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Exploration of the topographic effects on surface deformation due to magmatic and tectonic processes

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The induced deformation and stress field by faults and magma bodies such as dikes and sills is influenced by topography. The effect is particularly more significant for shallow sources and steep topography. However, the analytic deformation models in an elastic half-space, cannot account for these topographic effects.
To include these "topographic effects", we use the triangular dislocation elements (TDE) which are very flexible during discretization of the complex dislocation surfaces. Here we solve the problem of singularities along the sides or beneath the vertices of TDEs, and then apply them to develop a boundary element method (BEM). Since the TDEs applied in the BEM code are free from artifact singularities everywhere in the space, we are able to simulate open and closed surfaces with any complex geometry.
We first validate the results of our method by comparing them to a few well-known analytical solutions in either full-space or simple half-space. Then we apply this code to study topographic effects on the displacements' signal of dikes and faults as well as spherical and ellipsoidal magma chambers, under complex topography. After some synthetic tests, we couple this code with a genetic algorithm (GA) code in a fully numerical optimization approach for modeling of real volcano deformation observed by InSAR technique. We show that topographic effects along with the sources which are located inside the body of a volcano, are strongly dependent on the local topography, and cannot be resolved with the existing approximate solutions which account for these effects.