INVESTIGATING THE MARTIAN GULLIES FOR POSSIBLE BRINE ORIGIN: A PRELIMINARY SEARCH FOR EVAPORITE MINERALS USING THEMIS DATA. M. D. Lane[1], P. R. Christensen[2], and the THEMIS Science Team, [1]Planetary Science Institute, 620 N. 6th Avenue, Tucson, AZ 85705 (lane@psi.edu), [2]Dept. of Geology, Box 871404, Arizona State University, Tempe, AZ 85287-1404.

Introduction: Photographs taken by both the Mars Orbiter Camera (MOC) aboard the Mars Global Surveyor (MGS) spacecraft and the Thermal Emission Imaging System (THEMIS) aboard the Mars Odyssey (MO) spacecraft have shown the presence of young gullies on Mars (Figures 1 and 2). These gullies occur at middle and high latitudes (predominantly in the southern hemisphere) in the walls of both impact craters and canyons [e.g., 1,2]. They are thought possibly to be formed by the melting of ground ice, groundwater seepage (possibly as brines), surface runoff, or even liquid CO_2, activated sporadically as a result of oscillations in Mars' orbit [1-6].

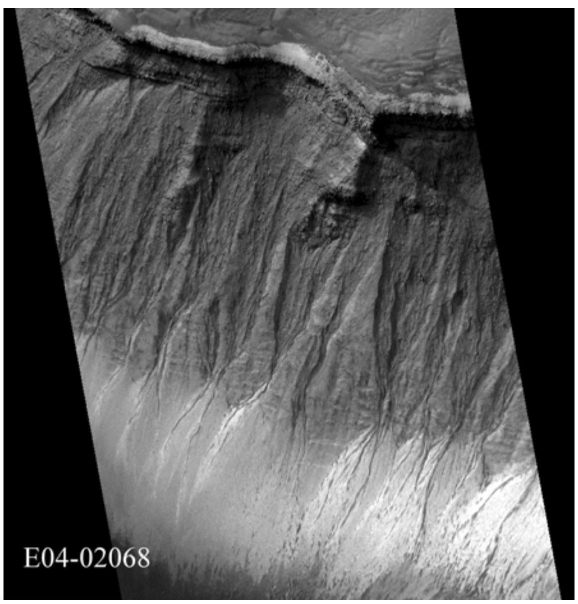

Figure 1. MOC image E04-02068 showing an example of gullies in a crater NE of Maunder.

For this work, the hypothesis of gully formation being related to the outflow of brines [4,5] will be investigated through the observation and study of spacecraft data. Brine–rich fluids expunged from underground onto the walls of canyons and craters would either evaporate or freeze and sublimate. Removal of water from a brine by evaporation or sublimation would cause the solutes to precipitate as evaporite minerals on the canyon and crater walls or at the base of the walls, and possibly on the canyon and crater floors. Hence, the gully sites are ideal target areas to search for evaporites using THEMIS data.

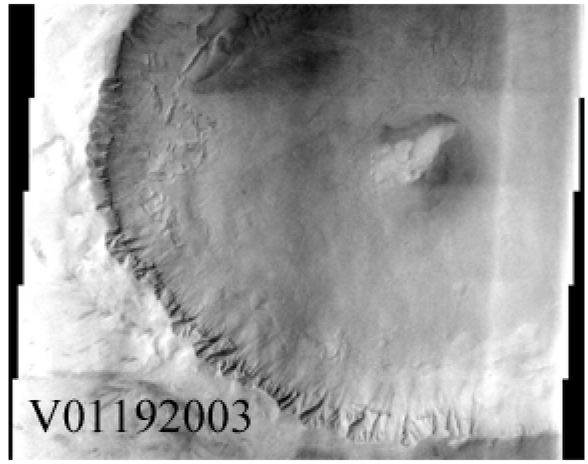

Figure 2. Portion of THEMIS visible image V01192003 (band 3; ~18-m/pixel resolution) showing an example of gullies on a crater wall. Image is 18-km wide.

Objective: The objective of this work is to survey the recently acquired THEMIS data for spectral evidence of evaporite minerals, with a focus on areas of gully formation. Identifying salt mineral residues could provide chemical evidence in support of the brine origin of the Martian gullies.

Preliminary work: Images from the MOC camera initially were surveyed to identify areas where salt deposits may occur on Mars in association with the gullies. The driving criterion for defining an initial area of interest was the presence of a relatively bright deposit in association with the gullies. Here we present a single example of our current strategy for finding and identifying evaporite minerals. Figure 3 shows a MOC image in which bright deposits appear in association with dark gullies. For this case, it appears that the bright deposits may possibly represent residual minerals that may have precipitated from the fluids that created the gullies. This example occurs in a small crater (centered at 41.5 °S, 201.8 °E) at the south-central portion of the Newton crater basin.

This crater has been targeted by the THEMIS instrument as well, but the THEMIS visible images acquired to date do not cover the northern crater wall seen in Figure 3. However, two daytime infrared (IR) images do include the crater (I0083002 and I01192002) in the Newton basin. A portion of THEMIS image I0083002 showing the entire crater is shown in Fig. 4.

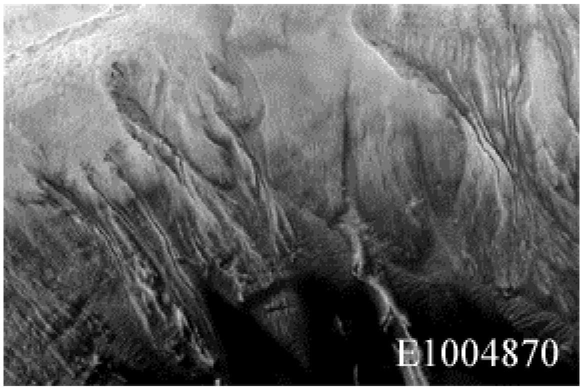

Figure 3. A section of MOC image E10-04870 showing dark gullies and bright deposits that may be associated with Martian brines.

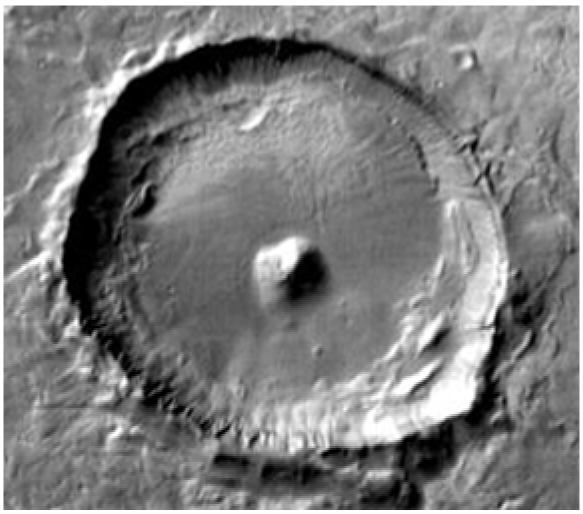

Figure 4. A subsection of THEMIS daytime IR image I0083002 (band 9) showing the crater whose north wall exhibits visible brightness (see Figure 3), possibly as a result of salt minerals.

The THEMIS daytime IR data consist of 10 midinfrared spectral bands (~6 to 15 μm), 9 of which are useful for studying the Martian surface mineralogy [7]. Band 10 is used as an atmospheric sounder. Bands 1-9 from image I00830002 were converted from spectral radiance measured by the instrument to emissivity. Thereafter, a principal component analysis (PCA) was performed. Figure 5 shows the results of one such analysis in which bands 3, 4, and 9 are assigned to red, green, and blue, respectively. Due to some band-to-band misregistration for the data shown in Figure 5, the PCA must be redone to account for the proper geometry prior to any spectral analyses.

At this preliminary point, spectral emissivity studies have not been done on the image so it is unknown what the 9-point spectra of any given color unit is; however, the variable colors in Figure 5 suggest that there will be mineralogical variety in this area where the Martian gullies occur. If evaporite minerals are identified in association with those features, their presence would support the brine-origin of the Martian gullies.

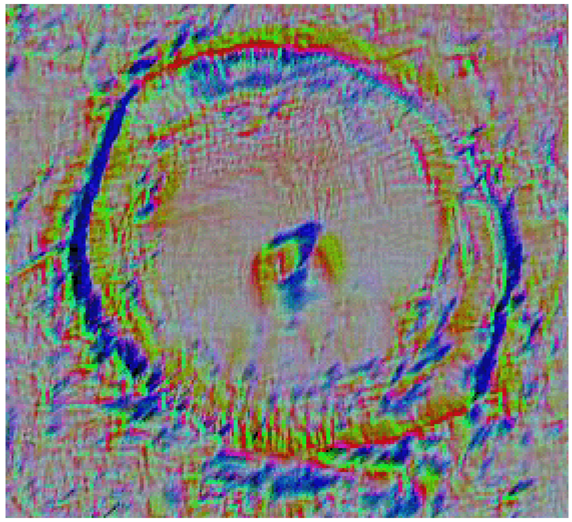

Figure 5. Three-band image using THEMIS daytime IR bands 3, 4, and 9 in red, green, and blue, respectively.

Future work: This abstract represents only preliminary spectroscopic work that has been done on the Martian gullies. In the near future more MOC images will be studied to identify target areas to be investigated using THEMIS visible and midinfrared spectral data. More laboratory work will be conducted to retrieve the emissivity spectra of additional salt minerals than currently exist in the ASU spectral library for comparison to the spectral data retrieved by THEMIS.

References: [1] Malin, M. C. and K. S. Edgett (2000) *Science, 288,* 2330. [2] Mellon, M. T. and R. J. Phillips (2001) *JGR, 106*, 23165-23179. [3] Costard, F., F. Forget, N. Mangold, J. P. Peulvast (2002) *Science, 295,* 110-113. [4] Knauth, L. P., S. Klonowski, and D. Burt (2000), *Science, 290*, 711-712. [5] Musselwhite, D. S., T. D. Swindle, and J. I. Lunine (2001) *Geophys. Res. Lett., 28,* 1283. [6] Burt, D. M., L. P. Knauth, and S. Klonowski (2002) *LPS XXXIII,* #1240. [7] Christensen et al. (2002) *Science*, submitted.

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