[JJ] Evening Poster | S (Solid Earth Sciences) | S-CG Complex & General

[S-CG64]Brittle-Ductile Transition and Supercritical Geofluids for Crustal Energy in Island Arc

convener:Noriyoshi Tsuchiya(Graduate School of Environmental Studies, Tohoku University), Hiroshi Asanuma(AIST), Yasuo Ogawa(東京工業大学理学院火山流体研究センター)
Mon. May 21, 2018 5:15 PM - 6:30 PM Poster Hall (International Exhibition Hall7, Makuhari Messe)
Nature of rock mass below the brittle-ductile transition (BDT) is of great scientific interest to understand various phenomenon in the Earth's crust. We will review and discuss current understanding of characteristics the rock mass below the BDT, including composites, stress, failure mechanism induced by liquid injection and associates earthquake generation mechanism, and water rock interaction, considering engineered geothermal development in the BDT. Discussions on the possible phenomena in the geothermal development in the BDT will be followed in this session.
New drilling technology is key of issues. This session will cover advanced drilling technology under high temperature conditions for energy extraction.

[SCG64-P05]Analysis of hydro fracturing behaviors of supercritical geothermal rock mass under true triaxial stress by elastic wave measurement

*Miura Takahiro[1], Noriaki Watanabe[1], Kiyotoshi Sakaguchi[1], Ryota Goto[1], Noriyoshi Tsuchiya[1] (1. Graduate School of Environmental Studies, Tohoku University)

Utilization of supercritical geothermal resources that can be formed in the island arc crust at depths of 2 to 6 km has been attracted. In order to apply the potential resources, it is necessary to create fracture networks and propagation by hydraulic fracturing method which can be an effective geothermal reservoirs. In previous study, hydraulic fracturing experiments under confining pressure under high temperature and pressure conditions using granite specimens were conducted, which was not similar to heterogeneous natural stress condition. Therefore, in this research, we conducted the hydraulic fracturing experiments using granite specimens under true triaxial stress of high temperature pressure conditions by using resin melt type true triaxial testing equipment, and the behavior of fracturing was evaluated by measurement of elastic wave velocity.

The greatest, intermediate and least principal stresses can be set independently in the resin melt type true triaxial testing equipment, and the confining pressure is controlled by melted resin. In this experiments, we used cube-shaped Inada granite (taken from Ibaraki prefecture) with a borehole for hydraulic stimulation. We conducted hydraulic fracturing by raising water pressure in the borehole (BP) after setting the temperature inside the equipment to the experimental conditions and injecting water into the borehole with load applied to the specimen in the pressure vessel. Exuded water to each surface after fracture propagate to each surface by fracturing was recorded by using the hydraulic gauge. Also, elastic wave velocity before and after fracturing was measured by using ultrasonic probes attached to the pistons to apply load to the specimen.

BP turned to decrease at the time when the water pressure increased to some extent during raising BP, which was thought to be due to fracture propagation from the vicinity of the borehole by reaching fracturing water pressure. As BP decreased, the value of the hydraulic gauge increased on each side of the specimen. In addition, as a result of measurement of elastic wave velocity before and after hydraulic fracture, it is considered that cracks are propagating in all directions, not only in the specific direction. Elastic wave

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velocity was declined in each direction.

Furthermore, it was confirmed that the elastic wave velocity decreased by about 40 to 50% in all directions, so that regardless of the direction of the greatest, intermediate and least principal stress, fractures due to hydraulic fracturing were considered to progress uniformly in all directions. However, extent of fracture propagation was enhanced in the parts where there were relatively high pre-existing fractures densities compared to the other parts in the specimen. Based on the experimental results, fracture networks were thought to progress through existing microfractures.

In addition, the permeability increased to the order of 10^{-15} m^2 from 10^{-18} m^2 of the intact specimen and it was considered that the permeability in the Earth’s crust can be sufficiently increased by hydraulic fracturing.

References

Watanabe, N. et al. Hydraulic fracturing and permeability enhancement in granite from subcritical/brittle to supercritical/ductile conditions. *Geophys. Res. Let.* 44, 5468-5475(2017).

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