

Water Ice Investigation in Crater of Residual Polar Region using THEMIS Data. M. Thueson and H. Xie, Earth and Environmental Science, The University of Texas at San Antonio, San Antonio, TX 78249, U.S.A. (misti.thueson@gmail.com) (Hongjie.xie@utsa.edu)

Introduction: The evolution of Mars is deeply tied to water. In order to find out about the past or present biological potential of Mars we need to start with water, which is necessary for life. The climate interactions of the planet are deeply imbedded in the hydrological cycle. The geology of Mars has been very obviously impacted by water. In order to have eventual human exploration of Mars, water sources must be found. All four scientific goals have water embedded within them.

The Northern polar cap of Mars is covered with a seasonal ice cap. This ice cap is a mixture of water ice and carbon dioxide ice. The carbon dioxide ice layer waxes and wanes with the seasons. During the Martian winter and spring in the northern hemisphere the temperatures are cold enough that the CO₂ ice is solid. As the later spring emerges, the temperatures begin to rise, allowing the CO₂ ice to sublimate and uncover water ice in some areas [1, 2, 3]. The water ice that is found at the surface of the Martian planet is of great interest because it is the water that readily participates in the Martian water cycle and can be easily sampled by future robotic missions and later human missions [4]. The CO₂/H₂O interaction is important to understanding the geological processes near the pole as well as the overall Martian hydrological cycle and climate. These seasonal frost/ice fluctuations are the basis of this study, as seen in Inuvik crater at 79°N/331°E.

Methodology: Thermal Emission Imaging System (THEMIS) images retrieved from the NASA/Arizona State University data archive were the primary data source used. Both visible images and brightness temperature images were used. THEMIS is an instrument aboard NASA's Mars Odyssey spacecraft that has been orbiting Mars since February 2002. THEMIS's high spatial resolution (20 m) visual imaging system uses a 5-wavelength system and the infrared imaging system, with a resolution of 90 m, uses a 9-wavelength system [5,6].

Craters investigated were previously identified high albedo craters north of 70° N [7]. The study examined all fifteen craters identified in [7]. OMEGA, THEMIS, and HRSC data have been used to study the impact features. With imagery currently available, only two craters have been identified as possible water ice basins.

Results: The crater examined in this study is located at 79°N/331°E. Inuvik crater is found outside of the perennial north polar cap. This impact feature has a diameter of 20 km and a depth of 850 m as measured using MOLA images. The crater cavity has no significant central peak but more of a U-shaped cavity [7].

Available THEMIS data, both infrared and visible, is

shown in Table 1. Included are the image index, the image ID, the solar longitude (Ls) with the corresponding Martian season, and the Earth day when the image was taken. Images available spread throughout the Martian spring and summer. Visible images are seen from mid-spring to mid-summer. Thermal images are available from early summer to mid-summer.

As seen in Figure 1, as the seasons progress, the shiny CO₂ veneer begins to dissipate from the center of the crater. On the northern tip and south eastern side of the crater a bright patch appears as the CO₂ sublimates. During the spring the H₂O ice cannot be seen (Figure 1, image ID 2 and 3, 4). As Mars enters its summer, the water ice is clearly visible. Temperature images (Figure 2) show no difference in the area where the water patch is and the surrounding area (left image) during the middle spring. In the summer there is a noticeable difference in the temperature where the water ice (low temperature) is and the surroundings (right image).

Table 1: Available THEMIS images for Inuvik crater at 79°N/331°E visible (V) and thermal (I) [8].

Image ID	LS, Martian season	Earth date
1, I04121002	96.863, summer	11/18/02
2, V10724001	33.594, spring	05/15/04
3, V11036032	45.162, spring	06/10/04
4, V11348002	56.507, spring	07/05/04
5, I11972005	78.962, spring	08/26/04
6, V13170002	123.386, summer	11/09/04
7, V12883002	112.392, summer	12/02/04
8, I13195002	124.359, summer	12/04/04
9, I13974004	156.197, summer	02/06/05

Discussion and summary: Based on currently available THEMIS data for Inuvik, the water ice is only clearly visible during the mid to late summer months. During the spring the water ice is obscured by CO₂ ice. As the seasons progress there is a significant increase in the visibility of the water ice patches.

Additional work is needed to examine other craters. Also, as more imagery available from the various Mars missions, the previously examined craters need to be reexamined and reevaluated to see if there is better proof of the existence, or non-existence, of water ice. This additional information will greatly aid in the efforts to understand the basics of Mars water, including biological potential, hydrological cycle, and geology.

References: [1] H. H. Kieffer and T. N. Titus, Icarus 154, 162-180 (2001). [2] J.-P. Bibring et al., Nature 428,

627 (2004). [3] M. T. Zuber et al., *Science* 282, 2053-2060 (1998). [4] T. N. Titus et al., *Science* 299, 1048-1050 (2003). [5] J. C. Armstrong et al., *Icarus* 174, 360-372 (2005). [6] P. R. Christensen et al., *Space Science Reviews* 110, 85-130 (2004). [7] J.B. Garvin et al., *Icarus* 144, 329-

352 (1999). [8] P. R. Christensen et al., *THEMIS Public Data Releases*, Planetary Data System node, Arizona State University, <http://themis-data.asu.edu>.

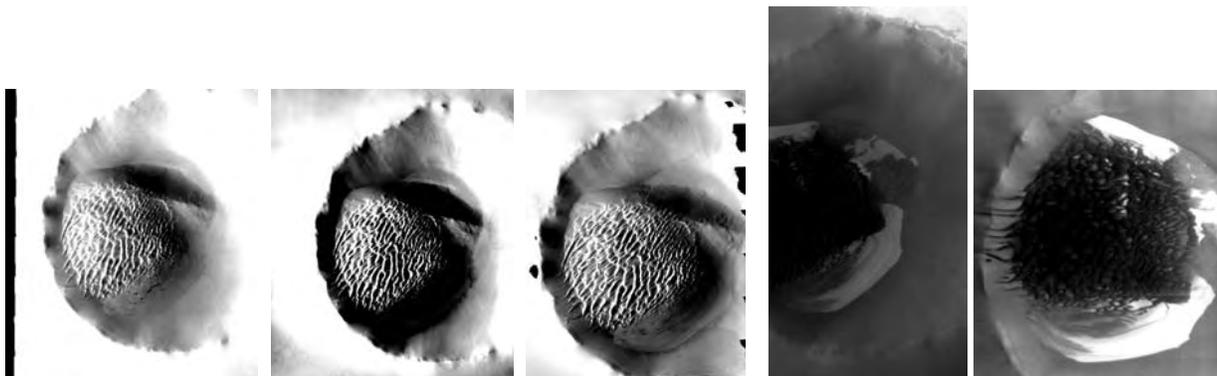


Figure 1: Visible THEMIS images of 2,3,4,6,9 from left to right (corresponds to Image ID from Table 1)

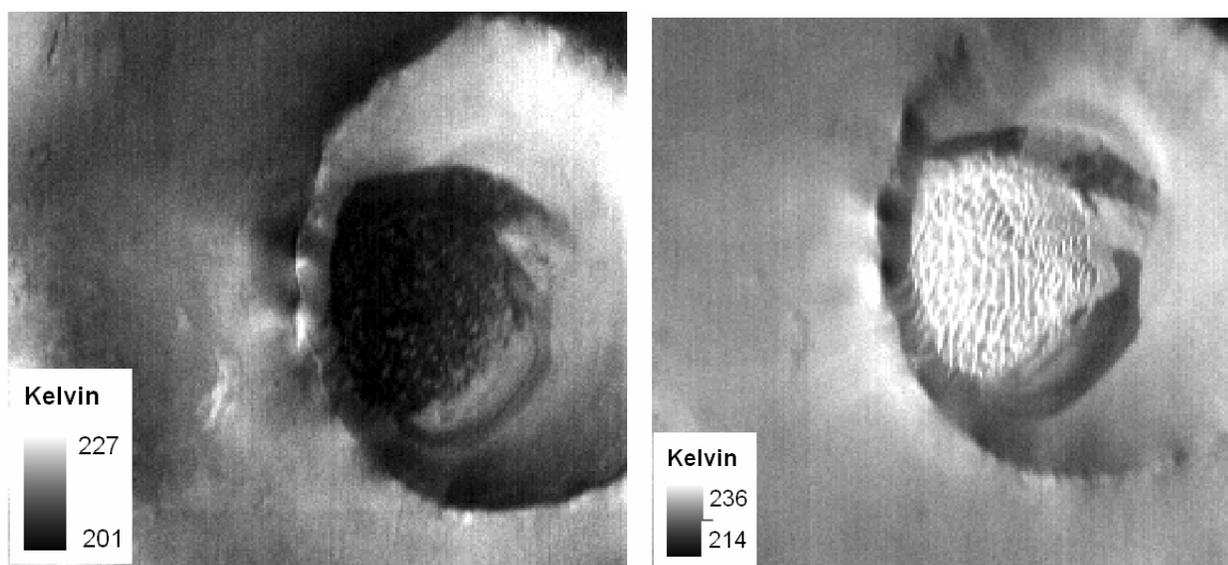


Figure 2. THEMIS thermal images of 5 (left) and 8(right) (corresponds to Image ID from Table 1)