COMPOSITION OF THE RESIDUAL SOUTH POLAR CAP OF MARS FROM CRISM. W. M. Calvin[1], P. C. Thomas[2], T. N. Titus[3], A. J. Brown[4], , and P. B. James[5], [1]Geological Sci. & Eng., University of Nevada, Reno, NV 89557, wcalvin@unr.edu, [2]Center for Radiophysics and Space Research, Cornell University, Ithaca, NY, [3]U. S. Geological Survey, Flagstaff, AZ, [4]SETI Institute, Mountain View, CA, [5]Space Science Institute, Boulder, CO.

Introduction: Among the many enigmatic features of the Martian surface, the appearance of loops, ramps, curlicues, mesas and fingerprint terrain of the upper surface of the residual south polar cap are fascinating. Numerous mechanisms have been proposed for the formation of these curious features and the underlying assumption is that composition of ice and non-ice materials must play some role in their formation, in addition to solar illumination and seasonal depositional variability [1-7]. In particular, water ice has been observed as a lag or as a deposit underlying the carbon-dioxide dominant upper surfaces [4,5,7,8]. The Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) acquired high spatial resolution targeted observations in the southern summer of Mars Year 28 (Figure 1). We discuss the compositional information revealed for the variety of terrain covered at various seasons (Ls) by these observations.

Observations: For this analysis we explored only the Full-Resolution Targeted (FRT) observations. The instrument covers the spectral range from 0.36 to 4.0 μm in 2 spectrometers and 535 spectral channels at a nominal spatial resolution of 18m/pixel in the FRT mode [9]. We examined the L-channel, from 1 to 4 μm, as being most diagnostic for separation of water and carbon dioxide ices, and potential additional compositional features [10, 11]. The spectra are corrected to an observed radiance over predicted radiance (I/F) value and divided by the cosine of the incidence angle. Methods for removing CO_2 atmospheric gas absorptions from the spectra are not employed as the CO_2 ice bands lie on top of the gas bands and the routines do not work well over CO_2 ice terrains.

The observational campaign for the first southern summer was designed to sample both seasonal and residual ice deposits. Complicating observations of the recessional phase was the large planet-encircling dust storm that obscures much of the south cap from Ls ~260 to 290 [12]. Previous work has suggested that much of the seasonal CO_2 frost should be gone by Ls 300 [11], however recent analysis has found that bright "seasonal" frost may be present to at least Ls 325 [13 and our own analysis]. Outlier seasonal ice covers an area mapped as water ice by Piqueux et al. [8] (between McMurdo crater and the Australe Montes) until approximately Ls 315. Figure 1 shows the locations of FRT's by season between Ls 280 and 10. Observations were binned by either 5 or 10 degrees of Ls and there is a large gap between Ls 342 and 3 when no FRTs were acquired.

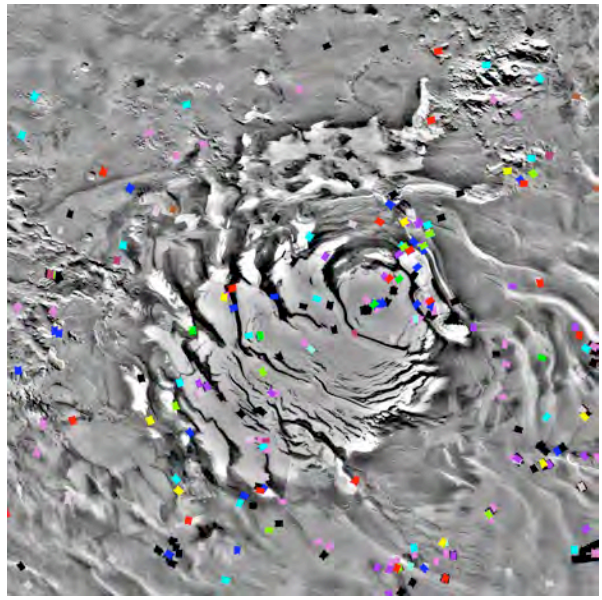

Figure 1: *Locations of FRTs color coded by Ls. Ls 280-300 (purples), 300-315 (blue, cyans), 315-330 (green, yellow), 330-10 (reds, magenta, brown).*

Overview of Spectral Types: The characteristic spectral features of CO_2 are present in many locations, and are even observed in low albedo trough material near Ls 300 (Figure 2). The strong features at 2.28, 2.34, 3.0 and 3.3, and often 2.45 and 3.65 μm suggest very large pathlengths in the residual "dry" ice. Later in the season, these diagnostic CO_2 ice features disappear over the low albedo polar layered deposits (PLD). Water ice spectral characteristics are highly spatially variable and the contribution from water ranges from very weak, impacting only the 3- μm region to fairly strong with evident 1.5 μm features clearly showing water ice.

Contribution of water ice. We qualitatively classify spectral signatures of water ice into three groups, weak, medium and strong: a) with small amounts of water the spectra show a slope down at 2.4 μm and suppression of the albedo level beyond 3.0 μm. The CO_2 ice features at 3.0 and 3.3 μm weaken. b) increasing amounts of water will cause a steep slope down from 2.2 to 2.5 μm, the CO_2 ice bands at 3.0 and 3.3 μm disappear. c) the largest amounts of water begin to show the characteristic 1.5 µm water ice band and this region shows a rounded shape with noticeable band depth and slopes down from 1.3 to 1.8 µm. The CO_2 bands near 1.6 µm (gas and ice) get suppressed. We estimate based on past models [10, 11, 14] that water ice ranges from a few tenths of a percent to up to a few percent by weight at most. Figure 3 shows the range of water ice contribution.

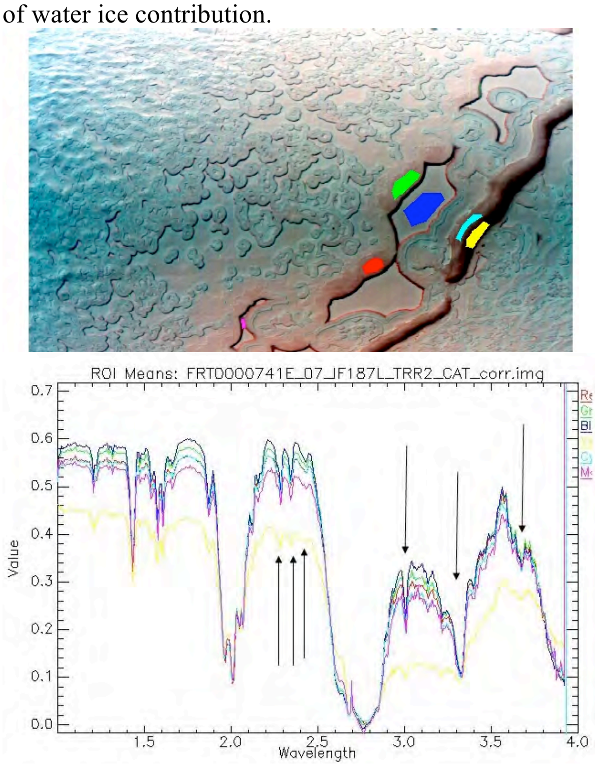

Figure 2: *Characteristic CO_2 ice features (arrows) in the early season over mesa rich terrain. Spectra are color coded to regions of interest in the image. The dark lane (yellow) shows CO_2 ice features even over low albedo terrain. None of the spectra show water ice. FRT 741E acquired at Ls 300.7.*

Summary of Findings to Date: Water ice is highly spatially variable as well as uneven in abundance. In many places, water appears as a lag or patina on the underlying (either bright or dark surface) and may be seasonally or locally controlled by insolation and winds. A water rich layer seems to be ubiquitious on the boundary between residual bright ice and underlying dark PLD. It is at present unknown if this represents a consistent stratigraphic unit. Carbon dioxide features remain over dark material until Ls 320 or later, suggesting continued removal of "seasonal frost" through the summer. Later in the season water ice is a common constituent of low albedo troughs and dark mesa edges, but does not appear everywhere. In all cases spectra are consistent with small amounts of water ice and large CO_2 pathlengths.

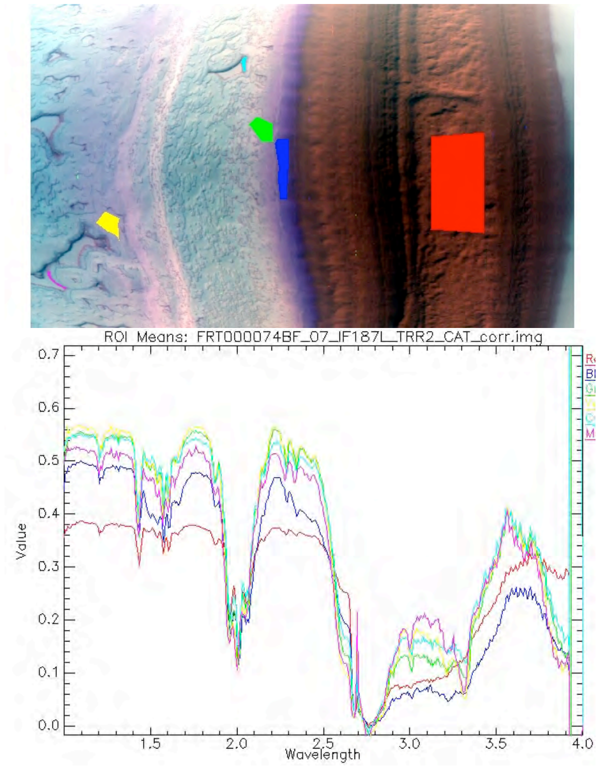

Figure 3: False color composite (upper) showing enhanced water ice absorption as purple tones along the trough edge and stepped layers. Color regions tied to typical spectra shown in lower plot. The blue spectrum shows features characteristic of "strong" water ice, while the dark lane (red spectrum) shows no water ice, but retains the 2.28 and 2.34 µm features of CO_2 ice. FRT 74BF acquired at Ls 302.

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