Wind-blown Sand on Mars: Preliminary Results of Transport Intermittency and Thresholds from Wind-tunnel Simulations. C. Swann[1], R. C. Ewing[1] and D. J. Sherman[2] Department of Geology and Geophysics, Texas A&M University, MS 3115 TAMU, College Station, Texas 77843, [2]Department of Geography, University of Alabama, 204 Farrah Hall, Tuscaloosa, AL 35487.

Introduction: Wind-driven sand transport is inherently intermittent because of the nature of atmosphere-surface energy exchange [1-7]. Boundary layer instability and surface irregularity spawn turbulent flow near the surface. Turbulent flow generates episodic high-energy gusts, followed by low energy lulls, and is identified by significant departures from the mean flow. However, transport models often assume steady-state flow conditions, using time-averaged wind speeds that ignore unsteadiness from turbulent flow [2-4]. Because of this, transport models differ from observed rates in field environments [8-9]. Earth-based field observations using the most commonly cited transport models [10-14] show discrepancies between predicted and observed transport rates on the order of 300% within each model, and up to 700% between Bagnold [10], Lettau and Lettau [14], and Kawamura [11]. The largest deviations from Earth-based models occur at lower transport rates and are attributed to errors in the threshold of motion [15].

Studies of aeolian transport within a simulated Martian environment have relied on the same transport models as have been used for most Earth-based studies. Greeley et al., [16-18], along with others [19-21], initially determined the threshold of movement for sand on Mars. They defined the threshold by "increasing the wind speed through the tunnel until saltation [along the entire wind tunnel] test bed was initiated (following Bagnold [22]). The free stream wind speed was noted and correlated with a standard velocity profile for the wind tunnel" (Greeley et al., [17], p. 418; Greeley et al, [23], p. 12). Four fundamental questions emerged from their definition of threshold. First, these studies did not focus on the intermittent nature of transport before full saltation begins, leaving open the question of how much transport on Mars occurs prior to full saltation. Transport rarely reaches a state of fully developed, continuous saltation. We now recognize an intermittency function, γp, introduced by Stout and Zobeck [3], that describes the portion of time sand transport occurs, and have found saltation rarely occurs more than 50% of the time in any 5-minute period. Lancaster et al. [7] found continuous saltation only to occur 11%-31% of the time during a storm event.

Second, the threshold of motion in those studies, was only evaluated for saltation, and not focused on the movement of bedload before saltation begins. Bedload consists of particles that roll, slide or move in small hops over the surface driven either by the direct force of the wind on the grains or as a result of bombardment from saltating particles [10. 24-26]. Little is known of bedload transport on Mars. Bedload is argued to contribute between 3 and 29% of the total load on Earth [1, 27-28]. This wide range of estimates exists because bedload had never been directly separated from saltation on Earth, until recently [29]. The fluid threshold on Mars is defined by the moment at which full saltation occurs over the wind tunnel, a point where bedload particles are already in motion, evidenced in wind tunnel experiments [16, 30-32]. Threshold predictions for Mars exclude this precursory, intermittent movement before a saltation cloud moves over an entire test bed.

As is widely recognized for threshold-of-motion studies for Earth and Mars, a single wind speed value cannot adequately describe all scenarios when transport begins. An assumption of a single value disregards other controlling factors: modes of movement, different grain size distributions, armoring effects, electrostatics, particle-to-particle contact, compaction, mineral composition of sediments and the exposure of different grains to surface winds. The combination of these factors on a surface makes the threshold of motion occur over a range of values. Intermittent transport, in addition to these factors, produces error in single-value threshold estimates [2-3, 6-7, 33]. Our research generates a range of threshold values related to the intermittency of transport.

The fourth question in Martian threshold predictions is the use of visually-noted free stream velocities, subsequently correlated with typical velocity profiles to resolve the threshold shear velocity. Turbulent shear stress initiates movement with characteristic lag times of the order of 0.5-1s [5, 34-36]. Velocity profiles are altered by the presence of a saltation cloud, producing potential order-of-magnitude errors in estimates of roughness lengths [37-38]. Typical profiles used to calculate shear velocity from free stream velocity must incorporate the variability generated from various levels of saltation transport, including potential changes in the value of the von Karman constant [39].

The presented research uses the MARSWIT to simulate transport conditions on Mars. A new bedload trap is used to individually separate surface creep, reptation and saltation. The initiation of each mode of movement is correlated to instantaneous velocity profiles to derive modal threshold shear velocities. Intermittency is calculated to resolve flux distributions prior to 'continuous saltation'.

Our study aims to quantify intermittent aeolian bedload transport under Martian atmospheric pressures using the Planetary Aeolian Facility MARSWIT. Much of the previous work done in MARSWIT focused on quantifying the threshold and sediment fluxes associated with the saltation mode of transport, whereas our research uniquely focuses on the fluxes associated with intermittent transport, primarily bedload that occurs prior to initiation of full saltation. The tasks accomplished in this proposal will improve our understanding of the atmosphere-surface interactions and rates of aeolian resurfacing on Mars by quantifying sediment fluxes associated with high frequency low-intensity wind events under Martian atmospheric conditions.

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