Modeling Internal Deformation Due to Inelastic Sources Under Inhomogeneous Structures

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Available geodetic/seismological data and inelastic crustal deformations such as fault motions, volcano deformation, and asthenospheric deformation have been tied by the modeling of the elastic deformations incurred in the crust (Yabuki & Matsu'ura, 1992; Ide & Takeo, 1997). However, theoretical Green's functions (observation equations) for the inversions of these inelastic sources are currently available only for the simple elastic properties of 1D or homogeneous structures. 3D modeling of the elastic inhomogeneity is already achieved with finite-element and finite-difference methods (e.g., Hashima et al., 2016) but still computationally expensive.

In this study, we present a suite of analytical and semianalytical solutions of Green's functions for the displacements, strains, and stress due to localized (faulting) and distributed (volumetric) inelastic deformation in an elastically inhomogeneous full- and half-space. Variations in elasticity are treated as piecewise constant elastically homogeneous regions. We prove the equivalence between the boundary traction integral equations with those for displacement or volumetric inelastic strain, which have known analytic forms. With this equivalence, we are able to express the traction balance on the boundaries between elastic regions with contrasting elastic parameters, by a corresponding virtual fault displacement or volumetric strain.

We demonstrate this approach with computer programs that evaluate these expressions free of major singular points. These expressions represent a powerful tool for the analysis of deformation data applicable to many primary geophysical applications.

Keywords: faulting and volcano deformations, velocity structure, integral equation methods

