Ecole Doctorale des Sciences Fondamentales

Title of the thesis: From magma ascent to deep-seated-ocean lava flow emplacement: the case study of the submarine 2018-ongoing eruption offshore Mayotte

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Summary:
Submarine volcanism represents about 85% of the volcanic activity on Earth and is an important source of mantle-derived components to the external and superficial envelops of the Earth. To understand how this magma form, quantify its volatile content, the ascent and degassing mechanisms and its emplacement mechanisms as lava flows on the ocean floor is of large interest for the scientific community. Following the seismic crisis that has been impacting Mayotte Island (Western Indian Ocean) since May 2018, a lithosphere-scale magmatic event gave birth to a 5 km^3 submarine volcano (50 km offshore Mayotte), and produced about 6.55 km^3 of magma on the ocean floor at ~3,300 m depth. This volcanic event is the second largest effusive eruption ever witnessed since the Laki (Iceland) eruption in 1783, and has been ongoing for more than two years. This unique discovery was a real thrill among scientists because the last known volcanic activity at Mayotte (Petite Terre) was dated between 7000 to 4000 BP.
Studying volcanism in a deep submarine environment is a real challenge. However, since May 2019 several scientific cruises, led by the French scientific community, have been probing, imaging and sampling the whole 60 km long ridge extending from Petite Terre to the current eruptive site. We now possess a large number of samples (obtained by see floor dredges) and an exceptional time-series of bathymetric data through the 2018-2021 period. Samples from the flank of the active volcano, and from distal ponded lava, lava domes and currently active distal fractures, allow us to have a unique dataset to track the spatial and temporal variations in lava effusive rate, facies and syn-eruptive degassing. Detailed petrological and geochemical data revealed that a crystal-poor and gas-rich evolved basanitic magma was stored at mantle depth (> 36 km) and reached the seafloor at very high output rates.
Yet, all the information brought by the texture of the collected lava samples has not yet being analyzed and the dynamics of magma ascent and of lava flow emplacement at this exceptional volcanic has yet to be understood.

This project proposes to first **perform a detailed quantitative textural analysis** of the basanitic to phonolitic lavas collected during the successive eruptive phases. Vesicle and crystal size distributions, density/porosity, connectivity and permeability measurements will be carried out to (i) quantify degassing variation in time and space, (ii) constrain volatile contents and (iii) provide more constraints to the percolation model. These textural data will then be used **to constrain the physical properties** of the erupted material that controls the ascent dynamics and submarine emplacement. In particular, the **effect of growing crystals and bubbles on viscosity** will be investigated. Viscosity measurements at high temperature will also be completed to provide the, yet not well known, temperature dependence of viscosity for these exotic compositions (basanite to phonolite). This will be coupled with decompression experiments **to determine crystal and bubble number density as a function of magma ascent rate**. Mixed volatile solubility will also be experimentally quantified to test whether CO_2 saturation could have triggered the onset of the eruption.

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