Geomorphology of High-Latitude, Ice-Rich Surfaces on Mars: Constraints on the Age, Thermal State, and Landscape Processes Active in Vicinity of Phoenix and the Martian Latitude-Dependent Mantle.

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Mars is a natural laboratory for testing the physical and chemical processes that shape planetary surfaces under cold and arid climate conditions [1-3]. The Phoenix lander has discovered a wide range of chemical constituents [3-6] in samples of high latitude portions of the martian latitude-dependent mantle (LDM) [7, 8]. Critical questions remain as to whether the identified species formed in-situ or elsewhere, when the materials formed, and under what temperature and water-related climate conditions the unique Phoenix chemistry developed [3-6]? In particular, the origin and geological history of materials present at the Phoenix landing site provides insight into the origin and modification history of high latitude martian ice, yielding clues into the structure of martian latitude-dependent, ice-rich deposits, as well as into the thermal history of these young surfaces [7-10]: e.g., is the martian LDM composed of massive precipitated ice, or atmospherically cycled pore ice? Has (brine-mediated) melting played a major role in shaping the LDM, or are solid-vapor phase transitions dominant?

We present observations of the Phoenix landing site and vicinity from the Surface Stereo Imager and HiRISE [11-12] interpreted to indicate that the surface unit on which the Phoenix lander is present is geologically young (<100 ka) and has been dominated by cold and dry geomorphic processes, rather than extensive wet or dry active layer cycling and/or churning (Fig. 1). No morphological evidence for geologically recent saturated soil conditions is observed at Phoenix landing site or across the martian northern plains. These observations suggest that chemical species requiring abundant water to form [3-6] were not produced recently in-situ at the Phoenix landing site, but rather have been mixed into the surface regolith from alternate (potentially impact-related) sources [13].

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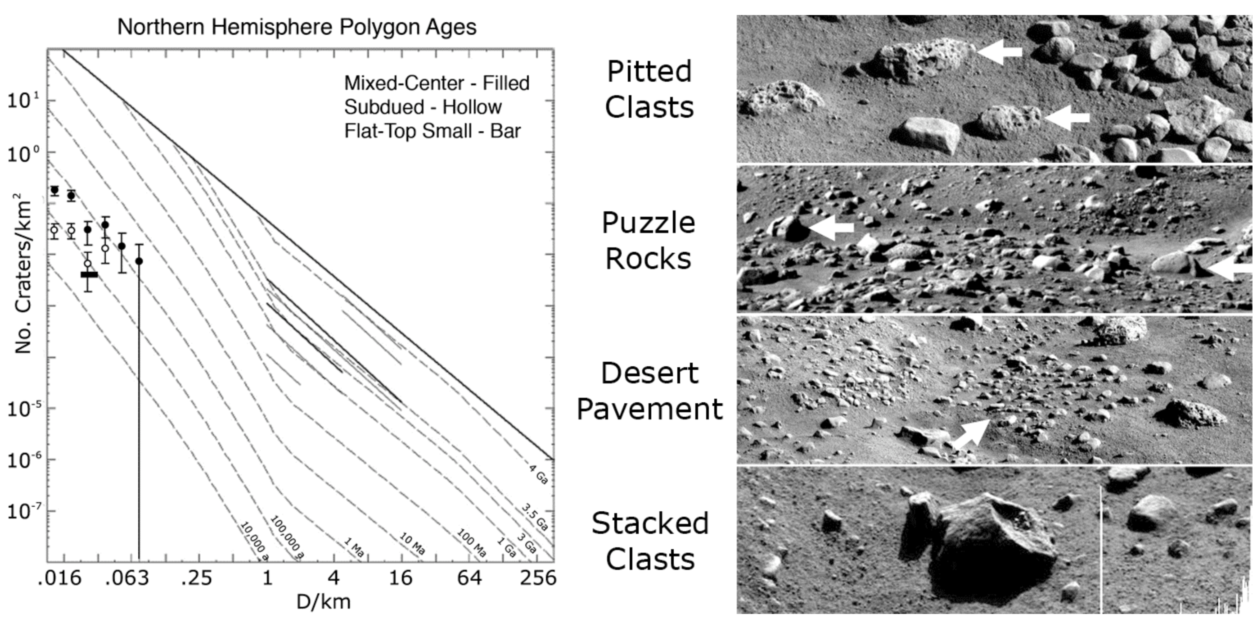

Figure 1. Left. Surface ages of polygonally patterned latitude-dependent mantle surfaces. Mixed-center polygons are typically found at ~45° latitude, subdued polygons at ~55° latitude, and flat-top small at ~65° latitude. High latitude icy surfaces on Mars are exceptionally young. Right. Landforms observed at the Phoenix landing site by the SSI interpreted to indicate a relatively stable, non-churning permafrost surface.