What Carved Martian Gullies?

- 'Gullies' are channels carved when material moves downhill. They are seen in a variety of locations on Mars, including crater walls, cliffs, and dunes
- Proposed formation mechanisms: water seeping from the subsurface, melting ice or snow, water frost, carbon dioxide (CO_2) frost, and dry flows - but there's no direct evidence for any of these
- Scientists must use indirect evidence: melting water would form gullies at the warmest times and locations, but subliming or condensing CO_2 would form gullies at the coldest times and places.

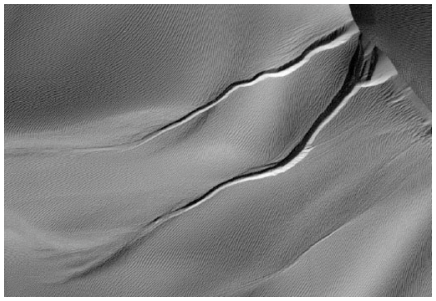
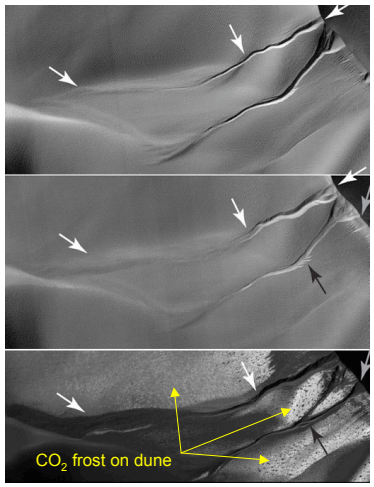


Image of two gullies on a sand dune taken by NASA's Mars Reconnaissance Orbiter. Gullies consist of a source 'alcove', transport 'channel', and lower 'fan deposit' and form when material is transported downhill (the dune ridge is at top right in this image). Scientists debate whether water, carbon dioxide, or dry material is responsible.

Testing the CO_2 Hypothesis

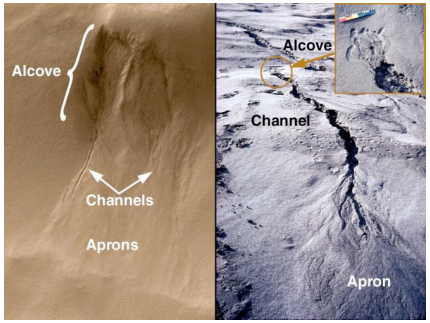
- Spacecraft images taken months apart show that gullies on Martian sand dunes change. The changes occur:
  - during winter months
  - in gullies closer to the south pole
  - in the southern hemisphere, where winter is more intense
- Each of these conditions suggest that the changes are related to CO_2 *frost* on the surface, and not *liquid* water
- The evidence favors CO_2, but the mechanism is uncertain: avalanches of accumulated frost? flows triggered by sublimation?



Time series images of changing dune gullies taken by Mars Reconnaissance Orbiter in 2008, 2009, and 2010.

The Big Picture

- Gullies are typically formed on Earth by flowing water
- Recent research shows some gullies on Mars appear to form because of CO_2; it's not yet known if all do
- Similar features on the two planets are not necessarily formed by the same mechanism - the solar system provides a rich array of conditions and processes!



Gullies on a Martian crater wall (left) and on a wall of Earth's Mount St. Helens (right). Are these gullies formed by the same processes?

For More Information…

Press

- MSNBC.com - 10/30/10 - "Mysterious Mars gullies likely carved by carbon dioxide"
  http://www.msnbc.msn.com/id/39928960/ns/technology_and_science-space/
- NASA MRO Mission Site - 10/29/10 - "Study Links Fresh Mars Gullies to Carbon Dioxide"
  http://www.nasa.gov/mission_pages/MRO/news/mro20101029.html

Images

- Slide 1 image courtesy NASA / Caltech / U. Arizona
  http://www.nasa.gov/mission_pages/MRO/news/mro20101029.html
- Slide 2 image courtesy NASA / Caltech / U. Arizona
  http://www.nasa.gov/mission_pages/MRO/news/mro20101029.html
- Slide 3 image courtesy NASA / JPL / Malin Space Science Systems
  http://www.msss.com/mars_images/moc/june2000/labeled/

Source Articles (on-campus login may be required to access journals)

- Diniega et al., 'Seasonality of present-day Martian dune-gully activity', *Geology*, 38, doi:10.1130/G31287.1, 2010.
  http://geology.gsapubs.org/content/38/11/1047.full
- Hansen et al., 'Seasonal Erosion and Restoration of Mars' Northern Polar Dunes', *Science*, 331, 10.1126/science.1197636, 2011.
  http://www.sciencemag.org/content/331/6017/575

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