Volcanic Venus

New research highlights recent volcanic activity on Venus, indicating that Earth's sister planet is alive — geologically speaking

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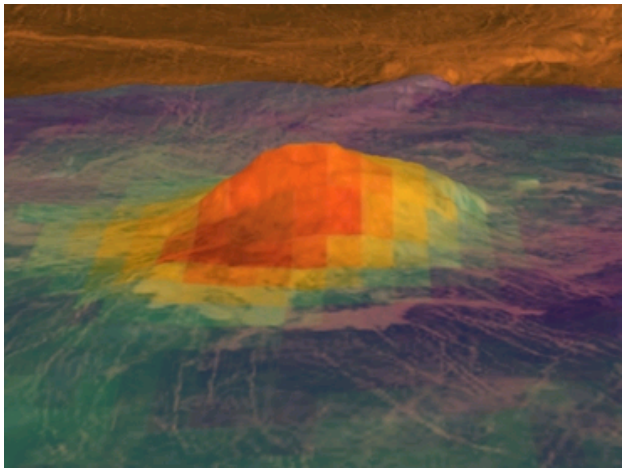

Based on topographic data obtained by NASA's Magellan spacecraft, this figure shows the volcanic peak Idunn Mons in the Imdr Regio area of Venus. The colored overlay shows the heat patterns derived from surface brightness data collected by VIRTIS aboard the European Space Agency's Venus Express spacecraft. The brightness signals the composition of the minerals that have been changed due to lava flow. Red-orange is the warmest area and purple is the coolest.
Image: NASA/JPL/ESA

Scientists have detected for the first time recent volcanic activity on Venus, the planet that is the most similar to Earth in terms of mass and density, but that has a surface temperature hot enough to melt lead.

Knowing that Venus is volcanically active could shed light on the mysterious geological history of Earth's sister planet, which does not have plate tectonics, meaning the planet's surface does not evolve through a process of rigid plates slowly shifting across the underlying mantle. Because the runaway greenhouse effect, or the phenomenon that occurs when a planet absorbs more energy from the sun than it can radiate back, was first discovered on Venus, this finding could also lead to a better understanding of climate change in general and, more specifically, how gas emitted from volcanoes may affect a planet's atmosphere.

Although previous data suggested volcanic activity on Venus, it wasn't until now that scientists were able to estimate how recent that activity was. By analyzing several "hot spots" on the Venusian surface — volcanic areas located on topographic rises that are thousands of kilometers wide — a team of scientists, including Lindy Elkins-Tanton, the Mitsui Career Development Assistant Professor of Geology in MIT's Department of Earth, Atmospheric and Planetary Sciences, concluded that several lava flows are up to 250 years to 2.5 million years old. Considering Venus is about 4.6 billion years old and its overall surface is thought to be about 500 million years old, even a 2.5 million-year-old lava flow would mean the planet is volcanically active, according to a paper published Thursday in *Science*.

These "recent" lava flows support one theory about the planet's evolution: that Venus resurfaces gradually through volcanism as a result of Earth-like processes involving heat loss from the interior, rather than through cataclysmic bursts of volcanic activity that are followed by long periods (hundreds of millions of years) of inactivity.

Lead author Sue Smrekar, a geophysicist at NASA's Jet Propulsion Laboratory, explained that studying the rate of volcanism on Venus will help determine how eruptions may have contributed to the high sulphur dioxide concentrations in the planet's atmosphere that limit how much solar radiation escapes from it. "Understanding the link between interior processes, gases given off during volcanism, and climate conditions on Venus can help us better understand climate processes on Earth, as well as help us

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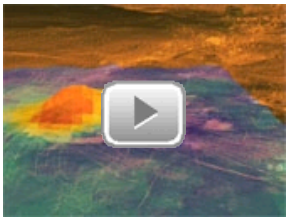

This movie features 360-degree views of the volcanic peak Idunn Mons on Venus and was compiled from VIRTIS data collected between May 2006 and late 2007. The research was carried out at the Jet Propulsion Laboratory under a contract with NASA.

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interpret new data for planets in other solar systems," she said.

'Hot spot' activity

Using topography and gravity data collected by NASA's Magellan spacecraft during the 1990s, scientists indentified nine hot spots on Venus. Smrekar's team then analyzed data for three hot spots observed by the Visible and Infrared Thermal Imaging Spectrometer (VIRTIS). VIRTIS is a device that is located onboard the European Space Agency's Venus Express spacecraft launched in 2006 and that measures thermal variations of the planet's surface.

By comparing the two sets of data, the scientists discovered that certain parts of the hot spots had "anomalously high" emissivity, or the ability to radiate energy. Because calculations and lab experiments replicating the Venusian surface and atmosphere show that emissivity decreases over time, emissivity can be an important indicator of a substance's age. "These apparently young rocks correspond to the youngest volcanic flows in each hot-spot region, giving us confidence that they formed during recent volcanic activity," Smrekar said.

The scientists believe that the lava flows have such a high emissivity because they are fresh — no more than 250 years to 2.5 million years old. They determined this range by using Magellan data to estimate the volume of the lava flows in the hot spot regions. They then divided the estimated volume levels by various rates of resurfacing that support the estimated date of the planet's most recent resurfacing event. The results provide an estimated age range for the lava flows.

Because lab experiments suggest that weathering, or the process by which rocks react with the atmosphere, proceeds very rapidly on Venus, Smrekar's team believes that the smallest values are more likely for the age of the lava flows, which indicates that Venus resurfaces through continual smaller volcanic eruptions rather than a more catastrophic process. Smrekar pointed out that the volcanoes could even be currently active, but that there is no data to confirm that.

Roger Phillips, a planetary scientist at the Southwest Research Institute, called the result "as close as possible to a smoking gun" in the hunt for evidence that Venus is volcanically active. He added, however, that in order to make even more progress in determining how Venus resurfaces, scientists need to learn exactly how weathering surface rates affect emissivity. "If you knew that rate, you could pinpoint precisely how old the lava flows are," he explained.

Charting a mission

Smrekar's follow-up work will include deeper analyses of the anomalies seen in the emissivity data, but she noted that such work is hampered by limited and outdated data. "We'd love to know more about the minerals on the surface, but those that we think are there are based on data from Soviet landers that landed on Venus 30 years ago," she said, adding that the poor resolution of Magellan's topography data makes it very difficult to interpret the emissivity anomalies in areas of rough topography.

This finding of recent volcanic activity contributes to an uptick in Venus research that has occurred in anticipation of a possible mission to the planet, such as one that has been proposed for NASA's New Frontiers program. As a member of the team that has proposed that mission, Elkins-Tanton believes this discovery reinforces the need for a mission to collect data to refine our understanding of Venus. "We need to reconsider its evolutionary history and the processes that forced Earth's sister planet to develop into its inhospitable current state," she said. "There is so little data on Venus that anything we can learn would be revolutionary," she said.

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