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Montagne Pélée (Martinique) and Soufrière (Guadeloupe):
Possible test beds for muon tomography in French volcanoes.
Situation, recent eruptions, detector development, inversion methods.

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During its cataclysmic eruption, at the beginning of the XXth century, the Montagne Pélée volcano (Martinique island, Lesser Antillas) totally destroyed the city of Saint-Pierre, killing practically all its 26 000 inhabitants. Because of this horrible experience, the French government supports around Montagne Pélée —and also around La Soufrière (Guadeloupe island) — one of the most advanced volcano observatories in the World. For this reason, because we have some technical expertise in making detectors, and, finally, because our know-how in methods of data interpretation (inverse problems) we propose to participate in the joint effort to further advance volcano muon tomography.

The activity of La Soufrière evolved significantly during the last ten years and seems to accelerate since about 2 years with a reactivation of several dormant vents on the summit of the volcano. Both the seismic and electrical tomographies recently performed by our team reveal that La Soufrière is very heterogeneous with parts made of massive andesite blocks and other parts composed of unconsolidated volcano deposits altered by the hydrothermal activity inside the dome. A better knowledge of the mass heterogeneity of La Soufrière is necessary to refine the models of flank collapse and to estimate the volume of the hot and pressured hydrothermal (i.e. energy available for an eruption) reservoirs located in the dome. We shall use muon tomography to perform both a global mass tomography of the dome and to study the time evolution of several particular parts of the dome where rapid changes are expected to occur as, for instance, liquid/vapor transformations at the top of the hydrothermal reservoir.

Our philosophy for data interpretation is not to try to arrive to one image (that could be “the best” under some criterion) but, rather, to use observations to simply falsify possible models of the volcano. We plan to start by building a large (prior) collection of volcano models all consistent with known geology, and to submit that collection to the comparison with muon data (informing about the mass distribution inside the volcano) to end with a posterior distribution of models. It should be as large as possible, although, hopefully, all of them will present some common characteristics

(those resolved by the muon data).

References

[1] Tarantola, A., Inverse Problem Theory and Model Parameter Estimation, SIAM (2005).

[2] Tarantola, A. Popper, Bayes and the Inverse Problem, *Nature Physics*, Vol. 2, p 492–494 (2006).