ÉCOLE DOCTORALE
SCIENCES DE LA TERRE ET DE L'ENVIRONNEMENT
ET PHYSIQUE DE L'UNIVERS, PARIS

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Titre du sujet : Time-lapse seismic imaging of Mount Fuji

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Mount Fuji has remained dormant for over 300 years, but an eruption could affect 30 million people and cause 17 billion euros in damage. This thesis project aims to quantitatively link low-frequency seismograms to volcanic activities, such as magma migration and the high risk of eruption from seemingly inactive volcanoes like Mount Fuji, by compiling seismic imaging technologies and statistical classifiers using artificial intelligence. By applying these technologies to observed data, we will seek to interpret seismic waveforms to deduce both the structure inside the volcano and the volumetric source mechanisms (4D) in time-lapse. This 4D seismic source image will then be interpreted as an eruption, whose acceptability will be validated with active volcanoes that have eruption manifestations via statistical methodologies such as machine learning. The ultimate goal of this project is to propose an effective alert system based on continuous seismic observation around Mount Fuji.

To do this, we would first like to illuminate the internal structure beneath Mount Fuji. We will use our tools for localized tomography of teleseismic event waveforms (see Fuji et al. 2012; Monteiller 2013; Xiao et al. 2020). We will need to calculate and store the displacements and strains on the surfaces of the box surrounding Mount Fuji. We will filter the seismic signals up to 2 Hz so that the minimum wavelength of the S-waves reaches ~1 km, which has never been done to this date.

Once the tomographic model of the region is established, we prepare Green's functions from 17 stations located on Mount Fuji, so that we can "back-propagate" continuous observed data to image the sources (cf. Kawakatsu & Montagner). This technique will allow us to create a 4D video and locate seismic sources from ~100 local events. With the help of petrological knowledge, we will be able to constrain the evolution of magma migration under Mount Fuji. By statistically comparing this 4D video with the analysis of continuous seismic signals using artificial intelligence (thesis of Adèle Doucet, IPGP, in progress, under the supervision of L. Seydoux and J.-P. Métaxian), we will be able to build a monitoring methodology for this seemingly dormant volcano.

This thesis will be supervised by N. Fuji (IPGP), S. Durand (ENS Lyon) in collaboration with Yosuke Aoki (ERI, U. Tokyo), Nozomu Takeuchi (ERI, U. Tokyo), L. Seydoux, F. Costa, and J.-P. Métaxian (IPGP). This project will be conducted within the framework of the IRC (International Research Centre) between the CNRS and the University of Tokyo, which was launched in 2022, based on several decades of close collaboration.