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Recent activity in the north polar region of Mars

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Abstract

The High Resolution Imaging Science Experiment (HiRISE) on the Mars Reconnaissance Orbiter (MRO) has observed the north polar region of Mars during 3 summer seasons. Here we summarize analyses of the north polar data, focusing on active and recent processes including evolution of frost streaks, the north polar residual cap (NPRC), frost avalanches, and scarp erosion.

1. Introduction

Full-resolution HiRISE images are typically 20,000 monochrome pixels (~6 km) wide with color data in the central 4000 pixels [1]. Such HiRISE images of the north polar region with scales of ~30 cm/pixel show morphologic details and reflectance variations indicative of currently active processes.

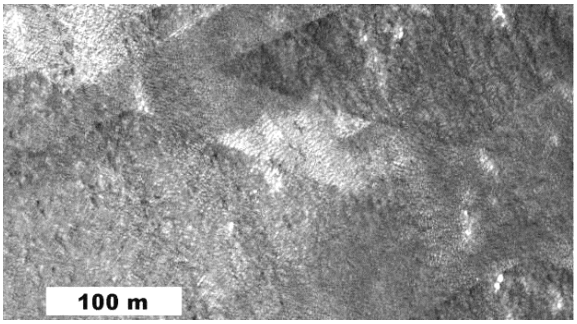

Figure 1: Subframe of red HiRISE image PSP_009273_2610 showing complex streak superposition at 80.8°N, 330.6°E.

2. Polar Streaks

Bright and dark streaks have been observed at the periphery of the NPRC by previous Mars orbiters and were the target of several HiRISE observations. The complex interactions between overlapping bright and dark streaks in some of these HiRISE images (Fig. 1) indicate that formation of the streaks involves processes more complex than the emplacement of dark veneers proposed by Rodriguez *et al.* [2]. Bright and dark streaks are seen to evolve during the northern summer, evidence for active eolian redistribution of frost and perhaps darker (non-volatile) dust or sand. But the sharp boundaries of the streaks remain unexplained.

3. Residual Ice Cap

The north polar residual cap (NPRC) on Mars has long been known to be composed of water ice [3]. Relatively dark patches observed within the NPRC during the summer indicate that the cap is very thin or very transparent in places. Counts of craters in Viking Orbiter and MRO Context Camera images indicate that the craters on the NPRC accumulated within the last 20,000 years or less [4,5]. HiRISE images of the NPRC show few fresh craters. Based on HiRISE and Context Camera observations of variously degraded craters on the NPRC, average accumulation rates are estimated to be 4-5 mm/yr within these craters, with lower rates likely on the intracrater NPRC surface [5]. It is likely that NPRC resurfacing is temporally episodic rather than continuous, and that annual changes may be detectable at HiRISE image resolutions. Therefore, a campaign of HiRISE observations of four NPRC targets near 87°N latitude (the maximum latitude of the MRO ground track) was initiated during the Martian northern summer of 2008 and continued during the summer of 2010. The images acquired during this campaign, with nearly nadir viewing geometry and similar solar azimuth, have been searched for evidence for current redistribution of NPRC material. Only minor albedo changes are observed, consistent with the resurfacing rate discussed above.

4. Avalanches

We also conducted an early- to mid-spring 2010 survey of circumpolar scarps to monitor for falls and avalanches of CO_2 frost and dust, of the type discovered on a scarp in northern spring 2008 [6] (Fig. 2). The results confirm the restriction of this activity to $L_s \approx$ 25-45° and reveal activity at additional scarps. Thermal models indicate that, by the beginning of northern summer, seasonal frost should have completely sublimed from the steep slopes on which avalanches are observed. Frost may be retained in fractures later into the spring, and thermal expansion of the underlying north polar layered deposits may play a role in avalanche initiation. A 2010 northern summer survey of steep scarps imaged in previous summers has documented the frequency of mass-wasting of icy blocks of the layered deposits and basal layers and their (potentially major) contribution to recent polar landscape evolution.

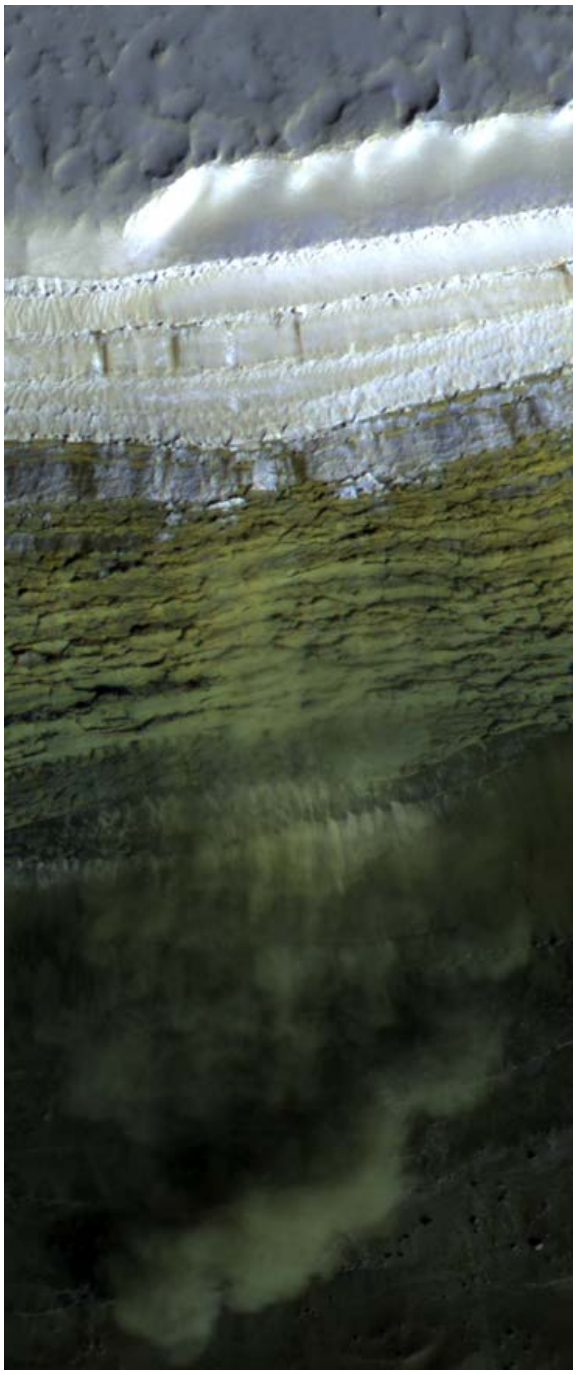

Figure 2: Part of false-color HiRISE image PSP_007338_2640 (83.74°N, 235.8°E, L_s=34°, illumination from lower right, subframe ~0.5 km in vertical extent) showing frost/dust avalanche at base of steep scarp and edge of seasonal cap at top.

5. Summary and Conclusions

The HiRISE north polar imaging campaign demonstrates that surface materials are mobilized annually and that the north polar region is currently active. Observations discussed here highlight the importance of both long- and short-term monitoring of north polar targets to further our understanding of time-variable phenomena in this region.

Acknowledgements

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