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Debris flows in a young mid-latitude crater on Mars: Evidence for recent water-bearing mass wasting and efficient insolation-controlled slope modification within the last <1 Ma.

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Debris flows are moving masses of loose debris of varying grain sizes, water and air that travels down a slope under the influence of gravity. Terrestrial debris flows are mainly studied and monitored because of their hazardous nature. On Mars they may serve as important geomorphologic indicators of transient liquid water. The discovery of well-developed debris flow deposits within a very young southern mid-latitude crater ($\sim$0.2 Ma) highlights the impact of periglacial slope processes during recent climate conditions on Mars. We compared the morphology of debris flows on Svalbard as possible analogues to the observed deposits on Mars in order to infer possible formation mechanisms. Within our study crater on Mars, high-resolution imagery obtained by the HiRISE instrument (High Resolution Imaging Science Experiment) revealed typical debris-flow attributes such as overlapping terminal lobes, debris tongues, debris-flow fans, scoured channels with medial deposits (debris plugs), and well-defined lateral deposits (levées). Collectively, these attributes are found on studied debris flows on Svalbard. Additionally, our study crater's interior walls display mass-wasting with strong aspect-dependence, ranging from debris-flow dominated pole-facing slopes, to east-and-west-facing single channel gullies, and north-facing talus cones (grain flow). Our findings suggest that the debris flows are neither related to impact induced heating and release of melt-water or melting of an ice-rich mantling deposit since the latter is absent in the study crater. Instead, we propose that the debris flows are formed by melting of very recent snow deposits after the termination of the last Martian ice-age. As such it may represent one of the most recent geomorphological indicators of transient liquid water in the Martian mid-latitudes. Our study crater further illustrates the importance of regolith differences and micro-climate variability (e.g., insolation) in debris flow initiation on Mars. The distinct north-south asymmetry demonstrates that insolation-controlled slope processes are surprisingly efficient on Mars during the last <1 Ma.