THE WINDBLOWN SANDS OF MARS: ESTIMATION OF THE AMOUNT OF SAND IN DARK INTRACRATER DEPOSITS. Kenneth S. Edgett and Philip R. Christensen, Department of Geology, Arizona State University, Tempe, AZ 85287-1404.

Windblown sands are probably the dominant and controlling agent in maintaining the morphology and characteristically low albedo of the dark units which occur on the floors of many martian craters [1-7]. The mean effective particle size of the dark intracrater features on Mars (between ± 50° latitude), derived from Viking Infrared Thermal Mapper (IRTM) thermal inertia determinations, is in the range of coarse sand (500 - 1000 μm), the standard deviation is from medium to very coarse sand (250 - 2000 μm) [4,6,7]. Thermal infrared data analysis and aeolian physics arguments, indicate that average martian aeolian dune grains are in the medium to coarse sand range (500 ± 100 μm) [8]. The effective particle size of dark intracrater features on Mars varies on a regional basis [6,7]. For example, dark features closest to dust-mantled Arabia have the lowest effective particle sizes (very fine sand), while those in the low-albedo Margaritifer Sinus have the greatest effective particle sizes (granules and pebbles) [6,7].

Spacecraft images have sufficient resolution to definitively identify dunes in only two of the regions examined; these pictures allow us to form a model which may explain the apparent regional differences in effective particle size of dark intracrater units. In Hellas Pontus there are several thick, continuous, transverse dune fields [9,10], while dune fields in Oxia Palus consist of very dark barchans superposed upon a less-dark interdune surface (Fig. 1). The Hellas Pontus dark features have thermal inertias of about 8.0 × 10^{-3} cal cm^{-2} sec^{-0.5} °K^{-1}; which corresponds to a particle size of ≈ 500 μm [8], while thermal inertias in Oxia Palus craters tend to be greater than 8.0 (10.1 ± 1.6) [7]. Provided that the interdune substrates in Oxia Palus barchan dune fields have higher thermal inertias than the dunes themselves, comparison of Hellas Pontus with Oxia Palus dark intracrater features suggests that the regional difference in effective particle size is the result of differences in the amount of windblown sand present within the craters.

Interdune thermal inertia was estimated for two barchan dune fields in Oxia Palus where Viking images reveal the presence of 25 ± 5% dunes in one and 30 ± 5% dunes in the other dune field. The thermal inertia of the interdune surface as a function of dune thermal inertia is shown in Figure 2. If the thermal inertia of the dunes is 8.0 [8], then the interdune inertia for the crater at 11.0°N, 2.8°W is 14.7, and for the crater at 6.5°N, 348°W, it is 13.0 (Fig. 2). These thermal inertias indicate material in the granule-to-small pebbles range, consistent with observations of terrestrial interdune surfaces in arid, unvegetated barchan dune fields [e.g., 11].

This analysis can be extended to other dark intracrater features where spacecraft image resolutions are insufficient to determine the presence of dunes. There are three variables involved: the thermal inertia of dunes, the thermal inertia of interdune or non-dune surfaces, and the fraction of each in terms of surface area. The thermal inertia of dunes is likely to be the closest of these variables to a constant of 8.0 [8]. The percentage of dune cover as a function of surface area is likely to be most variable when entire regions on Mars are considered, as demonstrated by the great difference in the amount of dune cover between Hellas Pontus and Oxia Palus. The thermal inertia of interdune surfaces likely varies from crater to crater, but in order to simplify the analysis, we can assume it is a value in the granule-to-small pebble range; here we have chosen the average, 13.9, of the two interdune thermal inertias from Oxia Palus (Fig. 2). Figure 3 shows our estimates, based upon these assumptions, for the amount of dune cover in 29 dark intracrater features in the central equatorial region of Mars. The model (Fig. 3) suggests that the craters in Margaritifer Sinus have very little sand cover, while those in Hellas Pontus have considerable amounts of sand, and those in Oxia Palus and Mare Elysium have moderate amounts of sand. The amount of sand present in a dune field can be indicative of dune morphology; barchans commonly occur where there is much less sand than in transverse dune fields. Thus we can predict the possible morphology of dunes that have not yet been identified in places like Margaritifer Sinus due to spacecraft image resolution constraints. We suspect that the differences in sand abundance is the result of the interplay between regional wind regime [7,12] and the amount of sand-sized sediments supplied by local source rocks [7]. Equatorial and mid-latitude regions of generally low albedo tend to be those that experience the strongest martian
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winds [7,12]. Salination is most likely to occur under the windiest conditions; thus, regions on Mars that have a low albedo are probably those where sand is actively transported, removing fine, bright dust. However, dune fields or the amount of sand cover in craters in the lower albedo regions, like Margaritifer Sinus, tend to be sparse relative to places of higher regional albedo like Hellasaeon. Perhaps the thicker, more continuous accumulations of sand in Hellasaeon indicate that it is more difficult to remove sand from crater floors in regions where the winds are not always strong. Alternatively, the differences in the amount of sand present on crater floors may be indicative of regional differences in the amount of sand-sized grains that have been provided by eroding bedrock.

Fig. 1. Barchan dunes (white arrow showing downwind direction) in crater at 1.9°N, 315.7°W (Viking 709A42).
Fig. 2. Interdune thermal inertia as a function of dune thermal inertia for 2 barchan dune fields in Oxia Palus craters. Crater at 11.0°N, 2.8°W is in Viking 708A03, Crater at 6.5°N, 348.4°W is in Viking 411B20.
Fig. 3. Model of dune cover in dark intracratr features in the central equatorial region of Mars (See text).