Kossge International Symposium on Soil & Groundwater Environment
October 27-28, 2005 Mayfield Hotel, Seoul, Korea

Hydrogeochemistry and Residence Time of the Deep Borehole Groundwater in the Yuseong Area, Korea

Yong-Kwon Koh · Geon-Young Kim · Kyung-Su Kim · Chun-Soo Kim

Division of Radwaste Disposal Research, Korea Atomic Energy Research Institute, Daejeon 305-353, Korea

e-mail : nykkoh@kaeri.re.kr

ABSTRACT

As a part of the radioactive waste disposal research program in Korea, the Korea Atomic Energy Research Institute has been conducting the geological, hydrogeological and hydrogeochemical research in the Yuseong area, mainly consisting of Jurassic granite. To understand the deep geological environment of the crystalline rocks, 11 boreholes (76mm) with depth of 200~500m have been drilled in the Yuseong area (E.L. ~80m) since 2000. Fracture system (orientation, frequency and aperture size) was investigated by core logging and BHTV scanning, and hydraulic conductivities were estimated by hydraulic tests such as injection and pulse tests. Also, the groundwater of 3 boreholes (Borehole YS-01, 04 and 07) was isolated to more than 10 sections by multi-packer system according to depth and fractures, and hydraulic and geochemical properties of groundwater including environmental isotopes have been monitored in each section since Sep. 2001.

The borehole YS-01 with depth of 500m is separated to 14 sections by multi-packer system. Before the MP installation, the grouting activity was carried out with Portland cement around GL-115m of borehole YS-01, due to collapse after the drilling and hydraulic testing. The thermal gradient is obtained to 2.6°C/100m. pH of groundwater at upper section shows about 7 and the pH below GL-200m reaches almost constant value as 9.9~10.3, whereas the groundwater affected by grouting has abnormally high pH up to 12.7. Redox potential of groundwater varies with depth and more negative values were recognized in deep groundwater. The redox potential of deep groundwater is measured to -150 mV according to long term measurement. The ion concentrations of deep groundwater are low (~150 mg/L TDS) and dissolved oxygen is free. Except the section affected by grouting materials, the concentrations of Na, Ca, Mg, K, Cl, HCO_3, and SO_4 of groundwater are constant below GL-200m. F concentration in deep groundwater is high (<12.7 mg/L) and tends to increase with

depth.

After installation of MP system, shallow groundwater shows Ca-HCO_3 type (pH ~7), whereas deep groundwater below GL-200m belongs to typical Na-HCO_3 type (pH ~10). The chemistry of groundwater from each section of borehole was stabilized within about 6 months after the installation of MP system. The $\delta^{18}O$ and δD values are nearly plotted along the worldwide meteoric water line, indicating that groundwater was recharged from local meteoric waters under present climate conditions. The $\delta^{13}C$ value of groundwater show the contribution of carbon from either microbial oxidation of organic matter or carbon dioxide from plant respiration. The high $\delta^{34}S_{SO4}$ value of groundwater indicates that the sulfate reduction might be occurred in the deep environment. The chemical and isotope data indicate that the groundwater has been geochemically evolved by simple water/granite interaction. It is noteworthy that $\delta^{18}O$ and δD values of deep groundwater are more negative than those of shallow groundwater in the borehole of the Yuseong area.

Tritium contents close to zero are observed in the deep groundwater, confirming a long residence time of deep groundwater. Carbon isotopes were measured by AMS for some groundwater sample of borehole YS-1. C-14 values of deep groundwater are about 30 pmc. Using the chemical and isotope calibration for dating of deep groundwater, the residence time of deep groundwater is estimated to be about 2000 to 6000 year old before present. For confirming the residence time, the additional C-14 analysis will be carried out.

Key words : Deep groundwater, borehole, hydrogeochemistry, radioactive waste, residence time