SEASONAL VARIATIONS WITHIN KOROLEV CRATER, MARS. J. C. Armstrong[1,2], T. N. Titus[2], and H. H. Kieffer[2], [1]Weber State University, 2508 University Circle, Ogden, UT, 84408-2508, jcarmstrong@weber.edu, [2]United States Geological Survey, Flagstaff Field Center

Water Ice in Korolev Crater: Following the work of Kieffer and Titus [1], we present results of thermal IR observations of Korolev crater, located at 73° N, 196° W in the Martian northern polar region. Similar to techniques employed by Titus et al. [2], we use thermal infrared images from the THEMIS instrument aboard Mars Odyssey to identify several units within the crater basin with distinct thermal properties. The THEMIS results show these regions exhibit both temperature and albedo variations, spatially within the crater and throughout the Martian year. In addition to the variations identified in the THEMIS observations, Mars Global Surveyor Thermal Emission Spectrometer (TES) observations show differences in albedo and temperature of these units on both daily and seasonal cycles. Modeling diurnal and annual temperature variations of the surface, we use TES observations to examine the thermal properties of these units.

This analysis reveals the units are likely thick layers (several meters) of high thermal inertia material (water ice, or extremely water-rich regolith) overlaid by a thin layer (several mm) of low thermal inertia material (dust). Variations of the physical properties of these units are likely due to variable dust content (caused by erosion and deposition patterns within the crater) and possibly variations in the subsurface material itself.

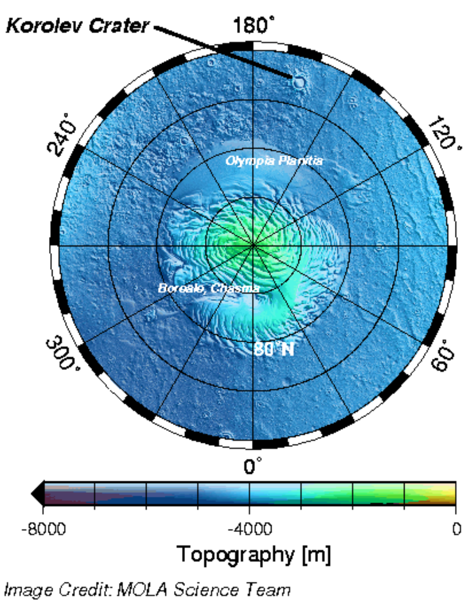

Figure 1. Location of Korolev Crater.

Location: The map (Figure 1) shows the location of Korolev crater relative to the residual ice cap on Mars. Fluctuations in the seasonal temperatures of the polar regions cause CO2 ice to condense from the atmosphere during the winter months, and regions such as Korolev exhibit evidence of water ice condensation in the summer months.

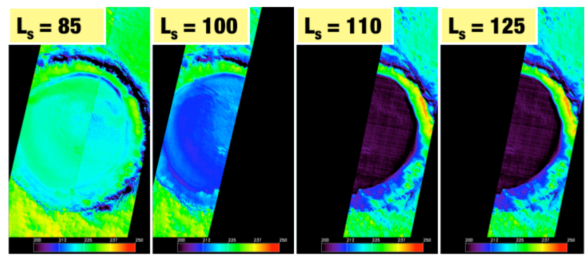

Figure 2. Above, the top row shows THEMIS thermal IR images of the variations of areas within Korolev as a function of season (L_s, where L_s = 0 is northern hemisphere spring).

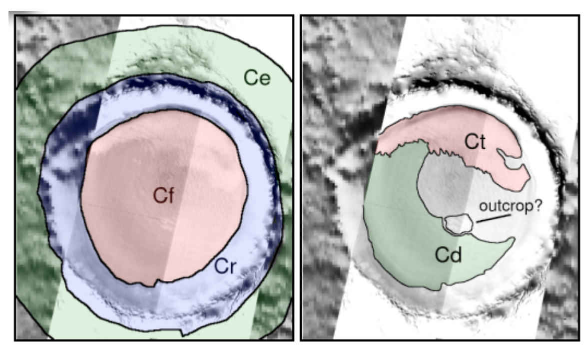

Figure 3. Identification of thermal features within the crater used in the analysis. Cf – Crater Floor; Cr – Crater Rim; Ce: - Crater Exterior; Ct – Northern light terrain; Cd – Southern dark terrain.

Thermal Imagery: Units identified from the thermal imagery are compared with thermal diffusion models of the top few meters of regolith. From Figure 2, we examine the thermal properties of the crater exterior, rim, and floor. We also focus on 'light' regions in the northern portion and 'dark' regions in the southern portion of the crater (units identified by thermal properties in Figure 3).

Thermal Models: Figures 4, 5, and 6 show albedo measurements as a function of season, along with bolometric temperatures derived from TES observations (open symbols). We derive thermal inertia curves (colored lines) for the specified

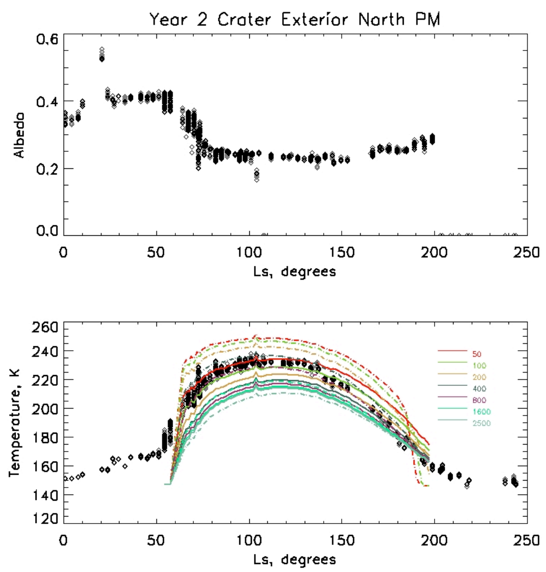

Figure 4. TES observations of the northern plains exterior to Korolev Crater. The upper plot shows the seasonal variation of albedo, and the bottom plot shows the seasonal temperature variations. The solid lines are the layered model thermal inertia and the dashed lines are the non-layered model

regions. Solid lines correspond to a layered model with the indicated thermal inertia in the top few millimeters (in the lower layers, thermal inertia is 2025 J m^{-2} K^{-1} $s^{-1/2}$, consistent with water ice). The dashed lines correspond to a homogenous model with the indicated thermal inertia. All thermal inertias are in units of J m^{-2} K^{-1} $s^{-1/2}$. The crater floor exhibits high albedo during winter due to condensed CO_2 but an increasing albedo after L_s = 125 degrees indicates re-condensation of water vapor at temperatures higher than the CO_2 frost point. This behavior is not seen outside the crater. The dark albedo exposed during early summer, and subsequent bright water frost, indicates exposure of a thin layer of dust, or mixture of dirty ice, in the top-most layer of the crater floor.

Thermal models of the crater floor reveal the current properties of the near-polar regions, and allow us to track both seasonal and inter-annual variation in these properties. Exploring the surface processes shaping the crater today allows us to extrapolate those effects into the past. Thus, this work will help identify potential landforms from previous climate regimes, when Mars' variable obliquity advanced the CO2 ice caps to much lower latitudes then currently observed [3], [4]

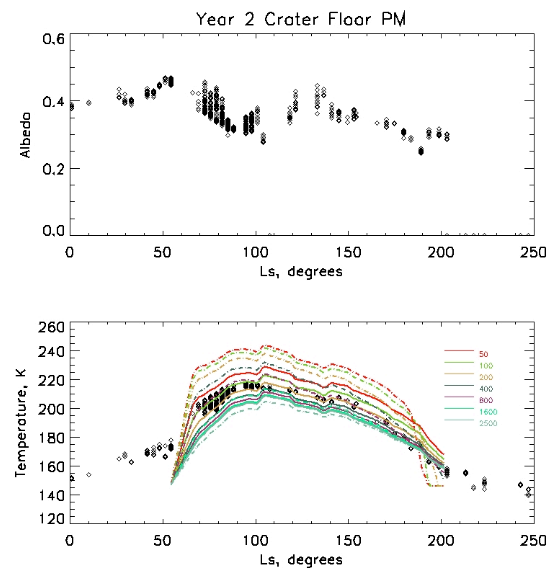

Figure 5. TES observations similar to Figure 4 for regions within the crater. The crater floor exhibits an increase in albedo after mid-summer, when the temperatures are too warm for solid CO_2 ice to form. We interpret this as summer H_2O condensation. The source of this water, based on the layered thermal model of the surface, is a region of subsurface ice or permafrost within the crater itself that releases water vapor as temperatures rise in the summer months.

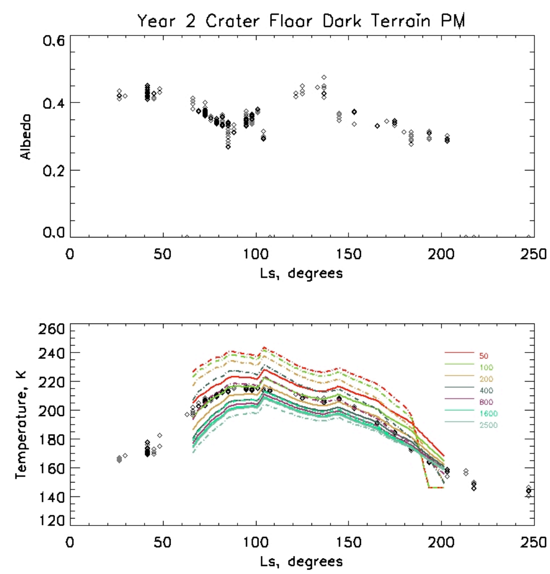

Figure 6. TES observations for region Cd, showing a stronger albedo peak after L_s = 125.

References: [1] Kieffer, H. H. and T. N. Titus 2001. Icarus 154, 162-180. [2] Titus, T. N., H. H. Kieffer, and P. R. Christensen 2003. Science 299, 1048-1051. [3] Armstrong, J. C. 2003. PhD Dissertation, University of Washington. [4] Armstrong, J. C., C. B. Leovy, T. R. Quinn, submitted to Icarus, 2004.