

Using noble gas concentrations and $\delta^{13}\text{C}$ to monitor CO_2 leakage in a carbonate freshwater shallow aquifer

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The Aquifer-CO₂Leak project is dedicated to the development of monitoring tools and a methodology for CO₂ leaking detection within the saturated zone, as well as understanding the behavior of CO₂ in a carbonate aquifer. From numerical simulations, an induced leakage experiment was performed on the pilot experimental site of Saint-Emilion in France. Water was saturated with a gas mixture of (1) CO₂, He and Kr, and (2) a gas mixture of CO₂, CH₄, He and Kr in a specially designed tank. These waters were then injected in the aquifer and monitoring was conducted through several observation wells by collecting periodic samples. This study focuses on the complementary usefulness of geochemical tracers (¹³C isotopes and noble gas) to monitor gas plume distribution, including CO₂. The comparison of noble gas concentrations with that of dissolved inorganic carbon (DIC) allow us to predict and estimate the extent and the rate of CO₂ migration. The DIC close to the injection site is isotopically enriched by 2‰ while its concentration jumps by 25%. Furthermore, He and Kr exhibit different times of arrival at the control well. However, far from the injection well, d¹³C and DIC concentrations change less significantly, while noble gases arrive simultaneously. This suggests a change in the transport of species, from an initial diffusion regime to advection.