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Giant earthquakes help predict volcanic eruptions

Researchers at the Institut des Sciences de la Terre (CNRS/Université Joseph Fourier/Université de Savoie/IRD/IFSTTAR) and the Institut de Physique du Globe de Paris (CNRS/Université Paris Diderot/IPGP), working in collaboration with Japanese researchers, have for the first time observed the response of Japanese volcanoes to seismic waves produced by the giant Tohoku-oki earthquake of 2011. Their conclusions, published in *Science* on July 4, 2014, reveal how earthquakes can impact volcanoes and should help to assess the risk of massive volcanic eruptions worldwide.

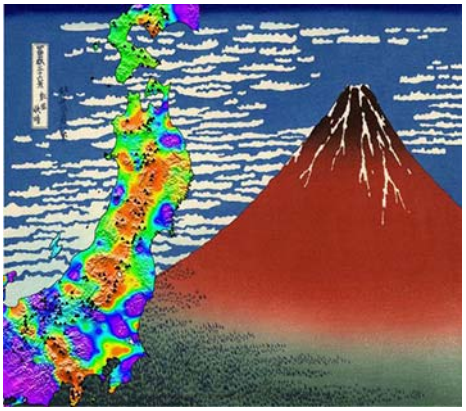
Until the early 2000s, seismic noise[1] was systematically removed from seismological analyses. This background noise is in fact associated with seismic waves caused by ocean swell. These waves, which can be compared to permanent, continuous microseisms, can be used by seismologists instead of earthquakes (which are highly localized over a limited time period) to image the Earth's interior and its evolution over time, rather like an ultrasound scan on a global scale.

Now, seismic noise has been used for the continuous measurement of perturbations of the mechanical properties of the Earth's crust. Researchers at the Institut des Sciences de la Terre (CNRS/Université Joseph Fourier/Université de Savoie/IRD/IFSTTAR) and the Institut de Physique du Globe de Paris (CNRS/Université Paris Diderot/IPGP) have applied this novel method while working in collaboration with Japanese colleagues using the Hi-net network, which is the world's densest seismic network (comprising more than 800 seismic detectors throughout Japan).

After the giant Tohoku-oki earthquake of 2011, the researchers analyzed over 70 terabytes of seismic data from the network. For the first time, they showed that the regions where the perturbations of the Earth's crust were the greatest were not those where the shocks were the strongest. They were in fact localized under volcanic regions, especially under Mount Fuji. The new method thus enabled the scientists to observe the anomalies caused by the perturbations from the earthquake in volcanic regions under pressure. Mount Fuji, which exhibits the greatest anomaly, is probably under great pressure, although no eruption has yet followed the Tohoku-oki earthquake. The 6.4-magnitude seism that occurred four days after the 2011 quake confirms the critical state of the volcano in terms of pressure. These findings lend support to theories that the last eruption of Mount Fuji in 1707 was probably triggered by the giant 8.7-magnitude Hoei earthquake, which took place 49 days before the eruption.

[1] Seismic noise includes all the unwanted components affecting an analysis, such as the noise produced by the measuring device itself or external perturbations inadvertently picked up by the measuring devices.

More generally, the results show how regions affected by high-pressure volcanic fluids can be characterized using seismic data from dense seismic detector networks. This should help to anticipate the risk of major volcanic eruptions worldwide.



Imaging seismic susceptibility makes it possible to detect regions affected by high-pressure volcanic fluids. The image in the background is catalogued as 'Red Fuji' (Katsushika Hokusai, 1830).
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Reference

Mapping pressurized volcanic fluids from induced crustal seismic velocity drops. Brenguier, F., Campillo, M., Takeda, T., Aoki, Y., Shapiro, N.M., Briand, X., Emoto, K., & Miyake, H. *Science*, 4 July 2014.

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