Inversion of pressure anomaly data for detecting leakage at geologic carbon sequestration sites

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Abstract:

Leakage from abandoned wells and geologic faults represents one of the greatest risks to the integrity of geologic CO_2 sequestration sites. The ability to detect leakage in a timely manner is, therefore, crucial for mitigating the potential adverse impacts of leakage to the public and environment. We present an inversion approach for recovering both leakage locations and rates by using observed pressure anomaly data. The approach is based on formulation of a linear system of equations using the unit-step response method, which is applicable to both analytical and numerical models. Because the resulting system is often ill conditioned, we investigate the efficacy of regularization methods for stabilizing the solutions. Further, when prior information is insufficient to restrict the number of search locations, a global optimization algorithm is used to solve the challenging problem of joint location and leakage history inversion. The performance of several linear inversion solvers is compared while considering effects such as measurement error and spatial heterogeneity. The results are promising and suggest that our pressure-anomaly-based leakage detection algorithm can be used to identify leaky wells in practice. It can be deployed as an integrated component of CO_2 risk management frameworks.