WIND ABRASION ON MARS *R. Greeley, Department of Geology, Arizona State University, Tempe, AZ 85287-1404*

Aeolian activity was predicted for Mars from earth-based observations of changing surface patterns that were interpreted as dust storms. Mariner 9 images showed conclusive evidence for aeolian processes in the form of active dust storms and various aeolian landforms including dunes and yardangs. Windspeeds to initiate particle movement are an order of magnitude higher on Mars than on Earth because of the low atmospheric density on Mars. It was reasoned that saltating particles on Mars therefore would travel much faster than on Earth and would be effective agents of abrasion. This consideration, coupled with the frequent dust storms observed telescopically, led to predictions of extremely high rates of aeolian erosion (Sagan, 1973; Henry, 1975). Viking results, however, led to a reassessment of wind erosion on Mars. The Viking orbiters reveal surfaces that have small (~10 m) impact craters whose presence indicate surfaces that are millions or even hundreds of millions of years old but which have been little modified by erosion of any type (Arvidson et al., 1979). If the rates predicted prior to the Viking mission were correct, these craters should have been "erased" long ago.

In order to determine rates of abrasion by wind-blown particles, knowledge of three factors is required (Figure 1): (1) particle parameters such as numbers and velocities of windblown grains as functions of windspeeds at various heights above the surface, (2) the susceptibility to abrasion (S_a) of various rocks and minerals, and (3) wind frequencies and speeds. For estimates appropriate to Mars, data for the first two parameters can be determined through laboratory and wind tunnel experiments; data for the last factor are available directly from the Viking Lander (VL) meteorology experiments for the two landing sites.

Experiments (Greeley et al., 1982) have been conducted to collect information on the parameters required for Mars. Assuming an abundant supply of sand-sized particles, estimated rates range up to 2.1×10^{-2} cm of abrasion per year in the vicinity of Viking Lander 1. This rate is orders of magnitude too great to be in agreement with the inferred age of the surface based on models of impact crater flux. The discrepancy in the estimated rate of abrasion and the presumed old age of the surface cannot be explained easily by changes in climate or exhumation of ancient surfaces. The primary reason for the discrepancy appear to be related to the agents of abrasion. Either windblown grains are in very short supply, or the grains are ineffective as agents of abrasion. At least some sand-sized (~100 μm) grains appear to be present, as inferred from both lander and orbiter observations. High rates of abrasion occur for all experimental cases involving sands of quartz, basalt, or ash. However, previous studies have shown that sand is quickly comminuted to silt- and clay-sized grains in the martian aeolian regime. Experiments also show that these fine grains are electrostatically charged and bond together as sand-sized aggregates (Greeley, 1979). Laboratory simulations of wind abrasion involving aggregates show that at impact velocities capable of destroying sand, aggregates form a protective veneer on the target surface and can give rise to extremely low abrasion rates (Greeley et al., 1982).

It must be noted, however, that rates of <u>abrasion</u> at the scale of <u>rocks</u> centimeters to meters in size cannot be extrapolated to rates of <u>erosion</u> at the > kilometer-scale of landforms such as craters, and the rate of surface erosion determined by the preservation of impact craters may not be appropriate for consideration of abrasion of spacecraft. Moreover, the experiments outlined here emphasize the importance of the supply of sand-size material. Although such grains may be in short supply at the two Viking Landing sites, they may be abundant in other regions as evidenced by sand dunes.

References:
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