Quantitative Estimation of CO_2 and Brine Leakage along Old Wells

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Leakage of CO_2 and brine along abandoned oil and gas wells represents a potentially important leakage risk in CO_2 storage systems. This is especially true in North America, where millions of oil and gas wells have been drilled in the last 150 years, and most of those wells are located in areas identified as being appropriate for CO_2 storage. We have developed computational models to simulate the flow of CO_2 and brine, including leakage along old wells. These models can be applied to systems with multiple layers of permeable (aquifers) and impermeable (aquitards or caprock) formations in a sedimentary basin, and can include an arbitrary number of potentially leaky wells. To date we have only been able to use hypothetical well information due to a lack of data on leaky wells. Recent *in situ* measurements in old wells, as well as measurements and analysis of different kinds of leaky wells, have led to data-based estimation of effective permeability values for several hundred leaky wells.

We have now coupled our computational modeling with the new well data to produce more realistic estimates of CO_2 and brine leakage along old wells. The specific location for our computations is the Wabamun Lake area of Alberta, Canada. The model includes 11 permeable formations along the vertical direction, with a total of 1,146 old (potentially leaky) wells in an area of 2,500 square kilometers. Injection is assumed to take place in the Nisku formation, and the injection takes place for a period of 50 years. The computational efficiency of our models allow for Monte Carlo-type analysis. Results show that the mean leakage rate for the fraction of injected CO_2 that reaches the shallow (drinking-water) aquifers after 50 years of injection is less than 0.001%, with 95% of the results falling below 0.002%, and none of the 1,000 simulated results having leakage greater than 0.01%. The amount of brine that leaks into shallow aquifers is much lower than the amount of CO_2, indicating that shallow drinking water supplies should be safe from any significant leakage of CO_2 or displaced brine.