Real-time measurements of permeability of Aji granite during triaxial compression tests

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Hot dry rock power generation, one kind of the geothermal generation, is a generation system which uses technique to create an artificial geothermal fluid reservoir by the hydraulic fracturing of bedrock. This generation system is expected to generate more electricity compared with conventional geothermal generation because it can develop a much wider range of sites. In the reservoir, water transportation is restricted by the permeability of host rock (Townend and Zoback, 2000). Therefore, it is important to know how the permeability varies with deformation of host rock. Permeability variations in the process of deformation of granite have presented by Zoback and Byerlee (1975) and Mitchell and Faulkner (2008). However, there are some problems in their studies. First, permeability of prefailure sample was not measured. Second, their results of measurements are not continuous. Third, their results lack accuracy. This study aims to improve these problems and measure permeability in the process of granite deformation during triaxial compression tests.

Aji granite which was formed into cylindrical shape (20 mm long and 40 mm in diameter) was used as a specimen and a nitrogen gas was used as the pore fluid. The triaxial compression tests were conducted with Intra-Vessel Deformation and Fluid-Flow Apparatus (IVA) at constant pore pressure (1.5MPa), confining pressure (20 or 40MPa), displacement rate (0.02 or 0.04mm/min) and room temperature. All the experiments were performed by using a flow method and the permeability was calculated from the flow rate which was measured in every ten seconds. In addition, strain measurements by a strain gauge were performed at the same time. The relationship between the permeability and inelastic volumetric strain was investigated.

The experimental results showed that the permeability initially decreased and began to increase from the onset of dilatancy. Regardless of the experimental condition, variation of the permeability had this tendency. This indicates that as the sample initially stressed, preexisting cracks closed and new cracks were created by inelastic deformation with increasing differential stress. The permeability increased along with inelastic volumetric strain. As samples approached brittle failure, the permeability increased remarkably. The previous research reported that mean crack diameter increased in the prefailure stage (Takemura and Oda, 2004). Therefore, the permeability enhancement in the prefailure stage is due to the increase in crack diameter.

Keywords: Permeability, Dilatancy, Inelastic volumetric strain

