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Evidence of widespread degraded Amazonian-aged ice-rich deposits in the transition between Elysium Rise and Utopia Planitia, Mars: Guidelines for the recognition of degraded ice-rich materials

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Widespread deposits in craters, in valley systems and surrounding mesas are observed in the transition zone between the Elysium Rise and the Utopia Planitia. They are characterized by their relatively high albedo, their pitted surfaces, with textures ranging from lineations and fish-scale-patterns to widely distributed knobs as well as the presence of ring-mold crater (RMC) morphologies. These deposits are interpreted to be modified ice-rich material in the form of concentric crater fill (CCF), lineated valley fill (LVF) and lobate debris aprons (LDA) that have experienced deflation and sublimation, creating a patchy distribution of material in craters, in valleys and around mesas. The degraded CCF deposits (212 examples, covering an area of 1600 sq km) are observed from 31.2–40 N, 138–150 E over an elevation range of almost 9 km ranging from ∼4250 to 4575 m. This wide-ranging distribution demonstrates that degraded ice-rich deposits exist at every altitude and latitude in the study area, indicating that icy mantle materials were initially deposited over extensive areas and were stable over a long time period, allowing the deposits to coexist and interact with different processes under very different conditions. The degraded LDA deposits represent the largest unit of modified ice-rich material, with an area of ∼15,700 sq km, and are populated with a range of ring-mold crater morphologies that is interpreted to be related to a degradational sequence between previously described RMC and newly observed RMCs that appear to be more degraded. A distinctive frequency difference in the distribution of normal and degraded RMCs permits an evaluation of different degradation stages of the LDA deposits. We show how an RMC distribution can be used as a key tool for evaluation of altered LDA, LVF and CCF deposits. Taken together, these observations suggest that ice-rich material has played a major role in shaping the present-day landscape in the transition zone between the Elysium Rise and the Utopia Planitia Basin, and they provide a link for understanding Amazonian-aged degradation processes of ice-rich deposits in an area with no significant topographic relief.