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Meeting Paper

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FRACTURE AND HEALING OF ROCK SALT RELATED TO SALT CAVERNS

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ABSTRACT

In recent years, serious investigations of potential extension of the useful life of older caverns or of the use of abandoned caverns for waste disposal have been of interest to the technical community. All of the potential applications depend upon understanding the manner in which older caverns and sealing systems can fail. Such an understanding will require a more detailed knowledge of the fracture of salt than has been necessary to date. Fortunately, the knowledge of the fracture and healing of salt has made significant advances in the last decade, and is in a position to yield meaningful insights to older cavern behavior. In particular, micromechanical mechanisms of fracture and the concept of a fracture mechanism map have been essential guides, as has the utilization of continuum damage mechanics. The Multimechanism Deformation Coupled Fracture (MDCF) model, which is summarized extensively in this work, was developed specifically to treat both the creep and fracture of salt, and was later extended to incorporate the fracture healing process known to occur in rock salt. Fracture in salt is based on the formation and evolution of microfractures, which may take the form of "wing tip" cracks, either in the body or the boundary of the grain. This type of crack deforms under shear to produce a strain, and furthermore, the opening of the wing cracks produce volume strain or dilatancy. In the presence of a confining pressure, microcrack formation may be suppressed, as is often the case for triaxial compression tests or natural underground stress situations. However, if the confining pressure is insufficient to suppress fracture, then the fractures will evolve with time to give the characteristic tertiary creep response. Two first order kinetics processes, closure of cracks and healing of cracks, control the healing process. Significantly, volume strain produced by microfractures may lead to changes in the permeability of the salt, which can become a major concern in cavern sealing and operation. The MDCF model is used in three simulations of field experiments in which indirect measures were obtained of the generation of damage. The results of the simulations help to verify the model and suggest that the model captures the correct fracture behavior of rock salt. The model is used in this work to estimate the generation and location of damage around a cylindrical storage cavern. The results are interesting because stress conditions around the cylindrical cavern do not lead to large amounts of damage. Moreover, the damage is such that general failure can not readily occur, nor does the extent of the damage suggest possible increased permeation when the surrounding salt is impermeable.

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