Subject offered for a contract starting october 2018

SUBJECT TITTLE: The key role of two-phase flows (bubbles within viscous magma) in driving eruptions. Insights from fluid mechanics laboratory experiments and the analysis of long-time series of infrasonic-seismic records at Erebus volcano (Antartica).

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IPGP- Dynamique des Fluides Geologiques

Financing: Doctoral contract with or without assignment

For more information go to http://ed560.ipgp.fr, section: Offres de these (PhD offer), You must apply on the Doctoral School website

Presentation of the subject: (1 or 2 pages)

Title: The key role of two-phase flows (bubbles within viscous magma) in driving eruptions. Insights from fluid mechanics laboratory experiments and the analysis of long-time series of infrasonic-seismic records at Erebus volcano (Antartica).

The crucial role of the gas, in driving volcanic eruptions at depth and at surface, is now widely recognised. The viscous magma is displaced by the nearby bubbles (diameter from microns to several meters) in various ways (2-phase flows), depending on the type of volcanic activity, i.e. explosive, effusive or persistent at open-vents.

Open-vents volcanoes, often presenting series of Strombolian explosions of various intensities, i.e. a quasi-regular series of large Taylor bubbles breaking at the surface, are responding, although with a delay, to any changes in the degassing pattern within a shallow magma reservoir. Hence, they are providing a quasi-direct route to phenomena occuring at depth, where eruptions are initiated. Open-vents volcanoes display a persistent volcanic activity, although of variable intensity. Their phases of enhanced activity could therefore be interpreted as analogous to eruptive phases of a volcano alternating between eruptions and quiescence periods. Long-times series at open-vents volcanoes could therefore be key measurements to unravel physical processes at the origin of eruptions and be crucial for monitoring. For example, continuous infrasonic records (sound waves <20 Hz) can be used to estimate the gas volume expelled at the vent, both during explosions and between explosions, but also at depth, providing the use of an appropriate model of 2-phase flows patterns in conduit and reservoir. Additional key informations can be obtained from performing laboratory experiments in fluid mechanics, in which the key physical features of some eruptive patterns can be reproduced and modelled.

The core of the phD consists in the laboratory fluid mechanics experiments (currently set at 2 years1/2), with a touch of data analysis (infrasound, seismic) (currently set at 6 months), although the partition between laboratory experiments and data analysis can be adapted depending on the main interests of the phD student and on the results.

The first aspect of this phD will consist in analysing the long-time series of infrasonic and seismic signals recorded close to Erebus volcano (Antartica), using our existing automatic codes, written in matlab. These records will be interpreted to understand the temporal evolution of the eruptive activity (gas volume and strength of explosions) and the changes in degassing patterns, which impacts the behaviour of the local troposphere (bottom layer of the atmosphere) and the climate at a regional scale.

The second aspect of this phD will use the experimental facilities of the fluid mechanics laboratory to mimic 2-phase flows (small bubbles in viscous fluids) in an analog volcano. The formation of bubble clusters, produced by a foam accumulated at the top of a large reservoir and spreading into a small uppermost conduit (an initial condition most analogous to eruptive conditions) and their coalescence in the conduit will be characterised and modelled. Finding the conditions for the transitions between the various regimes and the characteristic diameter of bubble clusters will be a key to understand the eruptive patterns and their changes.

The third aspect of this phD will be a laboratory study of the foam dynamics, whose disruption mimics the expulsion of large eruptive columns or the periodic activity of basaltic volcanoes. The initiation of the "massive" foam coalescence will be studied under various conditions, such as by applying a shear stress or in natural conditions driven by the start of an instability.