Was this huge river delta on Mars the place where its oceans finally disappeared?

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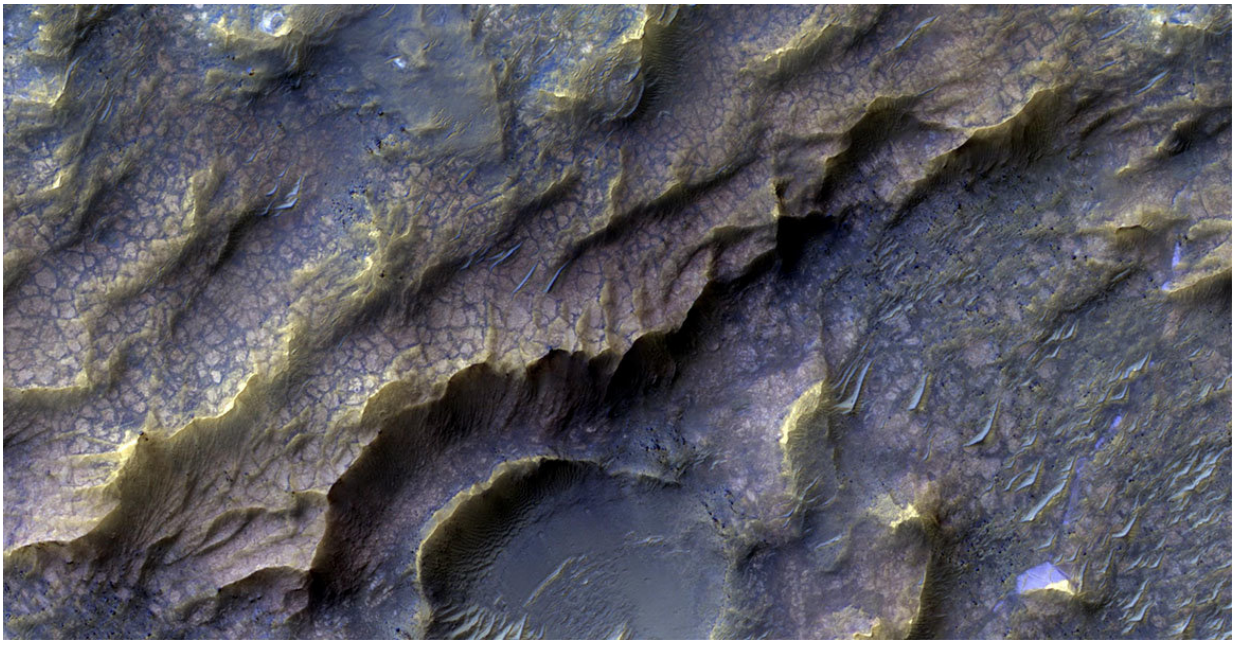


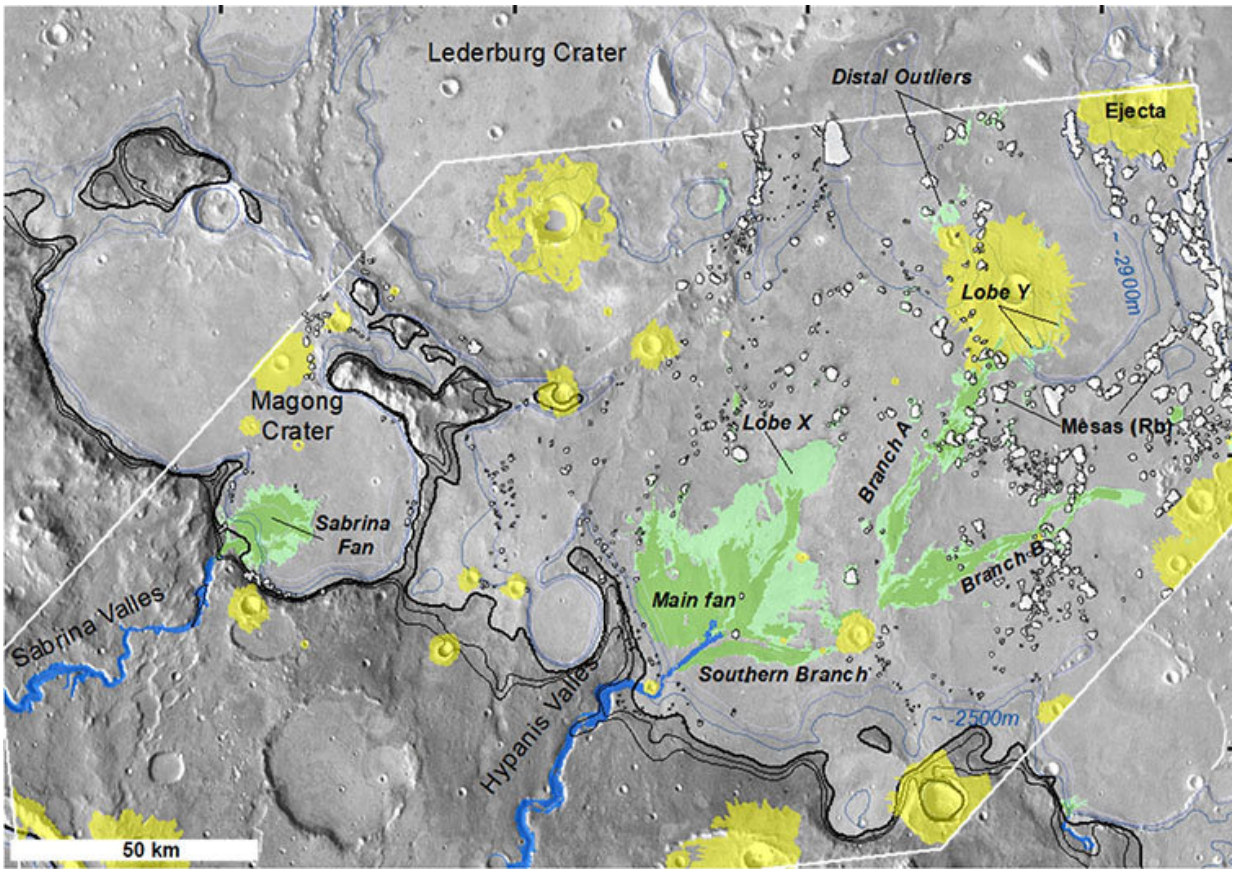
Mars Orbiter image of rock once carved by water. Credit: NASA

For some time, scientists have known that Mars was once a much warmer and wetter environment than it is today. However, between 4.2 and 3.7 billion years ago, its atmosphere was slowly stripped away, which turned the surface into the cold and desiccated place we know today. Even after multiple missions have confirmed the presence of ancient lake beds and rivers, there are still unanswered questions about how much water Mars once had.

One of the most important unanswered questions is whether or not large seas or an ocean ever existed in the northern lowlands. According to a new study by an international team of scientists, the Hypanis Valles ancient river system is actually the remains of a river delta. The presence of this geological feature is an indication that this river system once emptied into an ancient Martian sea in Mars' northern hemisphere.

For the sake of their study, titled "The Hypanis Valles delta: The last highstand of a sea on early Mars?" which recently appeared in the journal *Earth and Planetary Science Letters*, the international team consulted data from the Mars Reconnaissance Orbiter (MRO) and the 2001 Mars Odyssey probe to investigate the morphology, sedimentary architecture, and depositional environment of the Hypanis Valles region.

This delta is what separates the southern highlands from the northern lowlands, where an ancient ocean is once believed to have existed – a theory which has remained unproven. Based on data from the MRO's High Resolution Imaging Science Experiment (HiRISE) instrument and the 2001 Odyssey's THermal EMission Imaging System (THEMIS), the team found compelling evidence that a large body of water once covered the northern third of Mars.



An image from the study showing the Hypanis Valles sediment fan. Credit: Peter Fawdon et al./Science Direct/*Earth and Planetary Science Letters*

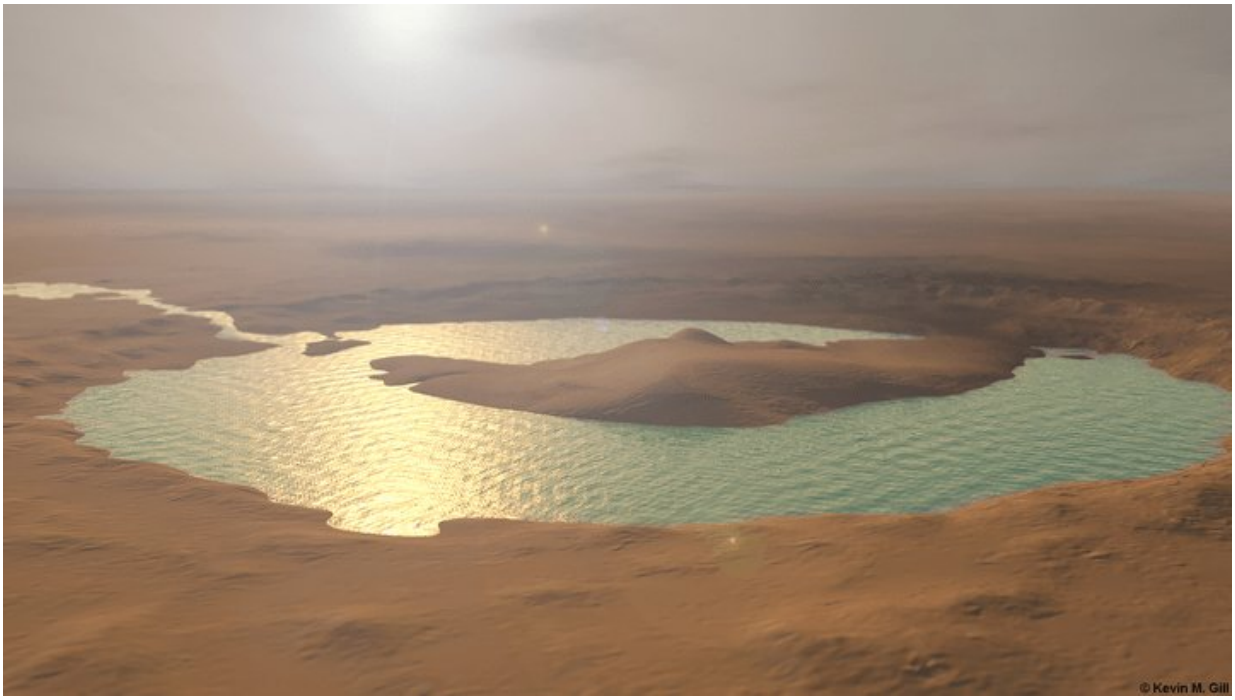
As Joel Davis – a postdoctoral researcher in the Planetary Surface Group at the Natural History Museum and a co-author of the paper – explained in a recent NHM press release:

"A Martian ocean means that Mars probably had a very Earth-like water cycle, with rivers, lakes, and now oceans, all of which probably interacted as part of a planet-wide system. We think this Earth-like hydrological cycle was active about 3.7 billion years ago, and started to shut down sometime after that. Our study is not definitive proof for an ocean, but these geological features are very hard to explain without

one."

Determining whether or not Mars had standing bodies of water in the past has been no easy challenge, mainly because Mars lacks the kinds of apparent indications of lakes and oceans on its surface (like fine-grained sand deposits or clear shorelines). As a result, scientists have had to look for other means of identifying where water flowed and sand was deposited, which is where sedimentary fans come into play.

In this case, the fan identified was a river delta, which form when a river slows down in the presence of a slower-moving or still body of water. This causes any small sediments that are being carried by the river to settle on the ground and form geological features (e.g. small islands at the mouth of the river) over time. In the past, river deltas have been found on Mars, but only in craters where water flowed into a lake.



Artist rendition of how the “lake” at Gale Crater on Mars may have looked

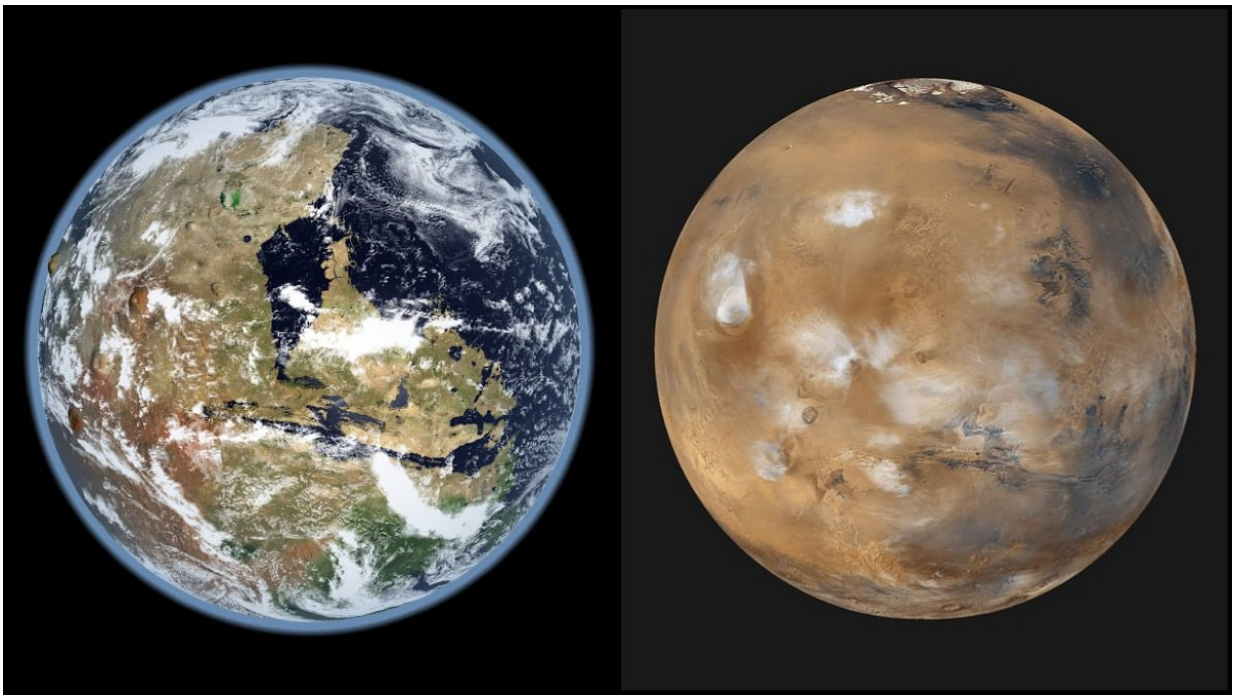
millions of years ago. Credit: Kevin Gil

Case in point, the Curiosity rover, which has been studying the Gale Crater since it landed there in 2012, has discovered abundant evidence that the crater was once a lake. This evidence included clay minerals at the base of Mount Sharp, as well as sedimentary deposits and channels discovered in the crater wall and Mount Sharp that could only be explained by water flowing into the crater.

Thanks to their study, scientists can now say with certainty that the Hypanis sedimentary fan is evidence of a standing body of water large enough to be an ocean. Their study also indicates how the ocean retreated as the climate gradually become colder and dryer. Basically, as ocean levels dropped by nearly 500 meters, the Hypanis delta began growing outwards as a result.

Finally, they determined that roughly 3.6 billion years ago, the water system dried up and disappeared, which is consistent with when Mars lost most of its ancient atmosphere. Since that time, no water has been able to exist on the surface in any form other than ice – with the exception of an underground lake that was recently discovered.

As Dr. Peter Fawdon, a post doctoral research associate from the Open University and the lead author of the study, explained:



Scientists were able to gauge the rate of water loss on Mars by measuring the ratio of water and HDO from today and 4.3 billion years ago. Credit: Kevin Gill

"The research has significantly contributed to our understanding of the climate on early Mars, which we now know went from having a water cycle similar to that of Earth to being a cold, desert-like landscape in a relatively short period. We would like to gain a better understanding of how many of these fluvial deltas exist on Mars so that we can determine the position and size of its ancient seas."

This study has not only provided definitive evidence of their being an ocean on Mars, it is also significant in that the shoreline of this ancient ocean is close to where the ExoMars 2020 and Mars 2020 rovers will be landing in the coming years. The fact that an ocean once existed there increases the odds that these rovers will find evidence of past Martian life – which is their primary goal.

Over the course of the last century, our collective understanding of Mars has changed dramatically. Once thought to be a planet crisscrossed by canals and inhabited by little green men, the first robotic missions to the Red Planet revealed a frozen landscape that was hostile to life. However, in recent decades, evidence has emerged that shows that Mars may have supported life in the past.

And though there may or may not be life there today, Mars remains a dynamic and fascinating place that can teach us much about the history and evolution of our solar system. However, if there are still microbes to be found on the Red Planet, the ExoMars 2020 and the Mars 2020 rovers are likely to be the ones that find it.

More information: Peter Fawdon et al. The Hypanis Valles delta: The last highstand of a sea on early Mars?, *Earth and Planetary Science Letters* (2018). DOI: 10.1016/j.epsl.2018.07.040

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