# Study suggests debris flows on frozen arctic sand dunes are similar to dark dune spot-seepage flows on Mars

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A team of scientists from Southwest Research Institute (SwRI) has demonstrated that frozen water in the form of snow or frost can melt to form debris flows on sunward-facing slopes of sand dunes in the Alaskan arctic at air temperatures significantly below the melting point of water. The debris flows consist of sand mixed with liquid water that cascade down steep slopes.

SwRI scientists made their observations at the Great Kobuk Sand Dunes, in Kobuk Valley National Park, Alaska. This site serves as an Earth-based cold-climate "analog" to dunes on Mars. Debris flows formed on days when air temperatures measured continuously by the team remained below the melting point of water. Very few minutes of above-freezing ground surface temperatures are needed to locally melt frozen water and mobilize sand down steep slopes.

The scientists hypothesize that fresh patches of wind-deposited dark sand on bright white snow caused local hot spots to form where solar radiation was absorbed by the sand and conducted into the underlying snow. This enabled meltwater to briefly form and sand to be mobilized despite subfreezing local air temperatures. A similar mechanism may be responsible for triggering debris flows on frozen Martian sand dunes. The Alaskan debris flows formed at ground temperatures that may correspond to those occurring locally and seasonally on the surface of Mars, said hydrogeologist Dr. Cynthia Dinwiddie, a principal engineer in

SwRI's Geosciences and Engineering Division.

The Alaskan debris flows are morphologically similar to small, defrosting-related "dark dune spot" seepage flows that seasonally form in late winter on frost-covered Martian sand dunes. Such features were described in detail by a number of other researchers, and in particular by a team from Collegium Budapest, Institute for Advanced Study in Hungary.

Dark dune spot seepage flow features gave rise to the popularly known "trees on Mars" optical illusion that was associated with Mars Reconnaissance Orbiter HiRISE images of the flows. Such imagery was published "upside-down" online in an inverted orientation relative to the downward direction of gravity flows on dune slip faces, thus creating the tree-like dendritic pattern.

Dark dune spots are non-uniformly distributed on all frost-covered dune surfaces on Mars, but only those occurring near dune crests or on steep slip faces result in downslope flows. A thin brine layer may form and flow downslope on Martian sand dunes after the seasonally deposited carbon dioxide frost layer has begun to locally sublimate. Because of preferential energy adsorption by these dark, ice-free surfaces, localized heating and thawing at scales too small for orbital sensors to identify may yield briny Martian debris flows under current climate conditions.

The SwRI- and NASA-funded study was published today online under the title, "Debris Flows on the Great Kobuk Sand Dunes, Alaska: Implications for Analogous Processes on Mars," by Drs. Don Hooper and Cynthia Dinwiddie in the journal *Icarus*.

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