Quaternary Mars?

Conference or Workshop Item

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On Earth, the Quaternary period, extending from ~ 2.6 Ma to the present day, is defined by the most recent periods of widespread northern hemisphere glaciation, and its deposits are generally very-well studied. On Mars, the concept of an analogous 'Quaternary' is harder to apply and study, as in situ data from 'fieldwork' is rare: only at a few locations has the local stratigraphy been observed using instrumented, robotic explorers. Thus, much of what we know about Mars chronology has been revealed by remote-sensing surface geomorphology studies, meaning that Mars' geological periods are far simpler, less sub-divided, and have greater uncertainties in their bounds than Earth's.

Mars' main geological periods (the Noachian, >3.7 Ga; the Hesperian, 3–3.7 Ga; and the Amazonian, <3.0 Ga) are defined by impact crater size-frequency statistics and global-scale morphostratigraphic mapping. Amazonian Mars has undergone little geological activity compared to Earth, so many ancient morphologies are preserved. Coupled with mounting evidence that the Noachian environment was more suitable for life than Mars today, the focus of Mars exploration has mainly been on the more ancient landscapes and rocks. Yet the most recent period of Mars' history is fascinating: there is growing geomorphic evidence for recent shifts in environmental conditions, and many questions to answer.

For example, Mars' polar ice caps host numerous layers of ice and dust. What can they tell us about recent climate cycles on Mars? Mars' mid-latitudes host older, debris-covered glaciers. What environmental conditions permitted glaciation of Mars' mid-latitudes, where exposed ice is currently unstable? Huge swathes of the high latitudes are draped in a smooth (at m-scale) ice-rich mantle that appears to be actively degrading. When did mantle modification processes change from deposition to degradation? Very young landforms in the northern latitudes appear to have formed by solifluction or freeze-thaw processes, yet Mars' climate is currently too dry and cold, and the atmosphere too thin, for water-ice to melt or liquid water to be stable at the surface. Do these landforms demonstrate a recent climatic excursion, or extreme micro-environments?

Additionally, 10m-scale aeolian mega-ripples known as Transverse Aeolian Ridges are abundant, appear to have pristine morphologies, yet must be relics of palaeoenvironmental conditions because larger dunes migrate by ~1 m per year under present-day winds, yet TARs remain immobile. Did global mean wind strengths change recently?

Theoretical studies suggest that Mars' obliquity (currently similar to the Earth's at ~25°) varies cyclically by up to tens of degrees on ~100 ka timescales, with orbital eccentricity having similar cycles. Additionally, mean obliquity shifted from ~ 35° to the present level around 5 Ma.

In this presentation we will describe Mars' 'Quaternary' landscapes, and discuss how they fit into the current understanding of Mars' recent palaeoclimate.