Mars gullies likely not formed by liquid water

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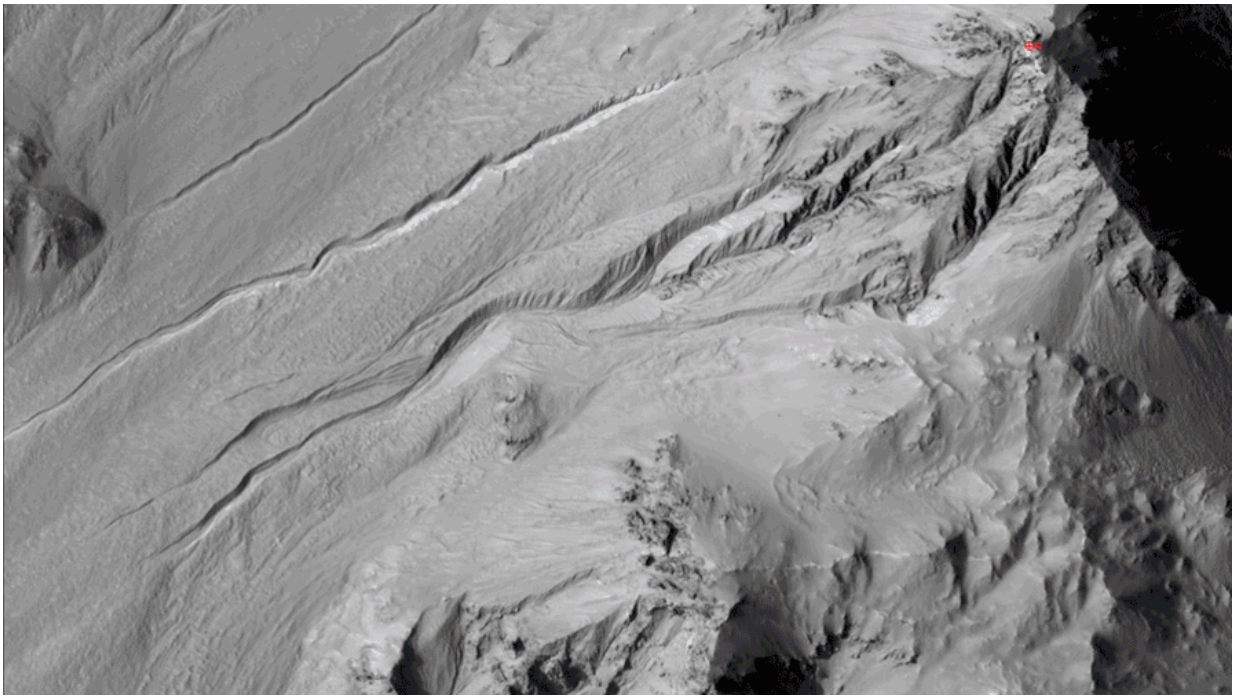

Martian gullies as seen in the top image from HiRISE on NASA's Mars Reconnaissance Orbiter resemble gullies on Earth that are carved by liquid water. Credit: NASA/JPL-Caltech/UA/JHUAPL

New findings using data from NASA's Mars Reconnaissance Orbiter show that gullies on modern Mars are likely not being formed by flowing liquid water. This new evidence will allow researchers to further narrow theories about how Martian gullies form, and reveal more details about

Mars' recent geologic processes.

Scientists use the term "gully" for features on Mars that share three characteristics in their shape: an alcove at the top, a channel, and an apron of deposited material at the bottom. Gullies are distinct from another type of feature on Martian slopes, streaks called "recurring slope lineae," or RSL, which are distinguished by seasonal darkening and fading, rather than characteristics of how the ground is shaped. Water in the form of hydrated salt has been identified at RSL sites. The new study focuses on gullies and their formation process by adding composition information to previously acquired imaging.

Researchers from the Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Maryland, examined high-resolution compositional data from more than 100 gully sites throughout Mars. These data, collected by the orbiter's Compact Reconnaissance Imaging Spectrometer for Mars (CRISM), were then correlated with images from the same spacecraft's High Resolution Imaging Science Experiment (HiRISE) camera and Context Camera (CTX).

The findings showed no mineralogical evidence for abundant liquid water or its by-products, thus pointing to mechanisms other than the flow of water—such as the freeze and thaw of carbon dioxide frost—as being the major drivers of recent gully evolution.

Gullies are a widespread and common feature on the Martian surface, mostly occurring between 30 and 50 degrees latitude in both the northern and southern hemispheres, generally on slopes that face toward the poles. On Earth, similar gullies are formed by flowing liquid water; however, under current conditions, liquid water is transient on the surface of Mars, and may occur only as small amounts of brine even at RSL streaks. The lack of sufficient water to carve gullies has resulted in a variety of theories for the gullies' creation, including different mechanisms

involving evaporation of water and carbon dioxide frost.

"The HiRISE team and others had shown there was seasonal activity in gullies—primarily in the southern hemisphere—over the past couple of years, and carbon dioxide frost is the main mechanism they suspected of causing it. However, other researchers favored liquid water as the main mechanism," said Jorge Núñez of APL, the lead author of the paper. "What HiRISE and other imagers were not able to determine on their own was the composition of the material in gullies, because they are optical cameras. To bring another important piece in to help solve the puzzle, we used CRISM, an imaging spectrometer, to look at what kinds of minerals were present in the gullies and see if they could shed light on the main mechanism responsible."

Núñez and his colleagues took advantage of a new CRISM data product called Map-projected Targeted Reduced Data Records. It allowed them to more easily perform their analyses and then correlate the findings with HiRISE imagery.

"On Earth and on Mars, we know that the presence of phyllosilicates—clays—or other hydrated minerals indicates formation in liquid water," Núñez said. "In our study, we found no evidence for clays or other hydrated minerals in most of the gullies we studied, and when we did see them, they were erosional debris from ancient rocks, exposed and transported downslope, rather than altered in more recent flowing water. These gullies are carving into the terrain and exposing clays that likely formed billions of years ago when liquid water was more stable on the Martian surface."

Other researchers have created computer models that show how sublimation of seasonal carbon dioxide frost can create gullies similar to those observed on Mars, and how their shape can mimic the types of gullies that liquid water would create. The new study adds support to

those models.

The findings were published in *Geophysical Research Letters*.

More information: J. I. Núñez et al. New insights into gully formation on Mars: Constraints from composition as seen by MRO/CRISM, *Geophysical Research Letters* (2016). DOI: 10.1002/2016GL068956