MONITORING THE KOROLEV CRATER ON SPRING AND SUMMER IMAGES IN THE MARTIAN NORTHERN POLAR REGION WITH CTX AND HIRISE. S. A. M. Bertilsson[1], M. Hajigholi[1], A. J. Brown[3], C. P. McKay[4], S. Fredriksson[1]. [1]Department of Physics, Luleå University of Technology 971 87 Luleå, Sweden, [3]SETI Institute, Mountain View, CA 94043, [4]NASA Ames, Moffett Field, CA, 94035. Email: angelique.bertilsson@gmail.com

Introduction: Change in albedo during spring and summer of the water ice covered crater Korolev have been previously reported. According to Armstrong et al. [1] Korolev exhibits an increase in summer time albedo, which they linked to water ice condensing during the summer months. Analyzing images of Korolev crater from different solar longitude, L_s, during spring and summer can help us understand how water behaves in the Martian Northern Polar Region, NPR. This work will analyze the images from CTX and HiRISE to map water ice and seasonal change in Korolev crater during northern spring and summer.

Location: Korolev crater is one of the northern Martian lowlands largest craters, roughly circular with an ~80 km diameter, containing significant ice rich material [2]. Figure 1 shows the location of Korolev crater relative to the residual cap at 73°N 165°E.

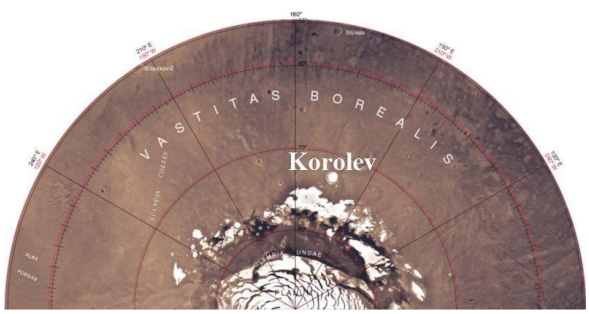

Figure 1. Topography map of Martian northern polar cap showing the location of Korolev crater at 73°N 165°E.
Source: Viking Color Image.

HiRISE and CTX: HiRISE, High Resolution Imaging Science Experiment, is a high resolution camera riding on MRO. It commenced operations in 2006 and is a 0.5 m reflecting telescope which give a colored (red, green and IR) and detailed resolution of 0.25 meter per pixel [3]. CTX is a context camera designed to obtain grayscale images with a resolution of 6 meter per pixel and a swath width of 30 km [4].

Korolev Data: With help of Google Mars, we have identified eight CTX images and three HiRISE images covering Korolev from northern spring to summer. We have created a database (*Information on craters in the Martian Northern Polar Region*) [5], to store information about craters from the Martian northern polar region. When selecting the images of Korolev crater the following criteria have been utilized. The images of the crater should be over different seasons, spring and summer, ordered by L_s. The crater should be clearly visible in all studied images and easily identified, i.e. no clouds or dust storms obscuring the crater. For information about Korolev crater all year around the reader is referred to M. Hajigholi et al. [5].

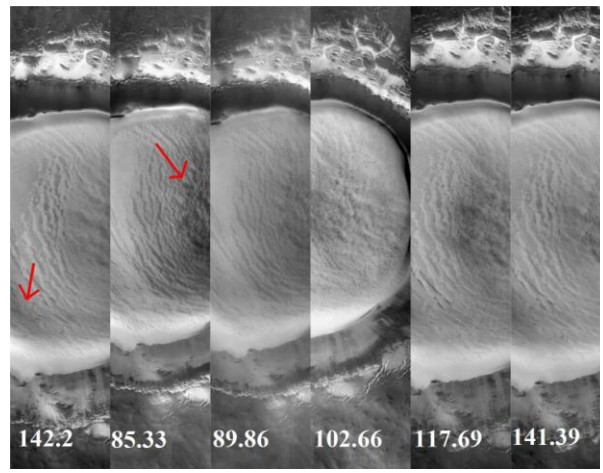

Figure 2. Korolev crater at different solar longitudes, L_s. Showing (left to right) how the albedo of the surface changes with time.
P01_001592_2530_XI_73N195W, Martian Year 28,
P20_008831_2529_XN_72N195W, Martian Year 29,
P20_008963_2529_XI_72N195W, Martian Year 29,
P21_009332_2529_XN_72N194W, Martian Year 29,

Analysis: In Figure 2 images of Korolev crater are ordered in solar longitude from L_s=142.2°, northern summer in Martian Year (MY) 28 to L_s=141.4°, northern summer, MY 29. The images are taken by CTX and show how a darker color from the left bottom and middle right corners change with time over the crater. Figure 3 shows four zoomed in images at the same area in the middle of the crater, from Figure 2, L_s=142.2° in MY 28, L_s=85.33° in MY 29, L_s= 89.86° in MY 29 and L_s=141.4° in MY 29. We have observed dark lineated features covering the icy surface in spring which later disappear in the summer. This behavior may be related to the albedo changes observed by Armstrong et. al. [6].

Figures 4 – 8 show images from CTX and HiRISE (from top to bottom) located at 73°N 165°E, taken at the same solar longitude, L_s=142.2° in MY 28. Figure 5, a HiRISE image, shows how the surface in the middle of the crater has smooth rippled terrain with darker lines of roughened terrain [7]. This could be due to a surface with a mixture of different material and layers with an icy regolith underneath. According to

Armstrong [6] a thermal pulse traveling through the regolith is capable of releasing water vapor from the icy regolith. This water vapor can then supply as a local reservoir that can condense in mid summer.

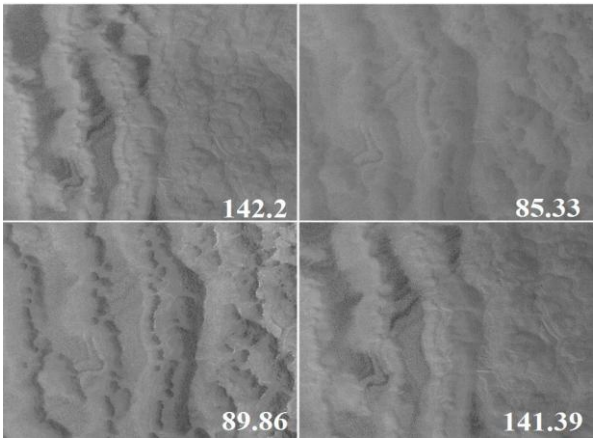

Figure 3. Images zoomed in to the same region in the middle of the crater ordered by L_s. Left to right top images: P01_001592_2530_XI_73N195W, MY 28, P20_008831_2529_XN_72N195W, MY 29, Left to Right bottom images: P20_008963_2529_XI_72N195W, MY 29, B02_010387_2529_XN_72N195W, MY 29

The higher albedo of ice allows the light to penetrate ice relatively easily. Depending on what might be underneath the high albedo surface, the sub-surface will absorb the sunlight and cause the covered material to heat up. This "solid state greenhouse" effect will eventually cause the overlying water ice to vaporize (from below) but if this process is incomplete it might temporarily leave behind a "remnant material". Depending on what kind of material could be stored under the ice, the surface may have a lower albedo, creating the darker lines seen on the CTX and HiRISE images, Figures 4 – 8. To find out if these black lines might change the color of the surface over time, images from the same solar longitude but in MY 29, have been studied from CTX and HiRISE. Unfortunately the images taken by HiRISE do not show this area of the crater and the theory can therefor not be confirmed. Looking at CTX images from spring at the same solar longitude as above, the black lines can be seen. This might indicate that the black lines are not responsible for how the surface albedo changes. If the change of the crater surface depends on solar longitude, a daily variation or due to temperature changing within the crater remains to be solved.

Conclusions: By monitoring and analyzing the images of craters in the Martian northern polar region, especially ice covered craters like Korolev, a deeper understanding of how water behaves on the Martian northern polar cap and what kind of influence it has on the CO_2 cycle between the northern and southern hemisphere can be reached. To understand what might cause the change of the surface albedo in Korolev, more images has to be taken in high resolution with HiRISE over different seasons to monitor the change over time and what relation the change might have due to temperature when comparing high resolution images with Thermal Emission Spectrum, TES, observations and thermal models.

Figure 4: Right Top image, P01_001592_2530_XI_73N195W, is an overview CTX image located at 73°N 165° E taken at solar longitude 142.2°, MY 28

Figure 5: Left Top image is an enlarged version of the high resolution Figure 7 image.

Figure 6: Left Bottom image is zoomed in image of the Right Top (red circle) image

Figure 7: Bottom Center image is a HiRISE image, PSP_001592_2530 taken at the same time and solar longitude as above.

Figure 8: Right Bottom image is zoomed in image of Figure 7 (red circle).

References: [1] Armstrong J. C. et. al (2004) *LPS XXXV* Abstract #1744. [2] Russell P. S. et al. (2004) *LPS XXXV* Abstract #2007. [3] McEwen A. S. et. al. (2007), *JGR, 112,* doi:10.1029/2005JE00265. [4] Malin M. C. et. al. (2007), *JGR, 112,* doi:10.1029/2006JE002808. [5] Hajigholi M. et. al. (2009), *LPSC XXXXI*, this meeting. [6] Armstrong, J.C. and Titus, T.N. (2005) *Icarus 174*, 360–372. [7] Brown A. J. et. al. (2007) *LPS XXXXI*, Abstract #2262.