Estimation of hydrogeological properties of a fault by geochemical analysis of groundwater and mass transport analysis

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Geological disposal is investigated for disposal of high-level radioactive waste. In geological disposal, it is required that radionuclides in the waste does not affect the biosphere even if they are transferred by action of groundwater. Therefore, understanding of groundwater flow regime around disposal site is important. Fault acts as conduit and/or barrier dependent on its internal structure and its hydrogeological property is not sufficiently understood. In this study, spatial and temporal variations of groundwater chemistry around a fault was estimated from geochemical analyses of groundwater samples and past data. Groundwater flow and mass transport regimes around the fault was interpreted by comparing the spatial and temporal variations and simulation results using three dimensional hydrogeological model.
Study area is the region around Mizunami Underground Research Laboratory of Japan Atomic Energy Agency (JAEA), Gifu prefecture, Japan. Main shaft of the laboratory is located adjacent to a fault referred to as Main Shaft Fault (MSF) with NW-SE strike and almost vertical dip. Groundwater samples were collected from 12 intervals of 5 boreholes on both sides of the MSF. Concentrations or isotope ratios of dominant dissolved ions, alkalinity, hydrogen and oxygen isotopes, sulfur hexafluoride, tritium were determined, and the spatial distribution and temporal change were considered by combining with geochemical monitoring data conducted by JAEA (Sai et al., 2011; Shingu et al., 2011; Shingu et al., 2012; Omori et al., 2013a; Omori et al., 2013b; Omori et al., 2014). In addition, a three dimensional hydrogeological model was developed, and groundwater flow analysis was carried out. Its results were used as boundary conditions in groundwater flow and mass transport analyses conducted using another model partly refined around the fault. The analytical results were compared with the actually measured values.
The sample analyses and past data revealed that spatial distributions of calcium, chloride, bromide ion concentrations, hydrogen and oxygen isotope ratios, and tritium concentration were different between both sides of the fault. Concentrations of calcium, chloride, and bromide ions similarly decreased with time only on the southwestern side of the fault. The results of the mass transport analysis considering the influence of the water drainage in the shaft excavation also showed decrease of chloride ion concentration only on the southwestern side of the fault. Head calculated in the groundwater flow analysis was different between both sides of the fault. In contrast, the mass transfer analysis of tritium showed infiltration of surficial young groundwater containing tritium along the damage zones on both sides of the fault. Estimated infiltration rate was larger on the southwestern side of the fault. These results indicated that the MSF acts as both of barrier and conduit.
This research was conducted under support of a grant from the Ministry of Economy, Trade and Industry (METI).

References

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Keywords: groundwater, environmental tracer, mass transport analysis

