Albedo Study of the Depositional Fans Associated with Martian Gullies. Jonathan Craig[1,2], Derek Sears[2], [1]Physics Dept., Southern Illinois University, Carbondale, IL 62901, [2]Chemistry Dept., Arkansas-Oklahoma Center for Space and Planetary Sciences, University of Arkansas, Fayetteville, AR 72701.

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 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. They cite a lack of albedo evidence from the depositional aprons located at the base of each gully. It is assumed that the percentage of salt necessary to accomplish the desired freezing point depression would be easily observable in the albedo of these aprons due to the "white" color associated with salt evaporites.

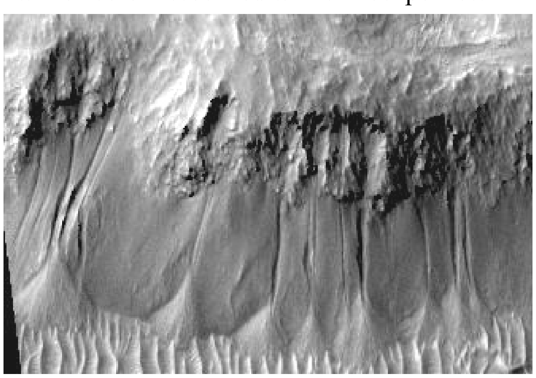

Figure 1. Martian gullies, MOC image E0501789 from Nirgal Vallis in the Margaritifer Sinus geographical region.

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, I 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 Figure1, multiple readings were possible in some cases. Using the mean luminosity values quoted by the histograms, I compared the apparent brightness of each area. The graph in Figure 3 displays this comparison.

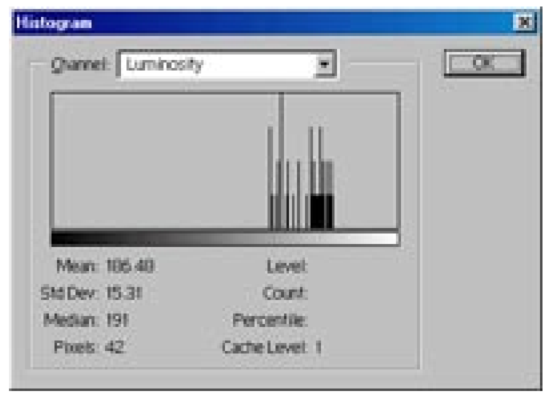

Figure 2. Adobe Systems Photoshop 5.0 Luminosity Histogram.

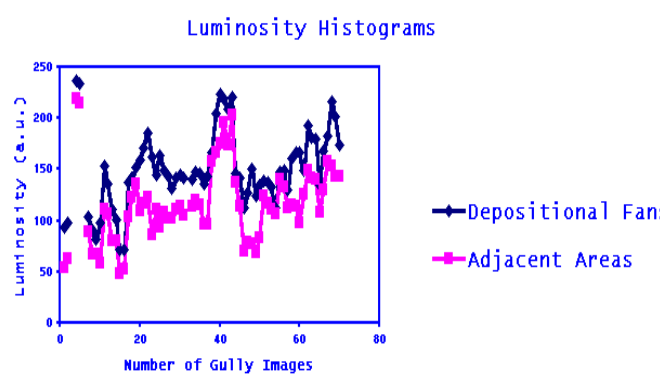

Figure 3. Graph of Luminosity Histograms

Part Two of this investigation required the use of simulated Martian soil JSC-Mars 1. Sixteen 5g samples were placed in a multiple sample holder to form a grid (See Figure 4). Rows 1-4 of the grid are brine concentrations of 15, 20, 25 and 0% respectively. Column 1 of the grid is the untreated control samples. Columns 2-4 are samples that have had 5ml, 2.5ml, and 1.5ml of 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, I produced luminosity histograms of the soil sample grid. The quoted mean luminosity values for each brine treated sample was then compared with that of the control samples. The graph in Figure 5 illustrates this comparison.

Figure 4. JSC-Mars 1 sample grid.

Discussion and Conclusions: Martian gully features are said to occur primarily between 30°–60° north and south of the Martian equator. There are isolated incidents of gully-like features outside of these areas but the majority occur within these latitudes and predominantly in the southern hemisphere. A thorough analysis of the MOC and THEMIS[4] images revealed that very few occur in the northern hemisphere. The southern hemisphere, on the other hand, has two major concentrations of classic gully features with only rare occurrence outside these areas. Nirgal Vallis in the Margaritifer Sinus region and Gorgonum Chaos in the Phaethontis region are the specific areas in which the majority of gully features appear to occur. Similar geologic features located in both hemispheres do not display the concentrations found in these two areas. Typically, images quoted in the various publications come from these geographic regions. Based on the Luminosity Histograms taken from images located in these two areas, the graph in Figure 3 shows a 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. Based on this investigation it is my opinion 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.

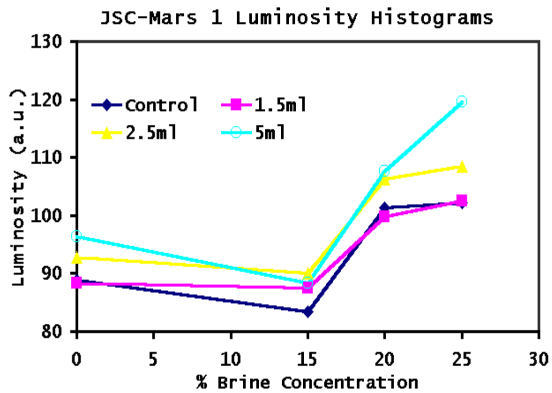

Figure 5. Graph of Soil Histograms

Further Study: Continue the luminosity comparisons using the JSC-Mars 1 soil with various types of dissolved salts. Conduct IR Spectroscopy on the soil samples to determine the minimum concentration necessary to produce an evaporite signature. Conduct an in-depth study of the Nirgal Vallis and Gorgonum Chaos regions to determine why these areas contain large concentrations of gully features.

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References: [1] Malin, M.C., and K.S. Edgett, Evidence for recent ground water seepage and surface run-off on Mars, Science, 288, 2330-2335, 2000. [2] Mellon, Michael T. and Roger J. Phillips,Recent gullies on Mars and the source of liquid water, Journal of Geophysical Research, Vol. 106, No. E10, 23165-23179, 2001. [3] M. C. Malin, K. S. Edgett, S. D. Davis, M. A. Caplinger, E. Jensen, K. D. Supulver, J. Sandoval, L. Posiolova, and R. Zimdar, [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/).