Mechanical properties of granites after triaxial deformation and fracturing in hydrothermal conditions under supercritical state

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In order to extract geothermal energy effectively and safely from magma and/or adjacent hot rock, we need to tackle many issues which require new technology development, such as a technique to control a risk from induced-earthquakes. On a development of induced-earthquake mitigation technology, it is required to comprehensively understand roles of factors on occurrences of the induced-earthquake (e.g., regional and local stress conditions, strength of the hot rock, pore pressure of supercritical fluid, crack density or porosity, permeability and fluid-rock reaction) and their intercorrelations (*e.g., Asanuma et al., 2012*).

Our purpose of this first series of the experiments is to clarify a relationship between the rock strength and the crack density under the supercritical fluid conditions. Although in this abstract we only show a preliminary result of triaxial deformation experiment on intact granite rock strength under high-temperature (250 –650°C), high-pressure (104 MPa) condition at a constant load-point velocity (0.1 μm/sec) using a gas-rig at GSJ/AIST, we at JpGU meeting will report alteration of the granite rock strength relevant to crack density increase. We used Oshima granite as the specimen for the deformation, which has initially less than 0.2 % of the porosity and 4.29±0.55 km/s in V_p (dry) and 2.49±0.19 km/s in V_s (dry), respectively. All experimental products showed the brittle feature having several oblique fracture surfaces with c.a. 35° to cylindrical axis of the specimen, but the amount of stress drop became smaller at higher temperature and/or at lower pore pressure. Estimated Young’ s modulus increased with decreasing the temperature from 35.9 GPa at 650°C to 57.4 GPa at 250°C. At 550 °C, the stress drop accelerated the deformation with 8~10 times faster velocity than that at load-point. In contrast, at 650 °C, the velocity during stress drop kept the velocity within the same order of the load-point velocity. Therefore, the deformation mechanism may start to be changed from brittle to ductile when the temperature exceeds 650 °C, even though the brittle fracture is observed.

Highly dense cracked granite specimens were formed by a rapid decompression treatment using an autoclave settled at Tohoku University (*Hirano et al., 2016JpGU*), caused by a reduction of the fluid pressure within several seconds from vapor/supercritical state (10 –48 MPa, 550 °C) to ambient pressure. X-ray CT scanning on the specimens after the rapid decompression treatment let us recognize that numerous microcracks developed mainly along grain boundaries. Using X-ray CT images, we also have a plan to evaluate the fracture density for the fractured granite rock specimens. The rapid decompression treatment imposed the porosity increasing towards 3.75 % and V_p and V_s decreasing towards 1.37±0.52 km/s and 0.97±0.25 km/s on the specimens, respectively. In future, we will compare the strength for the intact granite rocks resulted from the triaxial deformation experiments with that for the fractured granite rocks to create the relationship between the granite strength and the fracture density under the supercritical conditions.

Keywords: Supercritical geothermal resources, Rapid decompression fracturing, Brittle-ductile transition zone, Granite

