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Effects of crustal layering on the inversion of gravity data in volcanic areas.

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Distinguishing between magmatic and hydrothermal sources of volcanic unrest is the first node of any volcanic hazard tree, and gravity measurements are usually considered the best tool to constrain the nature of the source responsible for the observed unrest. Priorly to be inverted to obtain the intrusion mass density, observed gravity changes have to be corrected for the effects of a mass-less expanding source (Δg_{ml}), given by the addition of vertical movement effects (free air effect Δg_{fa}) and subsurface mass redistribution (deformation effect Δg_{def}) (here the background gravity noise due to water table fluctuations is assumed negligible). The deformation effect is strongly dependent on the shape of the expanding source. If the source (embedded in a homogeneous elastic half-space) can be approximated by a sphere or a prolate spheroid, Δg_{def} is null or negligible, but if the source can be approximated by an oblate spheroid (to a major extent a degenerate one, i. e. a penny-shaped crack) Δg_{def} is positive and so large as to dominate gravity changes corrected for Δg_{fa}. Consequently, assesment of volcanic hazard can be dramatically affected by these differences, since inferred intrusion mass density for a penny-shaped crack can be much lower than for a spherical source.

We use the open source code PSGRN/PSCMP to compute Δg_{ml} for point sources (both spheres and penny-shaped cracks) and consequently Δg_{def} after subtraction of Δg_{fa}. We compare Δg_{def} computed for homogeneous and layered elastic half-spaces. Test layering is appropriate to the Campi Flegrei volcanic area (Italy). We will show that Δg_{def} is negligible for point spherical sources in the layered half-space. Δg_{def} computed for point penny-shaped cracks in the layered half-space is still large, but much smaller than in the homogeneous half-space. As a consequence, inferred intrusion mass density for a penny-shaped crack is closer to that for a spherical source.