Integration of Wellbore Pressure Measurement and Groundwater Quality Monitoring to Enhance Detectability of Brine and CO₂ Leakage

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Summary

Leakage detectability is a key attribute of an effective monitoring plan. In this study, the detectability for different monitoring parameters (pH, TDS and pressure) collected from monitoring wells located were measured by leakage detection probability, using wellbore leakage simulations, monitoring background data at a hypothetical CO₂ storage site in south-central California. The wellbore leakage simulations at Kimberlina are stochastic, including the variation of permeabilities in sand and clay, sodium molality, trace metal molality and organic molality and CO₂ concentration.

The wellbore leakage simulations at Kimberlina site are stochastic, including the variation of permeabilities in sand and clay, sodium molality, trace metal molality and organic molality. The wellbore leakage simulations at Kimberlina site are stochastic, including the variation of permeabilities in sand and clay, sodium molality, trace metal molality and organic molality. The wellbore leakage simulations at Kimberlina site are stochastic, including the variation of permeabilities in sand and clay, sodium molality, trace metal molality and organic molality.

Leakage Simulations and Background Distributions

**Simulation domain and the wellbore location and leakage section**

The hypothetical CO₂ storage and leakage scenario is based on the Kimberlina site in south-central California. The leakage well is about 7,000 ft deep, located about 4 km from the injection point. Three depths are selected for study: 6,377 ft (2,000 m) and 1,831 m (600 m) from the injection point.

**Wellbore CO₂ and brine leakage rate profiles**

Four wellbore leakage sections (in red and yellow) are considered. Macoma orange and red sections are also shown. Four wellbore leakage sections (in red and yellow) are considered. Macoma orange and red sections are also shown. Four wellbore leakage sections (in red and yellow) are considered. Macoma orange and red sections are also shown.

**Background distributions of pH, TDS and Pressure**

Background distributions of pH, TDS and Pressure are shown. Background distributions of pH, TDS and Pressure are shown. Background distributions of pH, TDS and Pressure are shown.

**PH and TDS Probability of Detection (PD) using no-impact threshold low, medium and high scenarios**

Original simulated CO₂ (gas) saturation at various depths. Original simulated CO₂ (gas) saturation at various depths. Original simulated CO₂ (gas) saturation at various depths.

**Pressure PDs using Different Thresholds given Low, Medium and High Scenarios**

Pressure PDs at two depths using 1k Pa change threshold and fixed sensor monitoring. Pressure PDs at two depths using 1k Pa change threshold and fixed sensor monitoring. Pressure PDs at two depths using 1k Pa change threshold and fixed sensor monitoring.

Future Work:

- Update the PD estimations with updated and coupled wellbore leakage simulation scenarios and Kimberlina reservoir injection simulation results.
- Test the application of selecting pressure detection thresholds and multi-layer monitoring information using inverse modeling.
- Continue exploring detectability with various combined measures.

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