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Implications of the observations scarcity on the gravity data inversion within volcanic areas. Ciomadul volcano

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RATIONALE

Gravity investigation of volcanoes is difficult due to their usual location in rugged topographic areas, where lack of access hardly offers possibility for adequate observations coverage.

In the absence of appropriate constraints this might have important consequences on the interpretation of the survey results.

BACKGROUND

Located in the inner part of the bending zone of East Carpathians, Romania, Ciomadul volcano represents the end member of the Neogene to Quaternary volcanism in the Carpathian - Pannonian Region. This cluster of dacitic domes last erupted about 30 ka ago, and there are authors claiming it might become active, based on indirect evidence on the presence of a magma chamber in the upper crust beneath it.

Inversion of relatively recent acquired gravity data outlined an extended mass deficit below central volcano initially interpreted as a magma chamber, in apparent agreement with previous MTS works unveiling an electrical resistivity low beneath volcano. The gradual decrease of density towards the inner (hotter?) part of the source seems to be consistent with hypothesis of a cooling body.

However, the overall geometry and in-depth extent of the density zone with values corresponding to volcanic rocks is not consistent with accepted structural models for such volcanoes, mainly developed on the topography.

Besides, the extreme density values predicted were never encountered on samples collected from outcrops, and according to literature there is no increase in temperature able to provide the density lowering shown by inversion.

Finally, the idea of magma chamber at relatively shallow depths may be hardly accepted because it would generate strong geothermal manifestations at the surface (e.g. geysers), nowhere encountered.

APPROACH & RESULTS

For better understanding/interpreting the inversion results, limitations of the approach were studied by computing/inverting the gravity effect of synthetic sources. Fluid-filled vertical volcano conduits of variable size/content (but always dimensioned bellow the sampling step of the gravity signal provided by the survey coverage) were subject to study.

The research showed that inversion was not able to accurately predict the parameters of the source in any simulation. Basic 2D geometry of the volcano conduit with step density change along the edges is replaced by a 3D broadly extended body with gradual decrease of density towards its inner part. The larger the cavity, the smaller densities may occur. Some densities outside the source model range are also predicted, and a pseudo-mass excess may be inappropriately generated above the upper end of the conduit.

CONSEQUENCES

Following the simulations, the density model of Ciomadul volcano was fully revised by using an iterative 3D forward modelling. The new model unveils peculiarities of a largely developed plumbing system, partly open to magma access, but does not support any longer the hypothesis of a magma reservoir in the upper crust beneath Ciomadul.

SPECULATIONS

Given the above-mentioned aspects, we may assume that former solution of the MT data inversion was also biased by data scarcity that inherently led to the integration of local effects of several narrow fluid-filled conduits into a unique electrical resistivity anomaly interpreted as a magma chamber.