Constructions of hydrogeological structure and mass transport model around hydraulic conductive fractures

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In geological disposal of high-level nuclear waste, hydraulic conductive fractures in crystalline rock such as granite have been considered as a main pathway for radionuclides. Diffusion and absorption of radionuclide through microstructure in rock matrix can make mass transport to retard. Because the change of the characteristics of microstructure in rock matrix by structural movement and hydrothermal alteration have an effect on mass transport, it is important to understand hydrogeological continuity of fractures as well as their porosity and mass transfer characterizations by field survey and laboratory test and moreover to construct hydrogeological structure and mass transport model around hydraulic conductive fractures by reflecting their parameter from physical property values. For the purposes of effectiveness evaluation of technological development for estimating the interstitial structure of hydraulic conductive fractures in Japan, we have conducted the advancement of hydraulic fracture investigation methods for Toki granite of Mizunami Underground Research Laboratory of JAEA. In this study, we focus on hydraulic fractures of the western part around GL −300 m Measurement Niche off Ventilation Shaft and suggest that hydraulic geological structure and mass transfer model and their parameters for groundwater flow / nuclide migration analysis taking into account for nuclide diffusion / sorption behavior based on in-situ resin infiltration tests and diffusion and sorption tests.

In the rock around GL −300 m Measurement Niche off Ventilation Shaft, on the west side, NW fractures with hydrogeological continuity form higher-permeability zone through low dip angle fractures (Hamada, 2019). The hydraulic conductive fractures across multiple boreholes to the west sides, which were recognized as resin infiltrated fractures, mainly show NW fracture. They are open along cataclastic vein texture which consists of fractured rock-forming minerals, with euhedral calcite crystals between the surfaces of fracture. From the composition analysis by EPMA, minerals consisting of cataclastic vein texture do not include secondary minerals. It is considered that NW strike fractures were formed by opening along weak lines of the surface of the cataclastic vein structures after crustal movement, which were granulated by the grinding action. Low dip fractures are universally distributed at this depth and euhedral calcite crystals developing between fracture surfaces were thought to be originated from freshwater because of C-axis developing (Folk, 1974). From these, low dip fractures were formed by uploading after granite ascending and filled with euhedral crystals of calcite formed after the intrusion of surface water.

Based on the characteristics of hydraulic fractures as described above, we suggest mass transport models for analyzing groundwater flow / nuclide migration through mainly single fracture model in crystalline rock as follows. From both macroscopic and polarizing microscope observation of core samples, we recognized the traces of past shear activity and hydrothermal alteration in the range from the fracture surface (0 mm) to 30 mm in depth. From the results of laboratory tests (diffusion test, sorption batch test focusing on mineral ratio), the porosity is generally larger near the fracture surface within this range, and the porosity becomes smaller as the distance from the fracture surface increases, resulting in an effective diffusion coefficient. The partition coefficient seemed to change according to the amount of secondary minerals, especially sericite, contained in each matrix around the fracture. In the conceptual model proposed from this, the mass transfer parameters obtained from the laboratory test are set for the range from the fracture surface to 30 mm for each width of 10 mm from the fracture surface. The region separated from the fracture surface by 30 mm or more is considered appropriate to introduce the value of non-alteration rock

as a reference value.
This study is commissioned by the Agency for Natural Resources and Energy in the Ministry of Economy, Trade and Industry. Core sampling were conducted as a part of a collaborative research with JAEA.

Keywords: geological disposal, hydrogeological structure, hydraulic conductive fracture, Toki granite, Mizunami Underground Research Laboratory, mass transport model

