Basic Studies for Developing Rational Treatment and Disposal System of Radioactive Wastes Generated by Fukushima Dai–ichi Nuclear Accident
(56) Precipitation of Calcium Carbonate in Compacted Bentonite by Electrokinetic Method

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Abstract: Calcium carbonate ($CaCO_3$) precipitation may occur in bentonite which will be used as a part of engineered barriers in disposal of radioactive waste generated from Fukushima nuclear accident. Using an electrokinetic method, migration and precipitation behaviors of Ca^{2+} and CO_3^{2-} were investigated in order to study the porewater chemistry in compacted bentonite.

Keywords: radioactive waste disposal, compacted bentonite, calcium carbonate, electromigration.

1. Introduction

A precipitate of $CaCO_3$ may form in the engineered barrier in disposal of radioactive waste generated from Fukushima nuclear accident from the interaction between bentonite and cementitious materials, and as a result, properties of bentonite as a barrier may be altered. At a previous meeting, we have presented that different states of Ca can be distinguished by a sequential extraction method that has been developed, and the Ca profile obtained by the electrokinetic method indicated precipitation of $CaCO_3$ in compacted bentonite [1]. This presentation discusses the precipitation behavior of $CaCO_3$ in compacted bentonite from a spatial distribution of Ca^{2+}, Na^+, and CO_3^{2-}.

2. Method

Compacted bentonite saturated with 0.7 M $NaHCO_3$ was subjected to electromigration [1]. The sample was placed in a holder between the anode and cathode reservoirs containing 1 M $CaCl_2$ and 0.7 M $NaHCO_3$, respectively. Different sets of electromigration experiment were conducted at constant current of 5 mA using different tracers of ^{45}Ca and $^{14}CO_3^{2-}$. After 6 hour and 16 hour electromigration, the sample was sliced into 0.5 mm thickness, and the pH and the concentrations of free and bound Ca^{2+}, Na^+, and CO_3^{2-} were determined.

3. Discussion

Spatial distribution of ions and pH after a 16 hour electromigration is shown in Fig.1. The distribution shows that the bentonite sample can be divided into three zones: zone 1 has Ca-bentonite only, zone 2 has a mixture of Ca- and Na-bentonite, and zone 3 has Na-bentonite only. In zone 1, bound Ca profile exceeds the CEC value suggesting precipitation of $CaCO_3$. Free Ca decreases in zone 1 and becomes zero in zone 2. Before electromigration, CO_3^{2-} concentration was constant, as can be seen in zone 3, but it decreases in zone 2 and takes a smaller constant value in zone 1. In zone 2, a sharp increase in pH was observed. The concentration profile and the change in pH may suggest that there is precipitation reaction front in zone 2.

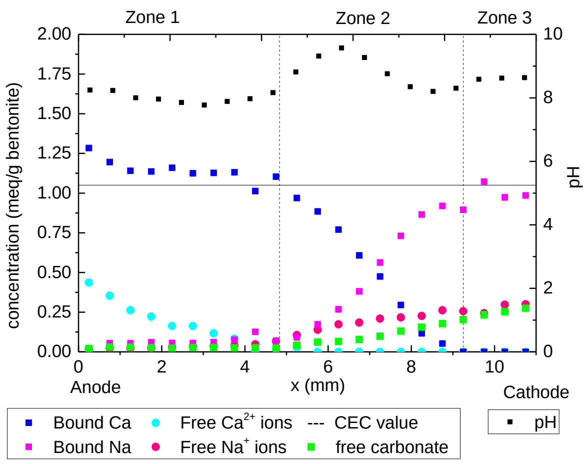

Figure 1. Spatial distribution of ions and pH at 16 h.

References

[1]. J. Rachmadetin, M. Mizuto, S. Tanaka, N. Watanabe, T. Kozaki1, Fall Meeting of the Atomic Energy Society of Japan, 2015.
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