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Porosity and permeability changes during fracture experiments of Inada granite as a pilot study of Hot Dry Rock geotherm

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Hot Dry Rock geothermal system can produce energy from previously unusable site, which does not require natural convective hydrothermal resources, and therefore it has large potential as a sustainable power generation. In this system, artificial reservoir is produced by hydro-fracturing in the basement due to water injection, and then water travels through fractures in the rock and inject back into the ground. To test time-scale of water circulation in this system, we investigate porosity and permeability changes during fracture experiments in the laboratory.

Inada granite was used as an experimental sample, which has been deformed by uniaxial compression test. Porosity and permeability were measured using intra-vessel apparatus at our institute, which is capable to generate pressure as high as 500 MPa at room temperature. The intact sample before compressional test has porosity of 0.8-0.9% and permeability of 1.0x10-18m2 at confining pressure Pc = 10 MPa, which is similar values reported by previous studies (Takeda et al. 2000). The fractured samples after deformation show systematic increase of porosity and permeability, 7.0% and 2.0x10-15m2.

Using these hydrological data of fractured rock, water migrating velocity is estimated to be 3.3x10-5m/s. This results travel time of water circulation as long as 670 hours in the Ogachi HDR test site. However, chemical tracer test shows approximately 70 hours as a water travel time in this site (reported by Central Research Institute of Electric Power Industry), which is one order of magnitude shorter than that expected from our experimental data. The discrepancy might be caused by different fracture structures in the laboratory compression test relative to the hydro-fracturing in natural test. We plan to perform water injection text in the laboratory and try to simulate more realistic system as a Hot Dry Rock geothermal test.

Keywords: porosity, permeability, granite, fracture experiments, Hot Dry Rock geothermal system