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Volcanoes are fundamentally cool, says Mark Jellinek. Especially if they're on Venus

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Mark Jellinek is an assistant professor in the Department of Earth and Ocean Sciences at UBC. But that doesn't mean his interests have any earthly limits; in fact, much of his work takes place on planets no human has ever visited. His work in comparative planetology means he can use information about other planets to enhance our knowledge about the processes that govern the earth. →

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Mark Jellinek's projects receive funding from NSERC and the CFI. He is a CIAR scholar at UBC. The National Science Foundation and NASA support his work in the US. In New Zealand, he has received funding from the Marsden Foundation. He also became a scholar in CIAR's Earth System Evolution Program in 2003.

One aspect of the earth's mechanics that holds particular fascination for Jellinek is the sight of an erupting volcano; in fact, it was lava flow that got him going in the first place. "I was on the big island of Hawaii, where you can sit and watch an eruption into the ocean. You can actually watch the island grow a few thousand square metres every day. It's astonishing." Previous to this, he had also spent time in the Galapagos Islands, where as an undergraduate he worked on an exploded volcano. He explains that most volcanoes make eruptions that humans can outrun, but the one he was exploring was one that humans could not.

The volcanoes sparked Jellinek's curiosity: "I got interested in the bigger problems by trying to understand how volcanoes work. I wanted to understand why there are volcanoes around here, why only a few are found in the middle of the earth, and how the spatial distribution and the style of the volcanoes can give you information about how the interior of the earth works. And generally, how the interior of the planet evolved through time."

He explains that volcanoes are directly related to the processes that govern how the planets cool off. "Planets are just big heat engines, essentially. The core of the earth is made of liquid iron; above it is the mantle, which is solid, and on top of the mantle float the continents. The oceanic lithosphere is essentially the rock that holds up the ocean. Plate tectonics is the process of stirring the mantle; it happens as a result of the oceanic lithosphere bending and going down beneath continents, which stirs up the mantle and melts it. If you stand back and look at the earth over a long time — a billion years — and you do a time-lapse movie of it, the stirring is really vigorous. The planet is very good at cooling itself off. Volcanoes are surface expressions of this process and their erupting is another way to draw heat out of the mantle."

But understanding these processes on earth was only the beginning for Jellinek. Soon he was making comparisons between what can be observed on earth, and what could be determined about other planets. Venus holds particular interest: it's the same size and the same mass as the earth, and is subject to the same amount of gravity. Yet it has no plate tectonics. Jellinek wants to know why. And in trying to answer that question, other questions pop up: why are volcanoes scattered all over the surface of Venus? If Venus and earth are approximately the same age (4.5 billion years old), then why is the crust of Venus only 700 million years old? Why is it so young if the planet has no plate tectonics? Did the entire mantle of the planet buckle down and collapse?

In trying to resolve some of these questions, Jellinek points to models that suggest Venus did at one time have plate tectonics. In a whole new spin on global warming, he also comments that the atmosphere of Venus could potentially turn plate tectonics back on. On earth, he says, we worry about an increase in temperature of 0.1 Kelvin every 10 years. On Venus, the temperature is going up several full degrees in that same 10-year period. Because there's no ocean on Venus to absorb the excess carbon dioxide, the planet cannot cool itself effectively. Learning more about the greenhouse effect on Venus offers a clear picture of what happens when the atmosphere of a planet continues to warm up, with no process to cool it down.

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Investigating the mechanics of a planet such as Venus or Mars isn't easy. But Jellinek says we actually know more about the topography of Mars than we do about the earth. The most effective measure of topography is done with laser altimetry, in which a satellite travels around a planet thousands of times, criss-crossing orbits, and shoots a laser at it. It measures the amount of time the laser takes to travel from the satellite to the surface and back to the satellite, and the topography is revealed. This works best on Mars, because the laser cannot penetrate cloud cover and Mars has no clouds. Venus is always covered in clouds so its topography is measured by radar only. And the earth of course, has partial cloud cover, which interferes with the laser process. Knowledge of topography, combined with information about gravity and the presence or absence of volcanoes on a planet, can reveal its interior processes.

Jellinek's work contributes to the fundamental body of knowledge that we have about the earth and its interior processes, but it also has some immediate practical applications. One is predicting volcanic activity, which is especially important given that a huge fraction of the earth's population lives on active volcanoes. An ambitious new project in New Zealand aims to further our predictive ability about volcanoes, not only there but in other countries as well. Jellinek is asking some big questions about the earth, and looking for some very small and precise answers.