Harvard University, Solid Earth Physics Seminar
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Room 204 Geological Museum
24 Oxford Street, Cambridge, MA

Monitoring and Locating Changes in the Elastic Properties of the Crust with Ambient Seismic Noise Interferometry

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In highly heterogeneous media waves do not propagate ballistically. They interact several times with the heterogeneities of the medium and enter the multiple scattering regime. In this regime, classical imaging techniques based on direct or singly scattered waves fail. This is typically the case in fault zones and volcanoes, two highly heterogeneous structures that are of great interest for many geoscientists.

We present a new imaging technique that uses the sensitivity of multiple scattered waves (coda waves) to tiny changes in the medium in order to monitor and locate these changes. We illustrate the method with ambient seismic noise recorded at Piton de La Fournaise volcano. After recovering the Greens functions by cross-correlating the ambient noise, we successfully monitored and located pre- and co-eruptive changes associated with two eruptions on different sides of the volcanic cone in 2010. Our results point out the possibility to locate forthcoming eruptions. In a second study, we used ambient seismic noise correlations from the Mw 7.9 2008 Wenchuan earthquake. We were able to image structural and mechanical changes associated with this earthquake and with seasonal hydrological changes. Our results indicate a postseismic relaxation of the Sichuan basin.

In these two studies, we assumed that the coda (reconstructed from ambient noise) was mainly composed of surface waves. However, we know that the heterogeneities of the medium should generate conversion to bulk waves. To study the depth sensitivity of coda waves, we performed a series of 2D numerical simulations of elastic waves in heterogeneous media, where a velocity change is introduced at different depth. We show that the depth sensitivity of coda waves can be related to a combination of bulk and surface wave sensitivity. Furthermore, the time dependence of the apparent velocity change in the coda can be used to discriminate a change that occurs at the surface from a change that occurs at depth.