# Alterations of Bentonite Buffer by Cement-induced Reactions: A Literature Review

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## 1. Introduction

Bentonite is a promising candidate as buffer material in geological repository for radioactive waste. Bentonite can effectively serve as a buffer due to low permeability, high swelling capacity, and nuclide retention capacity. After closure of repository, however, long-term evolved repository conditions along with infiltration of groundwater or seawater may affect the characteristics and capabilities of bentonite buffer. Particularly, cementitious groundwater with high pH generated by interaction between cement used for repository construction and groundwater may lead to alterations of bentonite and change in its performance. Still, most previous studies focused on the characteristics of bentonite alteration by highly alkaline solution. The effects of bentonite alteration process on its performance such as nuclide retention capacity are essential consideration for long-term safety of repository. Thus, we investigated the bentonite alteration processes by cement-induced reactions and its impacts on performance based on the results of previous researches.

## 2. Bentonite Alterations by Cement-induced Reactions

Bentonite alteration occurred through various geochemical interactions with infiltrated cementitious alkaline groundwater (Fig. 1). The major alteration processes of bentonite were controlled by cation exchange, dissolution of montmorillonite, precipitation of secondary minerals, and illitization. Interlayer cations of montmorillonite in bentonite were exchanged by other cations such as $Na^+$, $K^+$, and $Ca^{2+}$ in the groundwater. High pH (>11.5) of cementitious groundwater led to montmorillonite dissolution, which can be accelerated by temperature and solid-liquid ratio. Moreover, secondary minerals such as C(A)SH, illite, and zeolite can be formed during the bentonite-cementitious groundwater interaction (Fig. 2). This process varied depending on the distance from bentonite-concrete interface. Illitization was caused by long-term mineralogical alteration of bentonite, which is affected by temperature and chemical composition and pH of liquid.

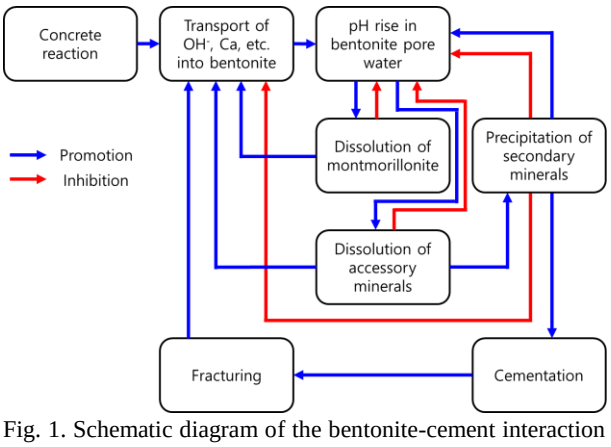


Fig. 1. Schematic diagram of the bentonite-cement interaction as a coupled non-linear system [1] (modified from [2]).

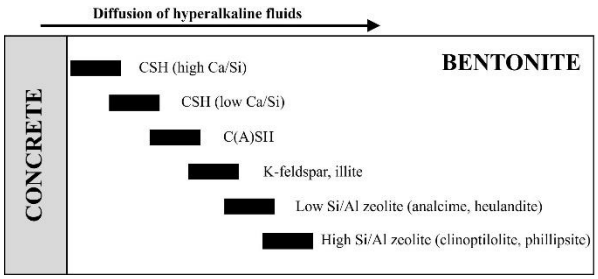


Fig. 2. Schematic diagram of the potential sequence of secondary minerals due to migration of hyperalkaline pore fluids through bentonite [1] (modified from [2]).

## 3. Summary and Conclusion

The characteristics and processes of bentonite alteration by cement-induced reactions were investigated based on the results of previous researches. Bentonite alteration process varied depending on pH and composition of fluids, reaction period, temperature, pressure, and chemical composition of bentonite. After the alteration, the nuclide retention capacity of bentonite was affected by the changes of montmorillonite content, mineral phases, type of interlayer cation. Thus, further study is necessary to explore the nuclide retention characteristics by bentonite buffer under evolved repository conditions such as high alkaline conditions.

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