# What's beneath Hawaii's most active volcano?

March 3 2015, by Katie Jacobs

Aerial view of Kilauea volcano. Credit: Flickr user exfordy

Step away from the villages and idyllic beaches of Hawaii, and you may think you've been transported to the moon. Walking along the lava flows of the Kilauea volcano, the landscape changes from a lush tropical paradise to one that's bleak and desolate, the ground gray and rippled with hardened lava.

That's how Christelle Wauthier, assistant professor in the Department of Geosciences and the Institute for CyberScience at Penn State, describes it, anyway.

Wauthier has been studying Kilauea volcano for several years and is getting ready to start a new project at Penn State—one using a radar imaging technique that researchers call interferometric synthetic aperture radar (InSAR) to try to peer below its surface and learn more about why the volcano is so volatile.

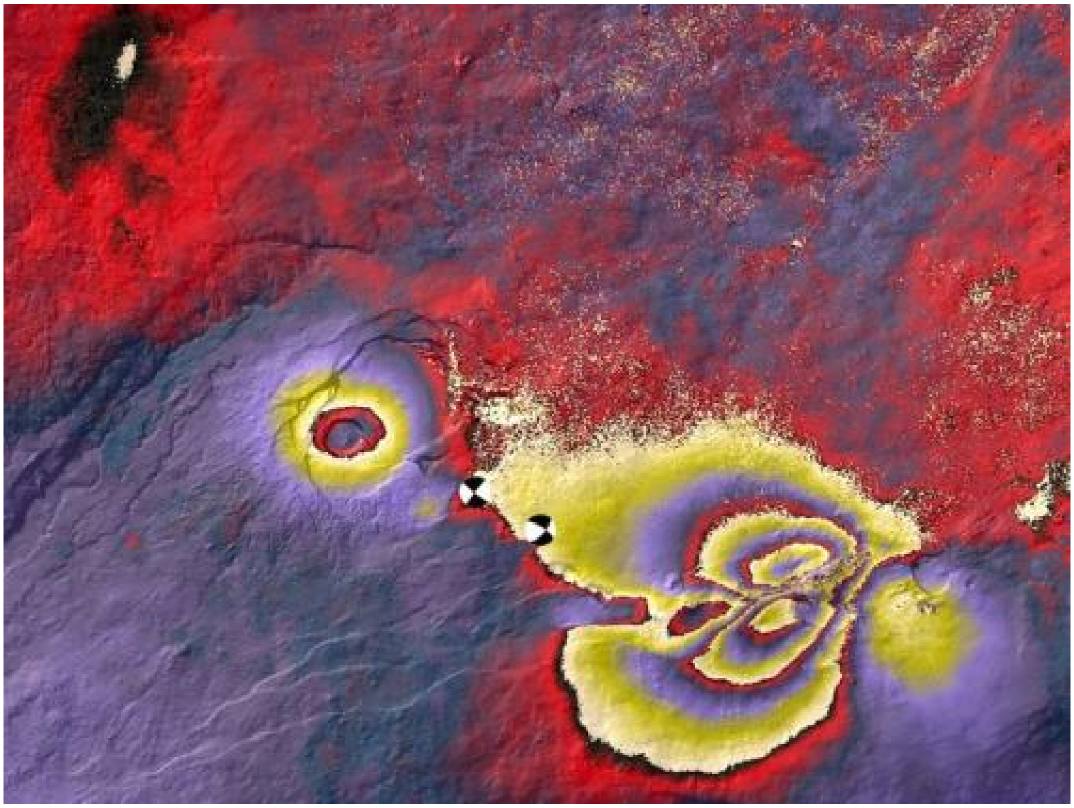
Kilauea is the most active of the five volcanoes that make up the island of Hawaii. It's been erupting continuously since 1983, so far spewing 3.5 cubic kilometers of lava onto the surrounding landscape. The lava usually flows southward, but last year an eruption started creeping east toward the nearby village of Pahoa.

The flow was inconsistent—advancing anywhere from 10 yards to one-quarter mile a day—but it was enough to cause evacuations and lots of anxiety for the residents of the small village.

Wauthier says the volcano's recent brush with the island's inhabitants reinforced the importance of studying not just what's happening on the surface of the volcano, but also what's going on below.

"The volcano has been erupting for 31 years, so obviously there's a lot of magma coming from below," said Wauthier. "There's lots of magma moving up and out, so one of the questions we're asking is where are all these magma sources and how do they relate to each other?"

One of the keys to answering this question is found in the deformations happening on the surface of Kilauea. While a deformation is simply a change on the volcano's exterior, what it implies goes much deeper—there has to be something below the surface causing the change. And without X-ray glasses to diagnose what's happening, Wauthier uses InSAR to try to piece together what might be going on.



An InSAR image spanning May 5 to June 20, 2007, shows the ground deformation associated with the May 24, 2007, earthquakes at Kilauea volcano. Credit: Christelle Wauthier

"InSAR is a remote-sensing technique that combines radar data taken from satellites to create images that show subtle movements in the ground's surface," said Wauthier. "In this case, the movements we're studying are deformations on Kilauea."

To begin the process, Wauthier gathers satellite data from archived databases. She looks for information about changes in elevation from before and after a "natural hazard event"—an eruption or earthquake, for example. Wauthier then uses this data to create two images: one from before the natural hazard event and one from after. This shows how the event changed the ground's surface.

The two pictures can then be combined to create a single, much more comprehensive InSAR image called an interferogram, which uses color to represent movement.

Wauthier says that while InSAR images can certainly be created from two images, she also uses a time-series approach called Multi-Temporal (MT)-InSAR when enough radar images are available. This technique uses multiple images instead of two.

"This approach is much more accurate, but it also requires much more data and computing power," Wauthier said. "The powerful computer clusters and IT facilities available through the Institute for CyberScience here at Penn State are tremendously helpful by providing the necessary computing power and efficiency."

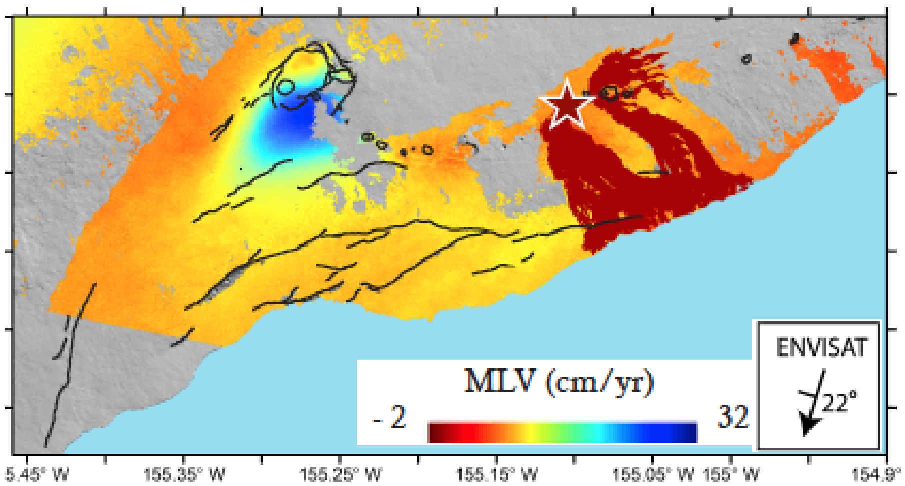
After Wauthier creates the InSAR images, she can begin to use them to predict what might be happening underneath Kilauea. She uses an approach called inverse modeling to estimate what caused the deformation.


Christelle Wauthier in Japan. Credit: Christelle Wauthier

"Basically, we use what's happening on the surface of the volcano to find a 'best fit model' for what's happening underground," said Wauthier. "For example, if we know the ground rose here but sank over there, we'll come up with a best guess for the type of magma process—like a magma reservoir or intrusion—that's below."

But magma processes aren't the only things that could be affecting Kilauea's volatility. The southern flank of the volcano is moving away from the island, and Wauthier says this could also be influencing the volcano's magma plumbing system and activity.

Wauthier says that although the flank is slipping seaward at an average speed of 6 to 10 centimeters a year, earthquakes in the past have caused more drastic movement and have even generated tsunamis.




InSAR image showing ground deformation at Kilauea. The star marks the volcano's eruption zone. Credit: Christelle Wauthier

Remote-sensing technologies like InSAR are important because they allow researchers like Wauthier to do important research without physically being on location. (Although when you're studying the Hawaiian landscape, you might want to be.)

Wauthier says she would like to return to Hawaii one day, but in the meantime, she hopes the project will help uncover information that could help the people of Hawaii as well as other scientists at the U.S. Geological Society Hawaiian Volcano Observatory. Having a better understanding of Kilauea would help researchers better grasp the behavior of other ocean islands volcanoes.

"Ideally, we'd like to get a much better picture of the underground magma systems and how they interact with the flank slip," she said. "The flank instabilities can cause earthquakes and tsunamis, so we'd like to be able to understand and forecast those better. Hopefully, the more we know about these natural hazards, the more we can help people anticipate and mitigate their risks."

Provided by Pennsylvania State University

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