



## **A large scale experiment to assess the effects of CO<sub>2</sub> leakage on benthic biogeochemistry**

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One of the major challenges associated with offshore Carbon Capture and Storage (CCS) is the potential leakage of CO<sub>2</sub> from a storage reservoir into the marine surface sediments. Released CO<sub>2</sub> is likely to increase concentrations of total dissolved carbon and reduce the pH of the sediment interstitial waters. This may result in the mobilization of trace metals from the sediment, which may be toxic to the benthic ecosystem. Understanding CO<sub>2</sub>-sediment interactions under different leakage scenarios is therefore important for proper assessment of the potential risk of CCS to the marine environment.

Here, we present results of geochemical analyses of sediments and their interstitial fluids from a large-scale CO<sub>2</sub> release experiment, 'Quantifying and Monitoring Potential Ecosystem Impacts of Geological Carbon Storage' (QICS). During QICS, a total of 4.2 tonnes of CO<sub>2</sub> gas was injected through a borehole drilled from land through the underlying bedrock into 12 m of sediment that was overlaid by 12 m of sea water. The chemical composition of the sediments and interstitial fluids was quantified before the start of the experiment, during the 37 day period of the gas release and up to 1 year after the injection was stopped.

After 33 days of CO<sub>2</sub> release, Dissolved Inorganic Carbon (DIC) and Total Alkalinity (TA) concentrations started to increase in the interstitial waters at the release site, reaching values of around 10 mmol L<sup>-1</sup>, compared with background levels of ~ 2.2 mmol L<sup>-1</sup>. DIC and TA concentrations even increased to values higher than 25 mmol L<sup>-1</sup> in the 7 days after the release of CO<sub>2</sub> was stopped. Analysis of the carbon isotopic composition of the DIC ( $\delta^{13}\text{C}_{\text{DIC}}$ ) confirmed that these changes were due to the injected CO<sub>2</sub>, which has a  $\delta^{13}\text{C}$  value of -27‰ as  $\delta^{13}\text{C}_{\text{DIC}}$  reached values as low as -20‰ in the high DIC high TA fluids, compared to the background value of -2‰. Concentrations of some major elements (Ca, Mn, Fe, Si), some trace elements and ammonium also increased in the high TA, high DIC interstitial waters. However, concentrations of all fluid constituents returned to background values 18 days after the CO<sub>2</sub> injection was stopped. Calculated solubility products from the DIC and TA measurements, indicate that precipitation of authigenic CaCO<sub>3</sub> is a plausible explanation for the quick return of DIC and TA concentrations to background values.