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A study of the mineral deformation and water-mineral interaction under various conditions

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In general, bentonite is considered as a buffer material in high-level radioactive waste disposal facilities in many countries and consists of 50 weight percent (wt%) quartz. It quartz strongly affects the behavior of bentonite such as a consolidation over very long periods. Because the consolidation behavior of the bentonite is influenced by main mineral deformation and water-mineral interaction such as the quartz, quartz dissolution experiment was performed under high-pressure and high-alkalinity conditions based on the conditions found in a high-level radioactive waste disposal facility located deep underground. In this study, two quartz dissolution experiments were conducted on quartz beads under low-pressure and high-alkalinity conditions and a single quartz crystal under high-pressure and high-alkalinity conditions. Following the experiments, a confocal laser scanning microscope (CLSM) was used to observe the surface deformation and surface-water interaction of samples. Numerical analyses using the finite element method (FEM) were also performed to quantify the deformation pattern of contact area. Quartz dissolution behaviors were observed in both experiments. This deformation and water-mineral interaction were due to a concentrated compressive stress field, as indicated by the quartz deformation of the contact area through the numerical analysis. According to the numerical results, a high compressive stress field acted upon the neighboring contact area, which showed a rapid dissolution rate compared to other areas of the sample.