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Asymptotic Dislocation Theory for a Spherically Symmetric Earth

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In order to study responses of the Earth to seismic dislocations, one often simplifies the Earth into some simple geometric models, such as a half-space, a homogeneous sphere and a stratified sphere, and presents corresponding dislocation theories. The theory for the half-space is usually expressed in analytical form (e.g., Okada, 1985; Okubo, 1991, 1992) and is easily applied to study or inverse seismic faults, due to their mathematical simplicity. However, the validity of these theories is limited only to a near field because the Earth's curvature and radial heterogeneity have not been taken into account at all. Sun and Okubo's (2001) recent study of comparing the discrepancy between the half-space and the homogeneous sphere (accounting for self-gravitation) indicates that both curvature and vertical layering have significant effect on the deformation field.

Nowadays, since modern geodesy is possible to observe crustal deformation in a far field, even a global co-seismic deformation, a dislocation theory for a more realistic earth model is demanded to interpret the far field deformations. Sun and Okubo (1993, 1998) and Sun et al. (1996) presented theories to calculate global displacements and gravity changes caused by arbitrary dislocations in spherically symmetric earth models. These theories, however, are hard to be applied due to the mathematical complicity and the huge numerical tables.

In order to overcome the disadvantages exist in the above two dislocation theories, therefore, this research presents a new theory for calculating asymptotic displacements excited by a point dislocation in a spherical symmetric earth model, as an approximation of the dislocation theory for the spherical earth model (Sun et al., 1996). The theory is derived in an analytical form, by employing the reciprocity theorem (Okubo, 1993) and the asymptotic solutions of an elastic earth to the tidal, the press and the shear forces (Okubo, 1988). The merit of the theory is that it is very simple mathematically and more reasonable physically since it takes the sphericity and the radial structure of the earth into account. Both the theory and the numerical investigation indicate that the theory is valid for an epicantral distance of about 3000 km, with a relative error of about 1%. Due to the mathematical simplicity, this theory can be easily applied to calculate co-seismic displacements, like the theory for a half space earth model, such as Okada (1985).