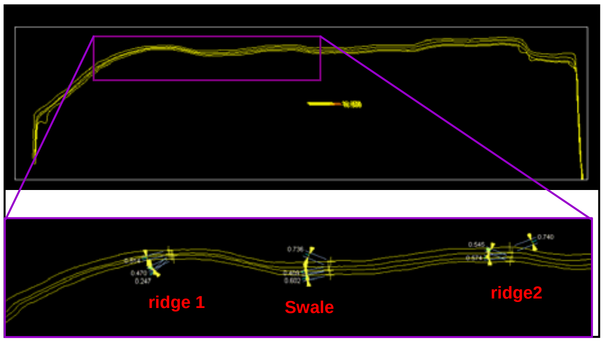

Figure 4 Side view of profiles from each wind tunnel abrasion experiments on target 1. Direction of abrasive sand is from the top in this view. Enlarged profile view (lower panel) is of the radial fissures, showing the location of the ridge and swale measurements reported in Table 1. Location of profile is shown in Figure 2.

Target 1	Abrasion run 1 (mm)	Abrasion run 2 (mm)	Abrasion run 3 (mm)	Total abrasion (mm)
ridge 2	0.74	0.57	0.55	1.86
swale	0.74	0.41	0.60	1.75
ridge 1	0.51	0.25	0.47	1.23

Table 1 Measured change in radial fracture on target 1 facet following each of the three wind tunnel abrasion experiments. See Figures 2 and 4 for location of samples.

Measurable abrasion was detected from the wind tunnel experiments. The example shown in Figure 4 (Table 1) suggests that differential abrasion of features is linked to convex curvature shape and sub-features may survive for longer periods than the entire signature. Furthermore, features with high initial relief, e.g., terminations and radial fissures (Fig. 1) may have lower feature persistence times than e.g., pits because of their relatively high and angular initial relief [for detailed description of features see 3] (Fig. 5).

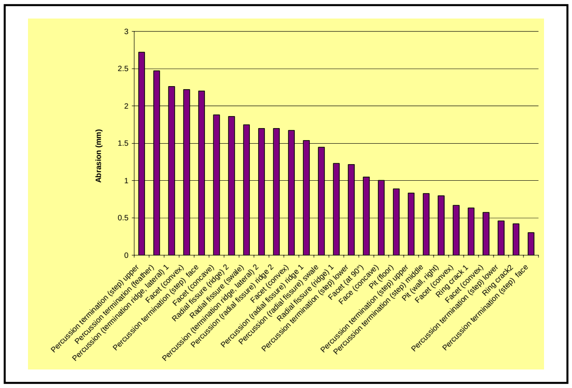

Figure 5 Bar chart (ranked) of abrasion on specific fluvial features on clasts following wind tunnel tests.

Conclusion: Preliminary results indicate that fluvial signatures were abraded at differential rates in the wind tunnel. This suggests that there is differential persistence of features on cobbles that are originally transported in fluvial environments but then subjected to aeolian abrasion. These findings are relevant to the Martian environment where features diagnostic of fluvial transport may also be differentially eroded by aeolian abrasion and may survive in a muted form or have been loci for enhanced aeolian abrasion.

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