Scientists unveil further proof of salty water on Mars

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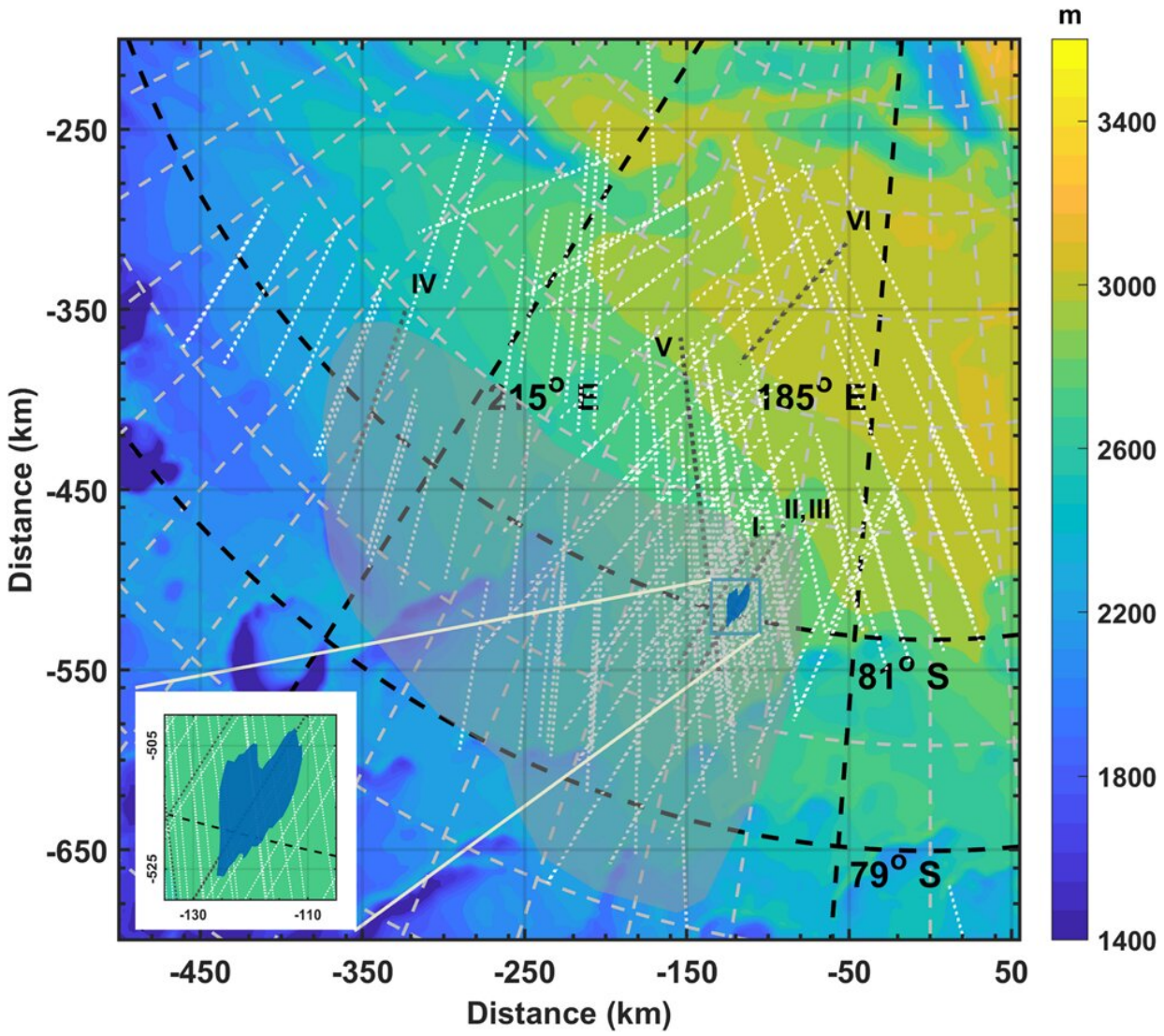


Mars Orbiter Laser Altimeter (MOLA) topographic map of the investigated area at Ultimi Scopuli. Dotted lines are MARSIS observations. The blue region

indicates the geographic location of the main bright area. The observations in the light-gray shadowed area have not been used for data inversion, as they cross high and low basal reflectivity areas and cannot be assigned neither to bright nor to non-bright datasets. Credit: *Nature Communications* (2022). DOI: 10.1038/s41467-022-33389-4

It may be known as a rocky, red planet but evidence is mounting that salty water exists at the base of polar deposits on Mars.

University of Southern Queensland's Professor Graziella Caprarelli is part of an international team investigating bright reflection signals below the Martian surface, first spotted in data acquired between 2010 and 2019 by the radar sounder MARSIS on board Mars Express.

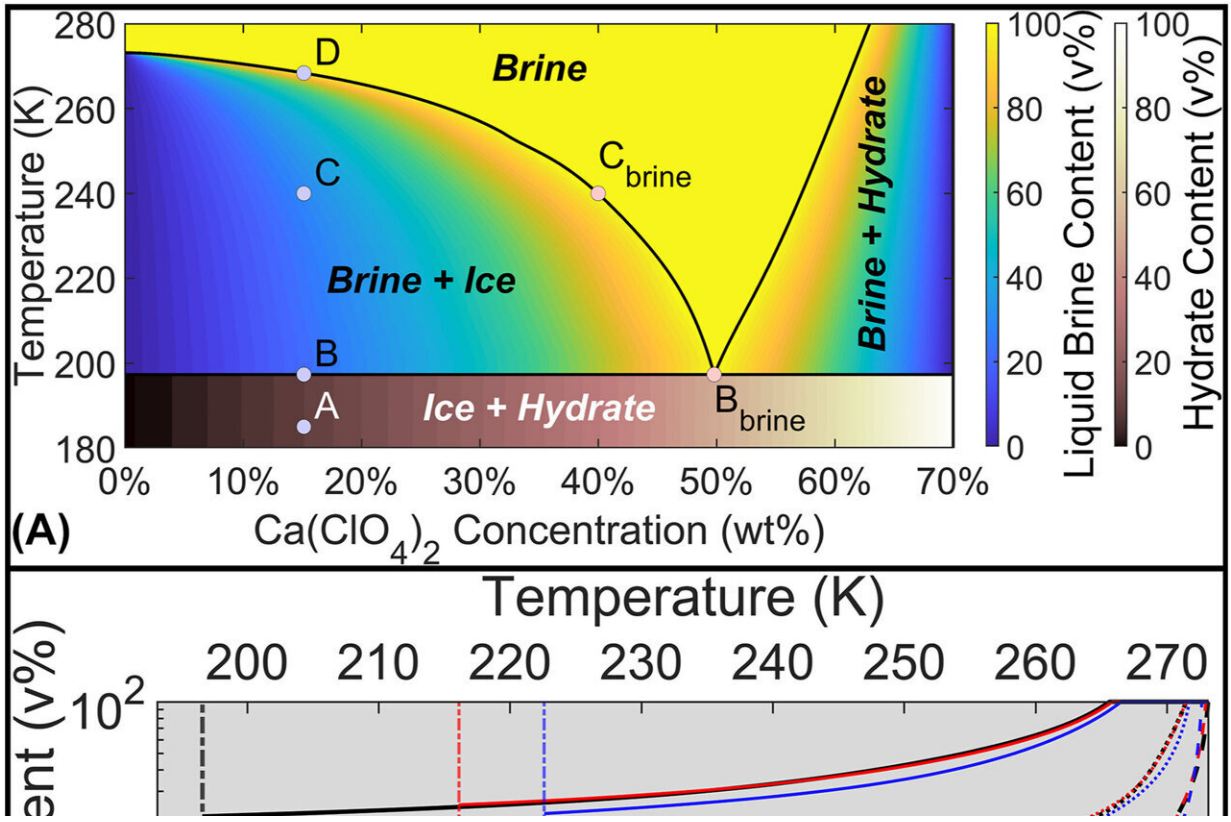
The primarily Italian team proposed that the reflections pointed to a patchwork of salty lakes, publishing their research in *Science* in 2018 and in *Nature Astronomy* in 2021. Recently a new collaboration between the Italian team and U.S.-based researchers provided new evidence further corroborating this interpretation.

The results of these studies have been recently published in the journals *Nature Communications* and the *Journal of Geophysical Research: Planets*.

Professor Caprarelli said new laboratory experiments and simulations have ruled out alternative interpretations.

"We've explored questions such as 'is it possible that the strong radar signals could be produced by other types of materials like clays or saline ice, or by constructive interference,'" she said.

"The latest papers address the long standing question related to the temperatures at the base of the south polar cap: thus far, these were considered to be too low even for brines to be liquid."



(a) Phase diagram of $Ca(ClO_4)_2$ with colored contours of bulk brine (parula colormap) and hydrate (pink colormap) concentrations. For example, a 700 mM (15.1 wt%) $Ca(ClO_4)_2$ sample at 185 K (Point A) has a hydrate content of ~12 vol%. At the eutectic temperature, the hydrate and ice melts to form a brine with a eutectic concentration (Point B_{brine}) and with a liquid content of ~14 vol%. At 240 K, the amount of liquid brine in the salt-H_2O mixture is ~22% (Point C), while the brine concentration is 40 wt% (Point C_{brine}). The sample then completely melts at 268.4 K (Point D). (b) Volume percent of brine at 100, 300, and 1,000 mM versus temperature. The eutectic temperatures for $Ca(ClO_4)_2$, $Mg(ClO_4)_2$, and $CaCl_2$ are ~197.3, 216, 223 K, respectively. Credit: *Journal of Geophysical Research: Planets* (2022). DOI: 10.1029/2022JE007398

Professor Caprarelli, who is an adjunct with the Center for Astrophysics of the University of Southern Queensland, developed the thermal models and calculated the range of temperatures at the base of Mars's south polar cap, beneath the South Polar Layered Deposits (SPLD).

"We decided to study the physical properties of the deposits themselves, by modeling the propagation of the radar waves through water ice and dust."

The new calculations constrain the percentage of dust inclusions in the deposits to be between 5% and 12%, further setting an upper limit of 230 K (-43°C) for the temperature at the base.

"Our studies show that the temperature at the base of the SPLD computed thus far by other researchers (approximately 170–180 K) have been greatly underestimated, and can instead easily reach 200 K (-73°C) which is within range of the melting temperatures of perchlorate brines," Professor Caprarelli said.

"New laboratory experiments conducted in the laboratories of Roma Tre University (Italy) and the Southwest Research Institute (U.S.) further demonstrate that the physical properties of brines at these revised temperatures are entirely consistent with the strength of the radar signals acquired from the base of the Martian south polar deposits."

More information: Sebastian E. Lauro et al, Using MARSIS signal attenuation to assess the presence of South Polar Layered Deposit subglacial brines, *Nature Communications* (2022). DOI: 10.1038/s41467-022-33389-4

D. E. Stillman et al, Partially Saturated Brines Within Basal Ice or Sediments Can Explain the Bright Basal Reflections in the South Polar Layered Deposits, *Journal of Geophysical Research: Planets* (2022).

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Provided by University of Southern Queensland