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Density Imaging of Puy de Dôme Volcano with Atmospheric Muons in French Massif Central as a Case Study for Volcano Muography

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High energy atmospheric muons have high penetration power that renders them appropriate for geophysical studies. Provided the topography is known, the measurement of the muon flux transmittance leads in an univoque way to 2D density mapping (so called radiographic images) revealing spatial and possibly also temporal variations. Obviously, several radiographic images could be combined into 3D tomographies, though the inverse 3D problem is generally ill-posed.

The muography has a high potential for imaging remotely (from kilometers away) and with high resolution (better than 100 mrad2) volcanoes. The experimental and methodological task is however not straightforward since atmospheric muons have non trivial spectra that fall rapidly with muon energy. As shown in [Ambrosino 2015] successfully imaging km-scale volcanoes remotely requires state-of-the art, high-resolution and large-scale muon detectors.

This contribution presents the geophysical motivation for muon imaging as well as the first quantitative density radiographies of Puy de Dôme volcano obtained by the TOMUVOL collaboration using a highly segmented muon telescope based on Glass Resistive Plate Chambers. In parallel with the muographic studies, the volcano was imaged through standard geophysical methods (gravimetry, electrical resistivity) [Portal 2013] allowing in depth comparisons of the different methods.

Ambrosino, F., et al. (2015), Joint measurement of the atmospheric muon flux through the Puy de Dôme volcano with plastic scintillators and Resistive Plate Chambers detectors, J. Geophys. Res. Solid Earth, 120, doi:10.1002/2015JB011969
A. Portal et al (2013) , “Inner structure of the Puy de Dme volcano: cross-comparison of geophysical models (ERT, gravimetry, muon imaging)”, Geosci. Instrum. Method. Data Syst., 2, 47-54, 2013