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Natural analogue study of the interaction between hyperalkaline groundwater and bentonite at the ophiolite of Philippine

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Bentonite is a one of significant engineered barriers in many radioactive waste repository designs. However, semctite, main component of the bentonite, could be dissolve and alter to the other secondary mineral such as zeolite by hyperalkaline leachates from cementitious materials in a repository. Therefore, this has been a key research issue in performance assessment of radioactive waste disposal. Although the greatest challenge is bringing the information produced by laboratory and modeling studies together to predict longevity of the bentonite with cement materials in the repository, this is complicated by the inherently slow kinetics of such reactions for geological term. Clearly, this is an area where natural analogues could play a valuable role. In this context, natural analogue sites to fill in the disparity have been looking for all over the world. Philippines consist of many volcanic islands and then have well-bedded tuffaceous members of the formations and subsequently altered bentonite deposits. There are also several ophiolite complexes with hyperalkaline groundwaters derived from low temperature serpentinization. To date, Mangatarem area on the west central of Luzon island in northern Philippines appears the most promising because there is the big bentonite deposit (Saile mine) in vicinity of the ophiolite complex.

The studied bentonite samples were collected from different locations and depths at the Saile mining and trench sites because our project focuses on the bentonite alteration by the interaction with alkaline fluid. In addition to the bentonites, fissure filling minerals were also collected at quarry and trench sites to determine whether alkaline fluid had been past along with the fissure or not, from the points of mineralogical composition and distribution. In the fissure of the bentonite at the quarry, materials with black color were frequently observed. From XRD and SEM/EDX analyses, the black material is assigned as Mn-hydroxide. The Mn-hydroxide is generally known as a product at hyperalkaline condition and formed at pH more than 11 from thermodynamic calculation. From the above measurement and calculation, the existence of black Mn-hydroxide observed in the fissure implies that the fluid passed through the fissures was hyperalkaline with pH more than 11. In the fissure observed at the trench, the materials with white and green colors were frequently observed. The white and green materials are respectively assigned as calcite, and smectite and/or serpentine. Based on the observations of abnormal serpentine in the hyperalkaline and low temperature condition at the other ophiolite complex, existence of the green serpentine observed in the fissure therefore implies that the fluid passed through the fissures was hyperalkaline.

At the trench, the bentonite samples with different distance in centimeter scale from pillow lava were collected to determine the alteration of bentonite by interaction with alkaline fluid which is expected to be supplied from ultrabasic rock via pillow lava in the ophiolite complex. There is no marked difference in mineralogical composition and interlayer cation composition. Based on the observation in the samples, the alteration by the alkaline fluid such as zeolitization was not confirmed. At the interface between bentonite and pillow lava, the parts with different color from the original bentonite were observed in the parts with several millimeter scale by microscopes.

The extent of alteration occurred at the interface between bentonite and pillow lava could be limited to several millimeter-sized regions for geological time, although we cannot determine the time period to form the altered parts without geochronogical data.
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Keywords: Ophiolite, Hyperalkaline, Serpentinization, Natural analogue, Bentonite, Radioactive waste disposal