GEOLOGICAL CONSTRAINTS FOR THE SOLIS PLANUM "OASIS" ON MARS.

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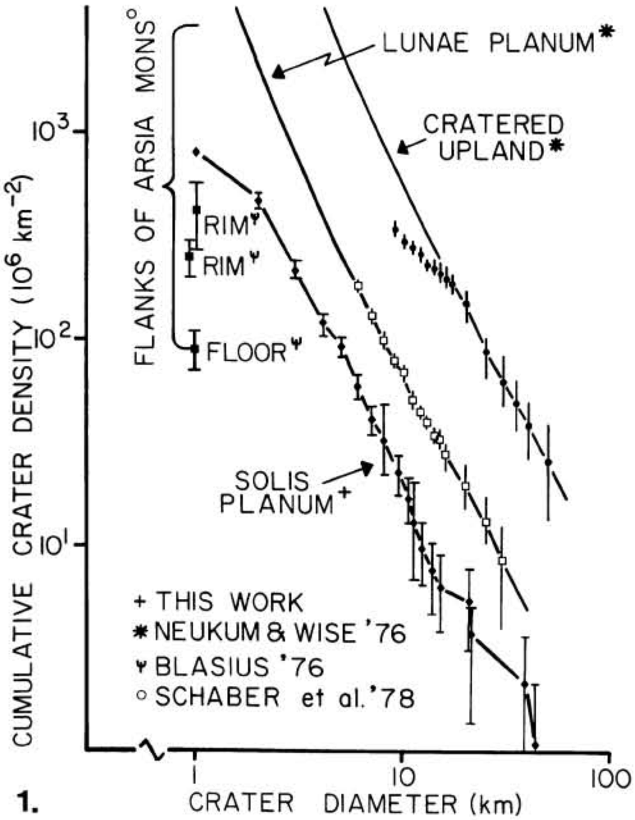
Introduction: Remote sensing data allude to the possible existence of anomalous H_2O sources at near-equatorial sites on Mars.[1,2] One such source region, or "oasis," is Solis Planum (18-32°S,75-110°W), an area prominent on global thermal inertia[3] and water vapor maps,[4] in addition to being the source region for many global dust storms.[1,5] We present here some geological observations of this region which might bear on its possible outgassing history.

Geology: Solis Planum has been mapped[6] as "cratered plains material" in the west and "ridged plains material" in the east, both of which were interpreted to be lava plains with a discontinuous veneer of eolian deposits. Viking orbiter images[7] illustrate that lobate flow boundaries and an extensive series of mare-type ridges[8] characterize these materials. Spacing of the ridges is about 40 km, while their lengths and widths are 300-450 km and 3-5 km respectively. The prominent N-S ridge orientation is attributed to deformation associated with the Tharsis updoming.[9,10] Crater size/frequency distributions (Fig. 1) indicate that Solis Planum is younger than Lunae Planum, older than the summit of Arsia Mons, and comparable in age to the flanks of Arsia Mons. At medium resolution (200-400 m/pixel), no present--nor past--sources of H_2O are obvious: there are no channel systems comparable to the features seen elsewhere on Mars.[11,12]

Craters: It has been shown that the range of fluidized ejecta from the crater center is influenced by the latitude, altitude, and target material in which the crater was formed;[13,14] this was interpreted as an expression of regional differences in target volatile content at the time of the cratering event. Fig. 2 compares the ejecta ranges of 48 Type 1 craters[13] in Solis Planum with similar data for 202 Type 1 craters between 15-35°S,75-95°W (i.e., the remaining craters measured within this latitude belt.) Clearly, no obvious differences in the two crater samples are seen, implying that the volatile contents of the upper 1-3 km of the martian crust are similar in both areas.

Radar: Goldstone radar data[15] have been utilized to examine the top 0.5-1.0 meters of the Solis Planum regolith through a comparison of surface reflectivity and roughness (c-factor) with values for other martian volcanic areas. Fig. 3 presents data for Solis Planum, Syria Planum and Arsia Mons. Unlike the other areas, Solis Planum is characterized by both high reflectivity (6-16%) and high c-factor (1600-5600) values. This combination indicates a very smooth and high-density (or high dielectric constant) radar-reflecting layer at or near the surface. While this cannot be conclusively associated with the existence of volatiles, these radar data do indicate unusual properties for the Solis Planum area that are consistent with the presence of small amounts of water or ice in the topmost meter of the regolith.[16]

Recent Conditions: Other evidence suggestive of geologically recent near-surface water or ice also exists. Fig. 4A illustrates a rayed crater with fluidized ejecta.[13] Because eolian erosion on Mars is a geologically rapid process,[17] bright ray material is quickly removed, suggesting that this crater is very young. However, the fluidized ejecta surrounding the crater intimates that subsurface volatiles existed within the target at the time of crater formation during recent martian history. High-resolution (10 m/pixel) Viking



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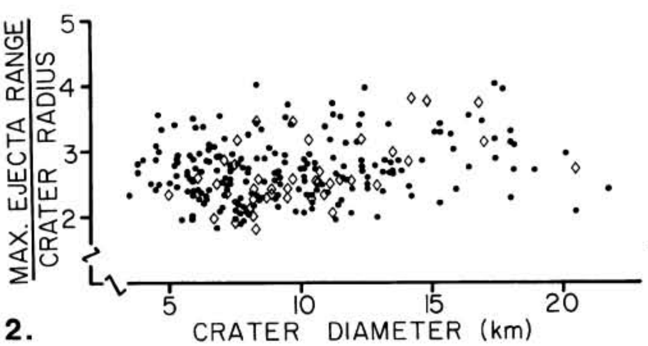

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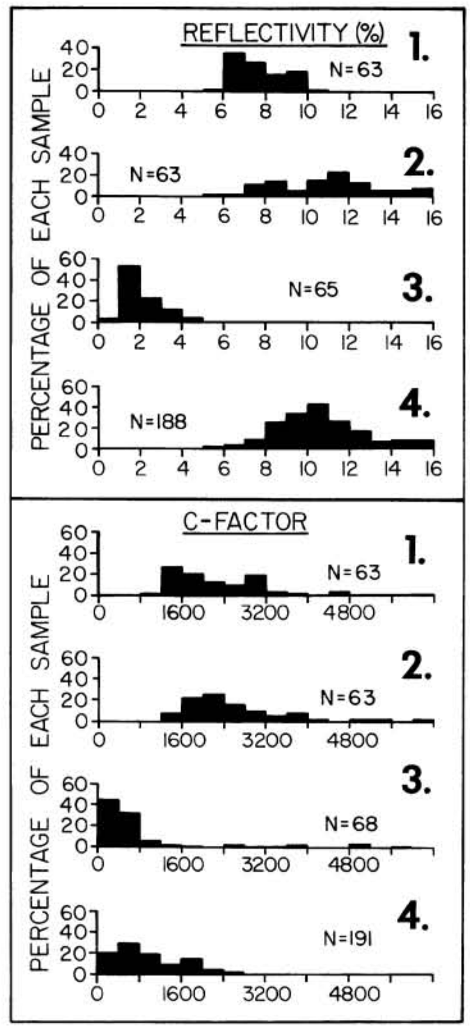

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Fig. 1: Cumulative crater size/frequency distributions for Solis Planum compared to other volcanic areas on Mars. 1 km intercept values are illustrated for flanks of Arsia Mons. Data from this work and refs. [20-22].

Fig. 2: Maximum ejecta range from crater center normalized to parent crater radius for 48 Solis Planum (diamonds) and 202 other (circles) Type 1 craters[13] between 15-35 S. The lack of a clear separation suggests that no significant preferential water/ice concentrations existed in Solis Planum at the time of crater formation.

Fig. 3: Goldstone radar data[15] for: 1) Solis Planum; 21.2°S, 80.0-90.0°W. 2) Solis Planum; 19.4°S, 80.0-90.0°W. 3) Arsia Mons lavas; 14.5°S, 115.0-130.0°W. 4) Ridges plains materials in Syria Planum; 17.0-22.0°S, 50.0-70.0° W.

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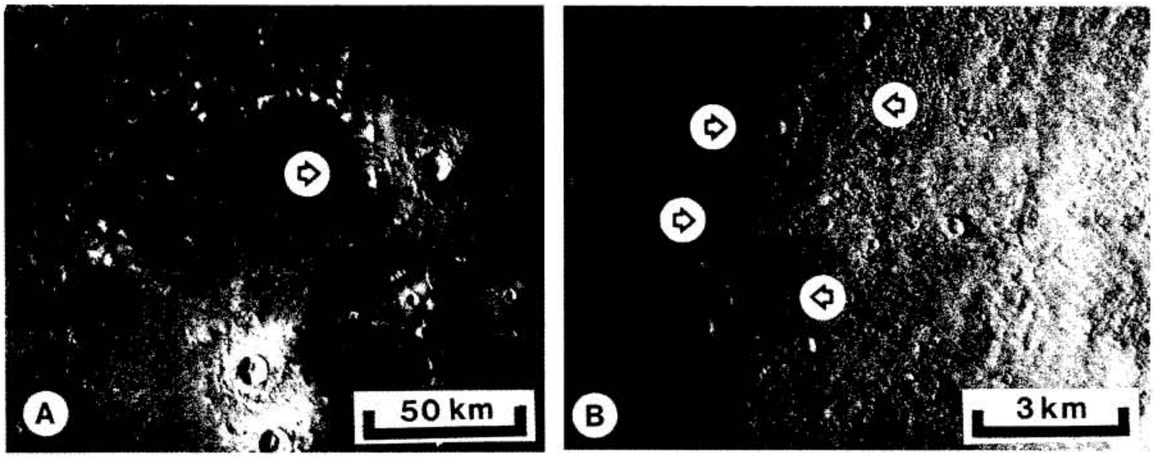

Fig. 4: A) 9 km diameter rayed crater (arrowed) at 26°N,25°W. Viking orbiter frame 864A01. B) Possible thermokarst terrain in Solis Planum at 27.9°S, 83.4°W. Arrows indicate depressions that may be the product of ground ice sapping, Viking frame 811A48. Illumination is from left.

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images of Solis Planum (Fig. 4B) also indicate many small depressions (<500 m diameter, ∿30-50 m deep) that are not observed in other volcanic areas of Mars. These small depressions may be thermokarst features,[18,19] which from their small size and close spacing would indicate near-surface deposits of ground ice.

Conclusions: No large-scale features corroborate the remote sensing evidence that Solis Planum is a source region for H_2O. Surface age, geology and crater ejecta ranges are similar to other areas of Mars. However, radar data and surface features smaller than 1 km are consistent with near-surface water or ice, although in themselves these data do not conclusively indicate the existence of the "oasis." If H_2O were to outgas in this region as suggested[1,2] it would apparently have to occur at a small scale on a regional basis, a conclusion which is reconcilable with the remote sensing observations.

References: [1]Huguenin et al., 1979, NASA-TM 80339, 208. [2]Huguenin and Clifford, 1979, Bull. Am. Astro. Soc. 11, 580. [3]Kieffer et al., 1977, J. Geophys. Res. 82, 4249. [4]Farmer et al., 1977, J. Geophys. Res. 82, 4225. [5]Huguenin and Clifford, 1979, Bull. Am. Astro. Soc. 11, 578. [6]McCauley, 1978, USGS Map I-897. [7]USGS Map I-1183. [8]Lucchitta and Klockenbrink, 1979, LPS X, 750. [9]Carr, 1974, J. Geophys. Res. 79, 3943. [10]Frey, 1978, J. Geophys. Res. 84, 1009. [11]Baker and Kochel, 1978, PLPSC 9, 3181. [12]Pieri, 1976, Icarus 27, 25. [13]Mouginis-Mark, 1979, J. Geophys. Res., in press. [14]Mouginis-Mark, 1979, NASA-TM 80339, 144. [15]Downs et al., 1975, Icarus 26, 273. [16]Zisk, 1980, pers. comm. [17]Arvidson et al., 1979, Nature 278, 533. [18]Carr and Schaber, 1977, J. Geophys. Res. 82, 4039. [19]Theilig and Greeley, 1978, Proc. 2nd Colloq. Plan. Water Polar Processes, Hanover, NH, 151. [20]Neukum and Wise, 1976, Science 194, 1381. [21]Blasius, 1976, Icarus 29, 343. [22]Schaber et al., 1978, PLPSC 9, 3433.