Residual South Polar Cap of Mars: MRO shows geography and history.
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Introduction: The residual south polar cap of Mars is a complex deposit primarily consisting of CO_2 ice, but with at least some water ice and dust [1], that is unique to the south pole, and is currently undergoing erosion [2,3,4]. The types of layers that make up this deposit, the amounts of erosion, and especially the history of that erosion can provide information on geologically recent climate change (or lack thereof). Mars Reconnaissance Orbiter is sending daily low-resolution views of the poles (Mars Color Imager, MARCI), 6 m/pixel images (Context Imager, CTX), and 30 –cm pixel coverage of small areas (High Resolution Imaging Science Experiment, HiRISE), and visible and infrared spectra from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM). MRO's first southern summer has now been completed. We report here findings largely from the CTX coverage. These data include a full mosaic of both spring and summer coverage of the residual cap. Additional summer coverage was allowed during periods of high dust opacity on much of the rest of the planet. The nearly complete coverage by CTX late in the summer, between Ls =327 -354 in mission phases P12 and P13 (Fig 1.) is the focus of our mapping work on the residual cap.

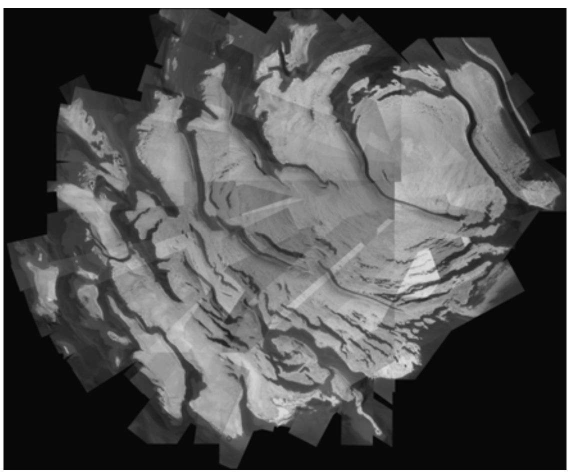

Figure 1: Coverage of the south residual cap by CTX in late summer. Tiled set of mosaics of sub-regions.

Units and geoography: MOC observations had shown there were at least two different units in the RSPC, an older, thicker unit (A), which currently backwastes nearly twice the rate that the younger, thinner unit (B) does [3,5]. The scattered MOC coverage did not allow firm determination of the geography of these units beyond the widespread occurrence of both units in the residual cap. The contiguous complete coverage by CTX shows that while remnants of the older unit (A) are widespread, this unit was removed from wide tracts before deposition of the older parts of younger unit B. The style of erosional forms in the younger unit B (such as presence of elongated forms, range of sizes of depressions) appears correlated (in general) with the amount of stripping of unit A, indicating that local slopes, topography (roughness), and elevation play a role in the erosion, and probably deposition, of both units.

CTX images show wind elongated forms, some are areas stripped down to the much darker polar layered deposits (PLD). They define regional wind patterns controlled by topography and latitude, and at the 100 m scale are close in form to those seen in Mariner 9 images. Significant disruption of atmospheric flow by remnants of unit A, only ~10 m in height, may have caused erosion of unit B, or perhaps prevented its deposition.

Beyond the effects of steep trough slopes on the occurrence of the residual cap, small scale topography on the PLD evidently influences the type of erosion of the overlying residual ice, such as the curled depressions in unit A, so-called fingerprint terrain [3], and the form of debris left from erosion of some areas of unit A.

Style and length of erosional changes: MOC data at 1.5+ m/pixel showed expansion of depressions at 2 – 3.5 m/Mars year [2,3,5]. HiRISE images (not shown here) reveal backwasting of some of unit B is by rotation of wall segments, presumably from thermal undercutting, followed by loss over one or more summers. Backwasting of unit A had been shown by MOC to involve complex ramps of debris trailing the retreat of scarp crests [3]. In some areas, however, MOC data showed inverted relief where the mesas of unit A had apparently collapsed, rather than backwasted [3]. CTX images show that areas of collapsed unit A are common, and in at least one area, show that this collapse occurred since Mariner 9 observations (Fig. 2). This style of loss implies a significant role for either heat flow from below (warmer, water-ice rich deposits?), and/or albedo and/or albedo changes imposed by deposition of dust or other materials from the atmosphere. The thermal undercutting implied by rotating blocks also suggests loss of material is not a straightforward result of insolation on the residual ice. CTX images of the seasonal cap recession emphasize the importance of deposition of insolation energy at depth [6], something which may not occur in the residual cap deposits.

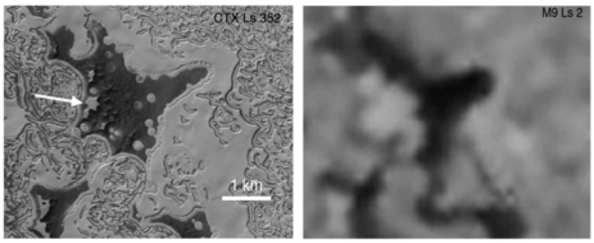

Figure 2. CTX image at Ls=352 (P13, orbit 6229), and Mariner 9 image at Ls=2, at 86.3S, 0.6W. These show a dark, "collapsed" area of unit A, which is preserved only as small, scalloped mesas in CTX (arrow in CTX image shows most prominent), but which occupy a much wider bright area at the left side of the dark area in the Mariner 9 image, taken 18 Mars years earlier.

The detailed mapping of forms will combine the occurrences and morphologies of the different depositional and erosional forms into a comprehensive picture of recent history of the cap, which should help reconstruction of climate stability or change in this region for the past ~ 100+ Mars years.

References: [1] Langevin et al. JGR, 112, E08S12 (2007). [2] Malin, M., Caplinger, M. A., Davis, S., Science 294, 2146-2148 (2001) [3] Thomas et al. Icarus 174, 535-559 (2005). [4] Byrne, S. and Ingersoll, A. P. Science 299, 1051-1053 (2003) . [5] James, P. B. et al., Icarus 192, 318-326 (2007). [6] Titus, T. et al. A. G. U., Fall Meeting 2007, abstract #P24A-05 (2007).