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CO2 dissolution in formation water as dominant sink in natural gas fields

(Abstract)

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CO₂ dissolution in formation water as dominant sink in natural gas fields

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A primary concern facing Carbon Capture and Storage (CCS) technology is the proven ability to safely store and monitor injected CO₂ in geological formations on a long-term basis. However, it is extremely challenging to assess the long-term consequences of CO₂ injection into the subsurface from decadal observations of existing CO₂ disposal sites.

Noble gases are conservative tracers within the subsurface, and combined with carbon stable isotopes, have proved to be extremely useful in determining both the origin of CO₂ and how the CO₂ is stored within natural CO₂ reservoirs from around the world [1,2]. This presentation will identify and quantify the principal mechanism of CO₂ phase removal in nine natural gas fields in North America, China and Europe. These natural gas fields are dominated by a CO₂ phase and provide a natural analogue for assessing the geological storage of CO₂ over millennial timescales.

Our study highlights that in seven gas fields with siliciclastic or carbonate-dominated reservoir lithologies, dissolution in formation water at a pH of 5–5.8 is the major sink for CO₂ [2]. This pH range is obtained by modelling the carbon isotope fractionation that results from dissolution of CO₂(g) to varying proportions of H₂CO₃(aq) and HCO₃⁻(aq). This is a major breakthrough as accurate subsurface pH measurements are notoriously difficult to obtain. In two fields with siliciclastic reservoir lithologies, some CO₂ loss through precipitation as carbonate minerals cannot be ruled out, but this is minor compared to the amount of CO₂ lost to dissolution in the formation water within the same fields.

Our findings imply mineral fixation is a minor CO₂ trapping mechanism within natural reservoirs and hence suggests long-term models of geological CO₂ storage should consider the potential mobility of CO₂ dissolved in water.