# Topographic and deformation source interaction effects on surface displacement modeling

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Topography influences the deformation of volcanic landscapes during magmatic and/or tectonic activity. This is particularly relevant if the deformation sources are shallow. Although the high spatial resolution of InSAR data enables us to detect and identify such topographic effects, most of the related modeling approaches still rely on a flat free surface in a half-space.

To include topographic effects in models, we develop a method based on triangular dislocation elements (TDEs). TDEs have accuracies similar to their rectangular counterparts, but are much more flexible during discretization of complex surfaces (magmatic sources and topography). First, we present a way to solve the problem of singularities along the sides or beneath the vertices of TDEs. Utilizing the method, we can simulate open and closed surfaces of any complex geometry. Second, we apply this approach to develop a code based on the displacement discontinuity method as an indirect boundary element method (BEM). We apply this code to study topographic effects during magma chamber inflation or deflation, as well as during fault displacements. In systematic tests, we explore the mutual interaction of the topography and the source location. We furthermore show that the existence of deep craters and valleys strongly affect the surface deformation. Finally, we use this approach for modeling an 8-year time series of surface displacement detected by InSAR around Lastarria volcano, located in the Lazufre volcanic region of the central Andes. We infer the interaction of two sources (potential magma bodies): a huge sill-shaped source at a depth of 12 km, and a small spherical source at a depth of 0.7 km. These findings from our new numerical inversion method are compared to previously applied half-space solutions. This demonstrates that topographic effects and source interactions, which are accounted for in our approach, have an important contribution to the signals and hence their accurate interpretation.