ALBEDO STUDY OF THE DEPOSITIONAL FANS ASSOCIATED WITH MARTIAN GULLIES.

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Introduction: The discovery of geologic features resembling terrestrial water-carved gullies reported by Malin and Edgett [1] in *Science* has sparked considerable debate among the scientific community. Numerous proposals have been submitted to explain what appears to be evidence of flowing liquid erosional features (gullies) on the surface of Mars in its recent past. Mellon and Phillips [2] reported on two possible mechanisms for the origin of liquid water on the surface of Mars in relation to these gully landforms. Using orbital climate changes for both mechanisms they investigated melting of near surface ground ice and melting of subsurface ice by geothermal energy. In both mechanisms reference to dissolved salts in the ice table are included as a possible factor in freezing point depression to a value low enough for liquid water to occur on or just below the surface of Mars. It is reported by Mellon and Phillips [2] that a 15-40% by weight of dissolved salts in a frozen aquifer is required to accomplish this effect. Using Mars Orbital Camera images provided by Malin Space Science Systems, Mellon and Phillips [2] have ruled out this possibility, citing lack of albedo evidence.

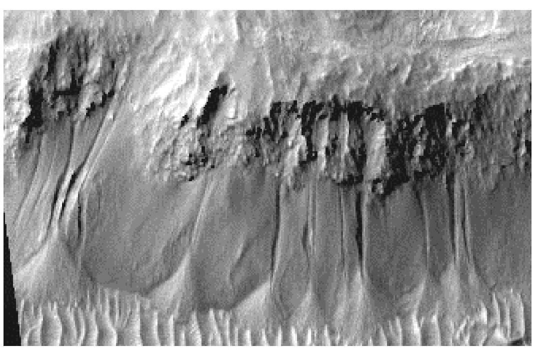

Figure 1. Martian gullies, MOC image E0501789 from Nirgal Vallis in the Margaritifer Sinus geographical region.

Experimental: This work is a two-part preliminary investigation concerning the albedo of the depositional aprons or fans associated with these gully features.

Part one involved analysis of numerous Mars Global Surveyor MOC [3] and Mars Odyssey THEMIS [4] images provided by Malin Space Science Systems and Arizona State University via the Internet. Using Adobe Systems Photoshop 5.0 software, we produced luminosity histograms, as in Figure 2, of the depositional fans and of the Martian soil directly adjacent to each fan. Due to image resolution, typically only one set of histograms was possible per image although, as seen in Figure 1, multiple readings were possible in some cases. Using the mean luminosity values quoted by the histograms, we compared the apparent brightness of each area. The graph in Figure 3 displays this comparison.

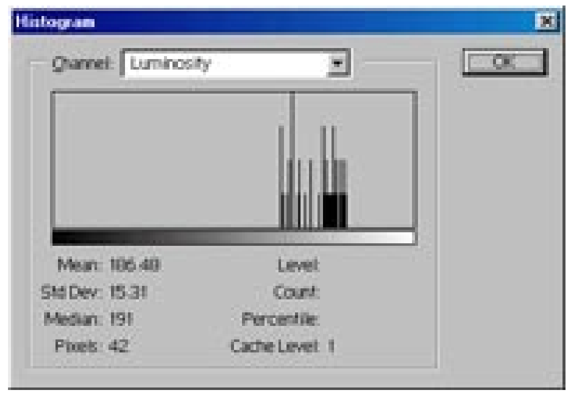

Figure 2. Example of the Adobe Systems Photoshop 5.0 Luminosity Histogram used to compare the albedo of the aprons with that of adjacent terrain.

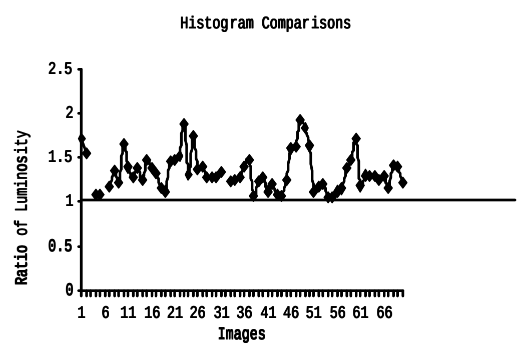

Figure 3. Ratio of the luminosity of 70 depositional aprons to that of their adjacent areas. All of the aprons measured had higher albedo than the surrounding terrain, typically by about 20%.

Part two of this investigation involved determining whether this albedo increase could be the result of evaporites. Sixteen 5g samples of Martian soil stimulant JSC-Mars 1 were placed in a multiple sample holder to form a grid (See Figure 4). To rows 1-4 of the grid were added brine concentrations of 15, 20, 25 and 0 wt %, respectively. Column 1 of the grid is the untreated dry control samples. Columns 2-4 are samples that had 5 ml, 2.5 ml, and 1.5 ml of brine solution added. In the case of the addition of 5ml of solution, the 5g soil sample was totally saturated with pooled liquid on top of the sample. The soil sample grid was placed in a convection oven set at 35 °C to evaporate the H_2O. The samples were stirred repeatedly during the evaporation process to ensure a homogeneous mixture of soil and salt evaporite. Digital imaging of the sample grid was performed with a 4 Mega-pixel Kodak digital camera under 4 G.E. Model 120BR40/PL 120 W Grow and Show floodlights. Grid imaging was conducted with 90° rotation between images so that lighting differences could be averaged out. Using Adobe Systems Photoshop 5.0 software again, we produced luminosity histograms of the soil sample grid. The quoted mean luminosity values for each brine treated sample were then compared with that of the control samples. The graph in Figure 5 illustrates this comparison.

Figure 4. JSC-Mars 1 sample grid photographed obliquely in room light. For the experiments, white lights were used and the samples were photographed perpendicularly. Various amounts of NaCl brine solutions were added and the after drying albedo was compared with that of control samples.

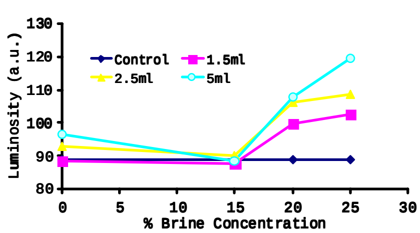

Figure 5. The luminosity of the soils as a function of the amount and concentration of brine added to the soil prior to drying. A 20 wt% solution of brine causes the albedo to increase, with a slight dependency on the concentration of the brine.

Discussion and Conclusions: Martian gully features occur primarily between 30°– 60° south of the Martian equator; only rarely are gully-like features observed outside of these areas. There are three major concentrations of classic gully features, Nirgal Vallis in the Margaritifer Sinus region, Gorgonum Chaos in the Phaethontis region and Dao Vallis in the Hellas region. Based on the luminosity histograms taken from images located in these three areas, the graph in Figure 3 shows an obvious difference in apparent brightness between the depositional fans and the adjacent soil areas. The graph in Figure 5 shows that the JSC-Mars 1 soil samples displayed the same trend toward increased apparent brightness as the brine concentrations and degree of saturation increased. These data would suggest that that the depositional fans could in fact contain the dissolved salts necessary to accomplish the desired freezing point depression despite the quoted lack of albedo evidence. We realize that there are other explanations for a higher apparent albedo for the aprons and are currently exploring this.

Further Study: This is a preliminary study of a program we intend to enlarge with a greater study of soil simulants treated with a variety of solutions and we also plan to investigate quantitatively the effects of particle size. We also want to investigate more thoroughly albedo variations in the images and factors such as geometry that affect the data. We want to conduct an in-depth study of the Nirgal Vallis, Gorgonum Chaos and Dao Vallis regions to determine why these areas contain large concentrations of gully features.

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References: [1] Malin M.C. and Edgett K.S. (2000), *Science*, 288, 2330-2335. [2] Mellon M. T. and Phillips R. J., (2001) *JGR*, 106(E10), 23165-23179. [3] Malin M. C. et al. [E0501789], Malin Space Science Systems Mars Orbiter Camera Image Gallery, (http://www.msss.com/moc_gallery/). [4]Arizona State University, Mars Odyssey THEMIS image gallery (http://themis-data.asu.edu/).