CHANGES AT THE VIKING LANDING SITES OVER SHORT AND LONG TIMESCALES, R.E. Arvidson, McDonnell Center for the Space Sciences, Washington Univ., St. Louis, Mo. 63130, E.A. Guinness, McDonnell Center for the Space Sciences, Washington Univ., St. Louis, Mo. 63130.

Data acquired during the Viking mission have provided an opportunity to examine the effects of aeolian processes on Mars integrated over billions of years, tens of thousands of years, and over the course of a single year. The effect of aeolian activity can be sampled over geological timescales by examining the extent of modification of features large enough to be seen by the Viking Orbiters. The degree of preservation of the impact craters and wrinkle ridges at the Viking Lander 1 (VL1) site implies that rock breakdown and removal has been limited to meters in depth (1). The crater abundance within a 100 km radius of the landing site is $1.5 \pm 0.2 \times 10^3$ craters larger than 1 km in diameter per 10^6 km^2. Using the Neukum and Wise (2) cratering flux model for Mars, we obtain an age for the VL1 site of 3.5 billion years. Given the uncertainties of the Martian cratering history the actual age could be a factor of 2 or 3 younger (3). Despite the possible range in age, the computed rock breakdown and removal rate is surprisingly small; $\sim 10^{-3}$ microns per year or one meter per 10^9 years. In contrast, there has been several hundred meters of wind erosion within a few hundred kilometers of the Viking Lander 2 (VL2) site, based on the relief between pedestal craters and the surrounding fine-grained aeolian deposits. The pedestal crater abundances indicate that the partially stripped deposits are about the same age as the VL1 site. The erosion rate for the aeolian deposits, averaged over such a lifetime, would be a few tenths of a micron per year, which is two orders of magnitude greater than the computed rate of rock removal at VL1. Such a large difference in erosion rates between rock and soil is in fact mandatory if the pedestal craters have resisted stripping due to a bouldery surface.

Windblown drifts seen at both landing sites may provide information on the intensity of aeolian processes averaged over tens of thousands of years. The drifts have morphologies indicative of accumulation during a prevailing north to south wind regime - the situation prevalent during the annual global dust storms occurring near perihelion (4,5). Due to precessional effects the subsolar latitude at perhelion (SLP) migrates $\pm 25^\circ$ in latitude about the equator with a 50,000 year peroid (6). Because of the enhanced stripping associated with regions close to the SLP, it seems probable that the drifts at VL1, with their strictly north to south trend, must have accumulated since the SLP was last over the landing site latitude (24° N. lat.), which would have been about 15,000 years ago. If this line of reasoning is accepted, then an average accumulation rate of about 10 centimeters (mean drift thickness) per 15,000 years, or several microns/year, can be computed.

A redistribution rate of microns per year is also consistent with the observations made by the Viking Landers over the past Martian year (7). Figure 1 illustrates the extent of activity at the sites. The images are ratios of VL2 Red (.68 μm) to Blue (.48 μm) frames acquired before and after the two major dust storms that engulfed Mars during the Viking extended mission. Pre-storm data for both landing sites show that soil exposures have a variable R/B ratio, and that, in general, rocks have a smaller R/B ratio then the soil exposures. Especially at VL2, a number of rocks can also be seen with R/B ratios essentially the same as that for the average soil. The post-storm data for VL2, and to a lesser extent for VL1, show that the R/B ratio has increased for the soils, while the contrast between soil exposures has markedly decreased. Rocks at both landing sites have remained essentially

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System

the same. Such data is consistent with accumulation of a thin (microns) layer of bright red dust on the soils but not the rocks. (Note also that the surface sampler shroud obtained a R/B ratio similar to the soil in the post-storm images.) The observed changes, although markedly influencing the albedo and spectral properties of the sites, imply a relatively quiescent aeolian environment that, at least over the past year, has involved the redistribution only microns of material.

In summary, results for the Viking landing sites indicate that little rock breakdown and removal by wind has occurred over approximately the past 3 billion years. On the other hand, relatively rapid redistribution of friable or loose, fine-grained materials has occurred. Many of the landforms seen in higher resolution Viking Orbiter frames covering other parts of Mars are consistent with such interpretations. Many volcanic flow fronts, well preserved crater populations, and other features indicative of little to no significant modification can be discerned. In other regions, the surface has been stripped, yardangs have formed, and in general the topography appears to have largely been configured by aeolian activity. Such regions must be composed of friable deposits, such as volcanic ash or older aeolian materials. Finally, the similarity of redistribution rates for aeolian deposits averaged over three vastly different time-scales implies that roughly the present aeolian environmnet has been operative for a significant fraction of geologic time.

References:

(1) Binder, A.B., Arvidson, R.E., Guinness, E.A., Jones, K.L., Morris, E.C., Mutch, T.A., Pieri, D.C. and Sagan, C., 1977. J. Geophys. Res. 82, 4439-4451.
(2) Neukum, G. and Wise, D.U., 1976. Science 194, 1381-1387.
(3) Shoemaker, E.M. and Helin, E.F., 1977. Reports of Planetary Geology Program, 1976-1977, NASA TMX-3511, 74-77.
(4) Veverka, J., Cook, K. and Goguen, J., 1978. Icarus 33, 466-482.
(5) Arvidson, R.E., 1974. Icarus 21, 12-27.
(6) Ward, W.R., 1973. Science 181, 260-262.
(7) Jones, K.L., Arvidson, R.E., Guinness, E.A., Bragg, S.L., Wall, S.D., Carlston, C.E. and Pidek, D.G., 1979. Science (In press).

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System

CHANGES AT THE VIKING LANDING SITES

Arvidson, R.E. and Guinness, E.A.

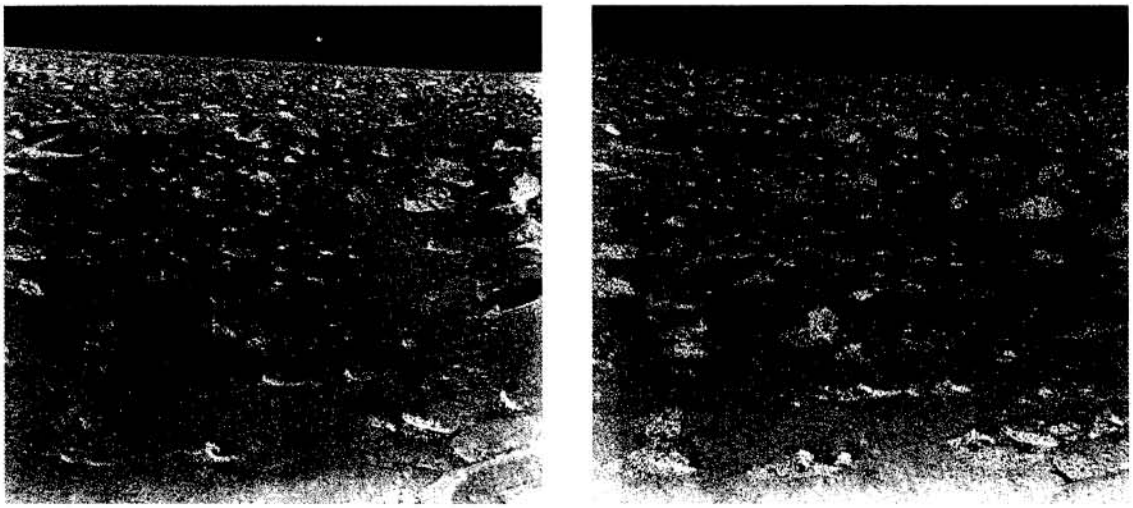

Figure 1: Viking Lander 2 Red/Blue images are shown for pre-storm (left) and post-storm (right) time frames. The sky (sunlight and skylight) has the lowest R/B ratio, while skylight in shadows (bright speckled areas extending from rocks) has the highest R/B ratio. The surface sampler arm shroud is the dark cylindrical feature on the left image - the shroud is made of gray metal and its brightness in the pre-storm image is controlled by the color of the sky. Note, however, that the shroud has increased in R/B relative to the sky in the post-storm picture, suggesting coating by red dust. The pre-storm image shows variable R/B ratios for the soils and rocks. In the post-storm image the soil contrast has markedly decreased, which can be explained by the accumulation of a small amount of red dust. VL2 frames 22A190/023 and 22F140/449.

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System