Study sheds new light on composition at base of Martian southern polar cap

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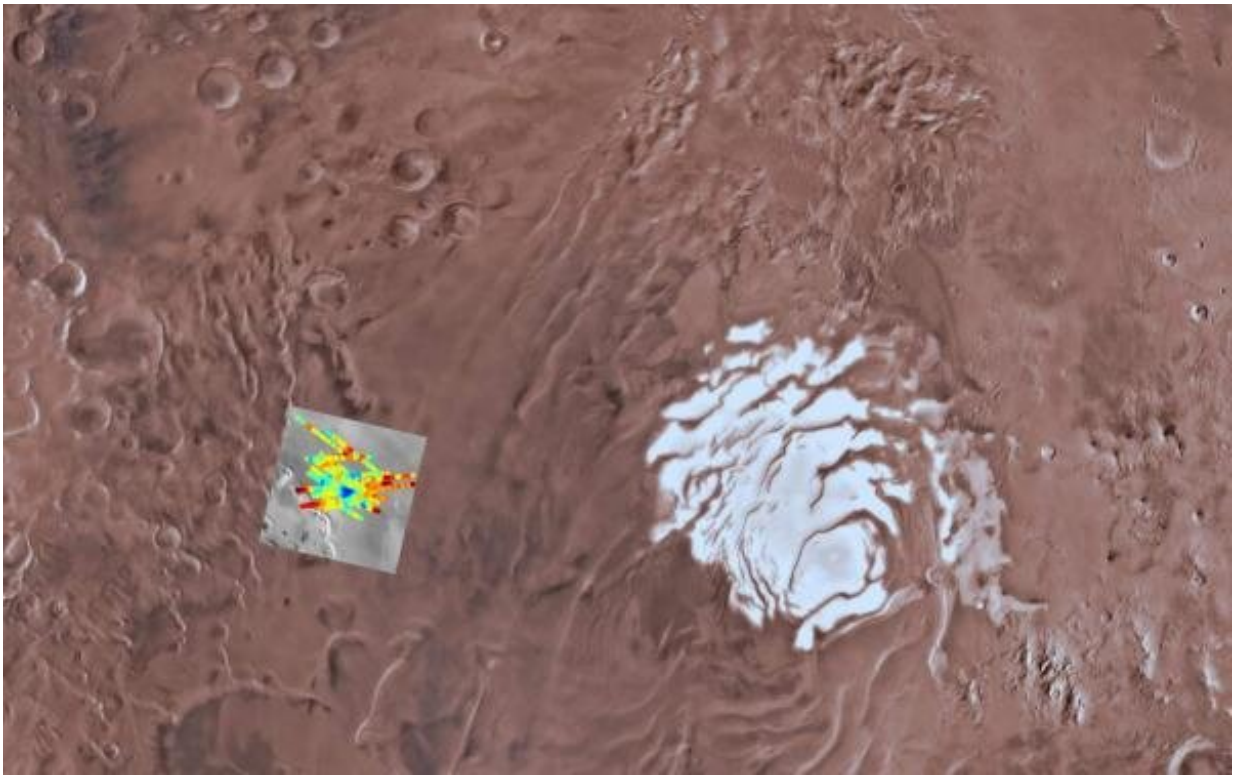

Credit: Planetary Science Institute Blue spots in the Martian south polar region earlier thought to show signs of possible subsurface water could now mark other subsurface materials. Credit: USGS Astrogeology Science Center, Arizona State University, INAF

An earlier discovery of liquid water lakes beneath Mars' south pole may not be as wet as believed, a new paper says.

Using the Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) radar instrument aboard the European Space Agency's Mars Express orbiter, scientists had earlier detected areas of high radar reflectivity they said were several lakes found deep beneath Martian surface ice.

But that might not be the case, says a new paper "Strong MARSIS Radar Reflections from the Base of Martian South Polar Cap may be due to Conductive Ice or Minerals" appearing in *Geophysical Research Letters* on which PSI Senior Scientist Nathaniel Putzig is an author. Carver J. Bierson of Arizona State University is lead author.

"It is not necessary to invoke liquid water at the base of the polar cap to explain the results of the MARSIS observations. Alternatives include clays, some metallic minerals, and salty ice," Putzig said.

"Our team wanted to step back and ask if there were other materials besides liquid water that could cause these bright reflections," lead author Bierson said. "Salty ice or conductive minerals at the base of the ice sheet are less flashy, but they are more in line with the extremely cold temperatures at Mars poles."

"Because water—particularly in a liquid form—is so important to sustaining life, seeking out where it may exist on Mars today or in the past is of paramount importance to astrobiological studies. Ensuring that we fully consider other possibilities for reported detections of liquid water is crucial to the scientific process," Putzig said.

MARSIS works by detecting the surface and subsurface reflected echo when a radar beam is directed toward Mars' surface. An underground zone of liquid water will have very different electrical properties from surrounding ice or rocks and it will reflect very strongly.

Earlier MARSIS analysis of subsurface radar reflections primarily focused on studying electrical permittivity. Permittivity controls the speed of radio waves within a material (fastest in vacuum, slower in ice, slower still in rock and water), and it also affects the power of reflected waves. The new paper considers electrical conductivity to explain what MARSIS saw.

The paper says that previous work reported a regionally strong radar reflection under Mars' south polar ice sheet. Due to its brightness, this radar reflection was interpreted as liquid water (likely with high concentration of dissolved salts). A radar reflection can be bright due to a large contrast in either dielectric permittivity or electric conductivity. Previous work only considered contrasts in dielectric permittivity. Contrasts in electric conductivity between materials could also explain the brightness of the reflection. The paper suggests that this difference could be due to clays, metal-bearing minerals, or saline ice under the polar ice sheet.

"Electrical conductivity and permittivity are interrelated. Most prior assessments of the power of subsurface radar reflections have chosen to ignore conductivity and focus on permittivity in assessing the reflective properties of materials that may be responsible for the radar reflections," Putzig said. "This choice led prior workers to the conclusion that liquid water—probably very salty in order for it to be liquid at the temperatures and pressures expected 1.5 kilometers below the surface of Mars' south polar ice cap—is the most reasonable explanation for the high radar reflectivity. However, the work presented in this paper demonstrates that conductivity can be an important factor for some materials, and hence such materials provide a viable alternative explanation for the data."

More information: C. J. Bierson et al, Strong MARSIS Radar Reflections from the Base of Martian South Polar Cap may be due to Conductive Ice or Minerals, *Geophysical Research Letters* (2021). DOI:

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