

Ecole Doctorale des Sciences Fondamentales

Title of the thesis: “Ascent velocity of basaltic magmas: experimental study and application to the volcanic fields of Ardèche and Chaîne des Puys, France”

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Summary:

There are many examples in the French Massif Central of basic magmas rising directly from a deep reservoir to the Earth's surface without undergoing differentiation in an intermediate reservoir. They are characterized by magmas that are almost undifferentiated (alkaline basalts in the broad sense) and by the frequent occurrence of mantle xenoliths. We can mention the volcanoes of La Vache-Lassolas or Beaunit in the Chaîne des Puys (trachybasalts with or without peridotite enclaves) or the Ardèche volcanoes (basanites with peridotite enclaves). These basic magmas have ascent velocities up to 0.1 to 1 m/s, which potentially leave only a few hours to a few days to detect possible precursor signals of the eruption.

The rise of basaltic magmas is a vast field of study still little explored using the experimental approach. Magma ascent can be simulated in the laboratory by means of high temperature decompression experiments, the ascent rate being proportional to the decompression rate. An internally-heated pressure vessel specially designed for this type of experiments has been installed at Laboratoire Magmas et Volcans in 2016. The aim of the thesis will be to use this instrument to study the effect of the ascent velocity on the kinetics of magmatic processes (degassing, crystallization, dissolution and growth of phenocrysts), and to identify the chemical or textural parameters that are good indicators of the ascent velocity of the magma. By comparing the chemical, mineralogical and textural features of natural samples with those of the experimental samples, the ascent velocity of basaltic magmas of different volcanic provinces of the Massif Central will be estimated.

A first part of the work will consist in characterizing the composition of the parental magmas of the Ardèche volcanic province, South-East France, using glass inclusions in olivine crystals: major elements by electron probe microanalysis, trace elements by ICP-MS-LA, and volatile components by Raman spectrometry. These results will be compared to those (already acquired or being acquired) on the Chaîne des Puys. The second part of the thesis work will be experimental. Decompression experiments will be performed to study the effect of ascent rate on the evolution of basic magmas in volcanic conduits. The initial conditions of the experiments (pressure, temperature, composition of the magma, volatile contents) will be determined using the results obtained in the first part of the thesis. The two main experimental variables will be the ascent velocity (typically between 0.1 and 10 m/s) and the variation of temperature during decompression. The main experimental techniques used to characterize the experimental products will be scanning electron microscopy, electron microprobe, vibrational spectroscopy techniques and X-ray micro-tomography.