Quantifying the way rivers bend opens up possibility for identifying origins of channels on other planets

March 5 2025

Credit: Leigh Patrick from Pexels

Whether it's rivers cutting through earth, lava melting through rock, or water slicing through ice, channels all twist and bend in a seemingly

similar back-and-forth manner. But a new study led by scientists at The University of Texas at Austin has discovered that channels carved by rivers actually have curves distinct to those cut by lava or ice.

The exact mechanism that drives the shape of these bends is not certain, but the researchers cite several previous models that point to the relationship between the topography of the channel and the fluid's flow within it.

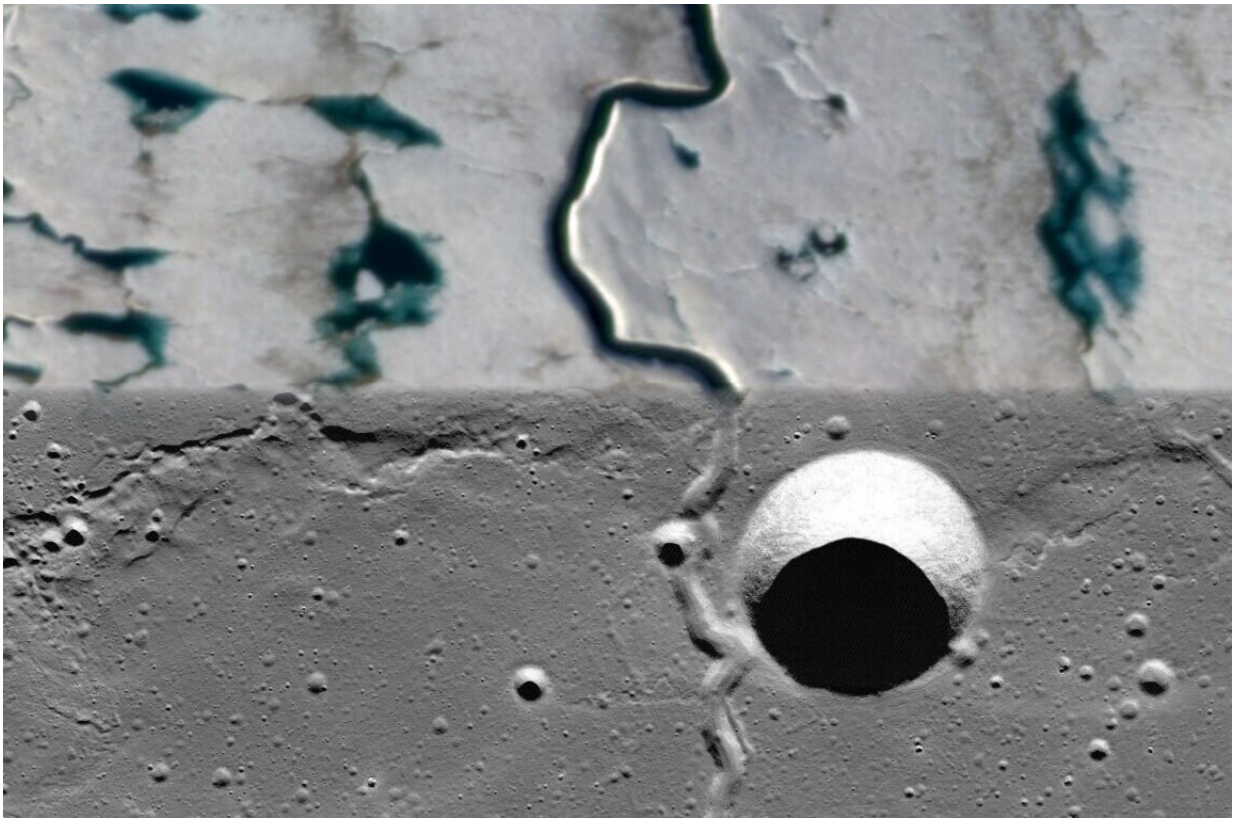
In rivers, centrifugal force pushes water to go faster around the outer edges of the channel's bends and more slowly along the inner edges. As a result, the water erodes the outer edge and deposits sediments along the inner edge, amplifying the river's bends.

Volcanic and ice channels, on the other hand, are eroded thermally, through melting. And because they do not deposit sediments like rivers do, the only change that occurs in these channels is along the outer edge of a bend, making their curves comparatively smaller than those in rivers.

"This distinction sets up a great natural experiment for us to see if the shape, or size, of bends in rivers is distinct from those in volcanic or ice channels," said Tim Goudge, a co-author on this paper and assistant professor at the Jackson School of Geosciences Department of Earth and Planetary Sciences.

These findings could have the potential to be used as a diagnostic tool for sinuous channels on other worlds, where the fluid's origin may be unknown and scientists cannot be on the ground to take measurements and samples.

The research is published in *Geology*.



Satellite images show a sinuous ice channel in North East Land, Greenland; volcanic sinuous rille Rima Seuss on the Moon; and the meandering Juruá River in Brazil. Credit: Tim Goudge / Jackson School

Juan Vazquez, who earned his undergraduate degree from the Jackson School in 2024, led the research while working with Goudge. He analyzed thousands of bends in rivers and ice channels on Earth and volcanic channels on the Moon. Vazquez said that what he thought was an analysis error at first ended up being an early indication that river bends have a more extreme size than other channels.

"It wasn't until the parameters for the code we had set for the volcanic channels on the Moon kept failing for the rivers on Earth that we

realized, "Oh, that's not a fault of the code. It's an intrinsically different amplitude,'" Vazquez said.

In their analysis, the researchers also found that thermally eroded volcanic and ice channels have a higher proportion of downstream accentuated bends compared to rivers.

On Earth, there are a number of ways to determine the origins of a channel, such as observing the fluid or noting geologic fingerprints the flow left behind. On planetary bodies like Titan, Saturn's largest moon, it's a trickier exercise. There, channels of liquid ethane and methane cut through water ice—but scientists can't say from orbit whether these channels are meandering due to sediment transport and deposition like rivers are, or if they are eroded through melting or dissolution. There is a similar debate about the origin of channels on Mars, where there were flowing rivers and active volcanoes several billion years ago.

"There are these sinuous channels on the sides of Martian volcanoes. Some people have interpreted them as volcanic channels, and some people have interpreted them as rivers that formed when maybe snowpack on the top of the volcano melted," said Goudge. "We're saying that because volcanic channel bends are so distinct, you can measure those channels to find out."

However, Goudge cautioned against this research being used as a hard and fast rule. When looked at individually, channels of all kinds can vary dramatically, so Goudge said he would like for more channels to be cataloged and analyzed before this can be widely applied as a diagnostic tool.

"But I think it has the potential to be if we understand it more," he said.

Mariel Nelson, a doctoral student at the Jackson School, also contributed

to this research and is a co-author on the paper.

More information: Juan A. Vazquez et al, Upstream bend skewing in alluvial meandering rivers is distinct compared to other sinuous channels on the Moon and Earth, *Geology* (2025). DOI: 10.1130/G52706.1