CO_2 geological storage in the southern Surat Basin: assessing CO_2-water-rock reactivity

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Background

CO_2 capture and storage (CCS) will be part of the low-cost energy transition to net zero emissions.
This presentation is part of a feasibility study for a demo injection.
The southern Surat Basin Precipice Sandstone is now undergoing feasibility for CO_2 storage (Fig. 1).
Injection of supercritical CO_2, and subsequent dissolution in formation water decreases pH and induces CO_2-water-rock reactions.
Feasibility studies include understanding potential changes to rock properties and water quality.

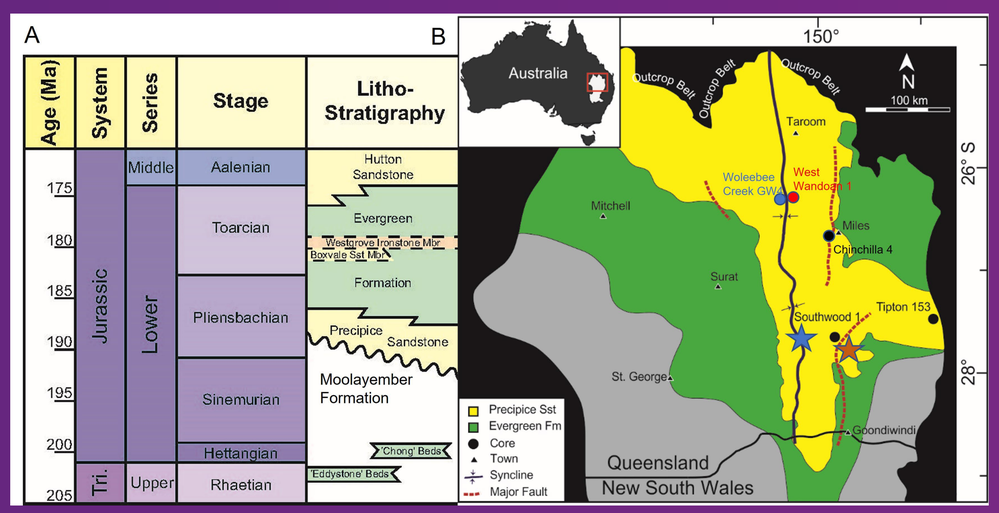

Fig 1: A) Stratigraphy of the Surat Basin. B) Map showing the well bores discussed here in the demo scale site, stars indicate future CCS sites. Modified after LaCroix et al., 2019.

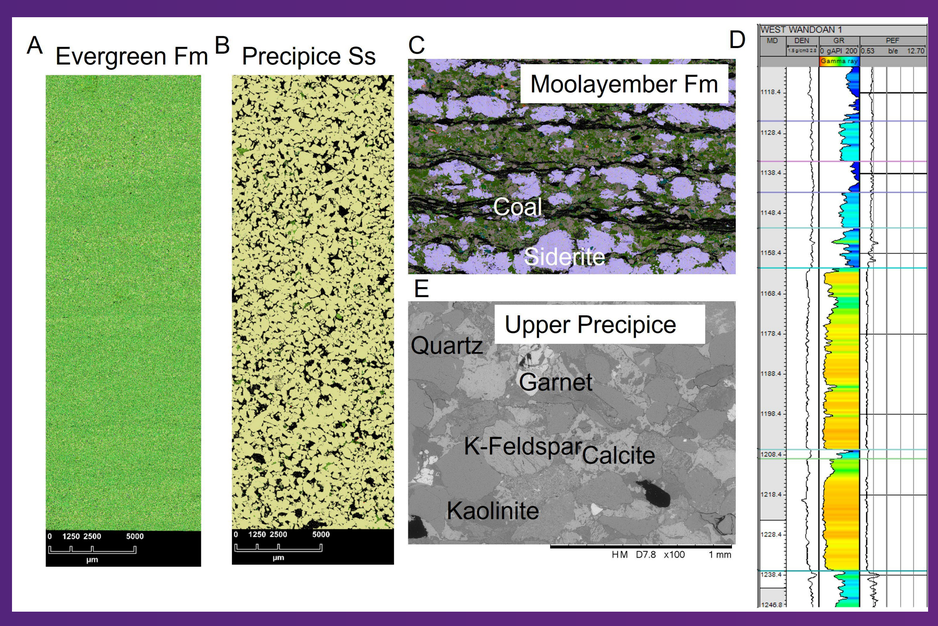

Fig 2: QEMSCAN of A) clay-rich Evergreen Fm, B) Precipice Ss, quartz grains with open porosity (black), C) Moolayember Fm with siderite cements and coal layers, D) Well log. E) Scanning Electron Microscopy (SEM) of minerals in an upper Precipice core.

Methods

- Cores were reacted at reservoir conditions with CO_2 containing SOx, NOx and O_2 (Fig. 3).
- Dissolved elements were released from dissolution of calcite, siderite, chlorite etc.
- Dissolved Fe, Pb, Mo, Cr, As increased and subsequently decreased with precipitation of Fe-oxyhydroxide (in Precipice), or carbonates.
- Kinetic reaction path modelling showed the precipitation of Fe oxyhydroxides act as a sink, provide new adsorption sites for re-sequestering metals. Trace metals released were restricted to the CO_2 plume in reactive transport models.

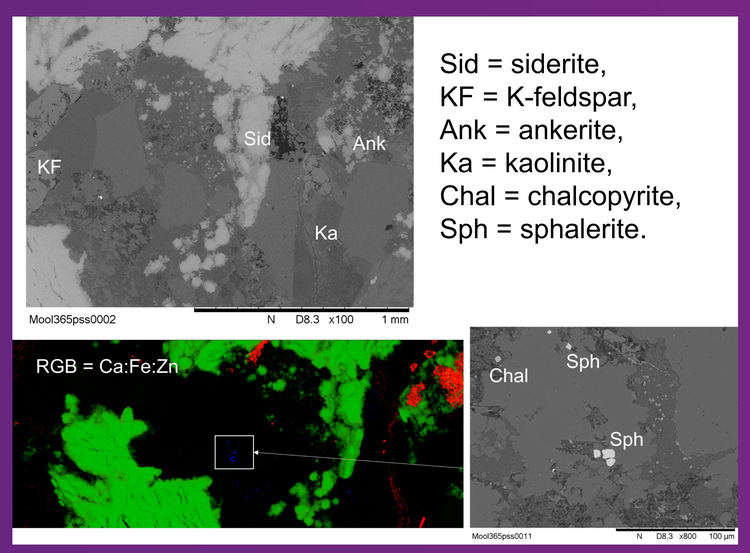

Fig 3: A) SEM and XFM images: Zn hosted in sphalerite in a Moolayember Formation core.
Red:Green:Blue = calcium: iron: zinc

Characterisation

- The Evergreen Formation cap-rock overlies the Precipice Sandstone reservoir. The Moolayember Formation of the Bowen Basin underlies the reservoir.
- West Wandoan 1 and Woleebee Creek well cores from a potential CCS demo site near Wandoan were characterised.
- Drill core minerals (QEMSCAN and XRD), porosity, permeability, and metal content (total digestions, sequential extractions, and synchrotron X-ray Fluorescence Microscopy) etc. were assessed.
- The lower Precipice Sandstone reservoir is generally quartz-rich with open porosity (e.g. Fig. 2b).
- The upper Precipice, Evergreen Formation, and Moolayember Fm are mineralogically diverse, with higher feldspar, clay and carbonate content (Fig. 2).
- Various minor minerals including pyrite are present.

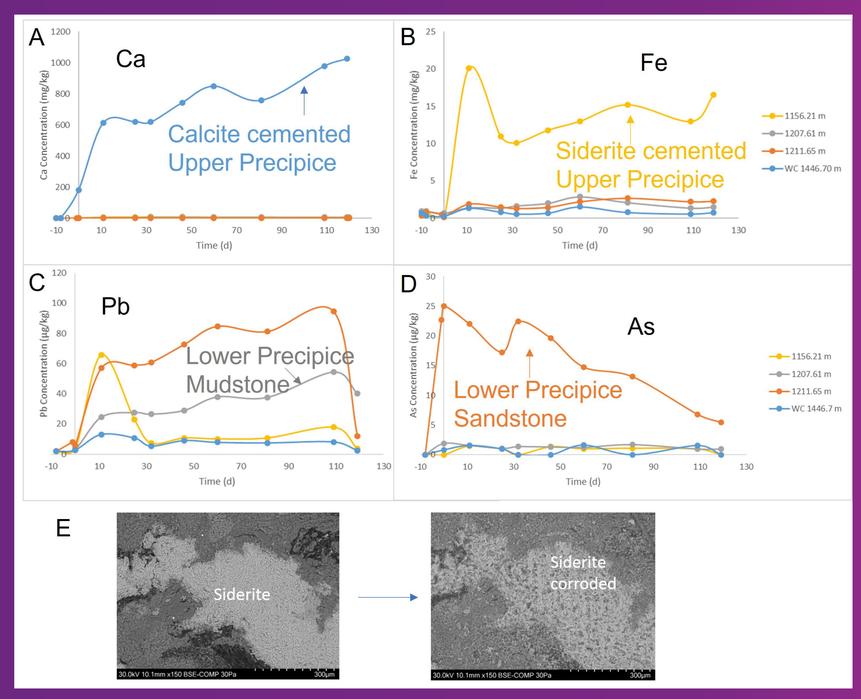

Fig 4: A) to D) Dissolved elements released over time in CO_2-water-rock reactions. E) SEM showing siderite corrosion after reaction.

Summary

- The southern Surat Basin is the more suitable CCS site.
- In general, feasibility studies are needed for more CCS sites to enable the capture and storage of greenhouse gas streams from a range of industries (e.g. power plants, blue hydrogen, ammonia, steel and cement production, direct air capture).
- The injection of gases subsurface can induce site specific gas-water-rock reactions that affect rock properties and water quality or induce CO_2 trapping.
- New subsurface technologies such as renewable energy with compressed air energy storage or hydrogen storage will also need site specific assessments with similar methodologies to those presented here.

Pearce, J.K., Dawson, G.W., Southam, G., Paterson, D., Kirste, D., Golding, S.D., 2022. Metal Mobilization From CO2 Storage Cap-Rocks: Experimental Reactions With Pure CO2 or CO2 SO2 NO. Frontiers in Energy Research 10.

Pearce, J.K., Dawson, G.W., Golding, S.D., Southam, G., Paterson, D.J., Brink, F., Underschultz, J.R., 2022. Predicted CO2 water rock reactions in naturally altered CO2 storage reservoir sandstones, with interbedded cemented and coaly mudstone seals. International Journal of Coal Geology 253, 103966.

CRICOS 00025B • TEQSA PRV12080

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Acknowledgements

Acknowledgments: The authors wish to acknowledge financial assistance provided through the Australian National Low Emissions Coal Research and Development (ANLEC R&D). ANLEC R&D is supported by Low Emissions Technology Australia (LETA) and the Australian Government through the Clean Energy Initiative. CTSCo Pty Ltd are thanked for access to core, data, and helpful discussions. The Australian Synchrotron, ANSTO, is acknowledged.

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