



## Well-based stable carbon isotope leakage monitoring of an aquifer overlying the CO<sub>2</sub> storage reservoir at the Ketzin pilot site, Germany

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At the pilot site for CO<sub>2</sub> storage in Ketzin, a new well-based leakage-monitoring concept was established, comprising geochemical and hydraulic observations of the aquifer directly above the CO<sub>2</sub> reservoir (Wiese et al., 2013, Nowak et al. 2013). Its purpose was to allow early detection of un-trapped CO<sub>2</sub>.

Within this monitoring concept, we established a stable carbon isotope monitoring of dissolved inorganic carbon (DIC). If baseline isotope values of aquifer DIC ( $\delta^{13}\text{CDIC}$ ) and reservoir CO<sub>2</sub> ( $\delta^{13}\text{CCO}_2$ ) are known and distinct from each other, the  $\delta^{13}\text{CDIC}$  has the potential to serve as an early indicator for an impact of leaked CO<sub>2</sub> on the aquifer brine.

The observation well of the overlying aquifer was equipped with an U-tube sampling system that allowed sampling of unaltered brine. The high alkaline drilling mud that was used during well drilling masked  $\delta^{13}\text{CDIC}$  values at the beginning of the monitoring campaign. However, subsequent monitoring allowed observing on-going re-equilibration of the brine, indicated by changing  $\delta^{13}\text{CDIC}$  and other geochemical values, until values ranging around -23 ‰ were reached. The latter were close to baseline values before drilling.

Baseline  $\delta^{13}\text{CDIC}$  and  $\delta^{13}\text{CCO}_2$  values were used to derive a geochemical and isotope model that predicts evolution of  $\delta^{13}\text{CDIC}$ , if CO<sub>2</sub> from the reservoir would leak into the aquifer. The model shows that equilibrium isotope fractionation would have to be considered if CO<sub>2</sub> dissolves in the brine. The model suggests that stable carbon isotope monitoring is a suitable tool to assess the impact of injected CO<sub>2</sub> in overlying groundwater aquifers. However, more data are required to close gaps of knowledge about fractionation behaviour within the CO<sub>2</sub>(g) - DIC system under elevated pressures and temperatures.

Nowak, M., Myrntinen, A., Zimmer, M., Wiese, B., van Geldern, R., Barth, J.A.C., 2013. Well-based, Geochemical Leakage Monitoring of an Aquifer Immediately Above a CO<sub>2</sub> Storage Reservoir by Stable Carbon Isotopes at the Ketzin Pilot Site, Germany. *Energy Procedia* 40, 346-354.

Wiese, B., Zimmer, M., Nowak, M., Pellizzari, L., Pilz, P., 2013. Well-based hydraulic and geochemical monitoring of the above zone of the CO<sub>2</sub> reservoir at Ketzin, Germany. *Environmental Earth Sciences*, 1-18.