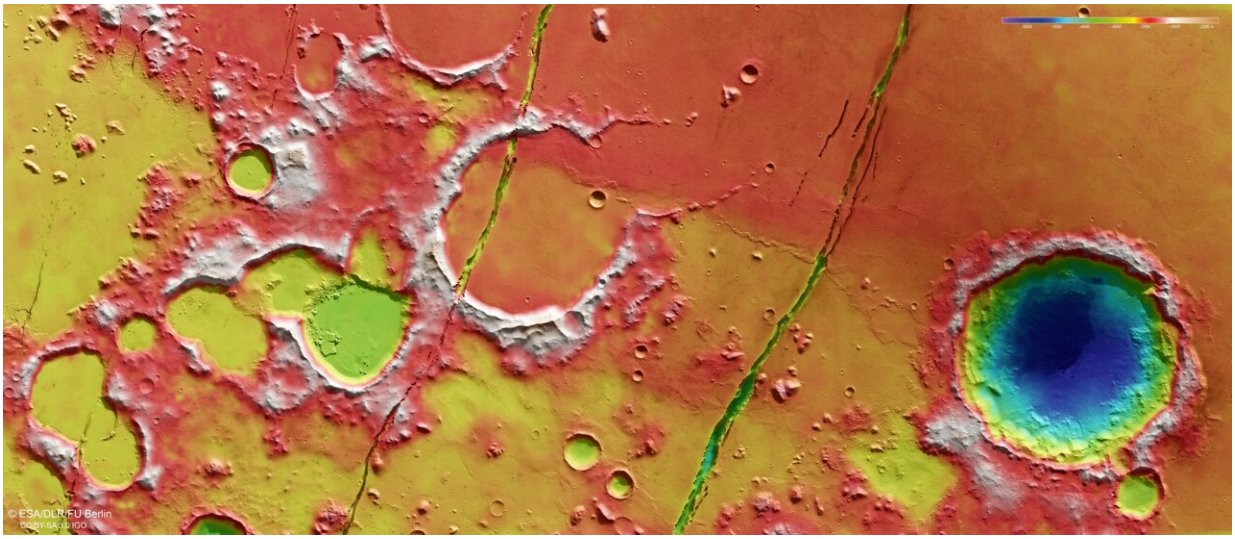
Magma on Mars likely, study finds

October 27 2022



Color-coded topographic view shows the relative heights of features in Cerberus Fossae: reds and whites are relatively higher than blues and purples. The image is based on a digital terrain model of the region, from which the topography of the landscape can be derived. https://www.esa.int/ESA_Multimedia/Search?SearchText=mars+AND+cerberus&result_type=images. Credit: ©ESA/DLR/FU Berlin, CC BY-SA 3.0 IGO https://www.esa.int/ESA_Multimedia/Terms_and_Conditions

Since 2018, when the NASA InSight Mission deployed the SEIS seismometer on the surface of Mars, seismologists and geophysicists at ETH Zurich have been listening to the seismic pings of more than 1,300 marsquakes. Again and again, the researchers registered smaller and larger marsquakes.

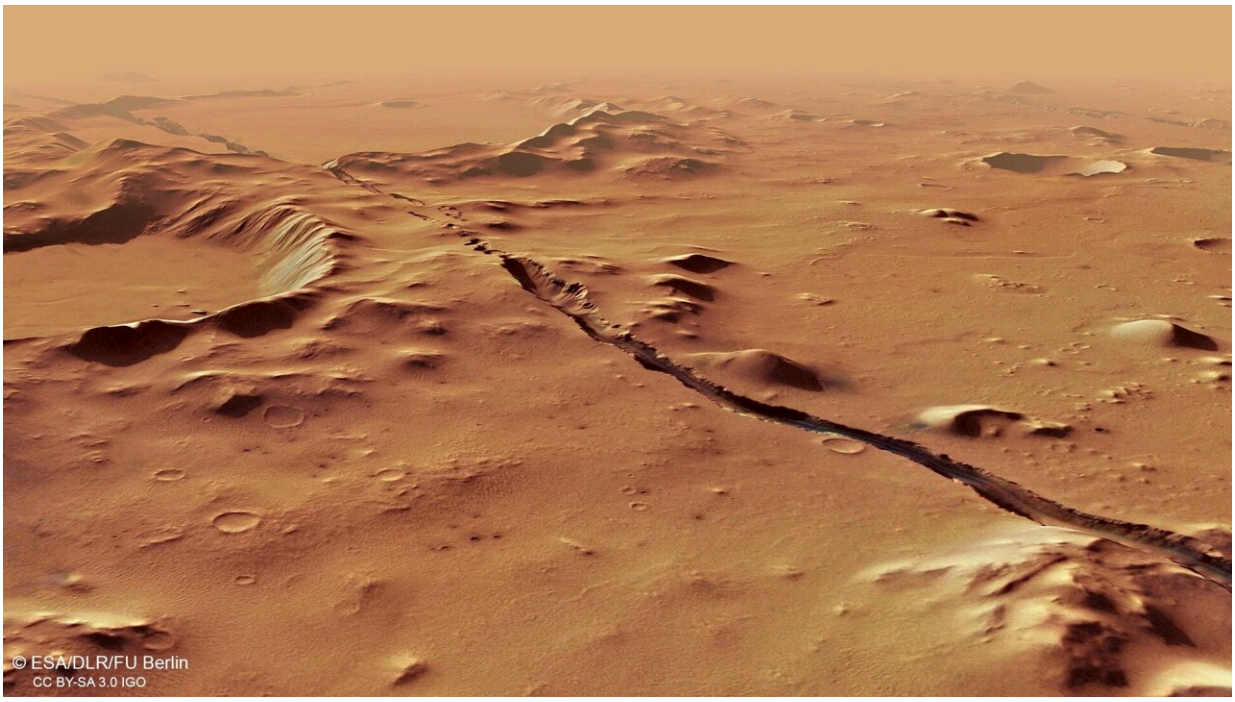
A detailed analysis of the quakes' location and spectral character brought a surprise. With epicenters originating in the vicinity of the Cerberus Fossae—a region consisting of a series of rifts or graben—these quakes tell a new story. A story that suggests volcanism still plays an active role in shaping the Martian surface.

Mars shows signs of life and youth

An international team of researchers, led by ETH Zurich, analyzed a cluster of more than 20 recent marsquakes that originated in the Cerberus Fossae graben system. From the seismic data, scientists concluded that the low-frequency quakes indicate a potentially warm source that could be explained by present day molten lava, i.e., magma at that depth, and volcanic activity on Mars. Specifically, they found that the quakes are located mostly in the innermost part of Cerberus Fossae.

When they compared seismic data with observational images of the same area, they also discovered darker deposits of dust not only in the dominant direction of the wind, but in multiple directions surrounding the Cerebus Fossae Mantling Unit.

"The darker shade of the dust signifies geological evidence of more recent volcanic activity—perhaps within the past 50,000 years—relatively young, in geological terms," explains Simon Staehler, the lead author of the paper, which has now been published in the journal *Nature Astronomy*. Staehler is a Senior Scientist working in the Seismology and Geodynamics group led by Professor Domenico Giardini at the Institute of Geophysics, ETH Zurich.



One of the fractures (graben) that make up the Cerberus Fossae system. The fractures cut through hills and craters, indicating their relative youth. Credit: ©SA/DLR/FU Berlin, CC BY-SA 3.0 IGO (https://www.esa.int/ESA_Multimedia/Terms_and_Conditions)

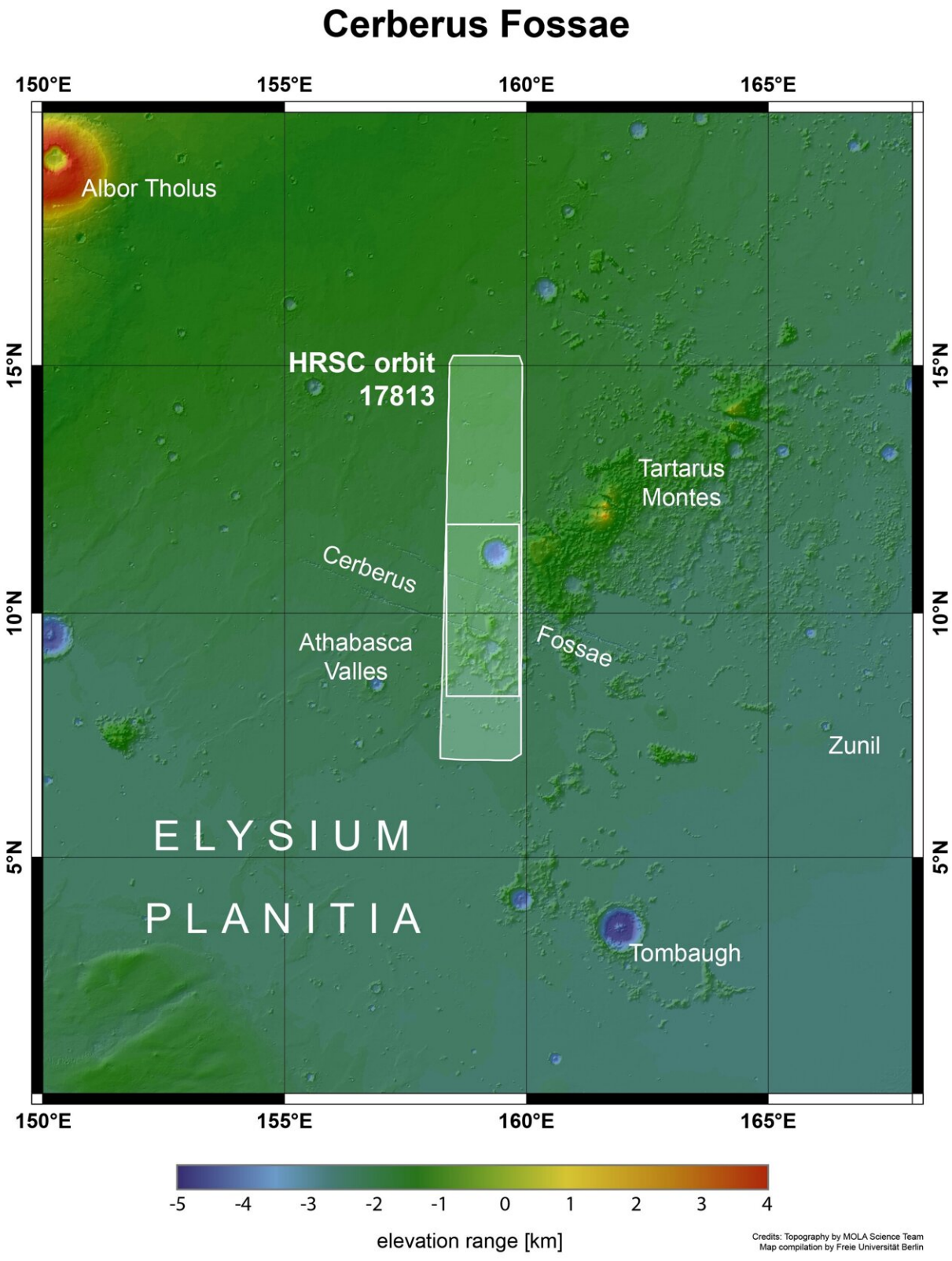
Why study the terrestrial neighbor?

Exploring Earth's planetary neighbors is no easy task. Mars is the only planet, other than Earth, in which scientists have ground-based rovers, landers, and now even drones that transmit data. All other planetary exploration, so far, has relied on orbital imagery.

"InSight's SEIS is the most sensitive seismometer ever installed on another planet," says Domenico Giardini. "It affords geophysicists and seismologists an opportunity to work with current data showing what is happening on Mars today—both at the surface and in its interior." The

seismic data, along with orbital images, ensures a greater degree of confidence for scientific inferences.

One of our nearest terrestrial neighbors, Mars is important for understanding similar geological processes on Earth. The red planet is the only one we know of, so far, that has a core composition of iron, nickel, and sulfur that might have once supported a magnetic field. Topographical evidence also indicates that Mars once held vast expanses of water and possibly a denser atmosphere. Even today, scientists have learned that frozen water, although possibly mostly dry ice, still exists on its polar caps. "While there is much more to learn, the evidence of potential magma on Mars is intriguing," Anna Mittelholz, Postdoctoral Fellow at ETH Zurich and Harvard University.



Cerberus Fossae in context of its surrounds in the Elysium Planitia region of

Mars near the equator. Credit: ©NASA MGS MOLA Science Team

Last remnants of geophysical life

Looking at images of the vast dry, dusty Martian landscape it is difficult to imagine that about 3.6 billion years ago Mars was very much alive, at least in a geophysical sense. It spewed volcanic debris for a long enough time to give rise to Tharsis Montes region, the largest volcanic system in our solar system and the Olympus Mons—a volcano nearly three times the elevation of Mount Everest.

The quakes coming from the nearby Cerberus Fossae—named for a creature from Greek mythology known as the "hell-hound of Hades" that guards the underworld—suggest that Mars is not quite dead yet. Here the weight of the volcanic region is sinking and forming parallel graben (or rifts) that pull the crust of Mars apart, much like the cracks that appear on the top of a cake while its baking. According to, Staehler "it is possible that what we are seeing are the last remnants of this once active volcanic region or that the magma is right now moving eastward to the next location of eruption."

This study involved scientists from ETH Zurich, Harvard University, Nantes Université, CNRS Paris, the German Aerospace Center (DLR) in Berlin, and Caltech.

More information: Simon Stähler, Tectonics of Cerberus Fossae unveiled by marsquakes, *Nature Astronomy* (2022). DOI: 10.1038/s41550-022-01803-y.
www.nature.com/articles/s41550-022-01803-y

Provided by ETH Zurich