Geophysical Research Abstracts
Vol. 20, EGU2018-17505, 2018
EGU General Assembly 2018

Bentonite erosion: possible role of accessory minerals

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Erosion and colloid formation are two processes that may compromise the safety of a compacted bentonite barrier in deep geological repositories for high-level radioactive waste (HLRW). Previous studies indicated that, under confined and compacted conditions, bentonite erosion was dependent on the inherent physico-chemical characteristics of the clay such as the smectite content, dominant exchangeable cations or charge distribution, all affecting its dispersion. Some bentonites presented lower erosion values than expected according to their chemical and structural characteristics. The relevant role of clay/water interactions and the chemistry at equilibrium was pointed out as possible explanation. In addition, it was concluded that the fact that natural clays have accessory minerals and (oxy)hydroxides in their composition, may compromise smectite erosion.
The aim of this study was to analyse the erosion behaviour of bentonite clays mixed with known proportions of other clay minerals and oxides, to verify if their erosion deviate from the pure smectite behaviour. To do so, the erosion of FEBEX bentonite mixed with known proportions of illite, kaolinite, zeolite, saponite or Al- and Fe-oxides, was analysed. Some experiments were also carried out with purified smectite fractions (FEBEX and MX-80) where accessory minerals were eliminated.
An experimental set-up which allows quantifying clay erosion under stagnant and confined conditions was selected. Experiments were carried out with clays compacted at 1.65 g·cm-3 dry density and immersed deionised water to account for favourable conditions for erosion. Complementary colloid stability studies were carried out by Photon Correlation Spectrometry, with mixtures of laboratory prepared smectite colloids mixed with other clay minerals or oxides to analyse their (hetero)aggregation behaviour.
Results showed that, under studied conditions, compacted illite, zeolite, kaolinite and saponite do not undergo erosion, and that their effect when mixed with smectite is very different. Illite has little effect on smectite erosion, zeolite diminished it and kaolinite, saponite and Al-oxides significantly inhibit smectite erosion. Overall results indicate that those accessory minerals and oxides, affecting smectite colloid stability, limit its erosion.

The research leading to these results was funded by the MIRAME Project (CTM2014-60482-P) supported by the Spanish Ministry of Economy and Competiveness and by the Swedish Nuclear Fuel and Waste Management Company (SKB) under POSKBAR.