Recent results of noise-based seismic velocity monitoring at Piton de la Fournaise Volcano, La Reunion

Florent Brenguier[1], Diane Rivet[2], Anne Obermann[1], Thomas Lecocq[3], Daniel Clarke[2], Nikolai Shapiro[2], Michel Campillo[1], Eric Larose[1], Valerie Ferrazzini[4]

[1]Institut des Sciences de la Terre, University of Grenoble, CNRS, France, [2]Institut de Physique du Globe de Paris, France, [3]Royal Observatory of Belgium, Belgium, [4]Observatoire Volcanologique du Piton de la Fournaise, IPGP, France

E-mail: florent.brenguier@ujf-grenoble.fr

Piton de la Fournaise Volcano, a shield basaltic volcano located on La Reunion island, has been strongly active these last 15 years with 2 eruptions per year on average. On April 2007, an unusually strong eruption occurred on the volcano's south-eastern flank, ejecting a volume of over 240 million cubic meter of lava, that is, ten times more than the typical value during the preceding decade. A few days later, the summit crater collapsed by 340 m. Since then, magmatic activity at PdF decayed until the last eruption of December 2010. Since 2000, Piton de la Fournaise Volcano Observatory records seismic signals continuously from 20 short-period sensors located on PdF Volcano. This set of data together with recent fundamental advances in ambient noise seismology have led to the development of a novel method to measure volcanic edifice seismic velocity changes continuously along time. Changes of seismic velocities of volcanic edifices are known to be sensitive to edifices deformation induced by magmatic activity or gravitational flank instabilities. Edifice seismic velocities may also be induced by external perturbations such as water content associated with rainfall, barometric pressure changes, temperature changes or tides.

In order to measure highly precise seismic velocity changes we deployed 15 new broad-band seismic sensors on PdF volcano between 2009 and 2011 in the framework of an international project called UnderVolc. During that time period, 5 eruptions occurred and the last 10 months of records were characterized by an unusual low volcanic activity. We focus on the location and characterization of edifice seismic velocity changes observed few weeks prior to the October 2010 PdF eruption. We show that precursory seismic velocity changes depend upon the frequency range of the filtered raw data. This observation seems to indicate a depth dependent process. We also present results of lateral location of seismic velocity changes for this precursory episode. We also study the long-term changes of seismic velocities during the low volcanic activity time period. Our results indicate a long lasting seismic velocity increase that we interpret as being associated with the slow compaction of the edifice following the 2007 crater collapse. We also study the link between seismic velocity changes and external perturbations such as in particular water content associated with rainfall. Finally, we have turned these fundamental developments into an operational computer routine called MSNoise for the purpose of continuously monitoring in real-time seismic velocity changes in volcanic domain.

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