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UQ Centre for Natural Gas
Annual Research Review

CO_2-water-rock reactions of low-salinity aquifer and oil field drill cores

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Precipice Sandstone

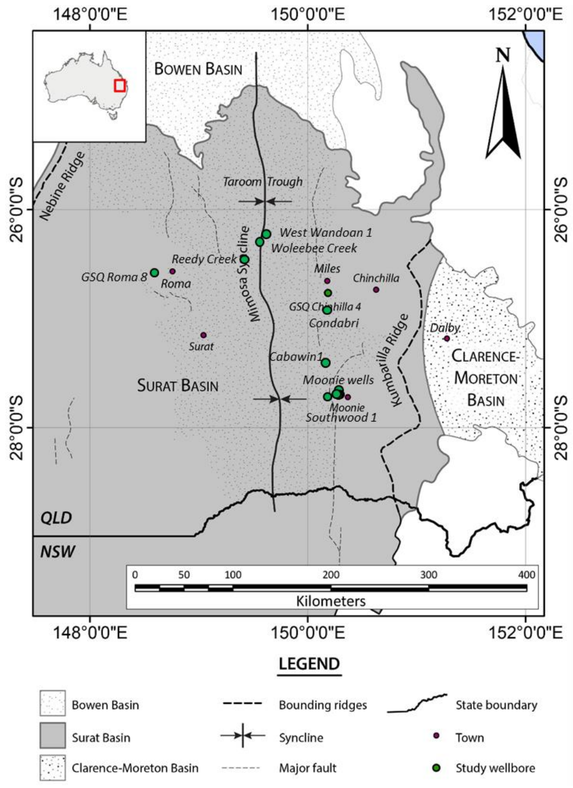

Figure 1: *Map of the Surat Basin showing well cores discussed here in green. Note "Moonie" wells are in the Moonie oil field south of a fault zone. Roma 8 is past the reservoir pinch out. Litho- and sequence stratigraphic columns are also shown.*

The Precipice Sandstone and Evergreen Formation (Figure 1) were appraised for their feasibility as a future CO_2 storage reservoir-seal pair. CO_2-rock reactions may affect reservoir scaling, water chemistry and mineral trapping.

Northern Surat Basin

Figure 2: *Mineral content in the Chinchilla 4 well core and QEMSCAN image of a natural calcite cemented fracture in the Evergreen Formation.*

Precipice Sandstone well cores in the northern Surat generally contain ~ 95% quartz (Figure 2), with porosity ~16-24% and large unimodal pore throats ~ 90-100 µm, indicating a good reservoir.

CO_2-water-rock reactions predicted low reactivity of the Precipice Sandstone, pH 4-5 in the plume, and low likelihood of scaling. Mineral trapping (chlorite → siderite) is predicted in the Evergreen Formation.

Southern Surat

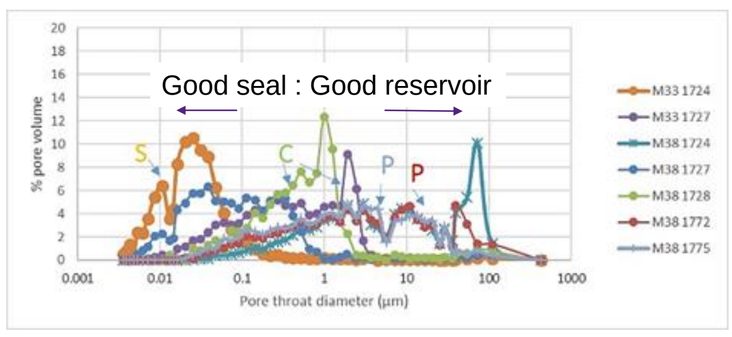

Figure 3: *Examples of pore throat distributions of Moonie core from MICP. P = Precipice Sandstone, others are Evergreen Formation. C = calcite cemented, S = shale.*

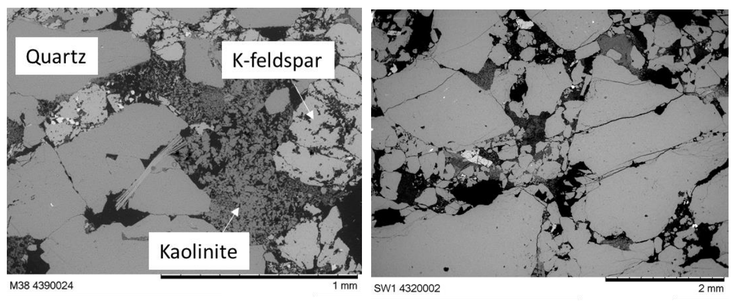

Figure 4: *Left: SEM image of a Moonie Precipice Sandstone, with K-feldspar extensively naturally altered to pore filling kaolinite/illite. Right: Southwood 1 well: fractured quartz.*

The southern Surat Precipice has a different character, likely influenced by natural fracturing and previous hydrothermal fluid flow.

Moonie field core

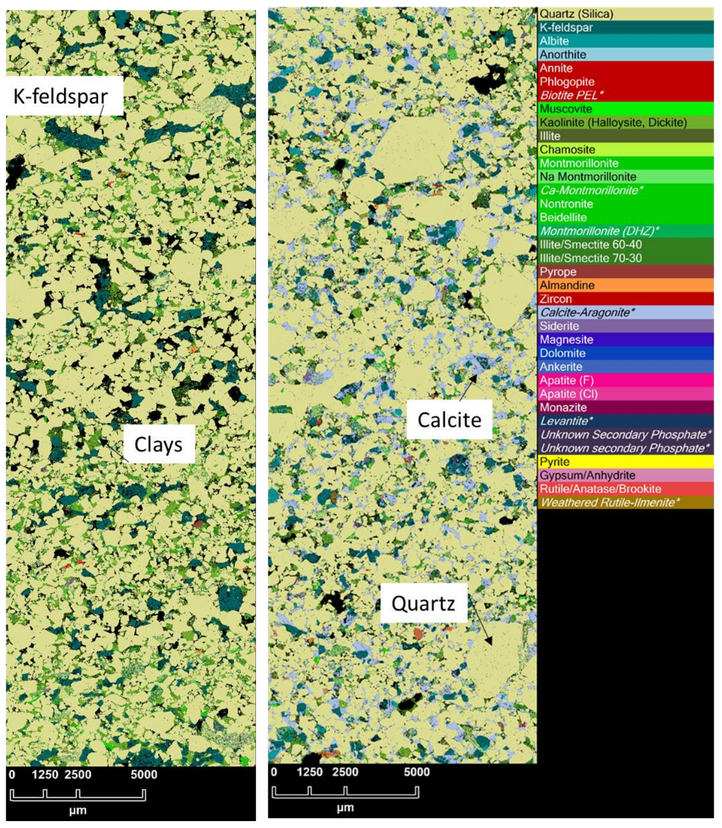

Figure 5: *QEMSCAN images of minerals, pores, and grain associations in Moonie well cores. Left: Precipice Sandstone (58 sands) has a higher K-feldspar and clay content compared to cores from the north. Black areas are open porosity. Right: Evergreen Formation (56 sands) example with calcite filling pores (near a natural fracture).*

CO_2 reaction models

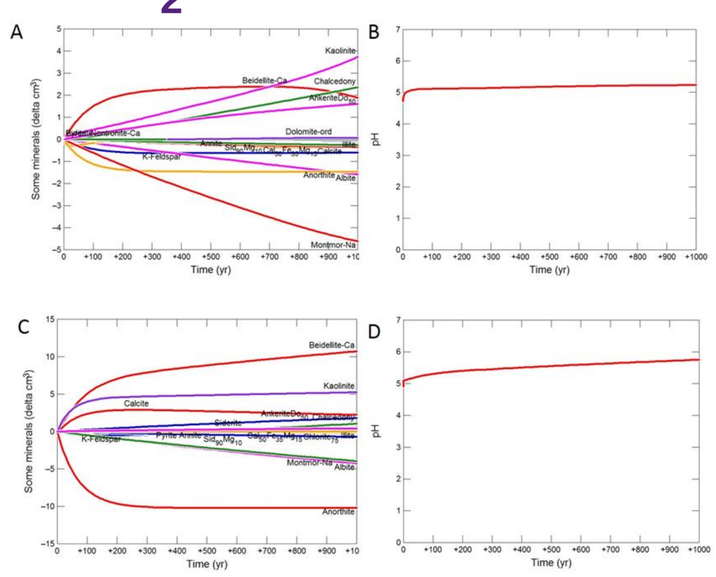

Figure 6: *Kinetic geochemical modelled change in minerals and formation water pH, with CO2 reaction of Moonie core. A)-B) Precipice Sandstone (58 sands), C)-D) calcite cemented Evergreen Formation (56 sands).*

Reservoir – no change in porosity but smectite precipitation predicted (Figure 6A).

Mineral trapping of CO_2 (plagioclase → ankerite)

Calcite dissolution, buffering to less acidic groundwater pH (Figure 6 C, D).

Conclusions

- Low likelihood of reservoir scaling, however smectite precipitation may block pores in Moonie. Mineral trapping of CO_2 as siderite (in north Surat) or ankerite (in Moonie) predicted in the base of the Evergreen cap-rock; precipitation of clays predicted. Less acidic groundwater pH predicted in Moonie owing to higher bicarbonate content and calcite cements.
- Natural fracturing and mineral trapping are observed especially near fault zones – essential data to validate models.
- Natural fracturing in the reservoir may influence preferential flow paths

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