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Radar-based observatiions of variable thickness debris cover on martian ice masses: evidence of debris transfer by flowing ice on Mars

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The mid-latitudes of Mars host a wide range of ice-based landforms, many of which display surface morphologies indicative of viscous flow of that ice. Despite being shrouded beneath a layer of rocky debris, these viscous flow features (VFFs) are thought to have similarities with terrestrial glaciers. Until recently most studies that focussed on the origin, structure and role of these martian VFFs were restricted to observations made from satellite imagery. Little data have been available to gain a clearer picture of VFF internal structure, which has impeded our collective ability to infer many particulars of VFF growth and flow, including the extent to which these ice flows have interacted with, and potentially helped shape, the martian landscape. However, the Shallow Radar (SHARAD) system mounted on the Mars Reconnaissance Orbiter (MRO) can, in some cases, provide a valuable insight into what lies beneath the surface of these ice masses. We present a SHARAD-based study of glacial systems on Mars which reveals pronounced heterogeneity in the thickness of their observed superficial debris covers. The surface debris layers in question appear to thicken in a down-slope direction. Radar data indicates that in the lower reaches of each studied glacial catchment, ice surface debris cover exceeds 10 m in thickness. The observed flow-parallel a-symmetry in debris thickness atop these martian glaciers is similar to that recorded on many terrestrial glaciers, indicating that cumulative down-flow debris mass transfer such as occurs within glacierised catchments on Earth may also currently operate, or have operated, on Mars. This suggests that glaciers on Mars have played a substantial role in redistributing lithic material from mountainous catchments to lower-lying areas, potentially throughout the glacial regions of Mars' mid-latitudes, thus making an important processual contribution to the evolution of Mars' contemporary landscape.