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Finite element modeling tests of the seven moment tensor approximation of ground displacement from tri-axial pressurized ellipsoids.

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Volcanic unrests can be studied through the induced surface deformation; one limiting factor however is the small number of available deformation source models. Till 2011, the only available (approximate or exact) expressions for finite expansion sources referred to spheres, prolate spheroids, and horizontal circular cracks embedded in a homogeneous half-space. Cervelli (2013) derived more general approximate expressions for displacement from a finite spheroid of arbitrary orientation and aspect ratio, embedded in a homogeneous half-space.
The only approximate expressions for displacements and stresses from the inflation of a finite pressurized tri-axial ellipsoid in a (possibly heterogeneous) half-space were published by Amoruso and Crescentini (2011). Starting from the equivalence (exact for an infinite elastic medium) between the external displacement field due to a pressurized ellipsoidal cavity and the displacement field given by a uniform distribution of seismic moments, Amoruso and Crescentini (2011) accounted for source finiteness by using an approach similar to the multipole expansion of the gravitational potential outside a mass distribution. The dipole term is null because of symmetry; terms to quadrupole order are kept. The resulting expressions can be evaluated by combining the effects of seven moment tensors (SMT model) and are approximately valid also for a heterogeneous half-space. In case of a layered half-space, the appropriate displacement Green functions can be evaluated analitically and the SMT model has already been used to invert ground deformation data of the Campi Flegrei Caldera, Italy. In case of a heterogeneous medium, the appropriate displacement Green functions can be computed, once and for all, using FEM, so that the SMT model still allows fast forward computations and can be included into inversion codes.
Amoruso and Crescentini (2011) could test the goodness of their approach only in case of spherical and prolate spheroidal cavities and horizontal circular cracks (and, later, in case of oblate spheroidal cavities) embedded in a homogenous half-space.
We have used Finite Element Modeling (FEM) to extend comparisons to arbitrarily oriented tri-axial ellipsoids embedded in both a homogenous half-space and a heterogeneous one.
We show that differences in ground displacement evaluated using FEM and SMT are usually small and, given measurement errors in geodetic data, negligible.

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