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Cold-Climate Geomorphology of Tempe Terra, Mars

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The fretted terrain at the Martian dichotomy boundary hosts an abundance of landforms related to the creep of mountain debris and ice which have become known as so–called lobate debris aprons and units of lineated valley fills and concentric crater fills. Although such features are related to different morphologic settings, there is a general consensus that these features are in principle genetically connected to the process of ice-assisted creep.

We here investigate lobate debris aprons in the Tempe Terra/Mareotis Fossae region of Mars on the basis of high resolution imagery and topographic data and focus on the emplacement and degradational history and on a mantling deposit which indicates the past and/or present existence of near surface ice.

According to our observations we propose a multi-stage model for landscape evolution in the Tempe Terra region, which needs further verification in other areas of the dichotomy boundary. We have currently no observational basis for assumptions on the formation of remnant massifs in the near–escarpment region of the highland–lowland boundary which means that all we can say about the emplacement and distribution of remnant massifs is that they are either autochthonous, i.e., erosional remnants of highland material or uplifted crustal material as suggested for the southern hemispheric circum–Hellas and Argyre Planitiae remnants.

Remnants have undergone erosional processes, be it by fluvial erosion, or be it by gravitational processes, such as landsliding and mass wasting as well as deflation and denudation. Additionally, cyclic obliquity changes as proposed for Mars and cyclic loss and redeposition of volatiles and dust produced a record of ice-poor and ice-rich landforms, respectively, that subsequently intermixed through degradational processes where the ice/dust-rich mantling deposit either covered the remnant completely or was remobilized gravitationally by downslope movement and revealed the underlying topography. Apron material moving downslope forms ridges or beads as well as furrows or crevasses as a function of compressional and tensional stresses, respectively. The process of mantling re–deposition and gravitational mass movement has advanced until geologically recent times, and even epsiodical events might be conceivable as indicated by our observations. Subsequent sublimation, perhaps also initiated at cracks and crevasses, contributed to apron degradation and revealed underlying surfaces.

This process is thought to have been active until at least 50-100 Myr ago as crater–size frequency distributions indicate. The activity might go on in recent times but the process of apron degradation might be prolonged and slowly paced so that impact–crater deformation is barely visible.