PRELIMINARY HiRISE POLAR GEOLOGY RESULTS. S. Byrne[1], K. E. Herkenhoff[2], P. Russell[3], C. Hansen[4], A. McEwen[1] and The HiRISE Team, [1]Lunar and Planetary Laboratory, University of Arizona. (shane@lpl.arizona.edu) [2]Astrogeology, United States Geological Survey. [3]Physikalisches Institüt, Universität Bern. [4]Jet Propulsion Laboratory, Pasadena.

Introduction: The north polar deposits of Mars consist of the polar layered deposits (NPLD), which are partly covered by the residual ice cap (NRC).

The High Resolution Imaging Science Experiment (HiRISE) on board the Mars Reconnaissance Orbiter (MRO) has successfully acquired a unique dataset over these deposits. Here, we review some of the major new findings associated with both the NPLD and the NRC.

Dataset Description: The HiRISE instrument [1] acquires images in three bands centered on the near-infrared (874 nm), red (694 nm) and blue/green (536 nm) portions of the spectrum. The typical resolution of red filter images produced by the camera in the north polar region is 30 cm/pixel. In addition, HiRISE uses time delay integration to achieve signal to noise ratios far in excess of previous high-resolution cameras, which has been especially important for imaging poorly illuminated polar terrain. The superior resolution and signal of these data allow for investigation of many polar features previously either barely detected or not detected at all.

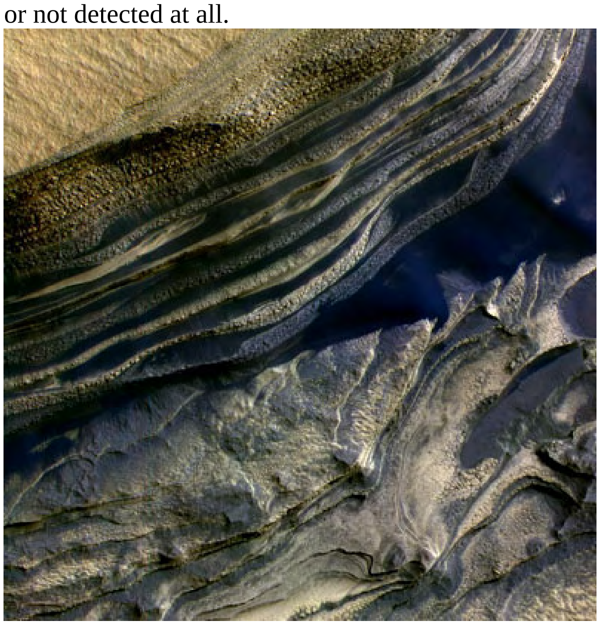

Figure 1. Part of HiRISE false-color image PSP_001334_2645 showing the western headscarp of Chasma Boreale. The scene is 1.2 km across and the pictured scarp has a relief of 700m. Original data is at 30 cm/pixel, illumination from the right.

MRO began primary science operations at L_s 130, well after northern summer solstice. All the data discussed here were acquired in late northern summer. The development of the north polar hood dictated the close of our polar observations at about L_s 150, although sporadic images were acquired after this date. Eighty-five images were collected of the north polar deposits with more images covering outlying polar material and dunefields. Among these, twenty stereo pairs were acquired which will yield topography at the meter scale for those targets.

Our three primary areas of study have been the stratigraphy of the NPLD, the characterization of the residual ice and the few impact craters superposed on these deposits.

North Polar Stratigraphy: The strata of the NPLD have been for several years divided into the classical layered deposits and the so-called basal unit [2,3,4]. The basal unit was theorized to be the source of sand-sized material in the circumpolar dunefields [2] and this material is known to be interbedded with brighter, perhaps icy, layers [4]. HiRISE data (Fig. 1) of these strata have confirmed these perceptions and added unanticipated detail.

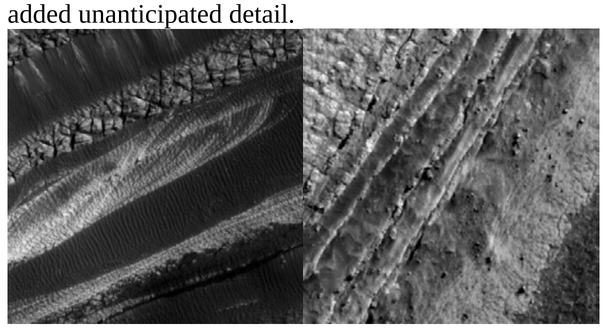

Figure 2. Left panel (A) shows structures within the stratigraphy, shown in Fig. 1, interpreted to be cross-bedding. Section of HiRISE image PSP_001334_2650, scene is 150m across. Right Panel (B) shows debris that has been shed from polygonally fractured layers. Section of HiRISE image TRA_000845_2645, scene is 100m across. Illumination from the right.

Cross-bedding (Fig. 2a), visible within the sandy layers, suggests that this material was saltating prior to being buried by overlying layers. This is inconsistent with the theory that this sand-sized material is composed of filamentary sublimation residues (bonded dust particles) [5], which had been suggested to explain the polar erg's unusually low thermal inertia [6].

The interbedded bright layers are commonly polygonally cracked into ~8m blocks. These polygonal blocks can be seen to detach from these layers and roll to the base of the scarp (Fig. 2b). However, debris is rarely evident at the scarp base indicating that when these blocks are detached they are quickly removed by ablation or broken into undetectably fine particles. Our preferred explanation is that the polygonally cracked layers are volatile rich, but are well protected from sublimation by a lag deposit. This lag is disturbed during the mass-wasting process allowing these icy boulders to be ablated away. This process may be an important new mechanism for polar scarp retreat and appears to dominate over pure ablation in places.

The NPLD overlying the basal unit appears divisible into two distinct units on the basis of the presence or absence of this polygonal cracking. The lower unit appears similar to the polygonaly cracked bright layers that are interbedded with the sandy material in the basal unit, whereas the upper unit shows no evidence of this polygonal breakup (Fig. 3). The lower unit also typically has a steeper exposure indicating either a differing resistance to erosion or (as postulated above) erosion by another process (such as mass-wasting) of different effectiveness.

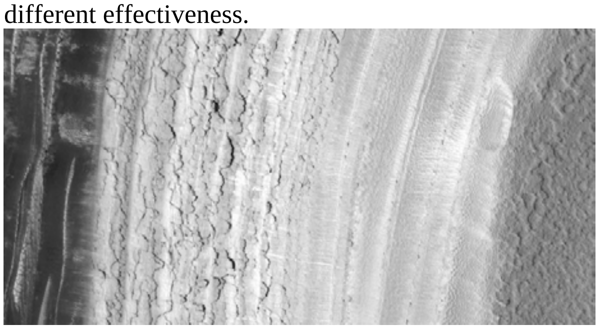

Figure 3. Transition in layering over polar scarp, section of HiRISE image PSP_001550_2640. Top of scarp is on the right, scene is 540m across. Illumination from left.

Residual Ice Cap: Another major focus of our investigation has been the NRC. This deposit is remarkably homogeneous at all observation scales. We sought to characterize its overall appearance as well as those interesting circumstances where unique features were identified.

Figure 4 shows a representative portion of the NRC. The decameter texture just visible in MOC data is clearly resolved into an undulating surface with mounds of frosted material interspaced with lows which appear to have been formed by coalescence of many pits. HiRISE color data show that this low terrain is beginning to defrost late in the season, the reddish patches in this image have an identical color to exposures of NPLD, which underlies this ice cap. Thus the thickness of the NRC in the low regions is virtually zero, and it is the mounds that contain the bulk of the NRC material. The relief of this terrain has previously been estimated to be at most 1m [7], the mounds occupy ~50% of the area implying a residual cap volume of at most 418.5 Km^3 (3.8×10^{14} Kg, assuming a pure water ice composition).

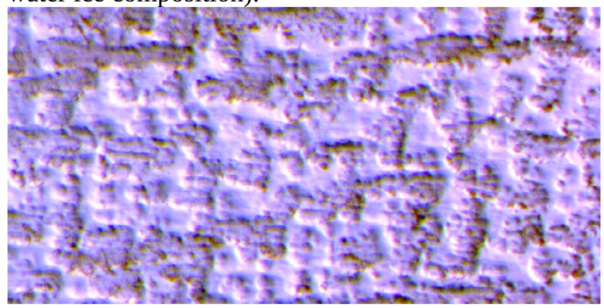

Figure 4. NRC cap from false-color HiRISE image PSP_001738_2670. The scene is about 240m across. Illumination from upper right.

Despite its homogeneous nature, several interesting features exist on the NRC, one of which is an apparent graben identified in MOC and MOLA data [8]. This feature extends for 10’s of kilometers in length with a width of 100’s of meters. HiRISE data now show the edges of this feature to consist of chains of pits (Fig. 5); modeling of formation mechanisms is underway.

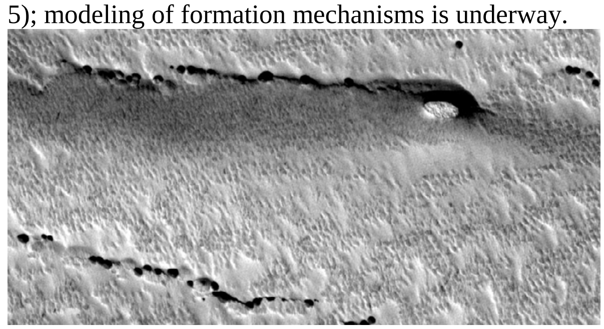

Figure 5. Chains of pits on the NRC. Section of HiRISE image PSP_001513_2650, illumination from the upper right, scene is 240m across.

Summary: HiRISE has already provided several new insights into martian polar geology. Analysis of these northern data continue even while we begin collecting data over the southern polar deposits.

We will report on analysis of these and soon to be acquired data including data and results that could not be covered in this abstract.

References: [1] McEwen et al., JGR, In Press, 2006. [2] Byrne and Murray, JGR, 107, 2002. [3] Edgett et al., Geomorph., 52, 2003. [4] Fishbaugh and Head, Icarus, 174, 2005. [5] Saunders et al., NASA TM, 87563, 1985. [6] Paige et al., JGR, 99, 1994. [7] Herkenhoff et al., LPSC, 1714, 2002. [8] Nunes et al., AGU, 2006.