Mars' water appears to have been too salty to support life

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A new analysis of the Martian rock that gave hints of water on the Red Planet -- and, therefore, optimism about the prospect of life -- now suggests the water was more likely a thick brine, far too salty to support life as we know it. The finding, by scientists at Harvard University and Stony Brook University, is detailed this week in the journal *Science*.

"Liquid water is required by all species on Earth and we've assumed that water is the very least that would be necessary for life on Mars," says Nicholas J. Tosca, a postdoctoral researcher in Harvard's Department of Organismic and Evolutionary Biology. "However, to really assess Mars' habitability we need to consider the properties of its water. Not all of Earth's waters are able to support life, and the limits of terrestrial life are sharply defined by water's temperature, acidity, and salinity."

Together with co-authors Andrew H. Knoll and Scott M. McLennan, Tosca analyzed salt deposits in four-billion-year-old Martian rock explored by NASA's Mars Exploration Rover, Opportunity, and by orbiting spacecraft. It was the Mars Rover whose reports back to Earth stoked excitement over water on the ancient surface of the Red Planet.

The new analysis suggests that even billions of years ago, when there was unquestionably some water on Mars, its salinity commonly exceeded the levels in which terrestrial life can arise, survive, or thrive.

"Our sense has been that while Mars is a lousy environment for supporting life today, long ago it might have more closely resembled Earth," says Knoll, Fisher Professor of Natural Sciences and professor of Earth and planetary sciences at Harvard. "But this result suggests quite strongly that even as long as four billion years ago, the surface of Mars would have been challenging for life. No matter how far back we peer into Mars' history, we may never see a point at which the planet really looked like Earth."

Tosca, Knoll, and McLennan studied mineral deposits in Martian rock to calculate the "water activity" of the water that once existed on Mars. Water activity is a quantity affected by how much solute is dissolved in water; since water molecules continuously adhere to and surround solute molecules, water activity reflects the amount of water that remains available for biological processes.

The water activity of pure water is 1.0, where all of its molecules are unaffected by dissolved solute and free to mediate biological processes. Terrestrial seawater has a water activity of 0.98. Decades of research, largely from the food industry, have shown that few known organisms can grow when water activity falls below 0.9, and very few can survive below 0.85.

Based on the chemical composition of salts that precipitated out of ancient Martian waters, Tosca and his colleagues project that the water activity of Martian water was at most 0.78 to 0.86, and quite possibly reaching below 0.5 as evaporation continued to concentrate the brines, making it an environment uninhabitable by terrestrial species.

"This doesn't rule out life forms of a type we've never encountered," Knoll says, "but life that could originate and persist in such a salty setting would require biochemistry distinct from any known among even the most robust halophiles on Earth."

The scientists say that the handful of terrestrial halophiles -- species that can tolerate high salinity -- descended from ancestors that first evolved in purer waters. Based on what we know about Earth, they say that it's difficult to imagine life arising in acidic, oxidizing brines like those inferred for ancient Mars.

"People have known for hundreds of years that salt prevents microbial growth," Tosca says. "It's why meat was salted in the days before refrigeration."

Tosca and Knoll say it's possible there may have been more dilute waters earlier in Mars' history, or elsewhere on the planet. However, the area whose rocks they studied -- called Meridiani Planum -- is believed, based on Mars Rover data, to have been one of the wetter, more hospitable areas of ancient Mars.

Source: Harvard University