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Physical and Numerical Simulations of Fluid-Filled Cavities In A Creeping Material

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ABSTRACT

Centrifuge creep experiments have been performed on six models of fluid-filled cylindrical cavities in a cylindrical block of the modeling material plasticine. Three of the experiments treated a single cavity on the axis of the plasticine cylinder. The other three experiments each treated an array of four cavities with three cavities symmetrically arranged around one central cavity. The three multi-cavity models differed in the spacing between the central and satellite cavities. The experiments were designed to physically model petroleum-filled caverns leached in rock salt. The experiments were performed for several reasons. First, plasticine is a creeping material which has a mathematical formulation similar to rock salt. Finite element computer programs that include material models for creep have been exercised by performing finite element analyses of the experiments using the plasticine creep model and comparing numerical and experimental results. Both two- and three-dimensional finite element analyses were performed. Second, the multi-cavity experiments were designed to gain an understanding of the behavior of arrays of cavities, specifically, how spacing between cavities influences their creep response. Three-dimensional finite element simulations of the multi-cavity experiments acted as a validation exercise for the code and provided information such as stress distribution that could not be measured experimentally. Third, information obtained about the interaction of cavities in plasticine can also be applied to cavities in rock salt.