Ecole Doctorale des Sciences Fondamentales

SUBJECT OF THE THESIS

Title of the thesis: Unravelling pre- and syn-eruptive degassing processes at persistently active basaltic volcanoes using short-lived ^{222}Rn-^{210}Po-^{210}Bi-^{210}Pb radioactive disequilibria in volcanic gases.

Supervisor : Dr Olgeir SIGMARSSON
Laboratory : Laboratoire Magmas et Volcans
University : Université Clermont Auvergne
Email and Phone : O.Sigmarsson@opgc.fr 04-73-34-67-20

Co-supervisor : Dr Pierre-Jean GAUTHIER
Laboratory : Laboratoire Magmas et Volcans
University : Université Clermont Auvergne
Email and Phone : P.J.Gauthier@opgc.univ-bpclermont.fr 04 73 34 67 26

Project Summary:

The last isotopes of the ^{238}U decay chain, that is ^{210}Pb, ^{210}Bi and ^{210}Po which are produced by the decay of ^{222}Rn, are well-known to be strongly enriched and fractionated in volcanic gas plumes. Significant short-lived radioactive disequilibria among these isotopes are thus generated upon degassing. Due to both the radiogenic and radioactive properties of the isotopes, such disequilibria have proved useful in identifying, deciphering, and putting time constraints on shallow degassing processes at active volcanoes. However, the role played by the noble gas ^{222}Rn on the ^{210}Pb-^{210}Bi-^{210}Po systematics has been neglected for long, mostly because of its very short half-life (3.82 days), and must be addressed. Recent theoretical and conceptual developments suggest that primary magmatic gases may be considerably enriched in ^{222}Rn. *In situ* radioactive decay of radon within gas bubbles during their transfer between the magma reservoir and the surface could thus produce new atoms of ^{210}Pb which could drastically alter the initial geochemical signature of the primary magmatic vapor exsolved from the degassing magma. The proposed research aims at better constraining this process and characterizing its effects on both short-lived radioactive disequilibria and their implications on our understanding of degassing processes at basaltic volcanoes. The research will be conducted according to several converging approaches: i) validate of our hypothesis of ^{222}Rn enrichments in volcanic gases through both direct measurements of radon in volcanic plumes (methodological developments required) and indirect measurements on the distribution of its progeny ^{210}Pb within the condensed aerosol fraction; ii) refine existing radionuclide degassing models by adding new field and experimental constraints on the volatility of the isotopes of interest in the pressure range ~10-300 MPa; iii) model pre- and syn-eruptive degassing processes at a few target basaltic volcanoes (e.g., Etna (Sicily) and/or Kilauea (Hawaii)) in order to set new constraints on the complex geometry of their feeding systems and to better understand the physico-chemical conditions required to produce long-lasting degassing activity, especially at those volcanoes characterized by a significant gas excess in comparison to their lava production rate.