Hydrogeochemical Approaches on the Evaluation of Redox Environments in Granitic Bedrock Through New Borehole Drilling in the KURT

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1. Introduction

A new borehole (DB-3, 350 m) was drilled in the KURT (KAERI Underground Research Tunnel) by 2018, which was established as a study for the disposal of high-level radioactive waste, in order understand the redox environments in granitic bedrock. The specific purpose of this study is 1) to analysis of joints from the investigated core samples, and 2) to evaluate hydrogeochemical characteristics of groundwater with a depth.

2. Study Area

KURT (KAERI Underground Research Tunnel) is located at a mountainous area at the site of the Korea Atomic Energy Research Institute (KAERI) at a northern part of Daejeon city. The topography of the study site is well characterized as rolling hills surrounded by upland of EL. The geology of the study area is mainly composed of Mesozoic plutonic rock, Precambrian metamorphic rock, and a dike (Fig. 1).

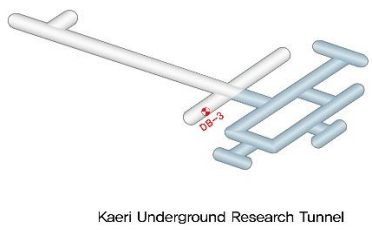

Fig. 1. Schematic diagram of the KURT and location of the investigated borehole (DB-3).

3. Results

3.1 Fracture and Hydraulic Conductivity

The detail core logging (fracture density study) was concurrently carried out with the hydraulic tests by applying a single/double packer system. As a result, we divided A (19 ~ 80 m), B (190 ~ 223 m), C (226 ~ 255 m) and D (275 ~ 350 m) sections with low fracture density (Fig. 2). The section A is considered to be difficult to preserve reduced groundwater because it is close to the surface. The number of fracture in section B is 9 ~ 19, with an average of 12. The number of fracture in the section C is 3 to 16, which is an average of 9. The D section with the lowest fracture distribution is fresh and not altered. This section is expected to be have reduced water because of the low fracture density, hydraulic conductivity and withdrawal rate.

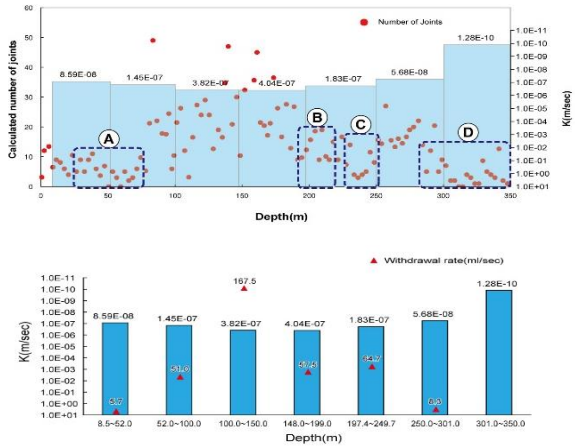

Fig. 2. (a) Hydraulic conductivity and fracture density, (b) Hydraulic conductivity and withdrawal rate of the DB-3 borehole with a depth interval.

3.2 Hydrogeochmical Characteristics

As the depth increases, the water quality evolves from the Ca-HCO_3 type to the Na-HCO_3 type. The geochemical behavior of uranium shows a positive correlation with DO, Eh and NO_3^- ion. Ca^{2+}, Mg^{2+}, SO_4^{2-}, and U-containing ions predominate in the upper section (0-100 m), but the concentrations of HCO_3^-, F^-, Na^+, and SiO_2 ions are higher in the lower

section (200 m or deeper) (Fig. 3).

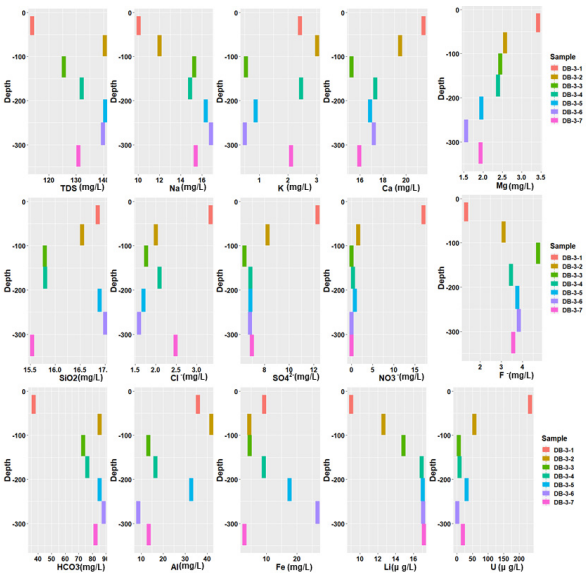

Fig. 3. Geochemical distribution of chemical constituents in DB-3 groundwater by depth interval.

3.3 Long-term Monitoring

Long-term monitoring was performed in D section of DB-3 to understand the redox characteristics in a low fractured area, and the result shows the reduced condition around -500 mV in redox potential (Fig. 4).

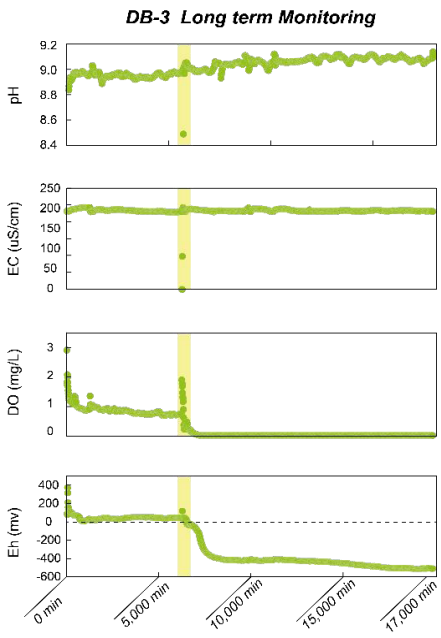

Fig. 4. Long term monitoring result (pH, EC, DO and Eh) of DB-3 borehole, yellow boxes indicates the moment of valve replacement.

4. Conclusion

In order to evaluate the geochemical environments of the granitic bedrock, core logging and on-site hydrogeochemical analyses were carried out at the new borehole in KURT. Homogeneous rocks and partially basic dykes are found in the lower section of deeper than 200 m. Particularly, the 300-350 m section disclosed the extremely reduction state (<-500 mV), and low hydraulic conductivity and flow rate. The changes Ca-HCO_3 type to Na-HCO_3 type with a depth shows the typical evolution in the granitic bedrock. Due to the weathering progress at the low section, concentrations of HCO_3^-, F^-, Na^+, and SiO_2 are increased. Long-term monitoring has been installed in the D section (deepest part) of DB-3 for continued management and characterization of reduced water.

ACKNOWLEDGEMENT

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