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Comparisons of Wind Streak Form in Egypt and on Mars.

It is evident in orbital photographs and images that wind-dominated landforms are the most abundant features throughout northern Africa and particularly in the Western Desert of Egypt. Both bright- and dark-toned wind streaks occur in the Western Desert. Bright streaks are composed of sand dunes and dune belts, sand sheets, and lag deposits of light-colored bedrock, whereas dark-toned streaks are predominantly local lag fragments and desert pavement (1). As seen from orbit, the dark streaks in the Western Desert occur in the lee of topographic obstacles to the predominant northerly winds, and create streamlined patterns similar to those in the lee of craters and knobs on Mars.

In the southern part of the Western Desert, knobs of protruding bedrock and associated wind streaks form an irregular line between the Kharga depression and the Gilf Kebir plateau region (Fig. 1). The bedrock exposures are composed of highly resistant, Fe-rich sandstones and conglomerates of the Nubia series, although east of the Bir Tarfawi region, the protruding knobs consist of outcrops of granite. The linear nature of the Nubia sandstone outcrops is created by the gently northward dipping attitude of the beds, which have been partially submerged by sand driven from the north. It is possible that these linear outcrops mark the positions of low cliffs retreating northward and partly subdued by eolian sand.

For comparison of streak form, the martian streaks were measured from enlarged Viking Orbiter images of the Cerberus region at a scale of 1:425,000. Martian crater and knob streaks range up to 36 km in length and 17 km in width, and the maximum area of 179 knob streaks is 450 km², whereas that of 62 crater streaks is 342 km². The 239 knob streaks in southwestern Egypt, as studied using Landsat false color images at 1:250,000 scale, range up to 21 km² in area, and are up to 12 km long and 5 km wide. Because of the less distinct outline of the larger Egyptian streaks, only those smaller than 100 km² were used for shape comparisons.

A plot of the maximum width and length of martian crater and knob streaks and Egyptian knob streaks indicates that all three streak types follow the same general curve, although the degree of scatter increases from crater to knob streaks. Knob streaks in the southwestern corner of Egypt exhibit the greatest scatter (r = 0.618) and are generally narrower than their martian counterparts. The relatively small width of the Egyptian streaks is also indicated by a plot of streak length versus total area. As shown in Figure 2, the total area of the Egyptian streaks is much less than that of martian streaks. In both cases, however, the range of values is similar for streaks less than about 50 km² in area.

In order to compare the degree of streamlined shape versus length for streaks on both planets, we have chosen a dimensionless shape parameter (K) used by Chorley (2) to analyze the shape of drumlins, and more recently by Baker (3) for loess islands in the channeled scablands of Washington. The value of K indicates the deviation of the observed form from that of a circle: $K = \frac{l^2}{\pi A}$, where $l$ is the length of the form, and $A$ is the area. Thus, a circle would have a value of $K = 1$. For streamlined forms in the
channeled scablands, K varies between 2 and 5, and may be related to the calculated Reynolds's number for maximum scabland flood flows (3).

For crater streaks on Mars, values of K range from 0.6 to 4, and can be correlated with the length of the streak (Fig. 3); the longer the streak, the greater the degree of streamlining. Although this relationship holds for knob streaks on both planets, there is a significant difference in the slope of the regression curve between martian and Egyptian knob streaks. Values of K for the Egyptian streaks range from 0.3 to 9, and have a greater ratio to streak length than that of the martian streaks, indicating the relatively higher degree of streamlining for the Egyptian knob streaks. Elongation of the Egyptian streaks most likely results from their mode of formation by the southward movement of sand by near-surface winds that deviate around topographic obstacles. This style of transport and deposition has resulted in the build-up of more than a meter of sand deposits surrounding the dark, lag-composed streak in the lee of El-Ma'ayyit hill (4). This suggests that locally-derived material from the hill forms the dark streaks, whose boundaries are defined by the wind-transported materials.

REFERENCES

Figure 1.

(A) Landsat mosaic of southwestern Egypt showing prominent wind streaks in the lee of hills and mountains.

(B) Close-up view of dark knob streaks in Egypt. Note composite streak in center of image, formed by several hills.
Figure 2. Length vs. area for martian and Egyptian wind streaks.

Figure 3. Shape parameter (K) versus length for martian and Egyptian wind streaks.