Improving the Understanding of the Coupled Thermal-Mechanical-Hydrologic Behavior of Consolidating Granular Salt

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ABSTRACT:

This project will improve the understanding of key aspects of the coupled thermal-mechanical-hydrologic response of granular (or crushed) salt used as a seal material for shafts, drifts, and boreholes in mined repositories in salt. Consolidation of granular salt in response to creep closure of excavations in salt is a fundamental element of the long-term waste isolation strategy, and it is critical that the process is sufficiently understood to confidently predict consolidation under all likely conditions (stress, temperature, and moisture regimes).

Granular salt consolidation will be investigated through an integrated program of laboratory measurements and observations, and constitutive model development and evaluation. This project focuses on the deformation and corresponding permeability reduction of granular salt as it consolidates to fractional densities greater than 0.90 since this is when the permeability of granular salt is expected to dramatically decrease to a condition comparable to intact salt, that is, it becomes nearly impermeable. Measurements of salt consolidation along with thermal properties and permeability measurements will be conducted under a range of conditions expected for potential mined repositories in salt, including temperatures up to 250 ºC. Consolidated samples will be characterized using microscopy to gain insight into the consolidation mechanisms. Data from the consolidation testing and microstructural characterization tasks will be used to evaluate, calibrate, and verify a mathematical model of granular salt behavior that describes the effect of consolidation on mechanical, thermal and hydrologic properties.

Specific objectives of the project are: 1. Measure the consolidation (pore volume reduction) and corresponding changes in hydrologic and thermal properties of granular rock at the critical range of conditions expected for nuclear waste repositories. 2. Interpret deformation mechanisms as a function of moisture, temperature and stress conditions from microstructural observations on consolidated samples. 3. Extend an existing constitutive model to include coupled thermal-mechanical-hydrologic behavior of consolidating granular salt for application in simulations of repository performance. The outcome of this study will be an improved understanding of and ability to predict granular salt consolidation as it compacts to high fractional densities and very small permeabilities, and will result in greater confidence in granular salt consolidation as a principal strategy for permanent isolation.