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Temperature Logging of Borehole Groundwater of Fractured Rock Mass in the Yuseong Area, Korea

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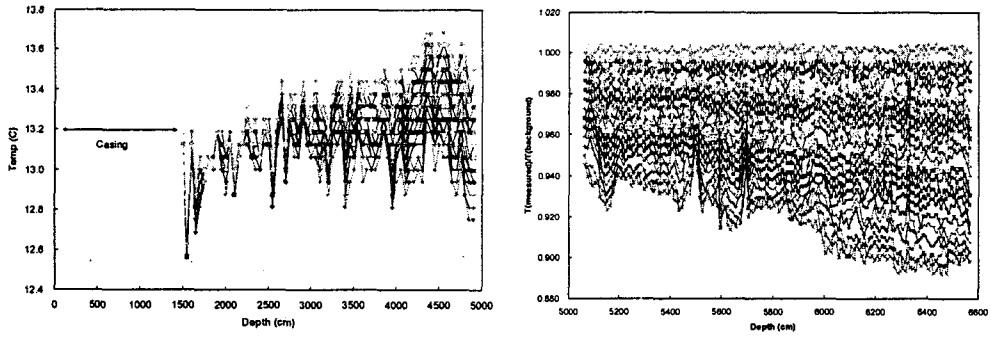
ABSTRACT

Temperature logging of borehole groundwater was carried out in order to elucidate the flow system of fractured rock mass in the Yuseong area as a part of radioactive waste disposal research program in Korea. Many boreholes (11 deep boreholes and 6 shallow boreholes) have been drilled in the study area since 1996. Fracture systems and hydrological properties of all boreholes are well recognized by BHTV, core logging and various hydrological tests. Among these boreholes, Borehole YS-2-1 was selected and temperature logging was carried out using temperature monitoring system which developed by Soam Consultant Co., Ltd. Borehole YS-2-1 is 200m in depth and the temperature logging was carried out from the surface to 65m depth. We applied two types of device for this study. One is 50m length type with 101 temperature sensors (cable 1). The other is 15m length type with 151 temperature sensors (cable 2). Therefore, the intervals of measurement points are 50cm and 10cm, respectively. Temperatures of whole sensors in the cables were recorded automatically every minute. Time interval of recording and other physical parameters can be easily controlled by control box connected to computer. Sensitivity of temperature sensor is less than ±0.1°C. Before the installation of the cables, single packer was installed at 65m depth in order to separate lower groundwater in the borehole. After that, cables 1 and 2 were installed simultaneously and background temperature was measured, then the injection water was continuously circulated from the bottom of the test zone. Temperature of the injection water was 9°C which was about 5°C lower than the borehole groundwater. After the temperature of whole test region was stabilized, we stopped the circulation of injection water and had made a difference of hydraulic head by rapid pumping from the top. After the injection water was circulated for more than 1

hour, the temperature of borehole groundwater has become 13°C, which is about 1°C lower than the original temperature of groundwater. Although there was not a great temperature difference between injection water and groundwater, the results of temperature logging suggest that the conductive fracture zones can be detected by this temperature logging method. In the temperature-depth diagrams, temperature of borehole groundwater has returned to the background condition in about 40 minutes and the temperature anomaly zones can be easily recognized (Fig. 1). Because the temperature of injection water is lower than the borehole groundwater, the temperature anomalies for the conductive fracture zones are appeared as high temperature peaks. Even though the results of cable 1 (50m) show anomaly peaks, the results of cable 2 (15m) show the peaks more clearly, because distance of adjacent sensors of cable 2 is closer (10cm) than that of cable 1. In the diagram of temperature normalized by background temperatures, the anomaly peaks become more definitely. We can detect the conductive fracture zones at 50.85, 54.95 and 56.95m depths from the normalized diagram for the 50~65m zone, and the positions of fracture zones coincide with the results of core logging, BHTV and hydraulic tests. In conclusion, measurement of background temperature is a prerequisite to temperature logging and it is required that circulating time of injection water should be sufficient to stabilize the temperature of test zone and the temperature difference between the injection water and borehole groundwater should be great.



(A) (B)

Fig. 1. Temperature-depth diagrams of (A) 0~50m zone using cable 1 (50m) and (B) 50~65m zone using cable 2 (15m). Temperatures of 50~65m zone are normalized with background temperatures.

Key words : temperature logging, conductive fracture, fractured rock mass, radioactive waste disposal, groundwater