Project Title

PI: Chen Gruber Vanderbilt University

Program: FC-3: Spent Fuel and Waste Disposition: Disposal

Collaborators: David Kosson (co-PI), Lesa Brown - Vanderbilt University; Carlos Lopez, Carlos Jove-Colon, Edward Matteo, Chven Mitchell – Sandia National Laboratories; Laura Pyrak-Nolte – Purdue University; Nadya Teutsch, Avihu Burg – Geological Survey of Israel; Erez Ben-Yosef – Tel-Aviv University; Gabriela Bar-Nes, Ofra Klein BenDavid – Ben-Gurion University of the Negev; Yotam Asscher – Israel Antiquities Authority

ABSTRACT:

The objectives of this proposal are i) validating long-term performance predictions of rock/cement interfaces using geochemical speciation reactive transport models in conjunction with characterization of natural analogues and ancient cements from the field, and ii) demonstrating applicability of the established workflow for performance prediction cement interfaces with argillite rock representative of potential U.S. repository systems. This will address the research gap of long-term validation and uncertainty assessment associated with cement barrier performance and multi-physics models.

GSRT models are often used for long-term performance assessments of geological waste repositories, deep boreholes, engineered barriers, and engineered structures. However, the validity of long-term predictions and uncertainty associated with it, are frequently in question as they are usually validated against reference materials aged under controlled conditions for relatively short time periods (ca 1-5 years). Therefore, the challenge is to validate long-term predictions with samples aged from a few hundred to thousands of years.

This project is addressing this knowledge gap by validating GSRT long-term predictions using samples of rock/cement interfaces representing different aging time scales. The first is Portlandite cement-like natural analogue representing aging hundreds of thousands of years, and the second is British Mandate of Palestine /Muslim/ Roman cements representing aging of 100s to 2000 years. Samples will be obtained from a known cement natural analogue site and historic sites in Israel through cooperation with the Geological Survey of Israel (GSI) and leading archeologists from Israel Antiquities Authority (IAA) and Tel Aviv University (TAU). Collaboration for characterization and modeling will include Vanderbilt University, GSI, TAU, Ben-Gurion University, Sandia National Laboratories, and Purdue University. One doctoral student and multiple undergraduate students will participate in the project.

This project is taking advantage of advanced characterization techniques including micro-CT, micro-XRF, nano-indentation, SEM-EDS and isotope source/aging methods for natural analogues and ancient cement, and interfaces thereof. These techniques help bound long-term predictions by GSRT models (using LeachXS/ORCHESTRA and PFLOTRAN) with long-aged samples and thereby reduce prediction uncertainty. Characterization and simulation approaches will also be applied to argillite and argillite-cement interfaces aged under controlled conditions to demonstrate applicability of the approach to geologic settings that potentially may be used for a U.S. repository. This project will help address several high priority needs identified for the US repository research program.