Damage Growth and Permeability Change in Triaxial Compression tests of Inada Granite

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Microcracking (crack growth), along with accumulation of inelastic strain, takes place in crystalline rock such as granite when it is subjected to differential stress. As a result, growing cracks become interconnected, completely altering permeability. Therefore, coupling between crack growth and permeability change must be determined to fully understand the hydro-mechanical response of rocks subjected to non-hydrostatic stress. Damage growth in triaxial tests on Inada granite under confining pressures up to 140 MPa was analyzed using the crack tensor concept proposed by Oda (1982), and permeability change was also formulated in terms of damage growth. Transient pulse tests were carried out on the damaged samples to see if the permeability change is really related to the associated damage growth. The conclusions are summarized as follows: A permeability tensor formulated by micro-structural parameters is well supported by the transient pulse tests. This is particularly true when we deal with highly damaged granite. Where crack density is low, however, the hydraulic properties must be considered by taking into account the effect of spherical pores on them. The permeability of the sample subjected to increasing stress up to failure is about two to three orders of magnitude larger than that of intact granite under the same confining pressure (140 MPa). This change is surprisingly large compared with the result by Zoback and Byerlee (1975). Permeability tensors of the damaged samples are represented as more or less isotropic tensors. Rocks under stress in the field can be regarded as isotropic porous media, in spite of the fact that cracks grow preferentially parallel to the major stress.