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

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Titre du sujet : Analysis of major and paroxysmal explosive phases of the Stromboli volcano using a multi-sensor geophysical network on land and on the seabed

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Stromboli is an open-conduit volcano characterised by mild intermittent explosive activity producing jets of gas and incandescent blocks. It is occasionally interrupted or accompanied by lava effusions inside the gravitationally unstable Sciara del Fuoco scar and, more critically but more rarely, by violent explosive eruptions referred to as "major explosions" and "paroxysms" (Pioli et al., 2014). In contrast to regular explosions, characterised by tephra ejected to heights of ~150 m, major explosions and paroxysms typically feed 1500–5000-m-high convective columns (Ripepe and Harris, 2008). The rate of major and paroxysmal explosions has increased significantly since 2019.

Seismic activity is composed of syn-eruptive, very long period (VLP) seismic signals, created by the sudden expansion of gas pockets rising in the shallow magma mush (Ripepe et al., 2021), and of tremor produced by the active (puffing) degassing phase of the magma column. Seismo-acoustics led to the identification of the source mechanisms associated with the different types of Strombolian explosions (Chouet et al., 2003). Tilt signal indicates pressurisation of a stable portion of the conduit during the pre-eruptive period, with a duration increasing with the eruption magnitude, which starts several minutes prior to paroxysmal eruptions.

Stromboli is equipped with a monitoring permanent network maintained by LGS (Laboratorio Geofisica Sperimentale) of the University of Florence comprising broadband seismic stations, infrasound sensors, borehole inclinometers, optical and thermal cameras, multigas sensors and 2 Boyes equipped with tide gauges. All these sensors are positioned on land, less than 3 km from the eruptive craters. The seismic activity is dominated by surface eruptive processes. The high amplitude of the permanent eruptive tremor could hide signals of deep origin. A network of 4 OBS stations has been installed around the volcano, 7-8 km from the coast (~approximately 10 km from the craters), in order to move away from the source of eruptive noise at the top of the volcano and better distinguish possible sources of deeper earthquakes, particularly those associated with the ascent of magmatic fluids during major and paroxysmal explosions. These OBSs include a Guralp 3-component medium-band seismic sensor (30 sec) and a hydrophone. The continuous seafloor recording campaign lasted 5 months (May-October 2024). One major eruption and one paroxysmal eruption occurred in July 2024 during the OBS observation period, as well as a lava flow which reached the shore.
The aim of this thesis is to compare onshore and offshore seismic recordings (OBS) in order to detect sources of deep earthquakes. We will also be looking at the detection and analysis of all types of signals associated with eruptive and gravitational processes extending out to sea (lava flows, pyroclastic flows, block falls) and their consequences (submarine landslides, tsunamis). To do this, we will use the various geophysical instruments in the monitoring system, including the buoys. OBS could be re-deployed to complement the existing data or in response to changes in volcano activity during the course of the thesis.
The identification of signal signatures will be carried out using antenna processing tools and automatic pattern search (clustering, pattern recognition) applied to continuous data.

The thesis will be carried out under the joint supervision of the University of Florence and IPGP. The candidate must plan to spend at least 1 year in each University. The schedule could be organised by alternating periods of half a year at each site, for example.