

Leakage characterization through above-zone pressure monitoring: 1-Inversion approach

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Abstract:

Deep saline aquifers can provide the capacity for disposal/storage of undesirable surface fluids. To maintain containment and thereby prevent leakage of the injected fluids, the target aquifer should be overlain by a confining layer (cap-rock). However, there may be pathways in the cap-rock (e.g., transmissive faults, abandoned wells, active wells that partially penetrate the seal, and local seal weaknesses and fractures) that permit leakage of the injected fluids. Leakage to the subsurface formations may adversely affect the existing and potential energy and mineral resources and shallow ground water resources and soils. As such, detection and characterization of leakage pathways from storage formations into overlying formations are required. In this work, we suggest a flow and pressure test and present an inverse methodology to detect and characterize radially shaped leakage pathways based on the pressure data. The flow test is based on the injection (or production) of water into (or from) a target aquifer at a constant rate. The pressure is measured at a monitoring well in an aquifer overlying the target aquifer, which is separated by a cap-rock. Characterizing the leak based on pressure data involves solution of the leakage inverse problem. We investigate the uniqueness of the solution to the inverse problem through the use of the Hessian matrix and an analytical approach. The stability of the solution is analyzed based on sensitivity coefficients and the correlation matrix. The analyses are applied to a base case problem for which the leak characteristics are obtained over a confidence interval.

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