INTRA-ANNUAL VARIATIONS OF THE MARTIAN SWISS CHEESE TERRAIN. T. N. Titus[1], G. Cushing[1], A. Pathare[2], P. R. Christensen[3], S. Byrne[4], A. B. Ivanov[2], A. Ingersoll[2], M. Richardson[2], R. L. Kirk[1], L. A. Soderblom[1], and the THEMIS Team[3]. [1]Astrogeology Team, U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, Arizona, 86004 USA (ttitus@usgs.gov), [2]California Institute of Technology, Pasadena, CA, 91125 USA, [3]Arizona State University, Tempe, AZ 85287 USA, [4]Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139 USA.

Introduction: Much of the surface of the carbon dioxide South Polar Residual Cap of Mars consists of quasi-circular pits with steep walls that have been dubbed "Swiss Cheese" terrain by Thomas et al. [1]. Using high-resolution Mars Observer Camera (MOC) images from two separate years of MOC observations, Malin et al. [2] showed that the Swiss cheese has retreated on the order of 1-3 meters per Martian year; more recently, a similar rate of retreat has also been observed for the third Martian year of MOC observations (Malin et al. [3]).

Byrne and Ingersoll [4] developed a sublimation model to explain the rapid interannual recession of Swiss cheese walls, concluding that their relatively high slopes (typically on the order of 20º) could only result from the presence of high albedo co2 frost over a low albedo substrate approximately 10 m deep. Titus et al. [5] showed with Mars Odyssey Thermal Emission Imaging System (THEMIS) infrared observations that there are numerous exposures of warm H_2O ice throughout the colder CO_2 South Polar Residual Cap. Hence, the curious morphology and inter-annual variability of Swiss cheese terrain most likely results from the interaction of a highly volatile surface layer of carbon dioxide frost overlying a base of less volatile water ice.

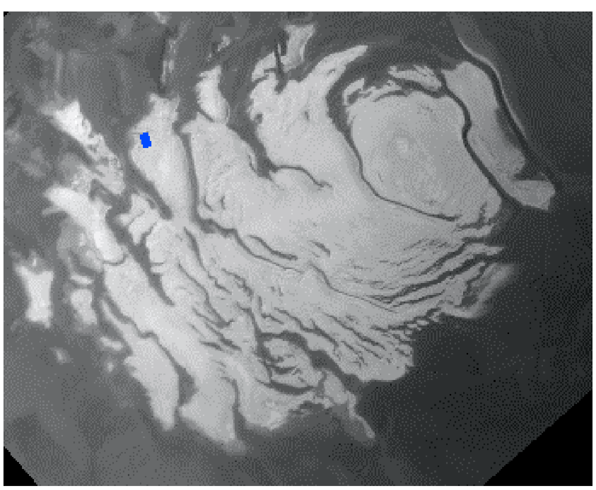

Figure 1: MOC Wide Angle Red M14/1236. This MOC image shows the south polar summer cap at L_s=337º. The location of the MOC and THEMIS images used in this study is indicated in blue.

Here, we examine the intra-annual variations of the Martian Swiss Cheese terrain using both MOC and THEMIS imaging. We compare digital elevation maps (DEM) derived from MOLA constrained photoclinometry of both MOC and THEMIS Vis images of Swiss cheese terrain. We also compare spring and summer THEMIS Vis imaging with the summer THEMIS IR, thus showing the distribution of CO_2 and non-CO_2 surface materials.

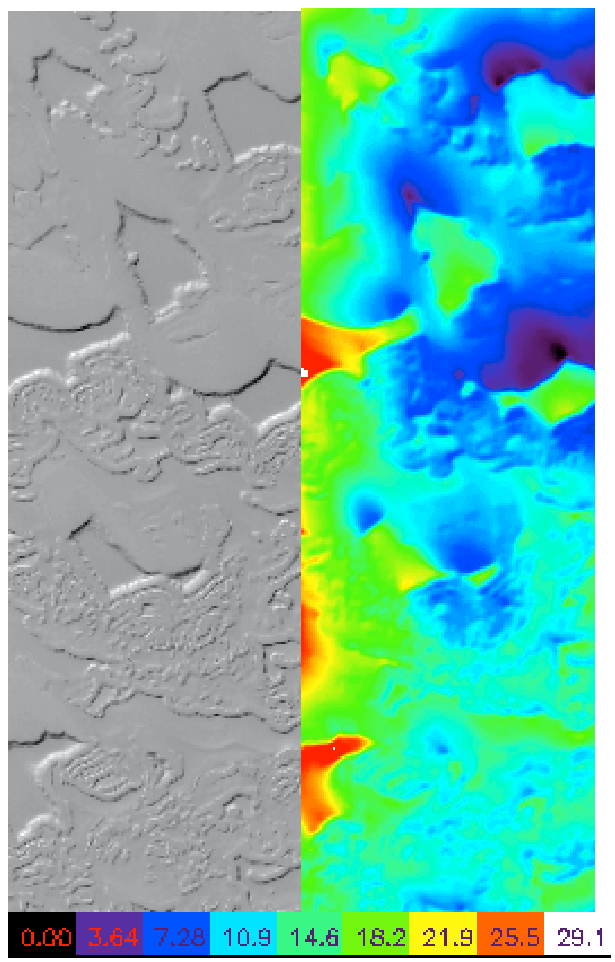

Figure 2: MOC image E09/1121, L_s=253º, and the corresponding Digital Elevation Map (DEM). The color bar is the elevation in meters. A slight slope has been removed from the DEM to bring out the topography of the Swiss cheese mesas.

Results: Swiss cheese terrain is wide spread across the southern residual cap. For this abstract, we selected a location (84.6ºS, 308ºE) that had coverage of both MOC and THEMIS images at various seasons (Fig. 1). Fig. 2a shows a MOC image taken while the terrain is still covered by layer CO2 that has a relatively uniform albedo. Fig. 2b shows the topography derived from the MOC image using MOLA constrained photoclinometry [6,7,8]. A slight slope has been removed to enhance the topographic contrast of the mesas and the surrounding depressions. A typical mesa has a height of 7(±2)m, which is consistent with earlier observations [1,2,4]. Fig. 3 shows THEMIS imaging of this same area at 3 different seasons (Ls = 177º, 309º, 324º). During spring, the area is covered by CO_2, showing the topographical relief. By mid summer, some of the CO_2 has sublimated, revealing the dark walls of the mesas. The depressions surrounding many of the mesas remain bright. THEMIS Vis image, V09010007(Ls = 177º, not shown), shows the depresssions darkening. The corresponding IR image shows these depressions to have brightness temperatures of 170-180 K, consistent with water ice.

Using the sublimation model of Byrne and Ingersoll (2003), we will attempt to derive CO_2 frost and H_2O ice albedos of features associated with Swiss Cheese terrain from our intra-annual THEMIS and MOC observations.

References: [1] Thomas P. et al. (2000) *Nature*, *404*, 161-164. [2] Malin M. C. (2001) *Science*, 294, 2146-2148. [3] Malin M. C. et al. (2003) MGS MOC Press Release No. MOC2-367 at www.msss.com. [4] Byrne S. and Ingersoll A. P. (2003) Science, 299, 1051-1053. [5] Titus T. N. et al. {2003) Science, 299, 1048-1051. [6] Kirk, R. L. 1987, Ph.D. Thesis (unpubl.), Caltech, Part III. [7] Kirk, R. L. et al. 2003, ISPRS Working Group IV/9 Workshop "Advances in Planetary Mapping 2003", Houston, March 2003, abstract online at http://astrogeology.usgs.gov/Projects/ISPRS/Meetings/Houston2003/abstracts/Kirk_isprs_mar03.pdf. [8] Soderblom, L. A., and Kirk, R. L., 2003, LPS XXXIV, 1730.

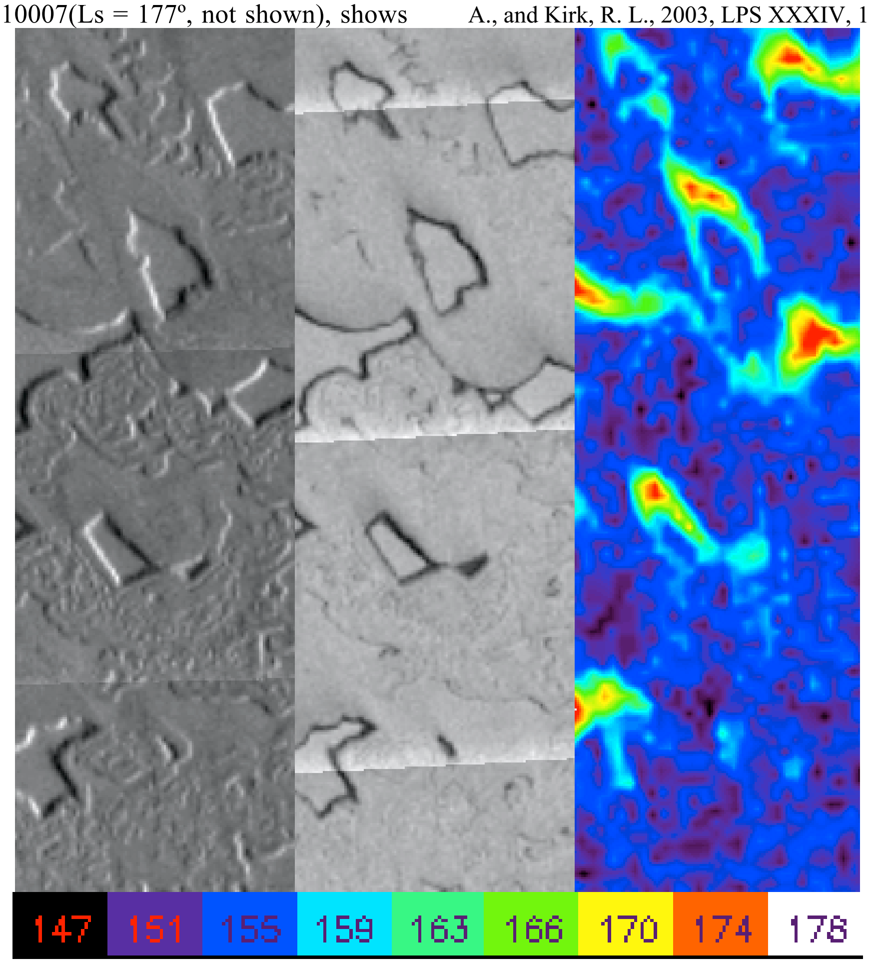

Figure 3: THEMIS VIS and IR images of Swiss cheese terrain. (Left) Image V06093001, L_s=177º, shows the topography of the Swiss cheese terrain. Wide depressions surround many of the mesas. (Center) Image V08727002, L_s=309º, shows the Swiss cheese mesas having dark walls. (Right) Thermal Image I09039002, L_s=324º, shows the depressions that surround the mesas having brightness temperatures between 170-180 K.