T233-P003 Room: Poster Session Hall Time: May 21

Tensile strength test of rock cores for reliable crustal stress estimation of hydraulic fracturing experiments

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The absolute magnitude of stress in the crust is the important parameter to constrain simulation of earthquake occurrences and modeling of tectonics. Therefore, the absolute value should be highly reliable. The hydraulic fracturing method is a technique to estimate the crustal stress and has been adopted at several sites by NIED. With this method, a borehole is pressurized by water until the occurrence of fracture on the wall of borehole. The maximum principal stress is estimated from the values of pressure at which the fracture is reopened by re-pressurizing and the fracture is shut by the *in situ* stress. Since the procedure of measurement is simple and can be conducted even at great depth, this method is widely adopted by various institutions. However, there are some claims that the pressure at which the fracture is reopened (reopening pressure P_r) is unreliable. Recently, Ito *et al*.(1999) showed that the conventional system with large compliance cannot inherently measure the reopening pressure by using the numerical simulation. On the other hand, we can also estimate the maximum principal stress from the breakdown pressure P_b at which the fracture is created. In that case, we need to measure the *in situ* tensile strength T. Here, P_r=P_b-T. In order to confirm the hypothesis proposed by Ito *et al*.(1999) and improve the reliability of measurement by avoiding this problem, we conducted the tensile strength test of rock cores. The tensile strength was measured by fracturing a cylindrical rock sample with pressurization inside the sample. Confining pressure is not applied in this test. Since Haimson and Zhao (1991) pointed out that the size effect on diameter of borehole is remarkable with the diameter less than 20 mm, we drilled a borehole with the diameter of 25 mm in core samples. The cores for test were sampled at Atotsugawa fault, Nojima fault (Hirabayashi, Iwaya and Kabutoyama), and Atera fault (Ueno, Fukuoka, and Hatajiri), where NIED conducted the stress measurement with the hydraulic fracturing method. To conduct the test under the condition similar to the *in situ* measurement, we saturated the rock samples with water by preserving the samples with water inside a vacuum vessel for 72 hours. Before using the rock cores sampled at faults, we tested the standard rock samples, Inada granite, whose property is well known. Inada granite has three planes, rift, grain, and hardway, which are easy to fracture. These three planes cross at right angle each other and the tensile strengths are low in the order of rift, grain, and hardway. We made three Inada granite samples whose core axes are perpendicular to one plane, that is, we prepared nine samples. All samples fractured in the direction of the weakest plane parallel to the core axis. The average tensile strengths of rift and grain plane are estimated to be 6.5 and 8.5 MPa, respectively. We concluded that our test is appropriate, because our estimated strengths are between the tensile strengths of Inada granite estimated with the uniaxial pull test (rift: 4.51 MPa, grain: 6.56 MPa) and the Brazilian test (rift: 9.78 MPa, grain: 9.99 MPa) by Hongo et al. (2006). We will show the results of tests with fault rock cores to estimate the correct reopening pressure and thus maximum principal stress with this test. In addition, we hope we can improve the reliability by removing the incorrect results such as the measurements of reopening pressure for an existing fracture, which could not be recognized from only field observation data.