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Rock Salt: Hydraulic Integrity and Creep for Safe and Efficient Cavern Operations

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Abstract

Salt caverns are used for underground storage of hydrocarbons by leveraging the essentially impermeable behavior of the salt within suitable pressure conditions. Hence, the safe and economical design and operation of caverns requires a proper understanding of the underlying hydromechanical behavior of rock salt. In this paper, we discuss fluid transport in rock salt, criteria for hydraulic integrity and the interplay with the mechanical deformations, in particular salt creep. Based on decades of experience in conventional and solution mining, a consistent picture of fluid transport in salt has emerged, where pressure-driven percolation is the principal mechanism. This paper presents conceptual approaches and numerical investigations as well as lab and field data. We specifically discuss published in situ - examples and show that they are consistent with our general analysis.
By reviewing various conceptual approaches, discussing evidence from laboratory and large-scale in situ tests and recalculating these findings in computational models, we present evaluation criteria and a hierarchical structure for increasingly complex numerical modelling approaches suitable for the specific task at hand.

Keywords: rock salt, gas storage, salt caverns, cavern abandonment, rock mechanics