Highly erosive glaciers on Mars - the role of water

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Highly erosive glaciers on Mars – the role of water

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Polewards of 30° in each hemisphere, the surface of Mars hosts a suite of landforms reminiscent of glacial landscapes on Earth. Amongst these landforms are: 1) Viscous Flow Features (VFF), which resemble glaciers on Earth and are thought to contain large volumes of water ice, 2) martian gullies which are km-scale features resembling water-eroded gullies on Earth and 3) arcuate ridges thought to be moraines from previous glaciations. Gullies have been long-associated with a surface unit originally called "pasted-on terrain" and now often called the "latitude dependant mantle". Arcuate ridges are often found at the base of hillslopes with gullies, but are also found on hillslopes with pasted-on terrain and no gullies. We have found a systematic lowering of the slope of the bedrock exposure located topographically above the pasted-on terrain whether that same slope hosts gullies or not. The lowered bedrock exposures display a different surface texture from bedrock exposed on other parts of the crater wall and from fresh crater walls – it appears fragmented and has reduced relief. Using 1-m-digital elevation models from the High Resolution Imaging Science Experiment (HiRISE) we compared the slopes of eight "eroded" craters and seven unmodified craters. We estimated their age using the crater size-frequency distribution of small craters on their ejecta blankets. From this information we calculated bedrock retreat rates for the eroded craters and found they were up to ∼103 m Myr-1 - equivalent to erosion rates of wet-based glaciers on Earth. This is several orders of magnitude higher than previous estimates of erosion by VFF (10-2-101 m Myr-1), which themselves are roughly equivalent to cold-based glaciers on Earth. Such erosion rates are sufficient to erase previously existing landforms, such as martian gullies. We hypothesise, therefore, that the pasted-on terrain is a glacial deposit, overturning its previous interpretation as an airfall deposit of ice nucleated on dust. We maintain the interpretation of the arcuate ridges as moraines, but further conclude that they are likely the result of glaciotectonic deformation of sub-marginal and proglacial sediment in the presence of sediment pore-water. We do not support the generation of large quantities of glacial meltwater because it would have broken-up and degraded the arcuate ridges and pasted-on terrain an produced a suite of landforms (e.g., hummocky moraine, lacustrine forms, outwash plains, eskers) which are not observed.