Weighing in on a Mars water debate: Analysis challenges previous findings

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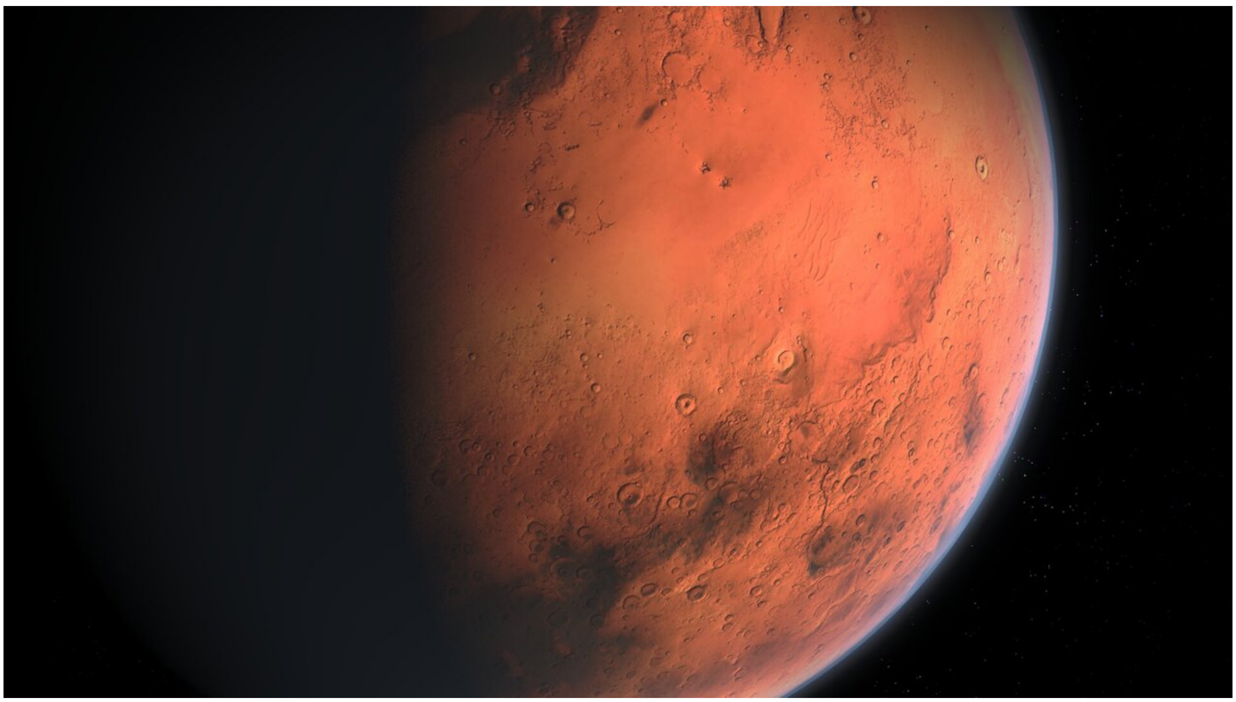

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More than 3 billion years ago, Mars intermittently had liquid water on its surface. After the planet lost much of its atmosphere, however, surface water could no longer persist. The fate of Mars's water—whether it was buried as ice, confined in deep aquifers, incorporated into minerals or dissipated into space—remains an area of ongoing research, one of particular interest to LASP Senior Research Scientist Bruce Jakosky, former principal investigator of the Mars Atmosphere and Volatile EvolutioN (MAVEN) mission.

Last week, in a letter to the editor of the *Proceedings of the National Academy of Sciences* (*PNAS*), Jakosky challenged the conclusion of a 2024 *PNAS* study that suggested Mars retains a significant amount of liquid water in its mid-crust. Jakosky notes that while that is one possible conclusion, it is not the only one, as the data on which the study is based do not require a water-saturated crust.

"While the approach and analysis are reasonable and appropriate, the results of their modeling suggest an alternative conclusion," Jakosky says.

The data used in the analyses came from NASA's Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) mission, which launched in 2018 and placed a single lander on Mars to collect geophysical data to study the planet's interior. Although the mission ended in 2022, when a Martian dust storm obscured the lander's solar panels preventing them from generating power, scientists are still analyzing data from InSight—and debating what it means.

In an August 2024 *PNAS* study, geophysicist Vashan Wright, of the Scripps Institution of Oceanography at the University of California, San Diego, and colleagues used rock physics models to determine what types of rocks, levels of water saturation, and pore space characteristics could account for the seismic and gravity data InSight had collected from the mid-crust, a region ranging from 11.5 to 20 kilometers below the surface.

The team concluded that a mid-crust made up of fractured igneous rocks saturated with liquid water "best explains the existing data." They estimated the volume of trapped water would reach a depth of between one and two kilometers—if it were spread evenly across the planet's surface, a measure called the global equivalent layer. For comparison, Earth's global equivalent layer is 3.6 kilometers, which is due almost entirely to the oceans, with very little water in the crust.

"We expect there to be water or ice in the crust," Jakosky says. "Actually detecting it and possibly determining its abundance is challenging, but extremely important for understanding how much water there is on Mars and what its history has been."

Jakosky's reexamination of the model results considered how the pore space is distributed and other conditions, like the presence of solid ice or empty pore spaces, which could also explain the seismic and gravity data InSight collected. While the InSight data do not require the presence of water in the mid-crust, Jakosky says, they also do not rule it out. After factoring in the distribution of pore space, he concluded the global equivalent layer could range from zero to two kilometers, expanding the lower limit found by the previous study.

The amount of water present in Mars's crust is a question that further missions—to conduct more detailed geological analysis and observations, including more advanced seismic profiling—could one day help answer. Additional implications of the findings include a better understanding of the red planet's water cycle, its potential conditions for life, and the availability of resources for future missions.

More information: Bruce M. Jakosky, Results from the inSight Mars mission do not require a water-saturated mid crust, *Proceedings of the National Academy of Sciences* (2025). DOI: 10.1073/pnas.2418978122

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