

**make  
history.**



THE UNIVERSITY  
*of* ADELAIDE

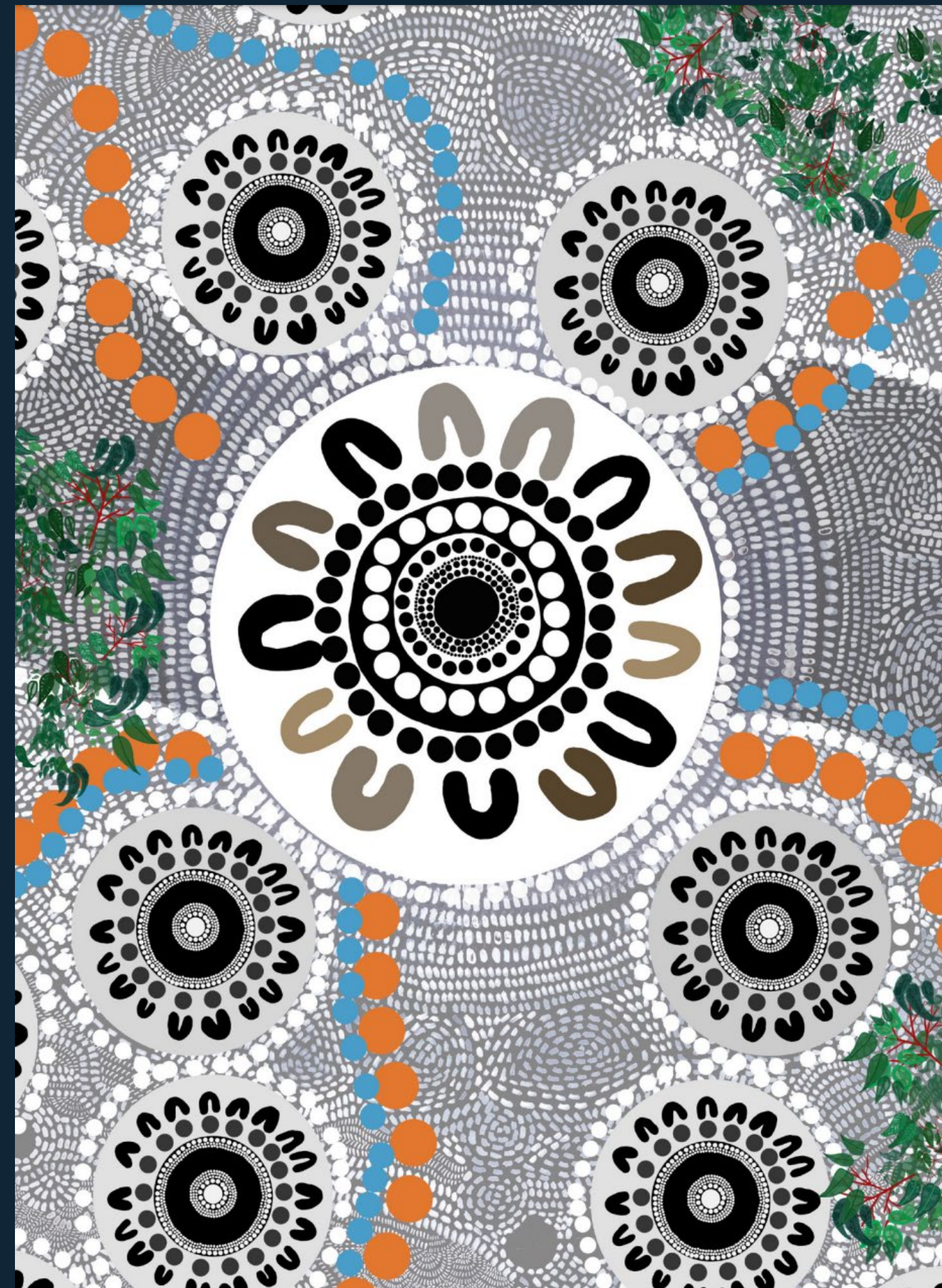
# GeoEnergy research

Roundtable for Energy Resources  
October 2024

**We acknowledge and pay our respects to the traditional custodians of the lands on which we live, work, teach and conduct research. We acknowledge the deep connections of First Nations peoples to land, waters and sky, and pay our respect to Elders past and present. We extend that respect to all Aboriginal and Torres Strait Islander people.**

Artist: Anna Dowling was born in Adelaide. Anna is a descendant of the Badimia people of the Yamatji region in Western Australia.

The meaning of the work is about people coming together from diverse places and backgrounds to learn from each other; sharing knowledge, traditions and stories.



# GeoEnergy at the University of Adelaide

A long and impactful history of expertise in petroleum engineering and geology. Consistently ranked highly - #1 in Australia and #6 globally in for Petroleum Engineering, top 100 for disciplines including Geology, Geophysics, Engineering, Energy.

**1902** - Department of Geology

**1949** - Department of Economic and Mining Geology

**1986** - National Centre for Petroleum Geology and Geophysics

**1994** - State Chair in Petroleum Geology established

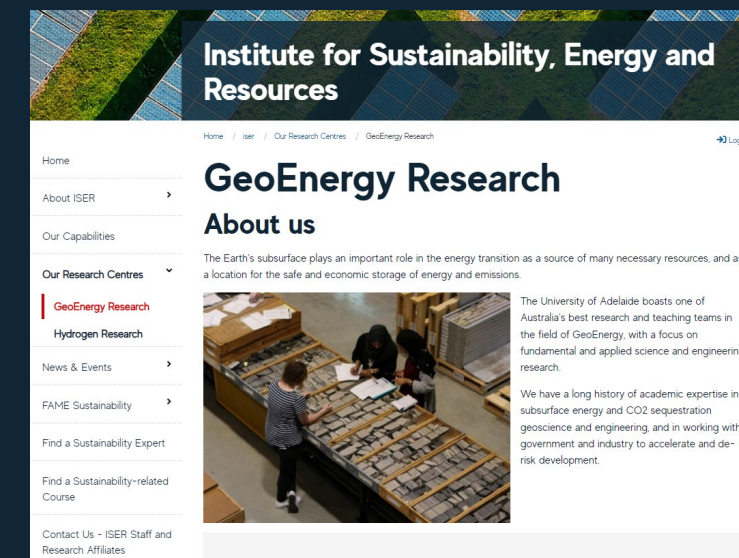
**2000** - School of Petroleum Engineering and Management, \$25M Santos sponsorship

**2003** - Australian School of Petroleum formed from merger of NCPGG and SPEM

**2020** - ASP evolved into ASPER (petroleum and energy resources)

**2023** - Discipline of Mining and Petroleum Engineering, Discipline of Earth Sciences.

**2026** – opening of *Adelaide University*



## What is GeoEnergy?

GeoEnergy encompasses any energy system and related engineering and management that involve the Earth's geological subsurface. This includes existing, new and emerging resources crucial to the decarbonisation of energy systems and meeting net zero emissions targets, such as:

- geothermal energy
- natural hydrogen exploration and production
- natural gas
- geological storage of carbon dioxide (CO<sub>2</sub>)
- energy storage through storage of hydrogen, heat and compressed air
- geological storage of radioactive waste
- geological siting of wind energy infrastructure
- related management of groundwater resources
- monitoring and assurance.

# ***Adelaide University* GeoEnergy Education**

- **Bachelor of Engineering (Hons), Major in Energy Resources Engineering**
- **Bachelor of Science, includes majors in: Geophysics, Geology, Geology and Earth Resources**
- **Master of Professional Engineering (Energy Resources)**
  - Includes courses: reservoir characterisation, drilling technologies, ccus, data analytics, engineering management
- **Master of Science specialising in Sustainable Georesources**

# GeoEnergy Research Updates

## 1) GeoEnergy collaboration with BP (2024-2028)

- Research, Education and Outreach; new Geomodelling Laboratory

## 2) GeoEnergy and Storage Laboratory

## 3) Research projects

- 8 substantial active, and 3 proposed, government and industry funded GeoEnergy research projects

# GeoEnergy Collaboration with bp

## 2024 - 2028

bp and the University of Adelaide to advance GeoEnergy research in South Australia

Release date: 22 May 2024

## Collaboration Boosts GeoEnergy Research and Education

The University of Adelaide and bp have signed a AUS\$10 million agreement that will support [GeoEnergy research](#), educational and outreach activities into the geological storage of hydrogen and carbon dioxide over five years.

- Establishing a new Geomodelling Laboratory to support research that will accelerate Australia's decarbonisation
- Multidisciplinary research will focus on the safe and economic storage of hydrogen underground, and the geological sequestration of carbon dioxide
- Outreach and education materials will be developed
- Academic leadership supported by establishing a Chair in GeoEnergy

# Geomodelling Laboratory

\$1.45M infrastructure development, \$950k facilities

Academic lead: Professor Simon Holford, SA State Chair in Petroleum Geoscience

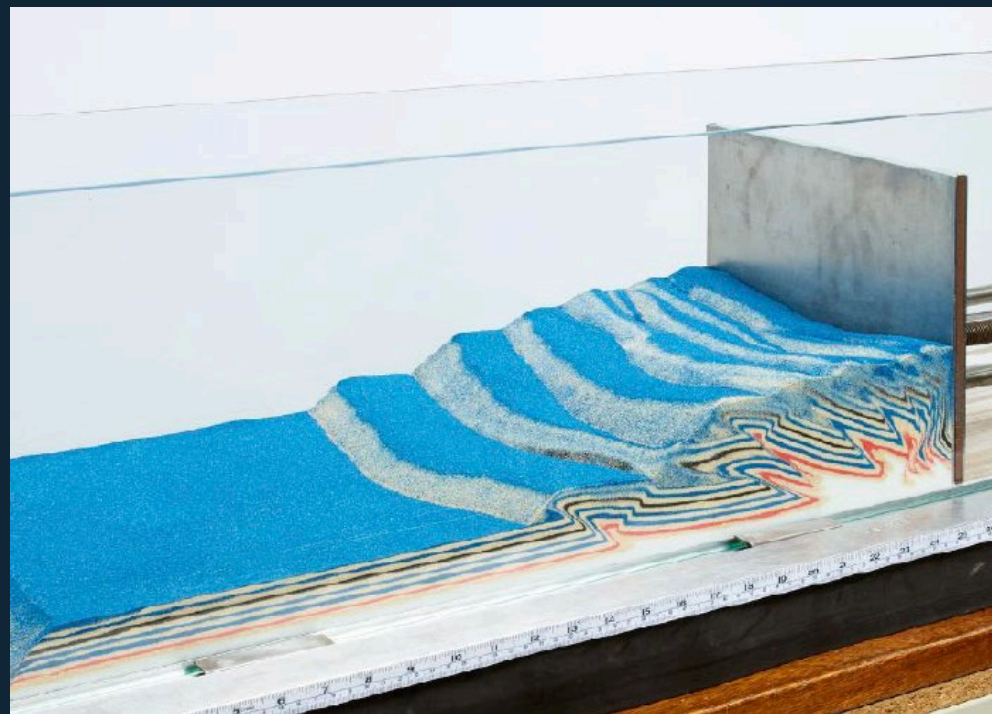
Operational: March 2025

Research

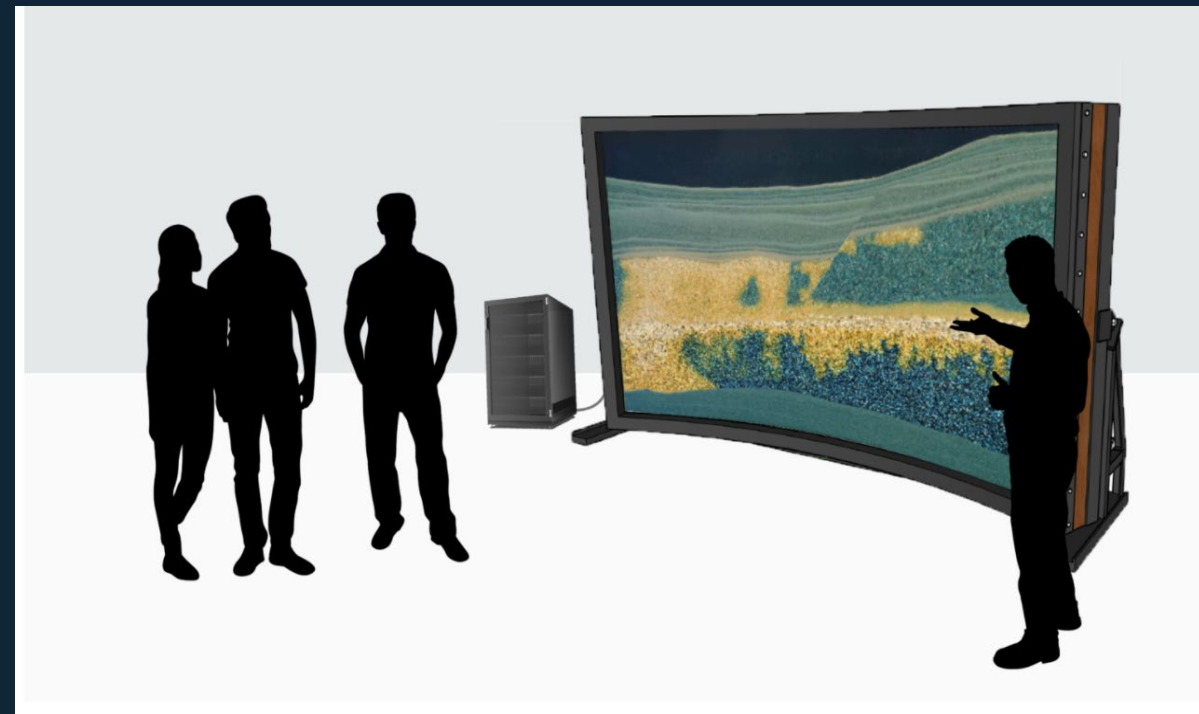
Education

Outreach

Crustal deformation



CO2 injection



Sediment Deposition



# Crustal Deformation

## World-leading teaching & research infrastructure

- 2D & 3D rigs for crustal deformation modelling to derisk CO<sub>2</sub>/H<sub>2</sub> storage and exploration
- Digital image correlation (DIC) visualization

## Addressing key NetZero GeoEnergy challenges

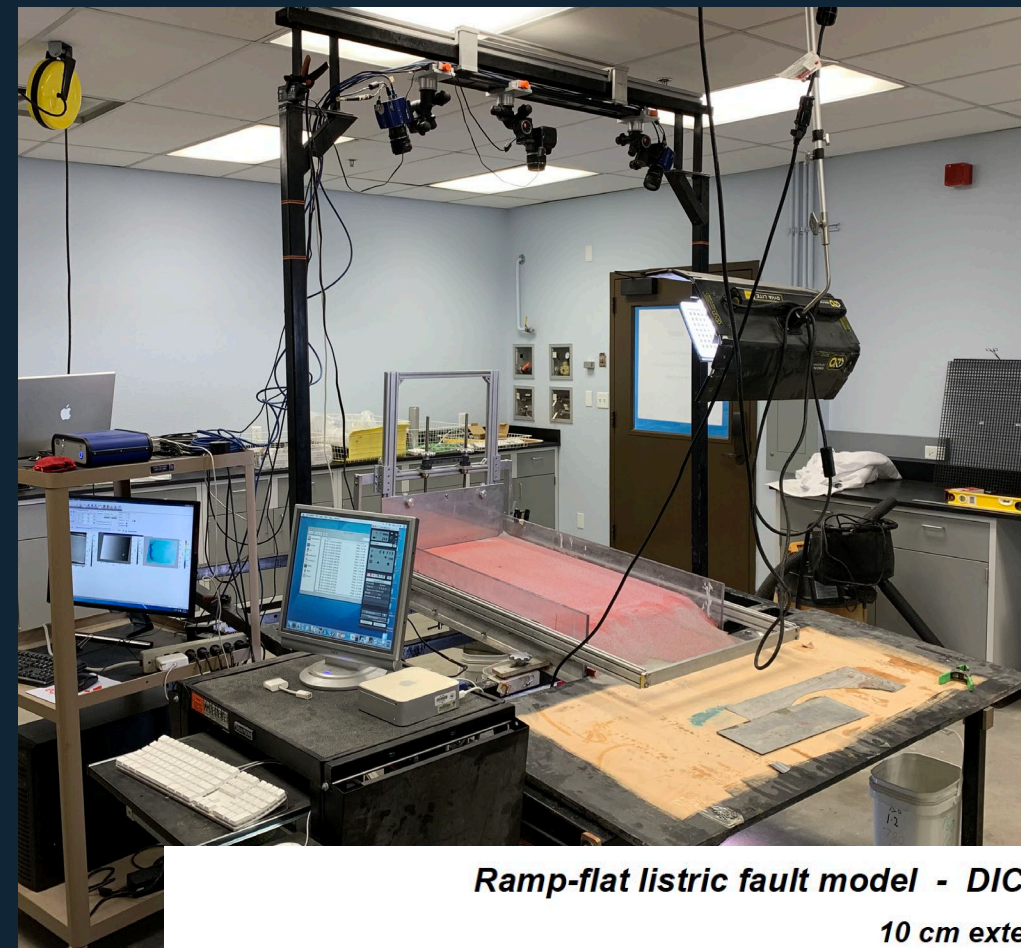
- Understanding crustal-scale pathways for transport of naturally occurring H<sub>2</sub> (SA case studies: Gawler Craton, Otway Basin)
- Modelling the evolution of salt structures for underground storage of green H<sub>2</sub> (SA case studies: Polda Basin, Ikara-Flinders Ranges)
- Identifying secure CO<sub>2</sub> storage locations in complex multiphase basins (SA case studies: Cooper and Eromanga basins)

## Industry skills training and knowledge transfer

- Templates for subsurface interpretation, and reservoir and numerical modelling in assets where subsurface imaging and data availability is a key obstacle

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## Reducing uncertainty in H<sub>2</sub>/CO<sub>2</sub> storage and H<sub>2</sub> exploration in complex geological settings



3D deformation rig AGL UT Austin

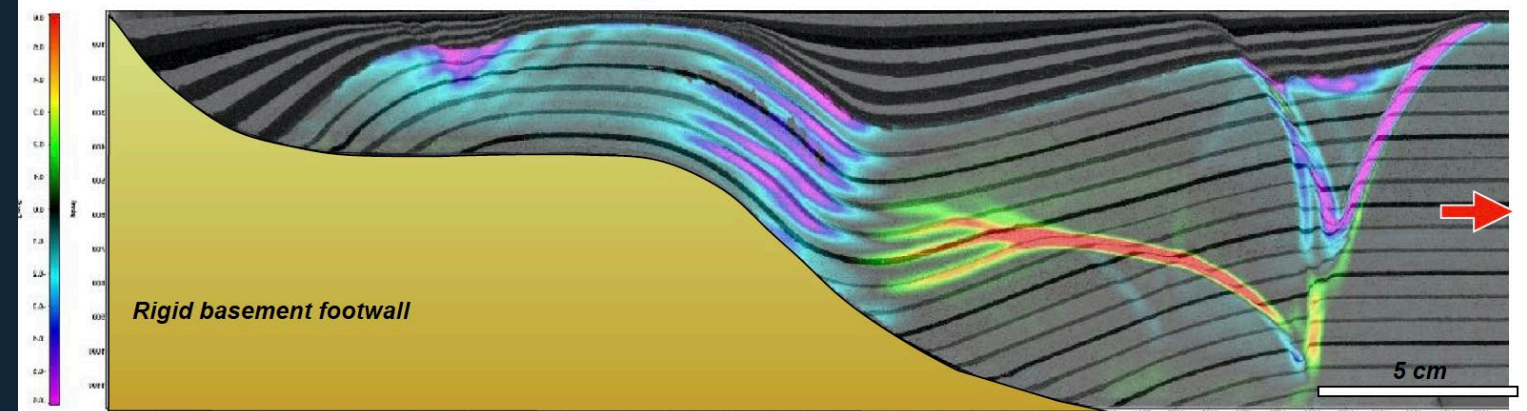
### Ramp-flat listric fault model - DIC Exx strain analysis

10 cm extension

Active crestal collapse graben

Inter-layer flexural slip above the ramp

Active crestal collapse faults



DIC analyses indicate fault activities, fault segmentation & interlayer flexural slip

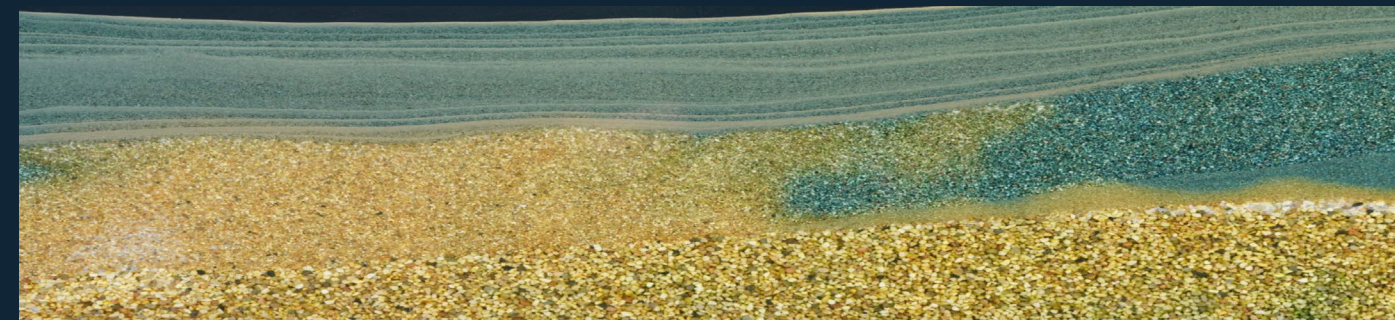
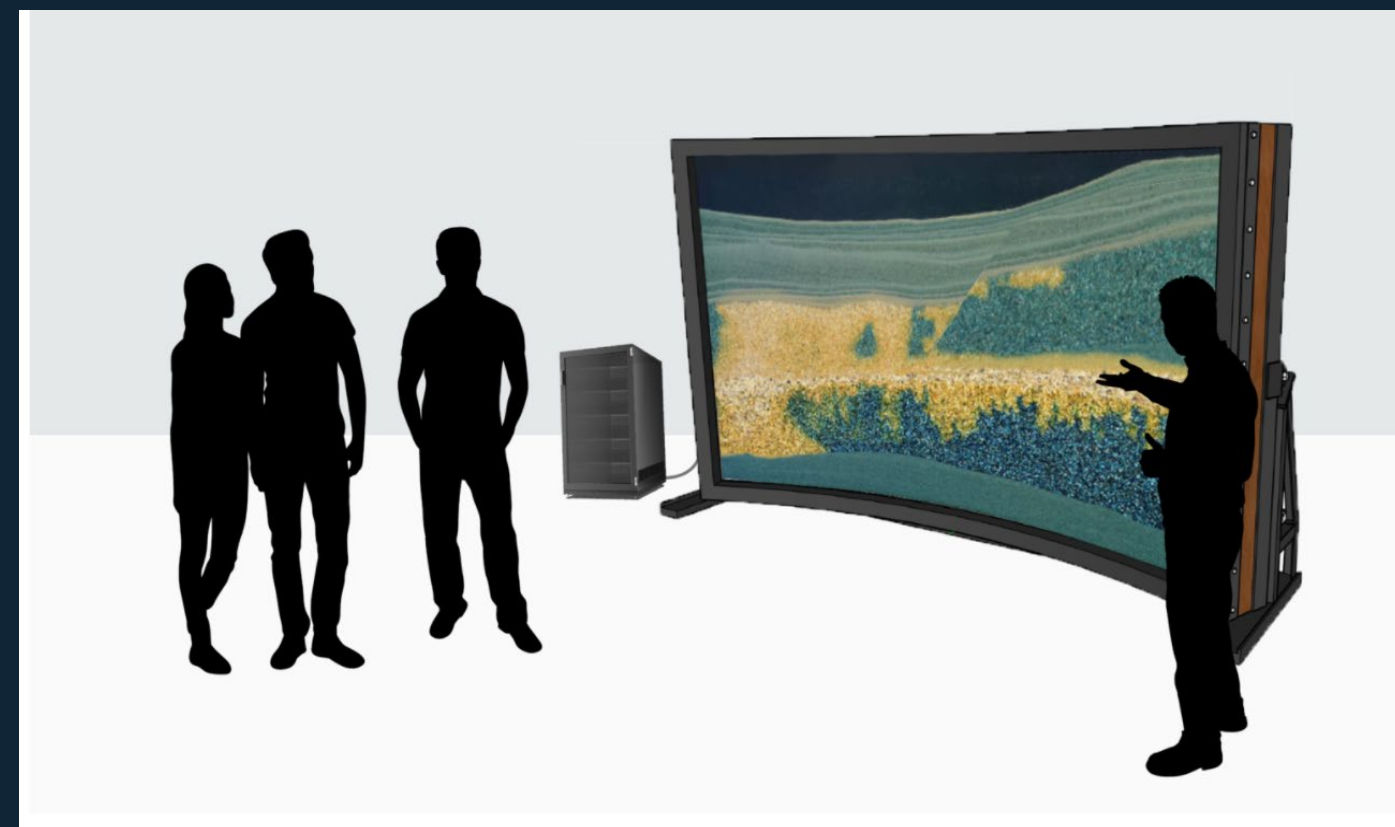
# H<sub>2</sub> and CO<sub>2</sub> Visualisation

## *Engaging interactive demonstration of H<sub>2</sub> & CO<sub>2</sub> injection*

- The rig can be filled with layers of sediment to mimic porosity and permeability characteristics and trapping mechanisms of H<sub>2</sub> and CO<sub>2</sub> geostorage reservoirs, such as in SA's Cooper Basin.
- Both large and smaller portable rigs to be constructed
- Enables live demonstration of H<sub>2</sub> and CO<sub>2</sub> injection and storage in front of a large audience
- To be used in community outreach: with school students, on-campus public events, in undergraduate teaching and CPE short courses
- Potential for collaboration with museums to exhibit

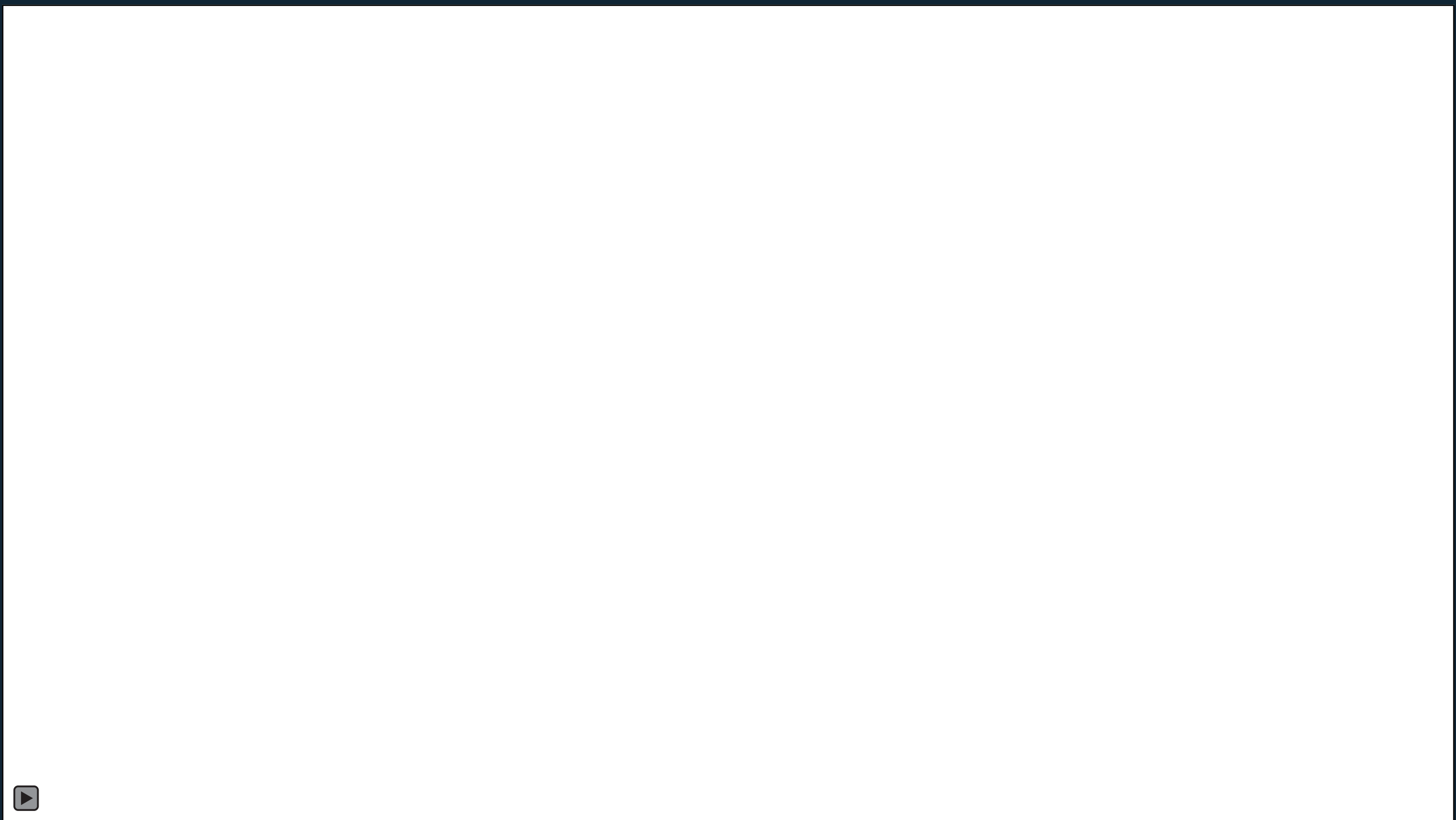
## *Research Potential*

- Opportunity for experimental testing of theoretical research in multiphase flow, and reservoir simulations



Prototype design by a University of Bergen team, collaborating with University of Adelaide on this project.

# 'FluidFlower' collaboration with University of Bergen



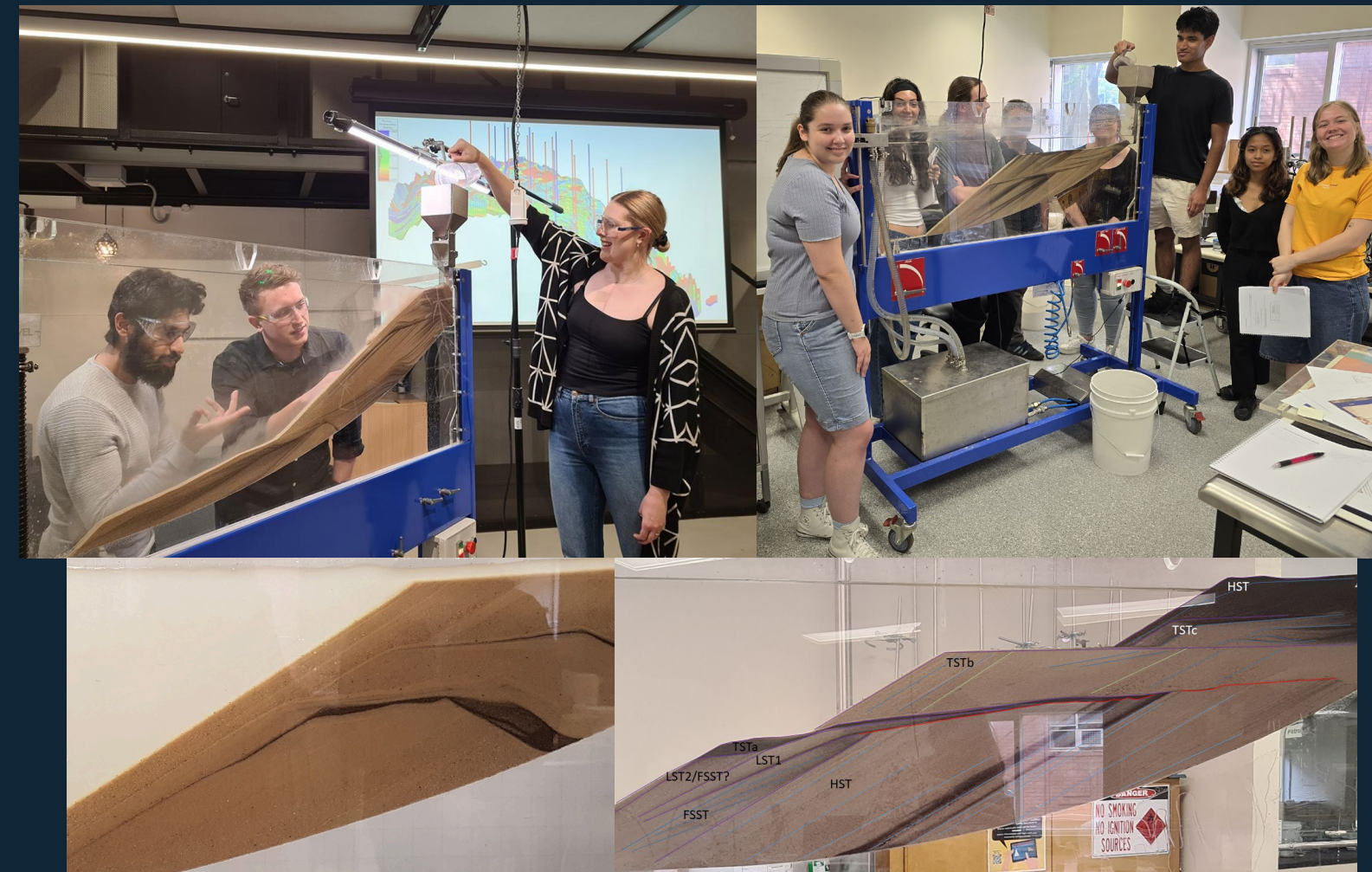
# Sediment Deposition

Interactive demonstrations to demonstrate controls on sediment deposition, directly applicable to subsurface reservoir characterisation and architecture.



## *Emriver stream table*

- 3.7 x 1.2m; 265 l water, 163kg colour-coded media
- Tilting base to simulate tectonic effects
- Wave maker
- Dye injection system
- Groundwater injection/extraction system



## *'Desktop Delta' sequence stratigraphy tanks*

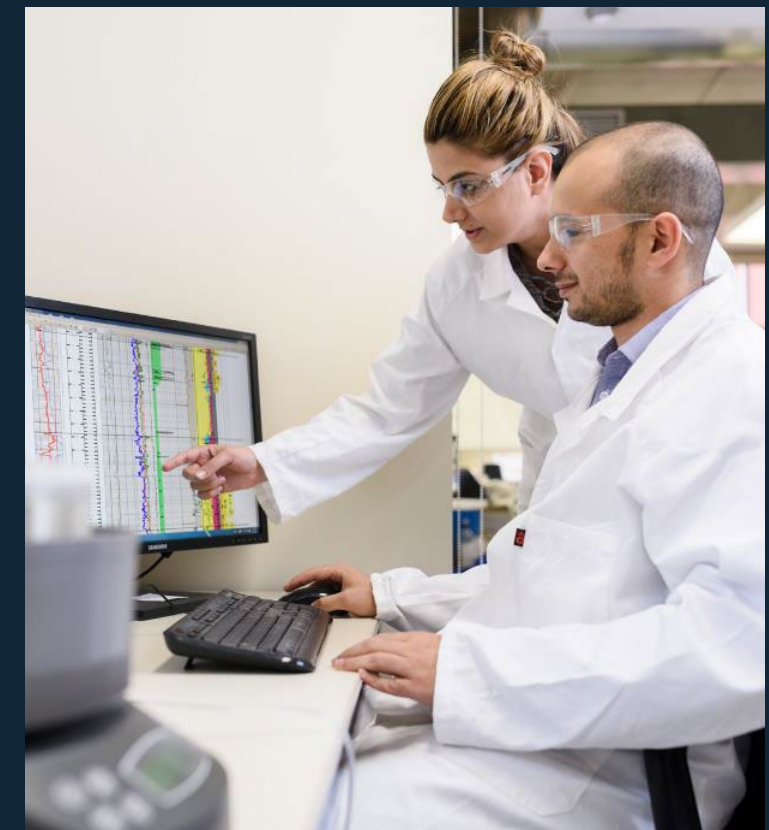
- Control rate and timing of base level, water and sediment input
- Generate deposition and erosion, with systems tracts and key surfaces of similar geometry to subsurface successions

# Research



Collaboration with bp provides:

- **\$3M for research projects; cutting-edge engineering and geosciences of global relevance, some of which will use SA basins as a natural laboratory**
  - 2024 Round 1, seed funding for 8-12 projects ~\$600k
  - Disciplines: petroleum, mining and civil engineering, geology, geophysics, chemistry
- **Three postdoctoral researcher positions**
- **Provision for a lab manager to support both laboratories**
- **Strategic direction-setting with input from bp and DEM**



# Education and Outreach

## Collaboration with bp provides:

- \$510k to support education and outreach projects
- Two Hons student scholarships per year

Translation of research projects into a suite of freely-accessible materials for inclusion in secondary to tertiary teaching

Activities aimed at engaging primary and secondary school students, inspired by the geology, environment and resources of South Australia

Supporting activities to engage the local community, as well as development of online resources designed to reach a global audience

To facilitate this, the bp collaboration provides a 3-year position for an outreach and STEM-communication expert



# GeoEnergy and Storage Laboratory

Operational: March 2025

Academic lead: A/Prof Abbas Zeinijahromi

CCS Coreflooding System, funded by Chevron Australia

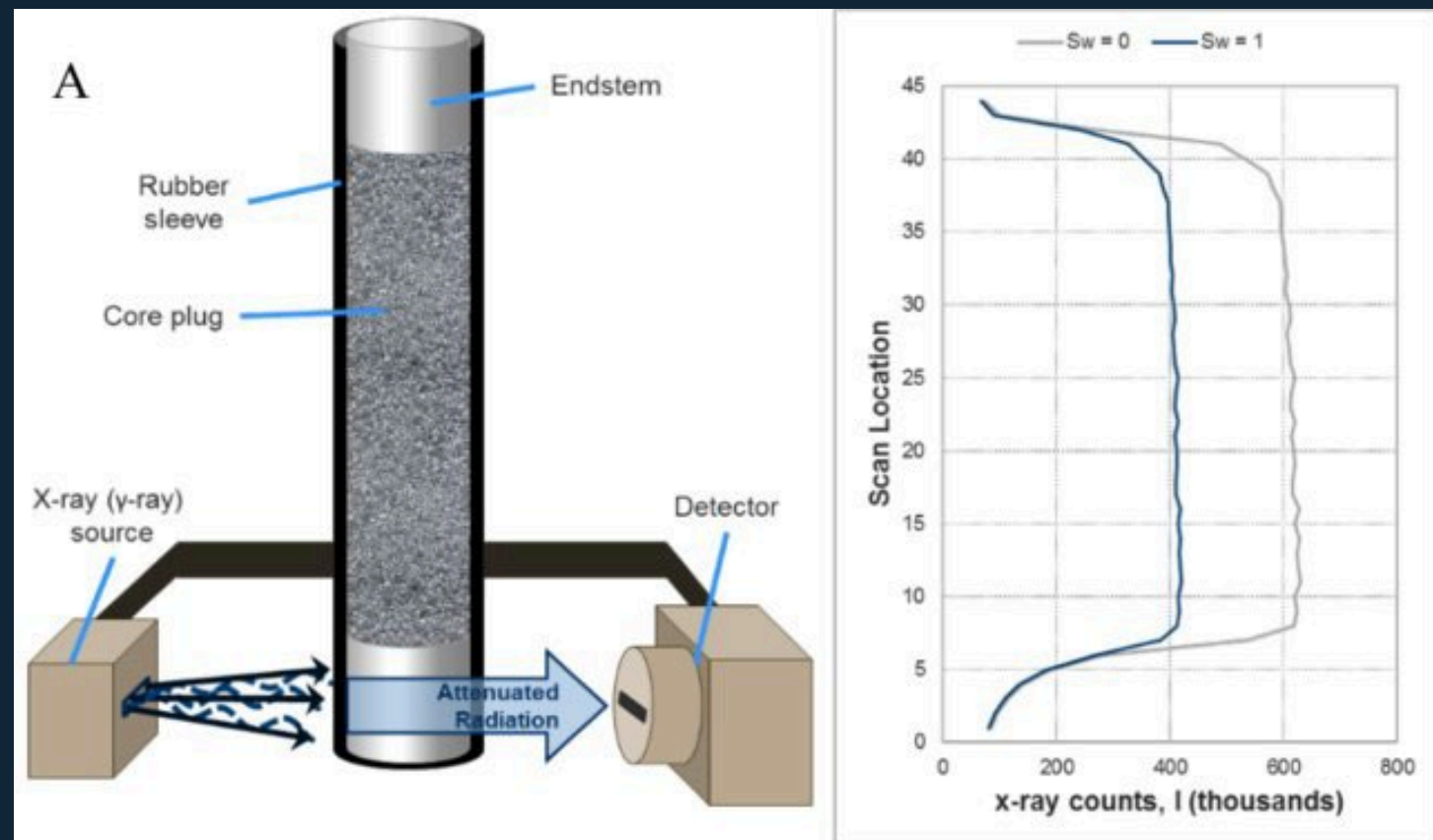
Integrated Facility for UHS Studies, funded by ARC LIEF and cash contributions from partners: Beach Energy, Department for Energy and Mining, The University of Adelaide, The University of Newcastle, The University of New South Wales, Monash University, The University of Melbourne, The University of Queensland



# CCS Coreflooding System

\$1.2M facility for CCS research:

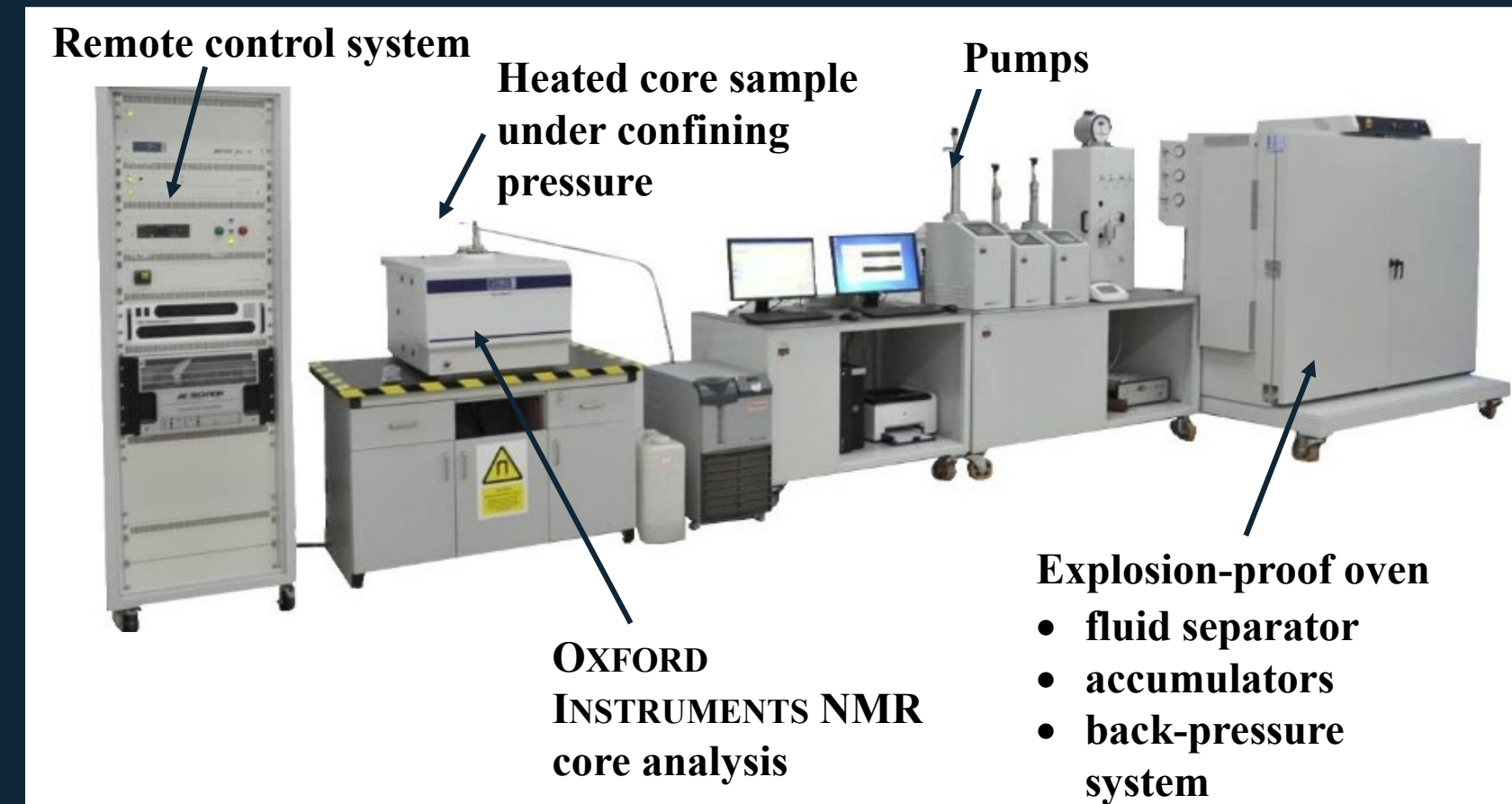
- 10,000 psi pressure
- 150 C temperature
- **1m long core**
- Linear X-ray scanner for in-situ saturation monitoring
- Mid point pressure measurement
- Acoustic separator
- SS and USS tests



## Integrated Facility for UHS Studies

\$3M unique integrated facility for UHS research:

- Hydrogen-compatible coreflood system
- Oxford GeoSpec High-Field NMR core analyser with 3D capabilities
- High-pressure drop shape analyser
- Hydrogen Compatible Batch reactor



### Hydrogen compatible coreflood system with fluid separator

- High-Field 12/53 NMR core analyser with 3D capabilities
- 5,000 psi pressure, 150 C temperature
- Multi-phase Reactive flow tests (H<sub>2</sub>, CO<sub>2</sub>, Oil, Gas)
- Mid-point Pressure Measurement
- Vertical and Horizontal flow

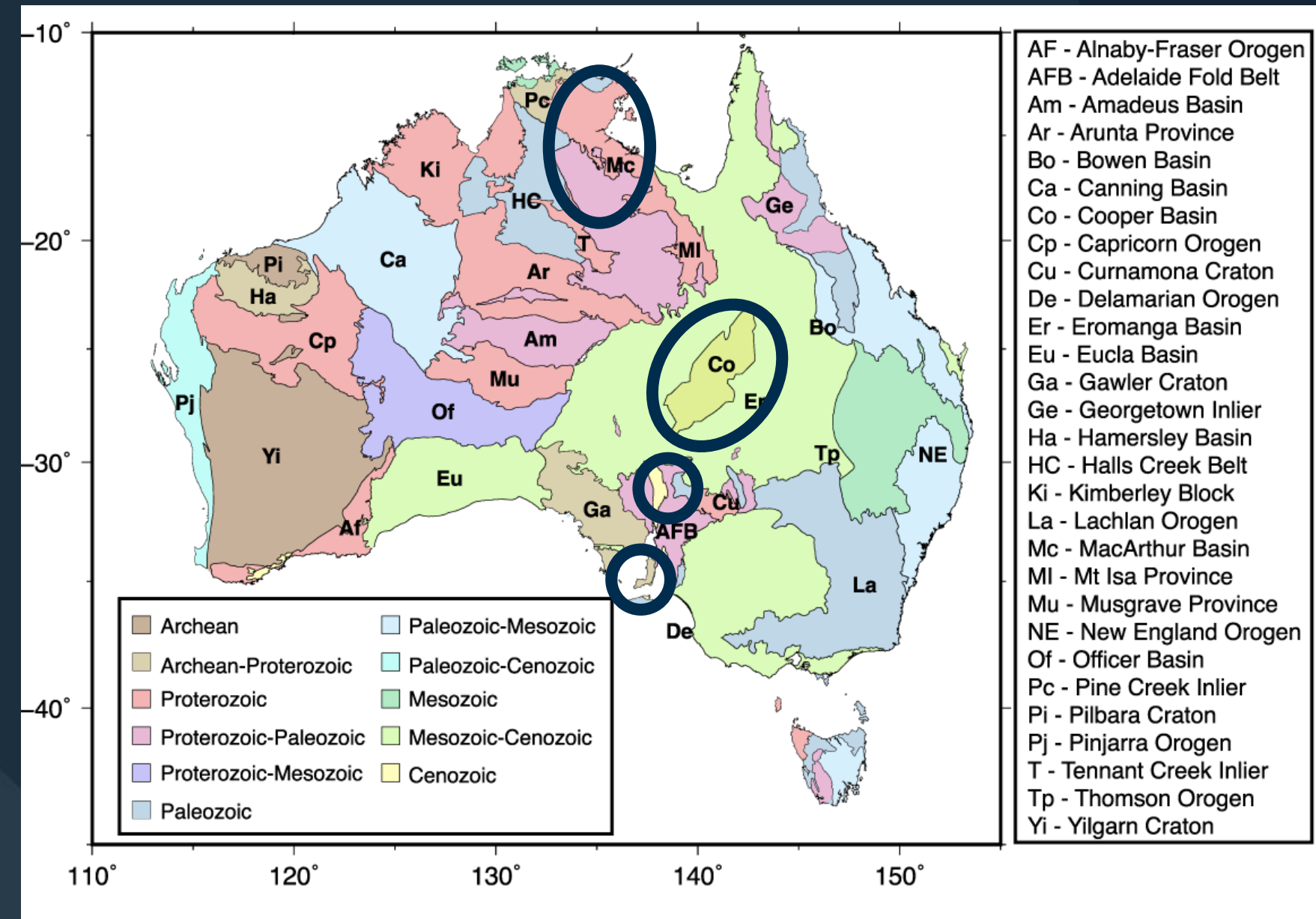
# World-leading GeoEnergy research facilities on the North Terrace campus

- Operational next year
- From basin scale to pore-scale processes
- Direct translation to industry applications
- World-leading, novel facilities, unique within our region



# Research Projects

- 8 substantial active government and industry funded GeoEnergy research projects
- 3 proposals
- academic disciplines of Earth Sciences and Petroleum Engineering



# ARC Linkage Project: **Reconstructing the Beetaloo/Greater McArthur Basin System (Feb 2022 – Feb 2025)**

**Chief Investigators:** Alan Collins, Juraj Farkas, Simon Holford, Rosalind King, Carl Spandler

**Partners:** Santos, Empire Energy, BHP, NTGS, Teck Resources, CSIRO

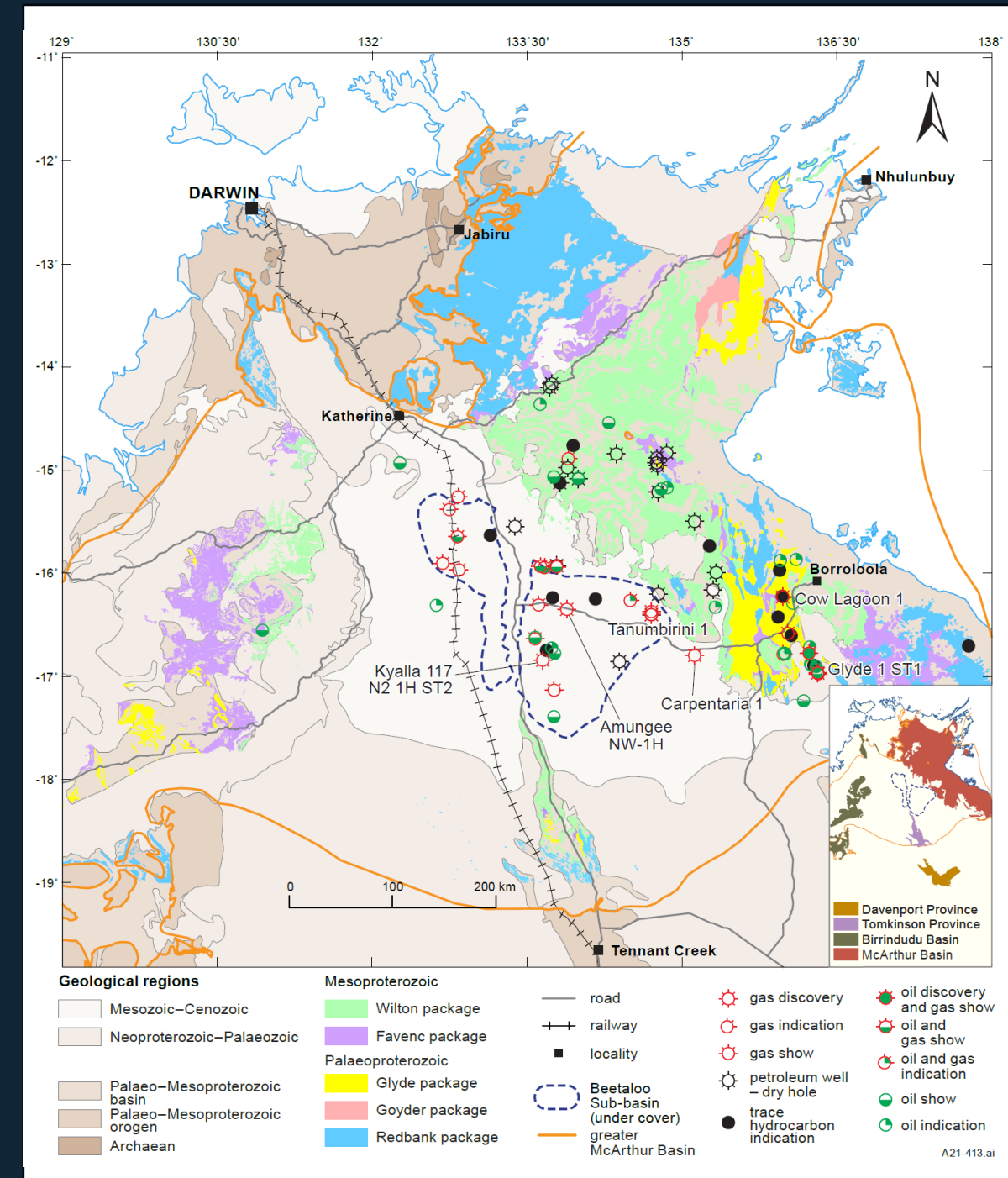
- *Unravelling the pre-competitive lithostratigraphy, chemostratigraphy and chronostratigraphy of a huge multi-resource rich basin in northern Australia*
- *\$1.22mill cash, 2 post-docs, 4 PhD students*

# ARC Linkage Project: **Novel isotope techniques to explore the Centralian Superbasin, Australia (May 2023 – May 2026)**

**Chief Investigators:** Juraj Farkas, Alan Collins, Morgan Blades, Stijn Glorie, Sarah Gilbert

**Partners:** SA, NT, WA governments, Agilent, Isotopx

- *Applying new technologies to understanding the energy-hosting basins covering central Australia*
- *\$610K cash, 1 post-doc, 3 PhD students*



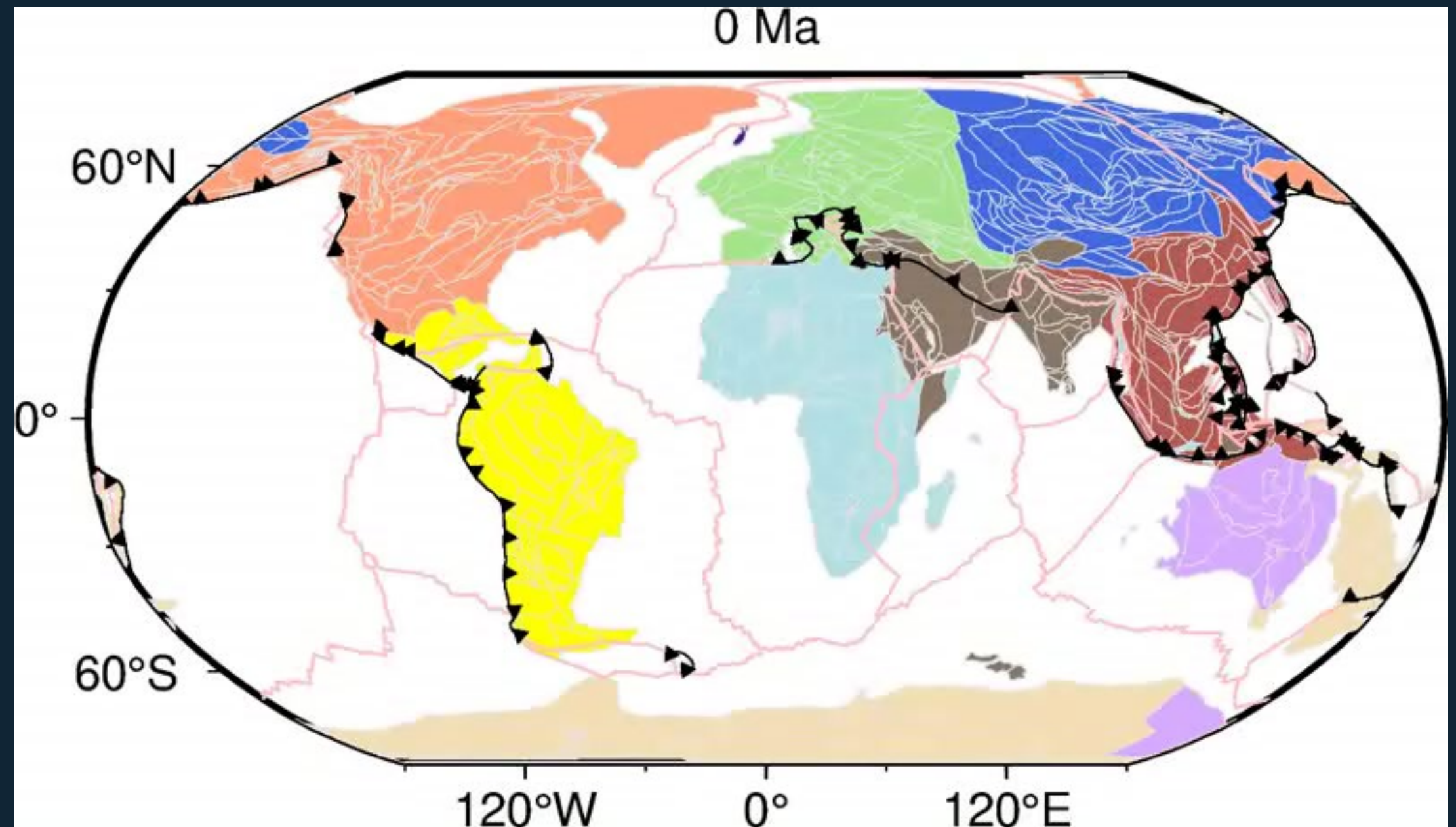
# ARC Laureate Fellowship: Plate Tectonics, Critical Metals and our Habitable Earth (July 2025 – June 2030)

Laureate Fellow: Alan Collins

- *Large multinational project to investigate the Proterozoic Plate Tectonics and Earth System (1.8-0.5 Ga), framework of Proterozoic hydrogen/helium, uranium and hydrocarbon energy systems.*

*\$5mill, 4 post-docs, 10 PhDs*

*Integrates with Andrew Merdith  
ARC DECRA, as well as  
groups in Sydney and Perth*



# CRC-P Project: Accelerating exploration and extraction of renewable natural hydrogen (Oct 2023 – Oct 2025)

**Chief Investigators:** Graham Heinson, Simon Holford, Ros King

**Partners:** H2EX Technologies Ltd, ANU, Black & Veatch Ltd

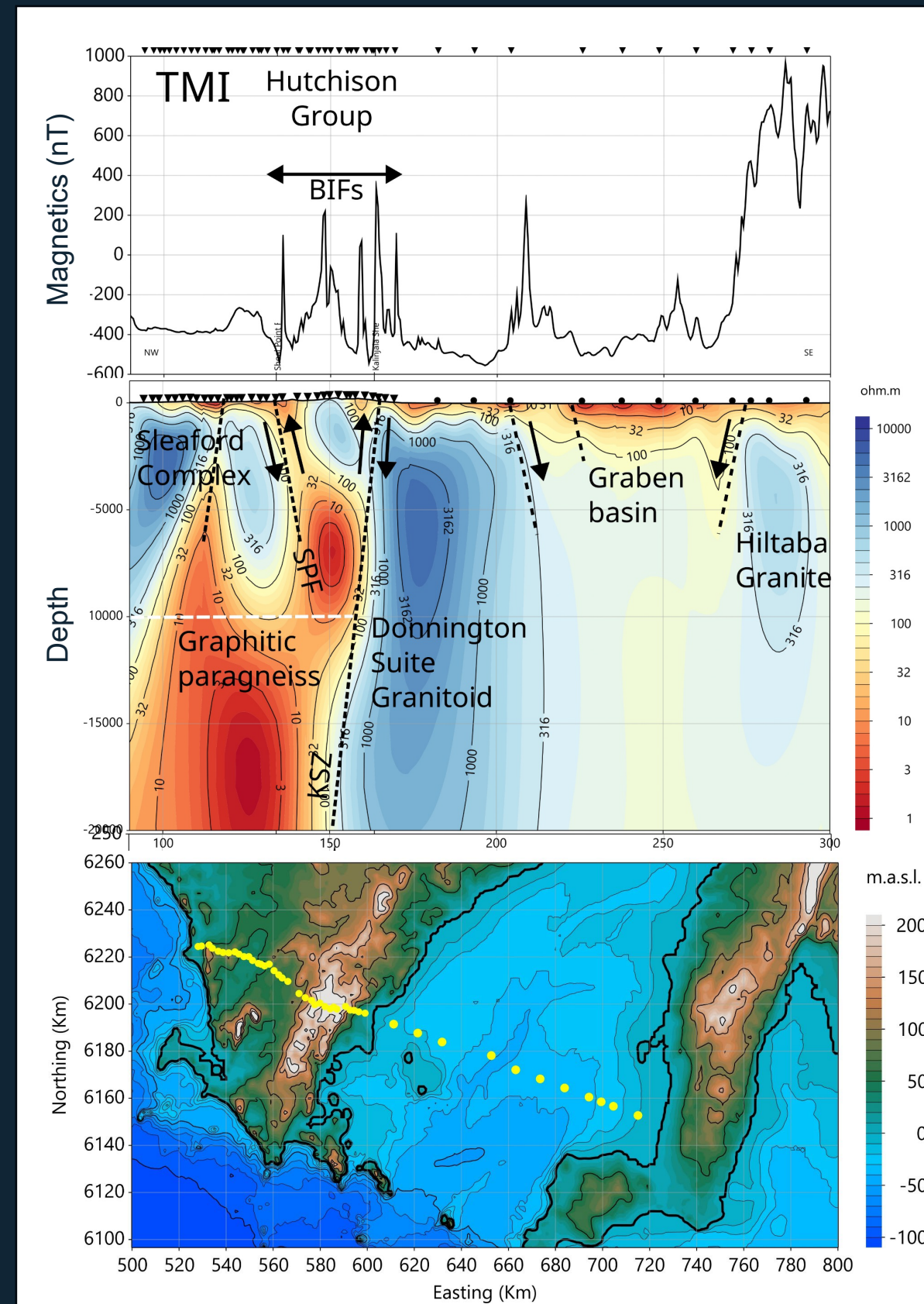
- *This project will enable green and passive exploration techniques to accelerate the discovery of natural hydrogen on the Eyre Peninsula*
- *Three phases of MT (University of Adelaide) and Passive Seismics (ANU) have been carried out*
- *The project involves 2 PhD students, 1 Honours*

## CSIRO: 3H Seep Tracker testing (Oct 2024 – Dec 2028)

**Chief Investigators:** Graham Heinson, Simon Holford

**Partners:** ASEG Research Foundation

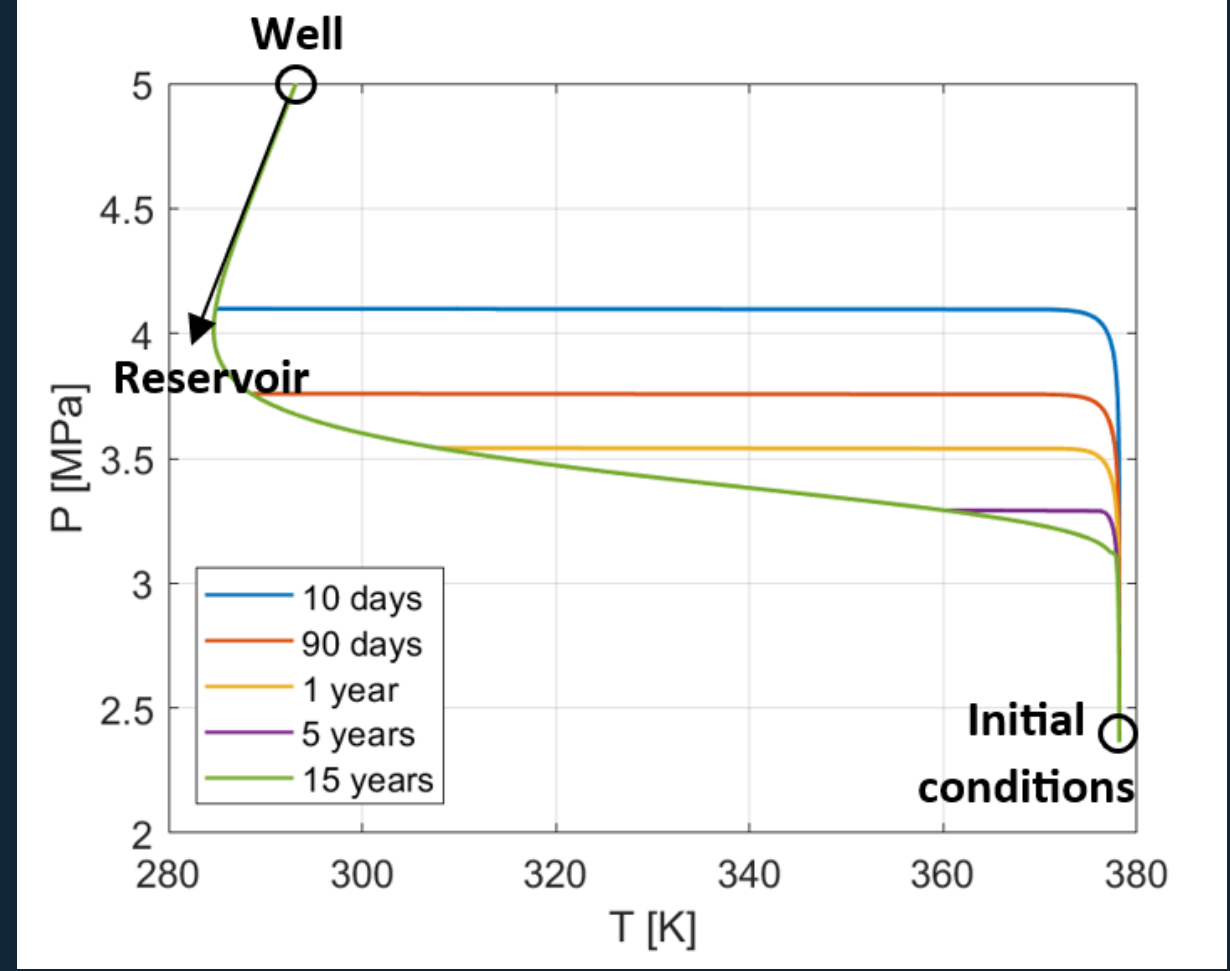
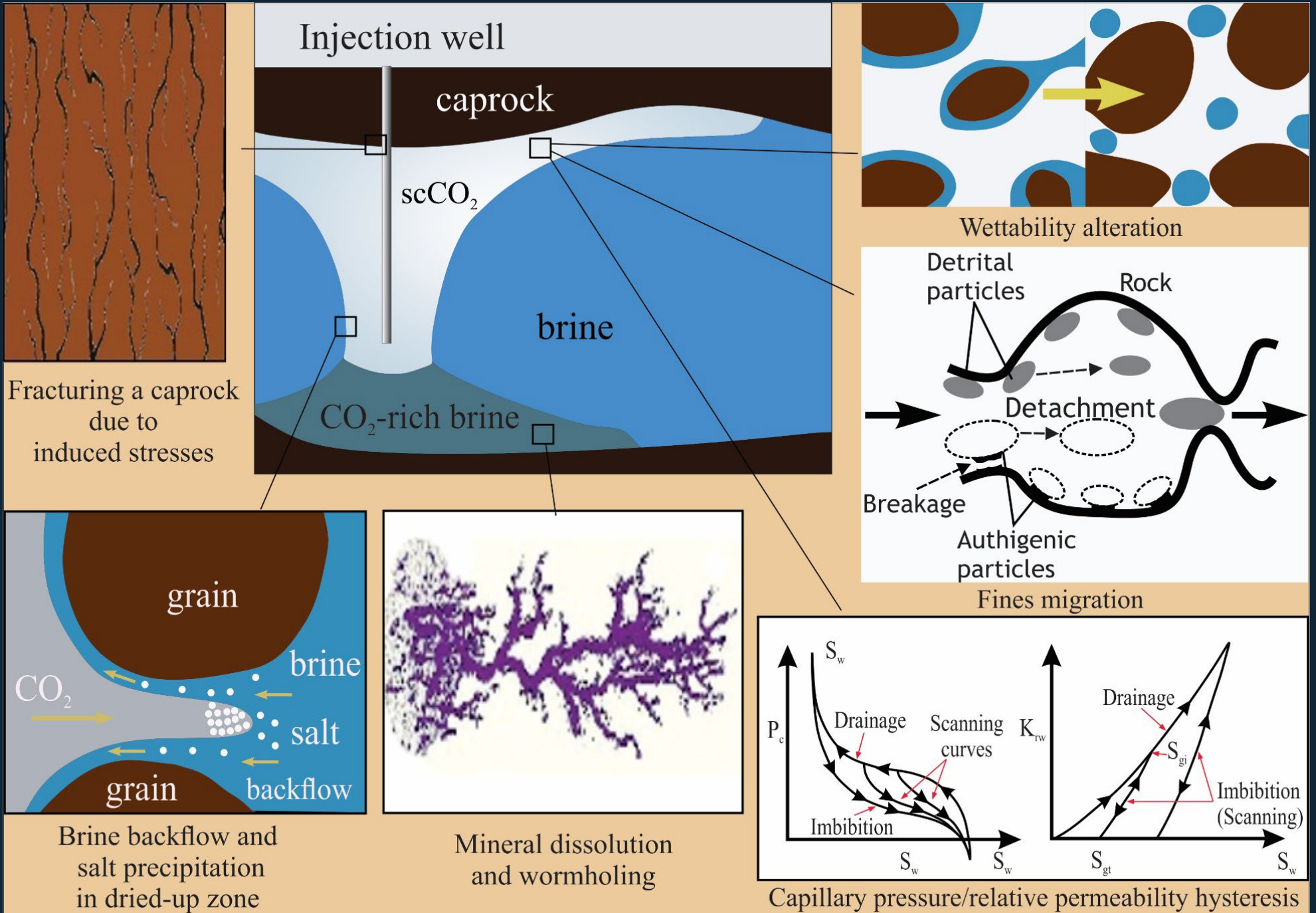
- *CSIRO will provide 5 units of 3H Seep Tracker (PCT/AU2024/050462) to the University of Adelaide to trial and test. The 3H Seep Tracker is multi gas long-term monitoring device intended for natural hydrogen exploration and assurance monitoring for underground hydrogen storage.*
- *The project involves 2 PhD students*



# Petronas: Advanced Wellbore Modelling Tool for CO2 Injection in Depleted Gas/Oilfield Reservoir (2019-2025)

Chief Investigators: Pavel Bedrikovetsky, Abbas Zeinjahromi, Alex Badalyan, Thomas Russell, Themis Carageorgos

The figure shows main physics factors reflected by the model:



## Shell Global B.V.: Well injectivity during CO2 storage in depleted gas fields and aquifers (2019-2025)

Chief Investigators: Pavel Bedrikovetsky, Abbas Zeinjahromi, Alex Badalyan, Thomas Russell, Themis Carageorgos

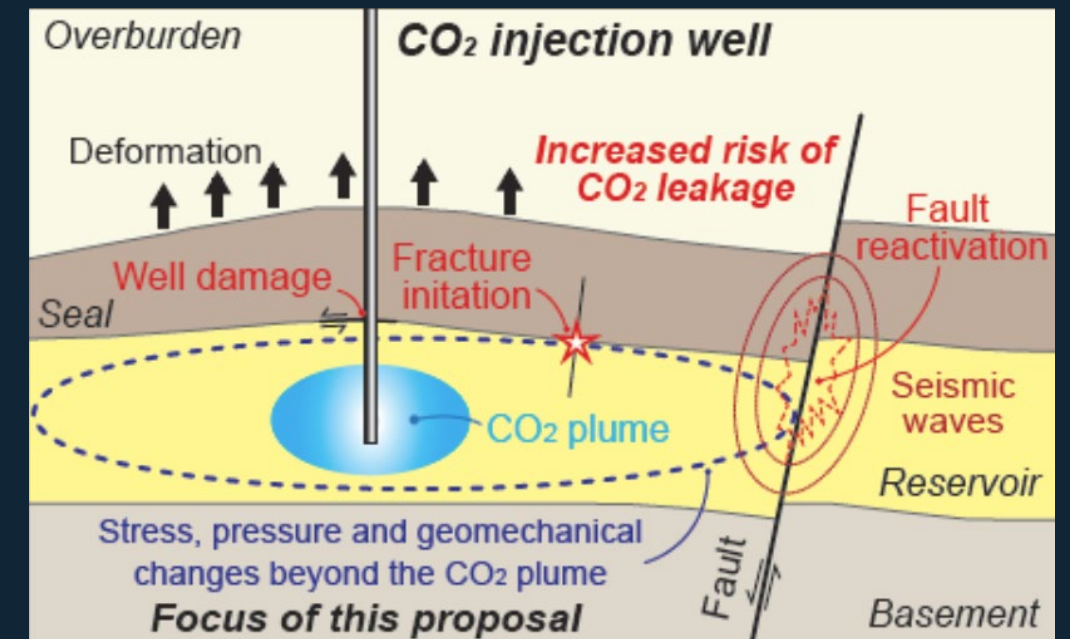
The figure above shows the path well-reservoir on the CO2-water phase diagram avoiding hydrate formation

## ARC Linkage Project (May 2024 – May 2027) : **Multiscale geomechanical modelling of basin-scale CO<sub>2</sub> storage**

**Chief Investigators:** Simon Holford, Mojtaba Rajabi, Ros King, Ken McClay, Alireza Salmachi, Mark Bunch

**Partners:** DEM, Tech Limit, Beach Energy, Santos, Geoscience Australia, University of Queensland

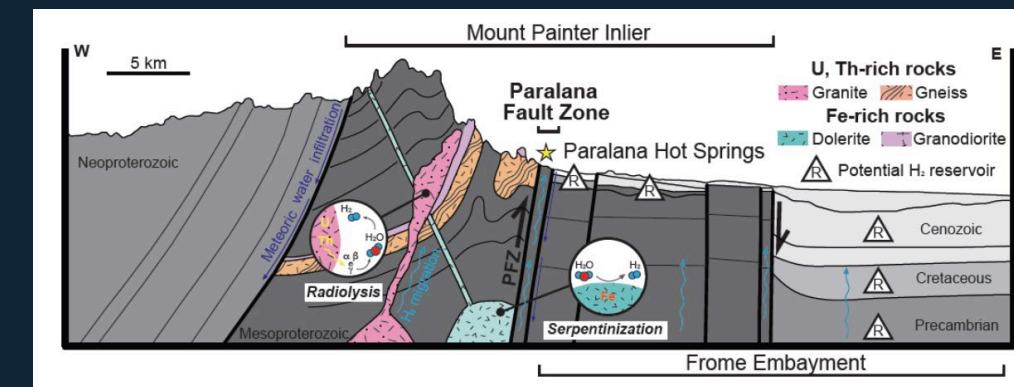
- addressing the geomechanical challenges to upscaling CCS to the Gigaton-scale necessary to meet emissions reduction goals
- leveraging data from the Cooper-Eromanga basins to develop multiscale (1D-4D) geomechanical risking tools to assist basin-scale screening for CCS sites with low risk of reservoir deformation
- 2 PhDs, 1 Research Associate, 2 Postdoctoral Researchers



## ARC Discovery Project Application (outcome late 2025): **Discovering natural hydrogen in continental interiors**

**Chief Investigators:** Simon Holford, Graham Heinson, Ros King **Partners:** University of Oxford, Durham University

- This project will use the natural laboratory of the Paralana Fault Zone in the northern Flinders Ranges to answer research questions critical to advancing natural hydrogen exploration:
  1. What are the relative contributions of radiolysis and serpentinization to H<sub>2</sub> production in continental interiors?
  2. What are the roles of faults and fractures in crustal transport of H<sub>2</sub>?
  3. What are the geological controls on H<sub>2</sub> accumulation and preservation?



- If funded, the project will support 3 PhD students (1 x Geophysics, 1 x Geochemistry, 1 x Geomechanics)

# ARC Linkage Project Application (outcome late 2025): **Lab- and modelling-based predictive tool for well injectivity during CO2 storage in aquifers and depleted gas fields.**

**UoA Chief Investigators:** Abbas Zeinijahromi, Pavel Bedrikovetsky

**Partners:** DEM, Edith Cowan University, The University of Newcastle, Santos Ltd

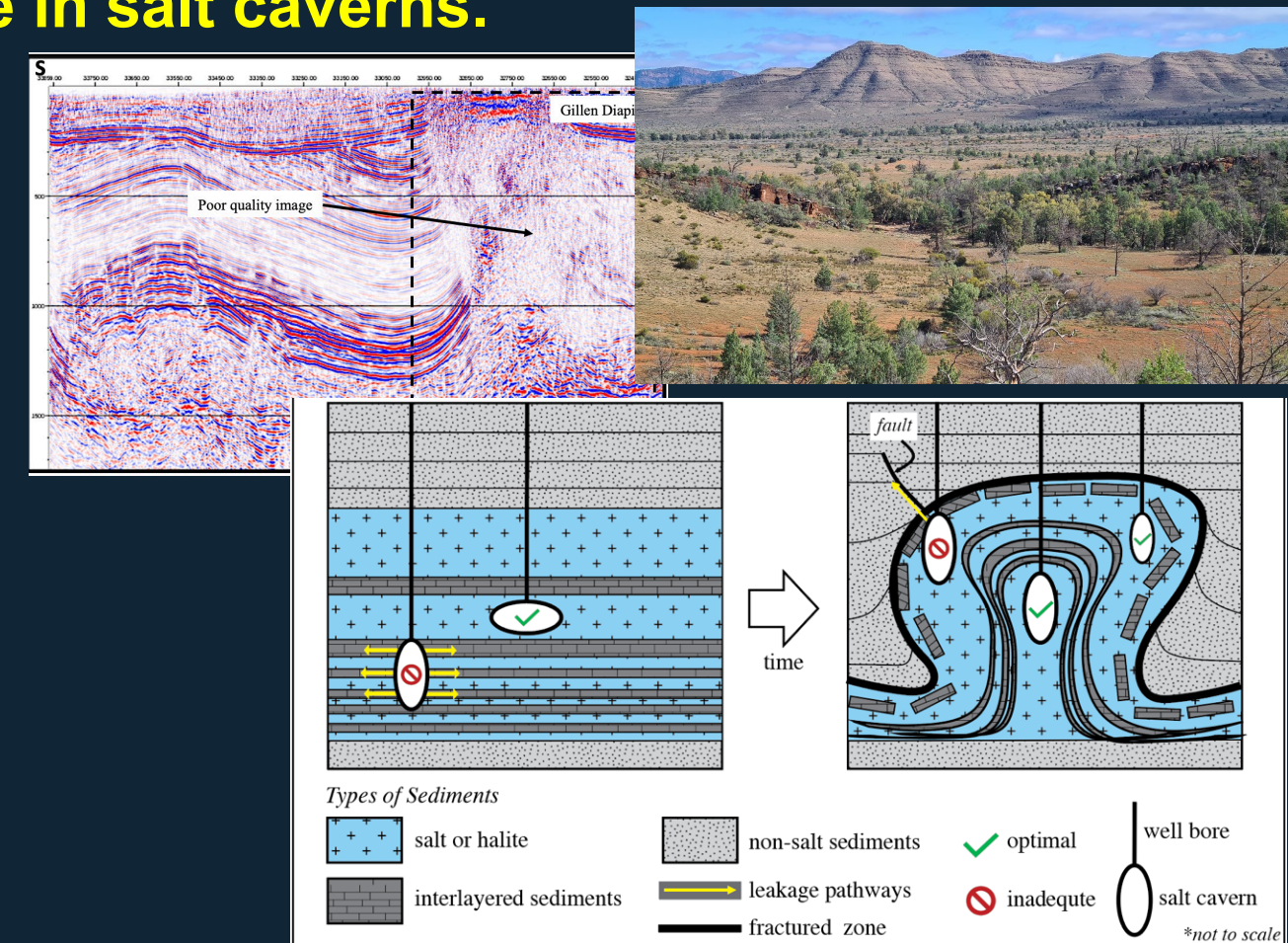
- If funded, this project will develop an analytical model for predicting well injectivity decline, CO2 plume propagation, and reservoir storage behaviour during CO2 storage. The project will encompass analytical modelling of 1D displacement of water/gas by CO2 accounting for major formation damage processes, novel coreflood experiments, and upscaling of results using exact solutions and averaging technique.*

# ARC Early Career Industry Fellowship Application – Dr Rachelle Kernan (outcome late 2025)

## **Unlocking Australia’s hydrogen industry through geological storage in salt caverns.**

**Partners:** Woodside Energy, DEM, NTGS, CSIRO

- If funded, this project will provide innovative geological approaches to develop models that can be used to predict optimal locations for hydrogen storage in salt caverns.*
- Through field geology, physical and synthetic seismic modelling, the project aims to: 1) Enable characterisation of halite thickness and geometry of deposits; 2) Identify and predict structural deformation patterns within diapiric salt sediments to reduce the risk of hydrogen leakage through faults and shear zones.*



# Industry and Government engagement

- Thank you to all our research partners, collaborators, sponsors and those who have contributed to strategic research development planning over the years.
- Institute for Sustainability, Energy and Resources Roundtables #1 - Underground Hydrogen Storage, Q2 2025
- Tailored discussions around potential collaborations welcomed

Kathryn Amos                      [kathryn.amos@adelaide.edu.au](mailto:kathryn.amos@adelaide.edu.au)  
Chair in GeoEnergy

Simon Holford                      [simon.holford@adelaide.edu.au](mailto:simon.holford@adelaide.edu.au)  
SA State Chair Petroleum Geoscience

Abbas Zeinijahromi              [abbas.zeinijahromi@adelaide.edu.au](mailto:abbas.zeinijahromi@adelaide.edu.au)  
Discipline Lead, Mining and Petroleum Engineering

[geoenergy@adelaide.edu.au](mailto:geoenergy@adelaide.edu.au)



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