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Natural analogue study on long-term reaction of bentonite and highly alkaline groundwater

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Geological disposal of high level nuclear waste has been planned and developed in many countries worldwide. In Japan, it is to be vitrified and an overpack enclosing metallic containers that contain the vitrified waste is to be placed in a deep geological repository with the multibarrier system consisting of an engineered barrier and a natural barrier by geological formations. One of the possible buffer materials for the engineered barrier is bentonite, which should possess the property of long-term stability, although the functions required for it depend on the method of disposal of the waste. When used with cement materials as reinforcing agents, however, the functions required for the bentonite-based barrier material may deteriorate due to such phenomena as dissolution and change of properties by highly alkaline groundwater formed by reactions of the cement materials with groundwater. Since it takes hundreds of thousands of years for the radioactivity of high level nuclear waste to decrease to the natural background level, it is impossible to clarify the reaction mechanism of bentonite and highly alkaline groundwater in the laboratory for such a long time. An appropriate method to examine such a long-term system is natural analogue study which is an investigation of a natural system that has some similarities with a radioactive waste repository and its surrounding environment.

The Mangatarem district, in the Philippines, was chosen as a study area in this natural analogue study due to the following reasons:

?Ophiolite suite is widely distributed and may be utilized for elucidation of the reaction mechanism of basic rocks with groundwater. Ophiolite is layered rock consisting of several rocks such as peridotite, gabbro and basalt.

?There are natural bentonite ore deposits (Saile Mine) in the district, where observation of the deposit outcrop is possible.

?Evidence is found that there existed highly alkaline groundwater at Saile Mine in the past (Mn-staining), which enables us to examine the reaction of bentonite with such a highly alkaline groundwater.

?There are world-prominent eruption spots of highly alkaline groundwater in the district (Manleluag National Park).

?There are regions where bentonite is currently interacting with highly alkaline groundwater (Bigbiga).

Through the investigation of the Mangatarem district with the above mentioned features, we tried to elucidate the following two points: 1) the origin of the highly alkaline groundwater and 2) the long-term interaction of bentonite with highly alkaline groundwater

At present, we are mainly trying to elucidate the long-term interaction of bentonite with highly alkaline groundwater. Analyses were made for rock samples collected from trenches of the bentonite mine and an outcrop of the quarry in 2009 and 2010. The major element contents of these samples were determined by XRF, and the contents of rare earth elements and trace elements (mainly heavy metals) were measured by ICP-MS. The constituent minerals of the samples were identified by XRD. Analytical results reveal some differences between the trench and outcrop samples. Assuming that the source rock of bentonite and zeolite is common for the rock samples of the two sampling points, those differences are probably attributable to the difference in the reaction of the source rock with the highly alkaline groundwater that had come up along faults. The trench samples collected from deeper parts in the ground have been influenced by the highly alkaline groundwater more substantially than the outcrop samples.

Keywords: high level nuclear waste, natural analogue study, bentonite, highly alkaline groundwater, basic rocks, rare earth element