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TENSOR ANALYSIS OF DISLOCATION-STRESS RELATIONSHIP BASED ON THE EXTENDED DEFORMATION GRADIENT

Kazuhito YAMASAKI

Department of Earth and Planetary Sciences, Faculty of Science,
Kobe University, Kobe 657-8501, Japan
e-mail: yk2000@kobe-u.ac.jp

Abstract

The dislocation density used to estimate the magnitude of paleostress in rocks has been expressed in terms of a scalar quantity. Dislocations are classified into two types: edge dislocations and screw dislocations. However, the scalar expression of dislocations does not contain information on the type of dislocations. Therefore, we cannot see the effect of stress on the type of dislocations. In other words, we can extract the information related to the magnitude but not the orientation from previous dislocation-stress relationship. Then, we attempted to derive the tensor equation for dislocation-stress field. For this analysis, we introduced the extended deformation gradient tensor, that is, a differential geometrical expression of the ordinary deformation gradient tensor. We assumed that: (1) the higher order terms and spatial derivatives of dislocation density can be ignored; (2) the material is isotropic. We found that our tensor equation for dislocation-stress field is the square root expression of the equation derived from the experimental data of aluminum under static tension. Moreover, we found that the type of dislocation affects the stress field through the difference in the value of coefficients of the dislocation-stress relationship.

Key words: deformation, differential geometry, dislocation, paleostress, stress theory.