TIMING OF FROST DEPOSITION ON MARTIAN DUNES: A CLUE TO PROPERTIES OF DUNE PARTICLES? P. Thomas, Cornell University.

The nature of the particles in martian dunes has been a source of controversy since the discovery of dune forms on Mars. Their color and high thermal inertias have suggested that the dark dunes are made of medium to coarse grained, minimally weathered basaltic or similar materials. The common association of the dunes with the polar layered deposits, however, has raised questions about whether the dune particles could be agglomerations of much finer particles that can be carried into the polar regions in suspension. It is also not known if the dark material at the surface of dune fields is representative of the bulk of a dune deposit; thick dune fields immediately adjacent to layered deposits are very suspect in this regard. Information on the physical properties of the dunes may be available from the behavior of frost deposition and loss from the dunes. Thomas et al. (1979) found that some dunes at high southern latitudes appeared to be sites of early frost deposition in the fall; James et al. (1979) noted many dunes retained frost late into the spring. We have now mapped the occurrences of dune brightening in the fall and have done the quantitative photometry needed to confirm that the dunes are the sites of early frost deposition.

Early deposition of frost on dark dunes is spectacularly displayed in early fall images by Viking Orbiter 2. Where there are data at the appropriate season, virtually all the dark dunes between 58 and 72°S become bright patches instead of dark areas a few days before the general cap edge passes their locale. The surroundings then brighten rapidly and usually become slightly brighter than the dunes. In the spring, some, but not all, of the dunes remain brighter than their surroundings for several days after passage of the general cap edge to the south.

We have made scans across the dunes in images taken at several different times to determine the time history of the dune albedo. We have estimated atmospheric contributions using optical depth data (F. Jaquin, pers. comm.) and the brightness of shadows in some images. Phase angles are generally over 90° but the viewing geometry does not vary greatly so phase functions are not a major problem. The data show that the dunes brighten very substantially between L_S = 10° and 40°, depending on the latitude. Bright coverings on dunes form outliers 1 to 5° north of the cap edge. Formation of the general cap then sometimes again reverses the contrast of the dune field with the surrounding area (Fig. 1).

Similar data are not available for the north, partly because of the imaging sequences, and partly because of the different distribution of dunes. However, some dunes that are outliers south of the main dunes retain frost throughout the martian year.

Early deposition of frost on dunes, relative to surroundings, could be caused by: (1) More rapid heat loss from dunes; (2) trapping of blown frost; (3) volatiles in the dunes being trapped at the surface in times of cooling atmospheric temperatures. A separate issue is whether the frost is

water or carbon dioxide. More rapid heat loss would imply a lower thermal inertia than the average. Most data on dark martian dunes suggests that they instead have a higher thermal inertia.

The dunes are trapped sediment, thus trapping of blown frost might be expected. However, the excellent correspondence of brightening with the edge of the dunes suggests the presence of dark material is the important characteristic. Additionally, winds in the fall season appear different from those that form the dunes (Thomas et al., 1979).

Water ice trapped in the dunes at depth and at warmer temperatures than the cooling surface might cause deposition of water frost on the surface in an otherwise very dry hemisphere of Mars. It is not clear, however, that the small amount of water that could diffuse to the surface could explain the amount of the albedo change or that it could help explain the extra retention of frost in the spring. The investigation is now concentrating on the amounts of frost necessary to cause the albedo changes and thermal modelling of the regolith.

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References

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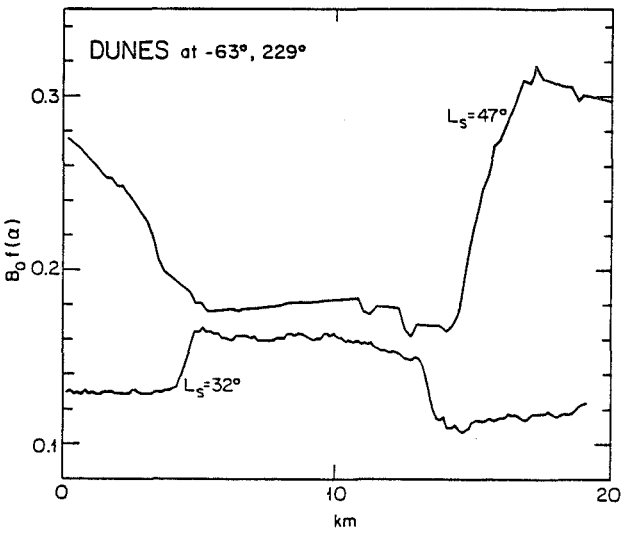

Figure: Reflectance scans across an intra-crater dune field, showing the early fall brightening of the dunes followed by greater brightening of area outside dunes. Data at L_s = 32° are from Viking image 510B76; at L_s = 47°, 545B15. The I/F values have been corrected for atmospheric contribution based on nearby optical depth data, and reduced to $B_0 f(\alpha)$ with a Minnaert k of 0.5. The dunes were 30% darker than surroundings at L_s = 353°. Part of the difference between dunes and surroundings at L_s = 47° is due to shadowing by the dunes.