Inner structure of a lava dome: comparison of geophysical models

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As part of the TOMUVOL (muon tomography) project, we started geophysical measurements on a 11,000 years old trachytic lava dome, the Puy de Dome, located in the Chaine des Puys volcanic field (Massif-Central, France), in order to compare muon imaging results with those obtained through conventional geology and geophysics. Ultimately, we expect that a joint interpretation of muon imaging and conventional geophysical data will lead to more accurate models and help to define a robust methodology to study the static and dynamic structures of active volcanoes.

Here we present the first results from the geophysical study of the Puy de Dome. As most large volcanic domes, it appears to be a composite construction. A surface morphology analysis indicates two distinct constructional units. The western half is characterized by an uneven morphology corresponding mostly to massive rocks. The eastern part seems to be emplaced in a scar belonging to the first unit and it is made of thin lava lobes associated with pyroclastic and talus deposits. Recent field observations show evidence of extensive hydrothermal alteration in the upper part of the volcano.

We performed various geophysical investigations between 2011 and 2012: electrical resistivity tomography, gravity measurements and muon imaging. Resistivity surveys were performed using multi-electrode arrays with both long (35 m) and shorter (5 m) electrode spacing. The arrays with the larger electrode spacing allow to image the resistivity structure of the dome down to its base whereas the arrays with the shorter electrode spacing have been used to refine the shallow structure of the summit area. The gravity data have been acquired with a high spatial resolution. The computed residual Bouguer anomaly provides 2D and 3D models of the density distribution within the dome that can be directly compared to the muon imaging results.

New detailed ERT and gravity measurements will be performed to refine the models of the structure of the dome and of its surroundings. A complementary high resolution magnetic survey will also be carried out at the same scale and its results will be discussed at the meeting. In addition, in situ and laboratory measurements of the physical properties of the dome-rocks will allow us to constrain the models.

The preliminary results show a good correlation between the gravity and the muon models. The resistivity models provide complementary information of the geological structures. Our goal being to promote the Puy de Dome volcano as a reference experimental site for structure imaging methods, we will refine in the near future each imaging technique and will try to combine their results in order to build a robust model of its structure.