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# REGIONAL SOURCES AND SINKS OF DUST ON MARS: VIKING OBSERVATIONS OF CERBERUS, SOLIS PLANUM, AND SYRTIS MAJOR;

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Seasonal variability of classical martian albedo features has long been noted by terrestrial observers [1,2]. Spacecraft observations of such features have shown them to be related to aeolian transport of bright dust into and out of regions, primarily in association with major dust storms [cf. 3,4]. Investigation into the amount and direction of dust transport related to variable features can reveal regions which, at present, act as either sources (net erosion of dust from an area) or sinks (net deposition) [5,6].

A study of seasonal variations of albedo features in the Cerberus, Solis Planum, and Syrtis Major regions has been based on Viking Orbiter data obtained over more than one complete martian year. Contour maps of Lambert albedo and single-point thermal inertia have been constructed from the Infrared Thermal Mapper (IRTM) experiment data, and Orbiter images have been used to determine the pattern and variability of regional winds ( inferred from wind streak orientations). Coupled with ground-based radar data, these data sets allow the regional sediment transport direction, surface properties (texture, morphology, and roughness), and the implications of the observed seasonal and longer term dust redistribution, to be investigated. The results of this study are outlined below.

Solis Lacus, the most prominent dark albedo feature in Solis Planum, extends over approximately 20° of longitude and 10° of latitude (centered at 25°S, 85°W), and contains and is surrounded by a conspicuous pattern of bright and dark wind streaks. The albedo feature is highly variable in extent and contrast with its surroundings, generally being most distinct during southern spring and summer (minimum Lambert albedo ~0.13) and less distinct during southern fall and winter (minimum albedo ~0.16). The regional thermal inertia values (~8-10 x $10^{-3}$ cal/cm$^2$/sec$^{1/2}$/°K) are indicative of a surface covered by particles larger than ~100 μm [7]. A seasonal dust-transport cycle has been proposed to explain these observations: 1) During late southern spring and summer, bright dust is eroded from the surface (possibly ejected by a saltation triggering mechanism) and transported from the region by local dust storms (several were detected by Viking, and have been commonly observed from Earth). Removal of dust over a wide area results in the dark, distinct, Solis Lacus feature. 2) Following cessation of dust-storm activity, sedimentation from the atmospheric dust load occurs over the entire region, decreasing the contrast of the albedo feature with its surroundings. 3) The cycle may be renewed by dust-storm activity the following year. The retention of some albedo features throughout the year, plus the constancy of the regional thermal inertia, requires that the albedo features do not involve erosion or deposition of substantial deposits; cycling of, at most, a few tens of μm of dust is indicated. Differences in time of occurrence, severity, and longevity of dust-storm activity may lead to the observed year-to-year changes in Solis Lacus.

Dramatic seasonal variability is also characteristic of Syrtis Major (~5°S - 25°N, 275° - 300°W). The feature lies on the low-albedo slopes of a volcanic shield [8] (generally darker than ~0.2 in albedo), the darkest area (albedo ~0.1) being closely associated with a mass of dunes located near the crest of the shield. Thermal inertias of ~8 x $10^{-3}$ cal/cm$^2$/sec$^{1/2}$/°K, plus the observed dunes, argue strongly for a sandy surface. Syrtis Major increases in albedo immediately following global dust storms, then darkens steadily through the balance of the year until reaching its pre-storm albedo (also confirmed in [9]). The observed trend of bright and dark streaks is in response to winds generally directed upslope and to the west. The dust-transport cycle consistent with these observations is: 1) Enhanced deposition from global dust storms increases the regional albedo. 2) The relatively mobile surface coupled with effective regional winds (possibly reinforced by the global circulation) results in ejection of dust from the surface and net transport to the west during the remainder of the year, yielding a decreased regional albedo. 3) Beginning of another global dust-storm cycle begins the process again. Such a transport cycle provides a mechanism for significantly enhanced deposition in the neighboring low thermal inertia region, Arabia (as suggested in [10]).

Cerberus is located to the south of the Elysium volcanoes on the gentle slopes (< 0.5°) of Elysium Planitia, extending over about 10° of latitude and 20° of longitude. The feature is generally darker than ~0.2 in albedo, with the eastern portion being darker (minimum albedo of ~0.14) than that to the west (minimum albedo ~0.16). The albedo pattern is closely correlated with the regional thermal inertias, with the darkest areas having inertias of ~10 x $10^{-3}$ cal/cm$^2$/sec$^{1/2}$/°K, while the slightly brighter western region exhibits lower inertias of ~8. The entire Cerberus feature is surrounded by brighter (albedos to 0.30), lower inertia (~4) material. The pattern of wind streaks suggests relatively constant effective wind directions from the east, indicating that the gentle topography is not sufficient to significantly alter or enhance the global circulation [5]. Seasonal albedo variations closely mimic those observed in Syrtis Major, although the post-dust-storm darkening is not as pronounced, suggesting that the aeolian environment is less vigorous in Cerberus. The albedo and thermal inertia east-west asymmetry is consistent, however, with coarser material residing in the east and being transported westward by the global winds. Cerberus may therefore be acting as a source of sediment which is transported by saltation rather than in suspension. .

These observations indicate that very different levels of aeolian activity give rise to the noted seasonal variability of these regions: 1) Syrtis Major presents a picture of an extremely active aeolian environment. Deposition occurs only during and immediately following major dust storms, while during the rest of the year regional winds are apparently effective agents of dust ejection and transport. Syrtis Major thus acts as a dust source region through most of the year, possibly supplying the neighboring dust sink region of Arabia. 2) Cerberus may be thought of as a less-vigorous version of Syrtis Major, with definite removal of dust following global storms. A net westward flux of coarser material is evident, possibly encroaching onto surrounding Elysium Planitia. 3) In Solis Lacus, local dust storms result in net removal of dust from the area, while deposition occurs from the atmospheric dust load throughout the remainder of the year. Solis Planum serves as a source region of dust only during the limited period (dust storm season) when regional winds are capable of inducing dust ejection from the surface. Contributions to the global dust load may occur only during major dust storms.

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C - 2