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Role of asymmetric deformation sources in volcanic areas

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Ground deformation and gravity changes in volcanic areas are the result of the action of deep structures and the inversion of these data may be used to infer the nature and the main features of these deformation sources. Triaxial ellipsoids (Davis, 1986) and circular horizontal cracks (Fialko, 2001) are generally employed in these inversions, but they do not represent the most general type of internal sources, since they can generate only a limited subset of moment tensors. Using dislocation theory and the boundary element technique, we present two alternative models of deformation sources: the first type is represented by pressurized parallelepiped cavities, while the second type by dipping elliptical cracks. We show that parallelepiped cavities extend slightly the set of moment tensors associated to ellipsoidal cavities, while dipping elliptical cracks can be useful when asymmetries are present in the surface deformation field. Furthermore, both models are able to take into account the release of a deviatoric stress field which instead cannot be present on the boundaries of a pressurized fluid filled cavity. The discretization order of the sources can be suitably selected according to the following considerations. To obtain the ratios between axes and the orientation of the source, a low order decomposition can be used in the boundary element procedure since the ratio u_z/u_r on the surface is approximately independent from the discretization order. Once the optimal parameters for the models are obtained, the discretization order can be increased in order to infer the depth and the size of the deformation source. We study also the possibility that shear dislocations take place on the boundary of a pressurized source when its geometry is not planar or when it is close to the free surface. The models proposed will be applied to study the deformation field associated to the 1982-84 unrest episode at Campi Flegrei caldera (Italy).