Natural CO₂ Generation, Entrapment and Water-Rock Interaction of the Otway Basin CO₂ Accumulations, Australia: Evidence for Optimizing Site Selection for CO₂ Geological Storage

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Natural accumulations of CO₂ offer an excellent opportunity to examine CO₂-water-rock interactions that are likely to occur in future CO₂ geological storage sites. The Otway Basin, Australia, is the focus region for the CO₂CRC’s natural analogue research. The Otway Basin is a known CO₂ province, with the initial discovery of CO₂ in 1966, and is currently producing CO₂ from the Gambier Embayment, Port Campbell Embayment and Penola Trough. Through carbon (d13CCO₂) and helium (3He/4He) isotopic analyses, a mantle origin has been determined as the predominant CO₂ source in these accumulations, linked to the degassing of Pleistocene to Recent magmas.

Comparative petrological studies from CO₂-rich gas fields and nearby CO₂-free gas fields display locally enhanced CO₂-water-rock interaction. Labile minerals, such as feldspars, chlorite and calcite are commonly altered to kaolinite and quartz. Precipitation of carbonate minerals also occurs, mineralogically trapping the CO₂. Mineralisation is more apparent in greensand lithologies, where higher concentrations of labile minerals allow increased CO₂-water-rock interaction. Fractured seal rock also displays CO₂ interaction, with siderite precipitation healing fractures and filling porosity, enhancing the seal capacity. The degree of reaction, reaction rates and mineralogical storage of CO₂ are dependent on mineral assemblage, concentration of CO₂ in the gas and CO₂-water ratios.

Studying natural CO₂ accumulations can help validate geological storage as an option for CO₂ emission reduction. This research has also determined the optimum reservoir criteria to benefit CO₂ geological storage, including aspects of CO₂ injectivity, containment and interaction within a reservoir system.