

Early Mars was covered in ice sheets, not flowing rivers: study

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UBC researchers have concluded that early Martian landscape probably looked similar to this image of the Devon ice cap. Credit: Anna Grau Galofre

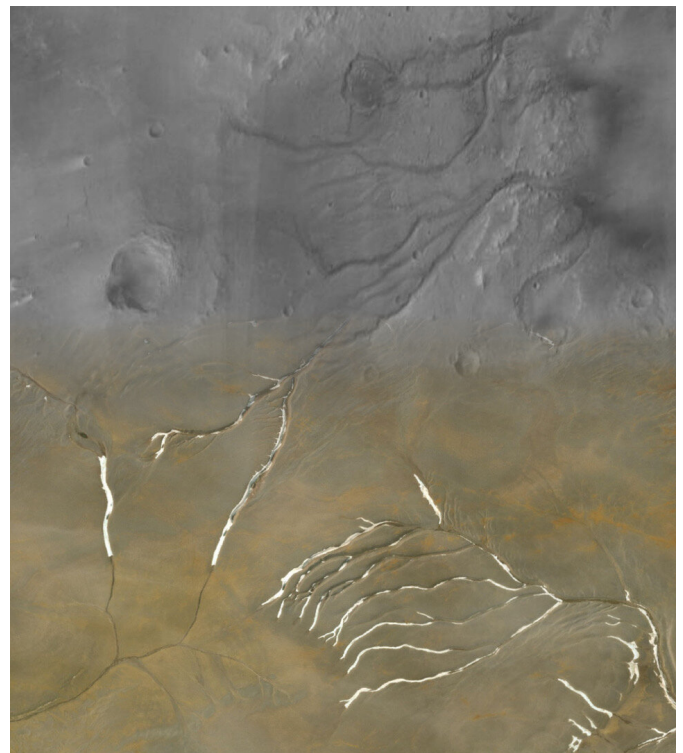
hundreds of valleys on Mars, and they look very different from each other. If you look at Earth from a satellite you see a lot of valleys: some of them made by rivers, some made by glaciers, some made by other processes, and each type has a distinctive shape. Mars is similar, in that valleys look very different from each other, suggesting that many processes were at play to carve them."

The similarity between many Martian valleys and the subglacial channels on Devon Island in the Canadian Arctic motivated the authors to conduct their comparative study. "Devon Island is one of the best analogues we have for Mars here on Earth—it is a cold, dry, polar desert, and the glaciation is largely cold-based," says co-author Gordon Osinski, professor in Western University's department of earth sciences and Institute for Earth and Space Exploration.

A large number of the valley networks scarring Mars's surface were carved by water melting beneath glacial ice, not by free-flowing rivers as previously thought, according to new UBC research published today in *Nature Geoscience*. The findings effectively throw cold water on the dominant "warm and wet ancient Mars" hypothesis, which postulates that rivers, rainfall and oceans once existed on the red planet.

To reach this conclusion, lead author Anna Grau Galofre, former Ph.D. student in the department of earth, ocean and atmospheric sciences, developed and used new techniques to examine thousands of Martian valleys. She and her co-authors also compared the Martian valleys to the subglacial channels in the Canadian Arctic Archipelago and uncovered striking similarities.

"For the last 40 years, since Mars's valleys were first discovered, the assumption was that rivers once flowed on Mars, eroding and originating all of these valleys," says Grau Galofre. "But there are



Collage showing Mars's Maumee valleys (top half) superimposed with channels on Devon Island in Nunavut (bottom half). The shape of the channels, as well as the overall network, appears almost identical. Credit: Anna Grau Galofre

In total, the researchers analyzed more than 10,000 Martian valleys, using a novel algorithm to infer their underlying erosion processes. "These results are the first evidence for extensive subglacial erosion driven by channelized meltwater drainage beneath an ancient ice sheet on Mars," says co-author Mark Jellinek, professor in UBC's department of [earth](#), ocean and atmospheric sciences. "The findings demonstrate that only a fraction of valley networks match patterns typical of surface water erosion, which is in marked contrast to the conventional view. Using the geomorphology of Mars' surface to rigorously reconstruct the character and evolution of the planet in a statistically meaningful way is, frankly, revolutionary."

Grau Galofre's theory also helps explain how the valleys would have formed 3.8 billion years ago on a planet that is further away from the sun than Earth, during a time when the sun was less intense. "Climate modelling predicts that Mars' ancient climate was much cooler during the time of [valley](#) network formation," says Grau Galofre, currently a SESE Exploration Post-doctoral Fellow at Arizona State University. "We tried to put everything together and bring up a hypothesis that hadn't really been considered: that channels and valleys networks can form under ice sheets, as part of the drainage system that forms naturally under an [ice sheet](#) when there's water accumulated at the base."

These environments would also support better survival conditions for possible ancient life on Mars. A sheet of ice would lend more protection and stability of underlying water, as well as providing shelter from solar radiation in the absence of a magnetic field—something Mars once had, but which disappeared billions of years ago.

While Grau Galofre's research was focused on Mars, the analytical tools she developed for this work can be applied to uncover more about the

early history of our own planet. Jellinek says he intends to use these new algorithms to analyze and explore erosion features left over from very early Earth history.

"Currently we can reconstruct rigorously the history of global glaciation on Earth going back about a million to five million years," says Jellinek. "Anna's work will enable us to explore the advance and retreat of ice sheets back to at least 35 million years ago—to the beginnings of Antarctica, or earlier—back in time well before the age of our oldest ice cores. These are very elegant analytical tools."

More information: Valley formation on early Mars by subglacial and fluvial erosion, *Nature Geoscience* (2020). DOI: [10.1038/s41561-020-0618-x](https://doi.org/10.1038/s41561-020-0618-x) , www.nature.com/articles/s41561-020-0618-x

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