Natural analogue study for interaction between alkaline groundwater and bentonite at Mangatarem region in the Philippines

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[en] Document available in extended abstract form only. Alteration of bentonite by alkaline leachate from cement/concrete in geological repositories for TRU radioactive waste is deleterious to bentonite performance as a buffer material. Although there have been many laboratory studies on high pH fluid-bentonite interaction for longer term understanding of the behavior of bentonites as buffer materials, different time scales between laboratory experiments and real disposal conditions impede its proper assessment. Thus, a natural analogue study can play an important role in (a) bridging the timescale gaps between laboratory experiments and real disposal conditions and (b) verifying the modeling studies of bentonite stability. Previous natural analogue studies on the cement-bentonite interaction are relatively few. Therefore, this study focuses on the process of serpentinization in ophiolitic rocks which resemble the process of leaching high pH ground waters from cement materials and report the results of study about alkaline water-bentonite interaction in Mangatarem, Philippines. In Mangatarem, in west central Luzon Island in the northern Philippines, there are bentonite quarries in the Aksitero Formation, which is part of the Zambales Ophiolite. Several alkaline hot springs derived from ongoing serpentinization of the ophiolite can be found in close proximity to the bentonite.Through a site characterization (including a foot survey, a series of boreholes and trench excavation in the Saile quarry in Mangatarem, the interface between the bentonite and the pillow lava of the upper ophiolite was confirmed, and chrysotile, a low temperature type of serpentine, was observed in the fault filling by XRD analysis. In the pillow lava, serpentine was also observed inside the fault that cut across both the bentonite and the pillow lava. From these facts, low temperature high pH fluids appears to have passed through the faults and came into contact with the bentonite. In order to investigate the influence of high pH water on the bentonite, samples were collected from the interface between the bentonite and the pillow lava and tested. The bentonite samples were collected at 10 cm intervals from the pillow lava into the bentonite to assess the reaction of bentonite by interaction with high pH water. The samples show no significant difference in mineralogy or cation exchange capacity on cm scales. In XRD measurements at 40% r.h, the bentonite samples showed the same position of the 001 reflection, which means that all the bentonite observed here contains Ca-smectite. However, the present data cannot exclude the possibility of Ca-rich alkaline fluids affecting the interlayer cation of smectite in the bentonite with. The contact zone between the pillow lavas and the bentonite is divided into five zones based on microscopic and mineralogical characteristics: (1) unaltered bentonite; (2) Fe-enriched bentonite; (3)altered bentonite(4) altered pillow lava and (5) unaltered pillow lava characterized by Si-enrichment. The altered bentonite area was limited to zones 1-5 mm thick and authigenic K-feldspar, zeolite, Fe-smectite were observed by SEM, EPMA and TEM. Previous studies have shown that these minerals can result from the alteration of smectite by high pH fluids (e.g. Bauer and Velde, 1999). In addition, the EPMA analysis revealed that Fe2+ was leached from the pillow lavas and enriched in the part of the altered bentonite. This suggest that alkaline fluids could have passed through fractures in the pillow lava and the bentonite, and converted the smectites in the bentonite to nontronite, which caused the clogging of fluid pathways with filling minerals. Here, a natural analogue study of bentonite-cement interaction was carried out in the Saile quarry in Mangatarem. An alkaline fluid pathway, from the source pillow lava into the overlying bentonite has been identified on the basis of presence of low temperature chrysotile. The alkaline solutions converted the smectite in the bentonite to secondary minerals, as well as causing the clogging of fluid pathways with secondary mineral fillings. Consequently, the alteration of the bentonite through the contact with hyper-alkaline solutions was limited to several millimeter-sized regions over the long term. It is intended to clarify the temporal aspect of alteration process with the use of geochronological data in the future. This study was initiated within a project to develop an integrated natural analogue program in Japan, which was funded by the Ministry of Economy, Trade and Industry, Japan. (authors)

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