Stress measurement with the hydraulic fracturing method performed in the Atotsu tunnel of the Kamioka mine

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We performed the in-situ stress measurement with the hydraulic fracturing method in the Atotsu tunnel of the Kamioka mine, Gifu prefecture. The measurement site is located at the area by the side of main tunnel, and is 1.1 km distant from the Atotsugawa fault. The width, depth and height of the area are about 6 m, 10 m, and 4 m, respectively. The thickness of overburden is about 550 m at the site. The vertical borehole was drilled down to the depth of 35 m, and various methods to measure the in-situ stress were carried out (Omura et al., 2006; this meeting). Diameter of the borehole is 123 mm, and that of recovered core is 85 mm. The lithological character of rock mass at this site is the Hida-metamorphic rock. Although the rocks were very hard, the recovered cores included cracks at some depths. We performed the hydraulic fracturing tests at the three depths, where very few cracks are ascertained (Depth: 9.4 m, 23.5, and 25.8 m). However, we could identify the distinct breakdown at the depth of only 9.4 m. Therefore, the only result at the depth of 9.4 m will be reported. We applied the drilling rod to the injection of water. Water pressure and flow rate were monitored at the ground surface in the tunnel. In addition, we inserted a pressure gage in the packer element to monitor the in-situ pressure. The length of test interval was about 2 m. The breakdown occurred at the pressure of 11.84 MPa. In order to determine the reopening (Pr) and shut-in (Ps) pressure, we carried out four repressurizations. We determined Pr and Ps to be 5.4 MPa and 7.8 MPa, respectively, from the first and second reopening tests. Substituting the inferred Pr and Ps into the conventional equations, Pr=3Sh-SH-Pp, and Ps=Sh, resulted in the SH of 17.9 MPa and Sh of 7.8 MPa, where SH, Sh are the maximum and minimum horizontal principal stresses, and Pp is the pore pressure and equal to 0.09 MPa. On the other hand, we also tried to estimate SH by using the equation proposed by Ito et al. (1999), Pr=(3Sh-SH)/2, and obtained SH of 12.6 MPa. The orientation of fracture (i.e. the direction of SH) was obtained by inflating the impression packer at the depth of test interval. We could find the fracture at the direction of S40-45E degrees. Although the in-situ stress was determined at the depth of 9.4 m as stated above, some researchers pointed out the problem of the conventional hydraulic fracturing method (e.g. Ito et al., 1999). They argued that we could not inherently obtain the correct value of Pr owing to the large compliance of the conventional system. Indeed, the compliance of our system was large and attained to 4.5 x 10ˆ-5 mˆ3/MPa. Therefore, the inferred SH in this study may include critical error. On the other hand, SH was not equal to Sh as Ito et al. (1999) expected. We need more investigation such as the measurement of tensile strength to obtain the reliable SH value.