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Interactions across interfaces between Ordinary Portland Cement (OPC) paste and oil shale

CHEN GRUBER[1], AUTUMN D TAYLOR[1], KEVIN G BROWN[1], ROSSANE DELAPP[1], LESA BROWN[1], CHVEN MITCHELL[2], LAURA PYRAK-NOLTE[2], ED N MATTEO[3], OFRA KLEIN-BENDAVID[4], GABRIELA BAR-NES[4], JOHANNES C L MEEUSSEN[5], JOHN AYERS[1] AND DAVID S KOSSON[1]

[1]Vanderbilt University
[2]Purdue University
[3]Sandia National Laboratories
[4]Nuclear Research Center – Negev
[5]Nuclear Research and Consultancy Group, Petten
Presenting Author: chen.gruber@vanderbilt.edu

Cement degradation is a major concern when designing and selecting chemically appropriate cement for a long-term applications. In applications where interfaces between cementitious materials and host rocks can be found, cement alteration as a result of cement-rock interaction may be the main degradation mechanism. Such interfaces may lead to chemical and structural alteration of both the cement and the host rock caused by diffusion and reaction driven by gradients in porewater pH and composition, pore structure, and mineralogical variation between the different materials.

The Israel Atomic Energy Commission is examining the possibility of locating a geologic waste disposal site within oil shale rock in the Negev, Israel. As oil shale is not traditionally being used as a host rock for geological waste disposal site, a thorough characterization of oil shale – cement interface is needed. Therefore, the goals of this study are: chemical and physical characterizations of oil shale and OPC paste; and long-term performance assessment of the interface and validation using laboratory experiments.

Materials were initially characterized using EPA methods 1313 and 1315. Separately, OPC paste was cast in a plastic cylinder on top of a saturated oil shale sample mounted in epoxy. The cylinder was held for a year in environmental chamber at 30 °C and 100% relative humidity. Then, the cylinder was cut perpendicular to the interface between the cement and the rock. The cut sample was polished and analyzed using SEM-EDS and micro-indentation for its chemical and mechanical properties.

The results of characterization tests were modeled using LeachXS/ORCHESTRA to derive geochemical speciation, mineral reaction set and calibrating tortuosity values for modeled materials. Then, solely based on the modeled results of both characterization tests, an OPC paste – oil shale interface model was developed. The model simulated interaction through a time frame of 100 years under saturated conditions and 30 °C. A comparison between an interface sample that aged a year to simulation results shows a good agreement. Furthermore, a long-term prediction shows the progression of altered cement depth up to 10,000 years.

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