Chemical monitoring during Fluid Injection Test in Taiwan Chelungpu-fault Drilling Project

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Taiwan Chelungpu-fault Drilling Project drilled two research boreholes (Hole A and B; 39 m of their distance) through the Chelungpu Fault in Da-Keng, which ruptured in the 1999 Mw 7.6 Chi-Chi earthquake, in 2004, and then a branched borehole of Hole B was drilled in 2005 (Hole C). Both Hole A and Hole C were perforated at the depth of the fault zone, and their depths of perforation were 1111 m in Hole A and 1137 m in Hole C, respectively. Between the two boreholes, Fluid Injection Test (FIT) was performed on from November 2006 to March 2007 to estimate permeability and to understand hydrological and chemical properties along Chelungpu fault. Water was injected four times from Hole C at constant pressure during this FIT (4 MPa on November 2006 and January 2007, 3 and 5 MPa on March 2007). The arrival of injected water was monitored by seismometers, manometers, a Quadrupole Mass Spectrometry and chemical sensors at Hole A. In this present, we will report the results of water quality and gas monitoring at Hole A.

During FIT, tap water was used for injected water, which was characterized by high Oxidation Reduction Potential (ORP; 250 mV) and high Dissolved Oxygen (DO; 5.6 mg/L). Because both ORP and DO of the well water at Hole A kept low (ORP; -350 - -150, DO; lower than 0.5 mg/L) before FIT, the arrival of injected water can be found by rise of these values.

1st FIT was performed for approximately 100 hours from 22:00 on 7th to 8:30 on 12th November. As a result, the values of ORP and DO increased from 10th November, which was 3 days after the start of 1st FIT. This suggests that water with oxygen gas mixed in the well water with low ORP and low DO. Results of gases monitoring by Q-MS also showed that concentrations of argon, oxygen and nitrogen gases, which were principally contained in the air, increased when ORP and DO suddenly increased. By contrast, those of methane and ethane gases decreased from the same time. These lines suggest that water mixed with air, that is, injected tap water arrived at hole A 3 days after the start of 1st pre-FIT. Then, the flow rate at hole A suddenly increased 7 days after the first change in the chemical monitoring on 10th November. Overall, the main part of injected water arrived at Hole A 10 days after the start of 1st pre-FIT. The results of flow rate suggests that the permeability is 10^{-16} m^2 assuming that the width of a permeable zone is 1 m by the preliminary estimation of the permeability based on the model of Kitagawa et al. (2002), which is consistent with the results on the previous hydraulic tests (10^{-18} m^2 and 10^{-16} m^2; Doan et al., 2006).