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Cold-Climate Landforms and Processes on Mars

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A variety of landforms on Mars are attributed to periglacial environments and processes connected to ice-rich permafrost. These landforms occur predominantly within two latitudinal belts pole-wards of about 40° which is consistent with modeling results of the stability and distribution of near-surface ground ice in the Martian regolith. Various periglacial and possibly even glacial landforms have been identified and discussed since the early years of spacecraft exploration of Mars and high-resolution data obtained from instruments that are currently imaging the Martian surface (MOC, HRSC, THEMIS, HiRISE) provide further observational evidence that support this view. So-called lobate debris aprons and lineated valley fill are related to the creep of ice and debris and are considered to be analogues for terrestrial rock glaciers. Other landforms indicative of an ice-rich permafrost environment comprise e.g., frost mounds and features that are formed by thermal contraction cracking processes and are similar to polygonal patterns observed on the Earth. Although analyses of various datasets strongly suggest a permafrost origin of such features, there is still an ongoing discussion on the nature and development of these landforms. We here report on the theoretic background and ongoing discussions regarding Martian permafrost and periglacial landforms and we also provide new observational evidence that support the view of climatically-driven formation and thermokarstic degradation of such features. The details seen in image data covering the Martian surface allow us to identify and study landforms that are undergoing either active formation, as seen in the generation of thermal contraction patterns at the Martian south pole, or degradation and thermokarstic disintegration on a global scale. We also report on relics that indicate the former presence of permafrost-related landforms and which suggest that many of such features are most probably connected to changes in the orbital configuration of Mars that controls the stability of Martian ground ice.