Subject offered for a contract starting October 2019

SUBJECT TITTLE: Temporal changes of seismic anisotropy in volcanic zones- Application to La Réunion island

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Financing: Doctoral contract with or without teaching assignment

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Presentation of the subject: (1 or 2 pages)

Time-dependent Seismology is developing very rapidly. By calculating cross-correlations of ambient noise, in different seismic stations of a dense array, it is possible to monitor the changes through seismic polarization anomalies, of the stress field in seismogenic zones such as Parkfield in California (Durand et al., 2011) and in northern Japan (Saadé et al., 2017) and to follow fluid migration in volcanic zones (Saadé et al., 2019).
Brenguier et al., (2007, 2008) showed that very small variations of S-wave velocity can be detected on Piton de la Fournaise. Seismic anisotropy, even though more difficult to retrieve than S-wave velocity, adds fundamental information on the stress and strain fields. Different kinds of data can be used for investigating temporal changes of seismic anisotropic parameters. The method using S-wave splitting requires much seismicity. By using continuous noise, it is possible to have continuous sources of seismic waves, well suited for monitoring of seismic and volcanic zones. The influence of anisotropy can be found on the nine components of the cross-correlation tensor. By using only ZZ (vertical-vertical), it is possible to retrieve the azimuthal anisotropy of Rayleigh waves, the joint inversion of ZZ and TT (transverse-transverse) makes it possible to derive radial anisotropy and the off-diagonal terms (ZT, RT, TZ, TZ) give access to the polarization anomalies.
Temporal variations of seismic anisotropy have been also observed before and after volcanic eruptions (Miller & Savage, 2001) and following large earthquakes (i.e. on Mount Fuji after the 2011 Japan-Tohoku earthquake, (Saadé et al., 2019).

The goal of the internship consists in calculating the whole cross-correlation tensor including the horizontal components, but the focus will be on the detection temporal changes of horizontal polarization anomalies.

Short term Objectives:
There is a dense network of broadband 3-component seismic stations operated for several years by the observatory in Piton de la Fournaise. Several volcanic eruptions have been observed during the recent years. The goal of the thesis is to use and apply the whole software developed by Maria Saadé during her thesis (Saade et al., 2017, 2018) for Japanese network to the seismic data of Piton de la Fournaise Observatory.

Long term objectives:
On a long-term basis, we plan to use the whole information of the 9 components of the cross-correlation tensor, to design a technique to retrieve the different forms of observable anisotropy and to interpret them in terms of stress field changes.

Pre-requisite for this internship: a good background in physics and/or in Seismology and basic knowledge in programming languages and computing methods.