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Meeting Paper

Damage-Induced Permeability Enhancement of Natural Rock Salt with Implications for Cavern Storage

by

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1.2 OBJECTIVES

The primary damage mechanism described in this paper is one known as stress-induced microfracturing. As described above, stress-induced microfracturing occurs during inelastic brittle deformation of salt subjected to relatively high deviatoric stresses and leads to a condition known as dilation; i.e., an increase in bulk volume resulting from the creation of new porosity. Conditions favoring the development of dilation may exist in the salt near liquid-filled caverns located at great depth or gas-filled caverns located at shallower depths but subject to changes in internal gas pressure.

The accurate characterization of damage evolution is typically accomplished through laboratory testing because test conditions can be carefully controlled and response variables (e.g., dilation) can be accurately measured. However, the impact of damage evolution on issues of design, operation, and plugging and abandonment of real caverns is most often assessed through geomechanical analyses that incorporate constitutive relations developed in the laboratory and structural models (e.g., the finite element method). Therefore, the objectives of this paper are as follows:

- Describe laboratory test methods used to characterize damage evolution in salt.
- Identify variables that affect or control damage.
- Present typical laboratory results that quantify damage evolution and relate damage to permeability.
- Predict damage and permeability enhancement in salt around generic cavern configurations using the results from sophisticated geomechanical analyses.

Test methods typically used to characterize damage evolution as well as the variables affecting damage are described in Chapter 2.0. Chapter 3.0 presents laboratory data that quantifies both the evolution of damage in salt and the relationship between this damage and changes in permeability. Predictions of damage and permeability enhancement using the finite element code SPECTROM-32 [Callahan et al., 1989] and the Multimechanism Deformation Coupled Fracture (MDCF) constitutive model [Chan et al., 1996a; 1996b] for salt deformation are presented in Chapter 4.0, which is followed by a summary and list of conclusions in Chapter 5.0. The paper concludes with a list of cited references in Chapter 6.0.