Strain Behavior and Deformation Property of Aji Granite under Triaxial Compression Tests

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Fracture behavior of rock has been much researched because it is related to the mechanism of the earthquake and strength of the earth's crust. Recently, outcomes of these researches have been applied for hydraulic fracturing, which can create artificial geothermal fluid reservoir and such resources may have potential to solve Japan’s energy issues. However, this application (Hot Dry Rock power generation) has some problems and fundamental research is needed in order to understand deformational properties of crustal rocks. Therefore, we investigated the effects of confining pressure and pore pressure on the strain behavior and deformation properties of granite. We conducted strain measurements during triaxial compression tests of Aji granite at constant strain-rate (1.7×10^{-5} s^{-1}) under confining pressure ranging between 10 and 40 MPa, and pore pressure ranging between 10 and 30 MPa. The experimental results showed that the maximum stress and the onset of dilatancy increase with effective pressure but slightly decrease under wet condition. Young’s modulus increases slightly with effective pressure, whereas Poisson’s ratio is nearly constant in our experiments. Dilatancy that is related to the formation of micro-cracks during deformation is suppressed at high confining pressure, while dilatancy tends to be enhanced at low pore pressure, and hence high effective pressure, under wet condition. This indicates that the stress concentration related to the formation of micro-crack can be relaxed at high pore fluid pressure. Wet experiments have shown a rapid increase of water injection volume within the specimen at stress level of 96–97% maximum stress, which is probably attributed to the formation of micro-crack network. In addition, such increase of water injection volume became nearly constant at and after maximum stress, indicating that pore volume is may not be changed by localization of micro-cracking or macroscopic fracture. Based on these results, it is expected in hydraulic fracturing test that fracture under the ground can be efficiently created by lower injection rate and macroscopic fracture may occur soon after pore pressure decreases.

Keywords: Stress-strain relationship, Dilatancy, Pore pressure, Triaxial compression test, Granite, Hot Dry Rock power generation

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