CO2CRC Otway Stage 2: CO_2 Storage in Saline Formation

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CSLF Technical Group Meeting
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The CO2CRC Otway CCS Research Facility

- Australia's only CO_2 sequestration facility
- Conceptualised in 2003, characterisation since 2004, operating since 2008
- Varying storage options within simple geological structure
- Multiple CO_2 sources and transport options
- Comprehensive & expanding datasets and infrastructure
- Supportive local community
- Politically stable and supportive government

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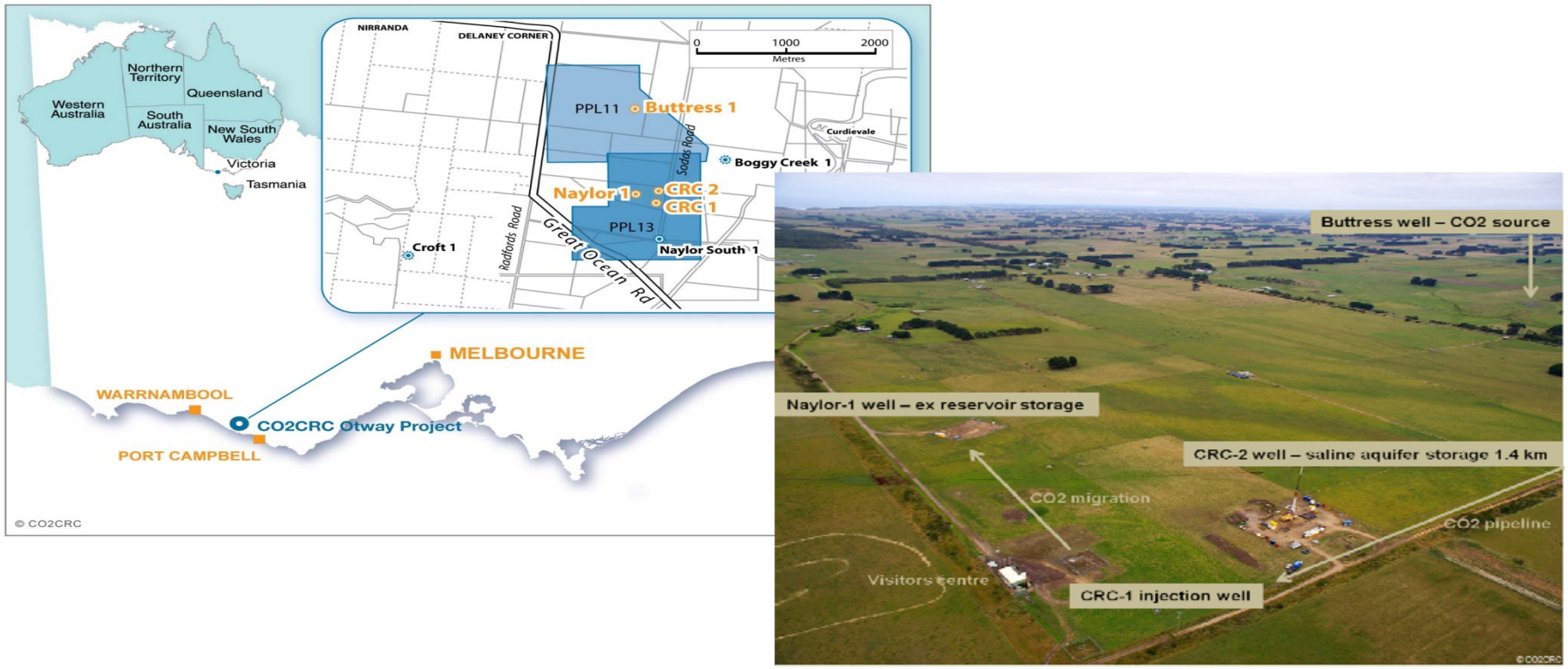
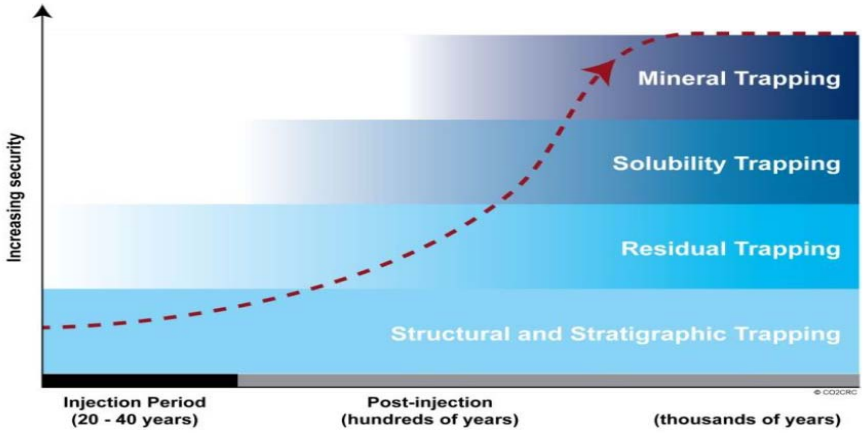
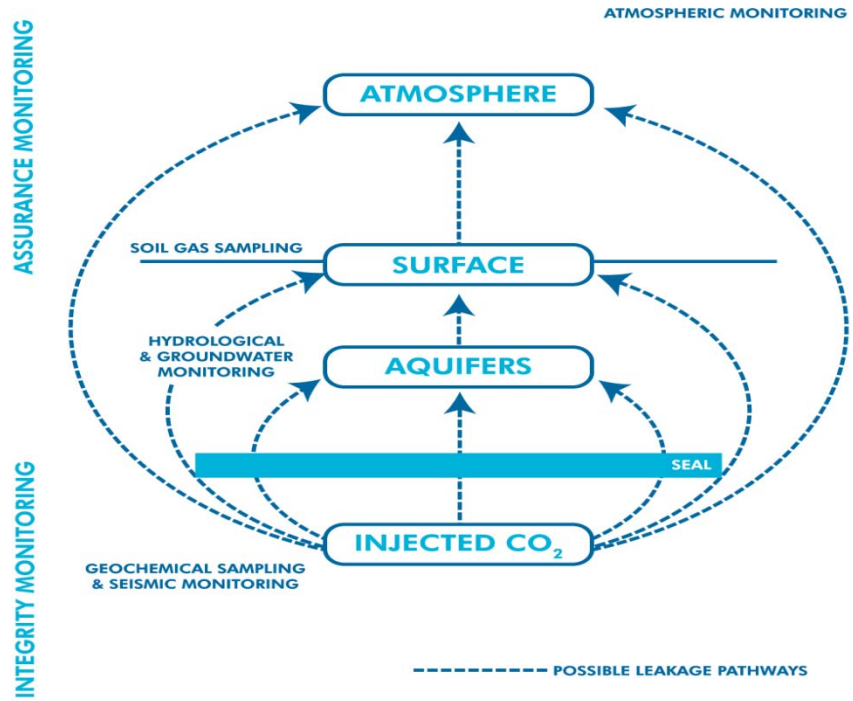
Location of CO2CRC Otway Facility



Characterising CO_2 Storage Processes and the Monitoring Capabilities to Validate Safe Storage





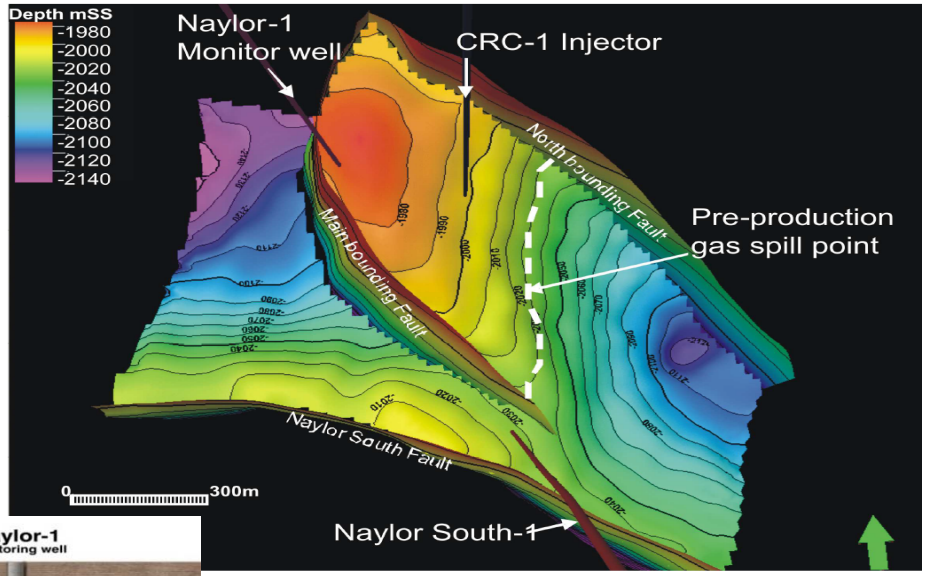
Otway Stage 1 – Complete

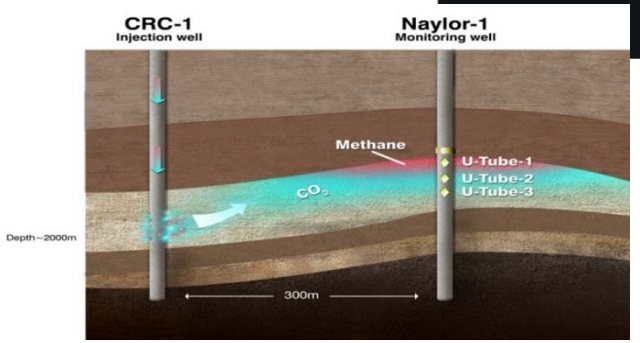
Science Outcomes

Demonstrated safe transport, injection and storage of >65,000 tonnes of CO_2-rich gas into a depleted gas reservoir.

Monitoring techniques:

- DH pressure, seismic, gas and formation water sampling (inc. tracers)
- Surface: Groun
  atmospheric, a
  micro-seismic

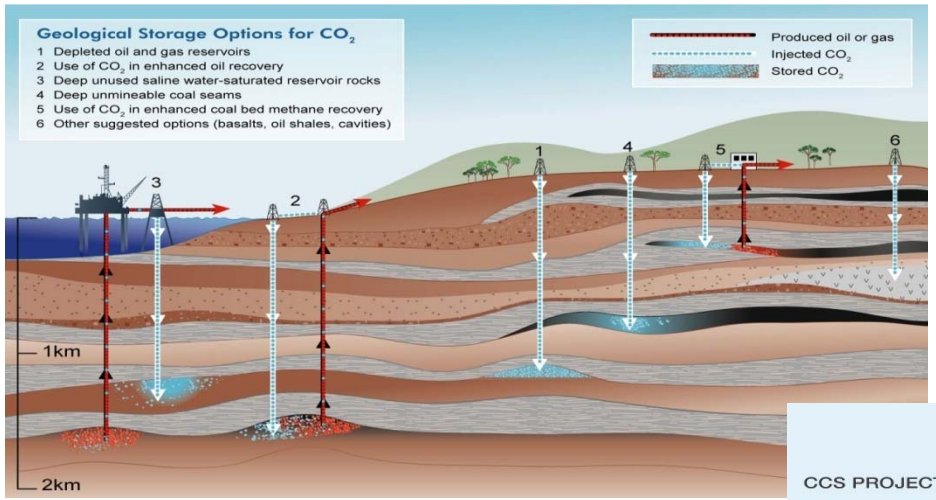




Additional Outcomes

- Positive regulatory environment
- Successful outreach program to stakeholders and local community

Australia's CCS Demonstrated Capabilities



Depleted Field Storage –

Otway Stage 1 ✓

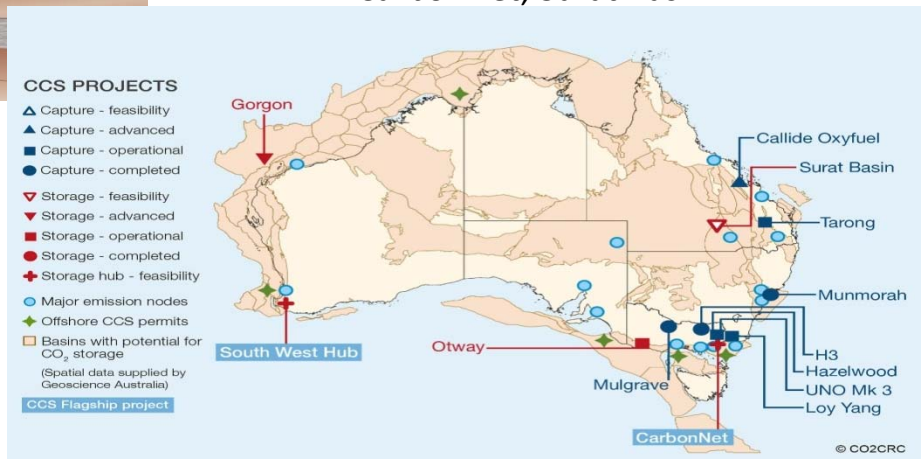
Saline Formation Storage –

Major storage option

- i.e. Gorgon, South West Hub, CarbonNet, Surat Basin

Large scale storage options in Australia

- Depleted oil and gas fields (10s of yrs)
- Saline formations (100s yrs)



The CO2CRC Otway Project Stage 2

Stage 2: 2007 – 2020

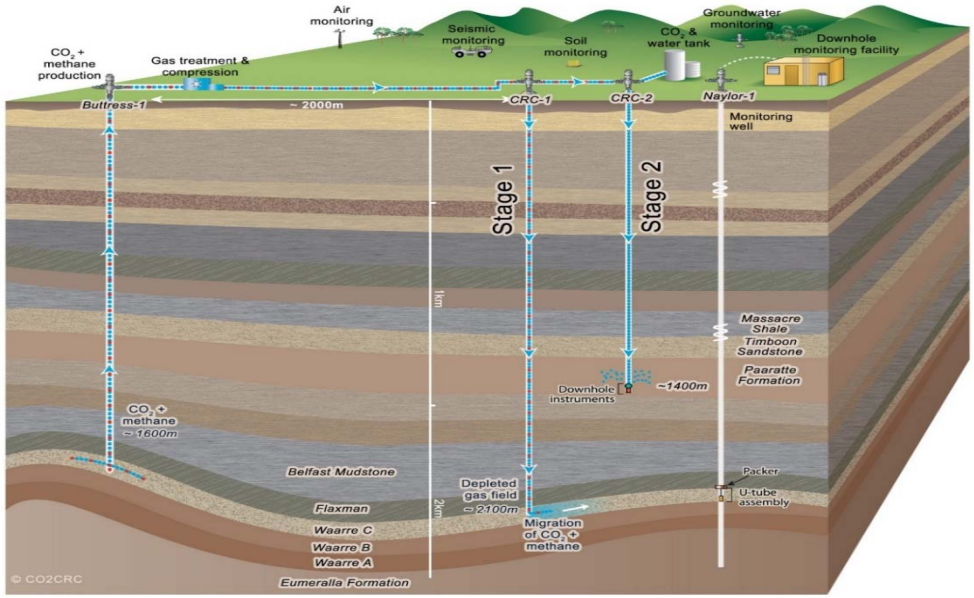
Demonstrate that CO_2 storage can be safely conducted at scale within a Saline Formation

Appraisal

- ✓ 2A :Drill CRC-2
- ✓ 2B: Measure parameters affecting residual and dissolution trapping in a saline formation
- ✓ 2B Extension: interactions with impurities & well test refinement

Operation

- 2C: Spatially track injected CO_2 in a saline formation
  - Minimum detection limit
  - Migration behaviour
  - Stabilisation



Stage 2 Appraisal

Development of an injection plan that ensures:

- CO_2 containment within storage complex
  - Within tenement
  - Below primary seal
- Suitable plume distribution for meeting science objectives
  - Detectable plume
  - Moderate migration
  - Short time to stabilisation

Development of a monitoring plan that ensures:

- Monitoring coverage across entire plume
- Monitoring resolution at highest level
  - High Signal to Noise
  - High repeatability
- Overarching Otway Research Facility Principles are maintained

CO2CRC

Residual Gas Trapping Characterisation (2009 – 2011)

Volumetric equation for capacity calculation

$$G_{CO_2} = A \; h_g \; \phi \; \rho \; E$$

G_{CO_2} = Volumetric storage capacity

A = Area (Basin, Region, Site) being assessed

h_g = Gross thickness of target saline formation defined by A

ϕ = Avg. porosity over thickness h_g in area A

ρ = Density of CO_2 at Pressure & Temperature of target saline formation

Objective: Test capabilities to determine residual gas saturation?

E = Storage "efficiency factor" (fraction of total pore volume filled by CO_2)

NETL DOE, 2006

Residual trapping measurements trialled

- Five (5) independent measurement approaches to determining residual trapping:
- The methods deployed have different depths of investigations, supply different information, and have difference benefits and limitations

Pressure response (<20 m)

Pulsed neutron logging tool (RST) (<1m)

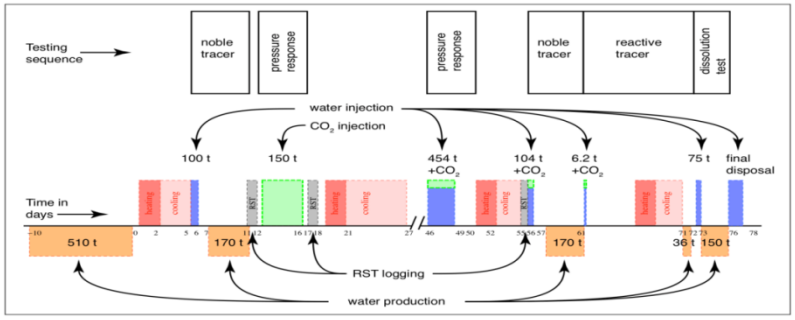
Thermal testing (Fibre Optics) (1 - 2 m)

Noble gas tracer testing (KR-Xe) (4 - 10 m)

Liquid tracer (reactive ester tracer partitioning) (4 - 10 m)

Dissolution testing (<1 m)

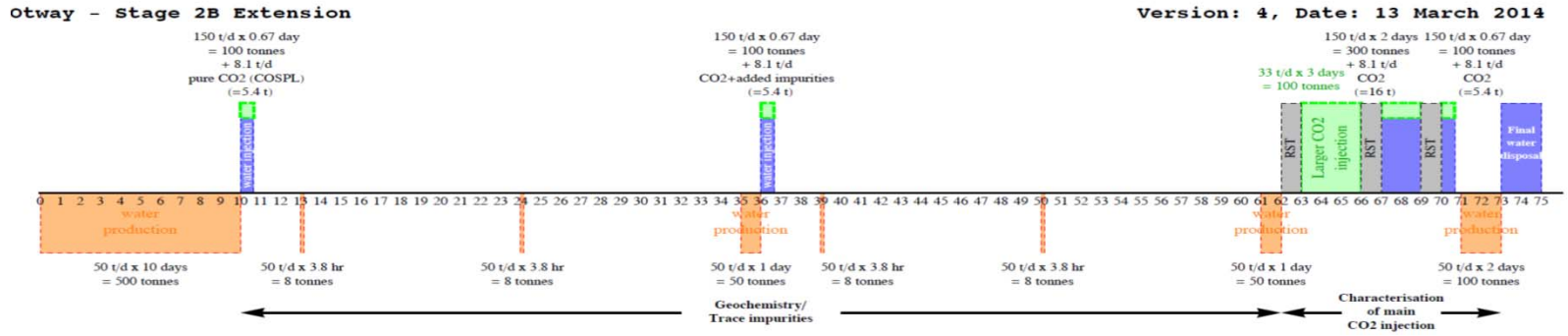
Laboratory core testing



Stage 2B Extension (2014 – 2015)

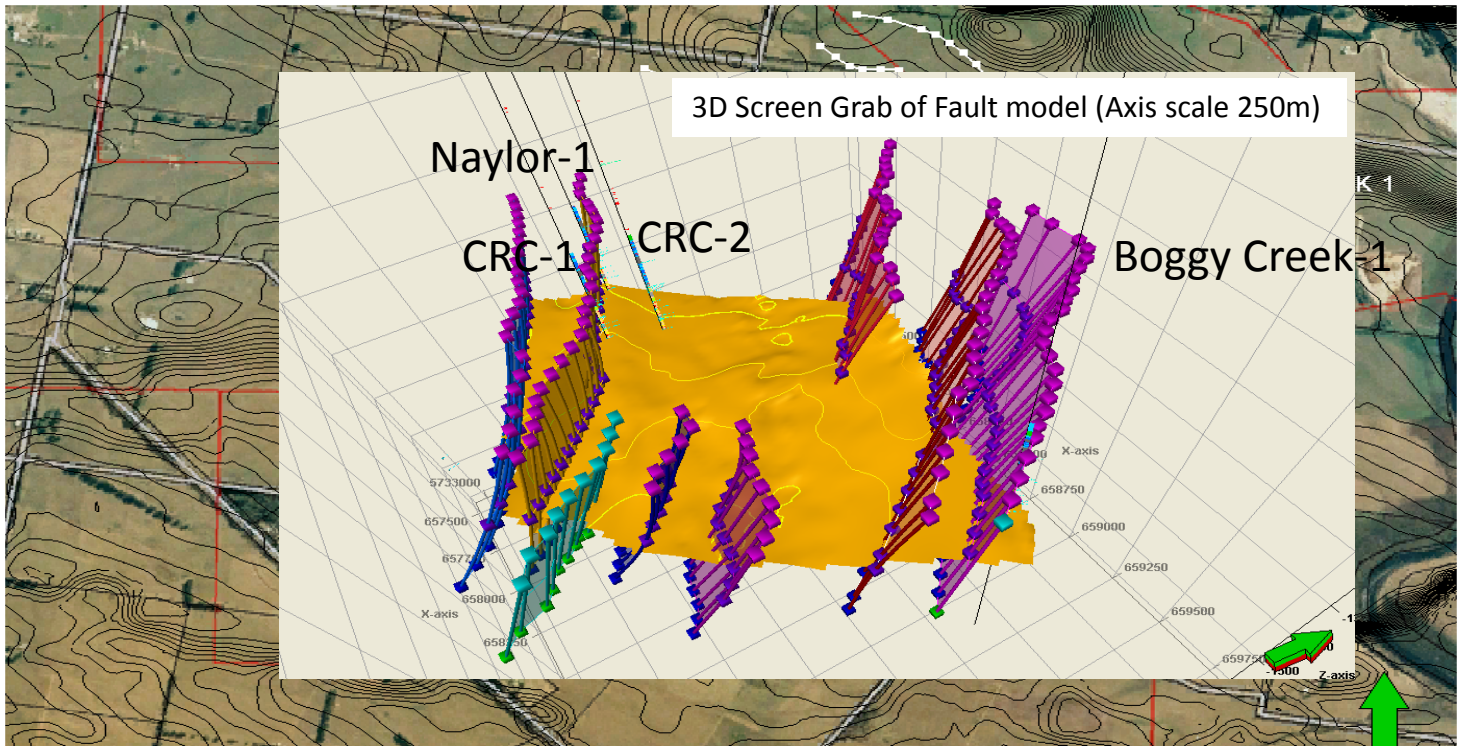
Part 1: Investigate the impacts of gas impurities on the formation water

Part 2: Further characterize residual saturations, evaluate techniques



- Part 1 funded by COSPL (Callide Oxyfuel Services Pty Ltd) and utilised CO_2 captured at the Callide Oxyfuel project
- Research is a collaborative effort between CO2CRC and its research partners, University of Edinburgh (funded by UKCCSRC) and Lawrence Berkley National Laboratories.

Stage 2C - Far Field Geological Appraisal



Plume Modelling

Questions addressed:

How does plume distribution influence:

- Seismic response?
- Containment risk?
- Tenement boundaries?

When does plume stabilise?

Dynamic parameters analysed

Geological realisations

Dolomite cement distribution

Model gridding

Relative permeability

Capillary pressures

Injection horizons

Injection rates

Pressure changes

Thermal changes

Stage 2C Injection Plan

Parameter	Description
Injectant	Buttress-1 gas
Injection Interval	1501 – 1512 mRT in CRC-2
Injection Mass	15,000 tonnes
Injection Rate	111 tonnes/day for 135 days
Injection Period	19th November 2015 – 4th May 2016

Stage 2C Operation (2015 – 2020)

GOAL

Safely complete seismic-focused, 2C injection experiment in a saline formation, such that it is meets the scientific objectives and the results provide high quality research value to CCS knowledge.

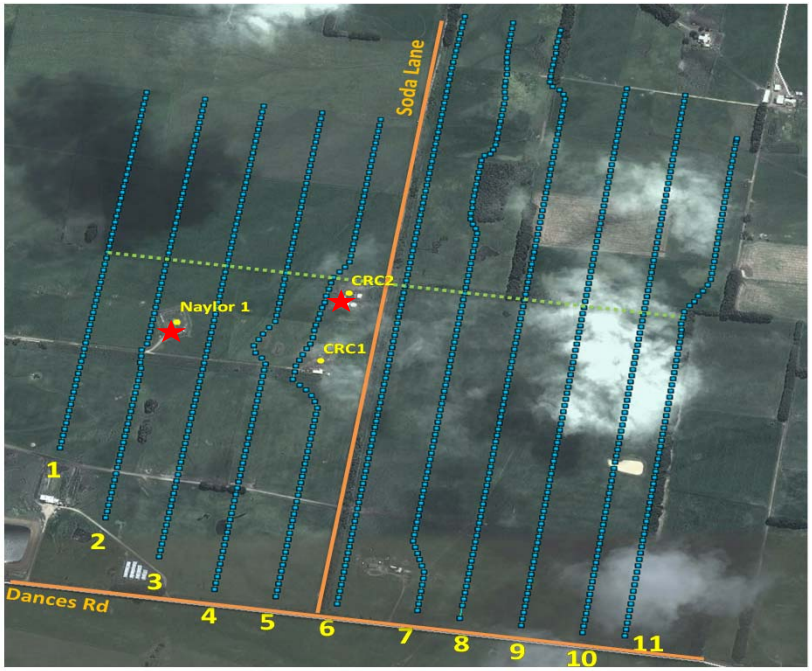
SCIENTIFIC OBJECTIVES

1.Detect injected Buttress gas in the subsurface; ascertain minimum detection limit;

2.Observe the gas plume development using time lapse seismic;

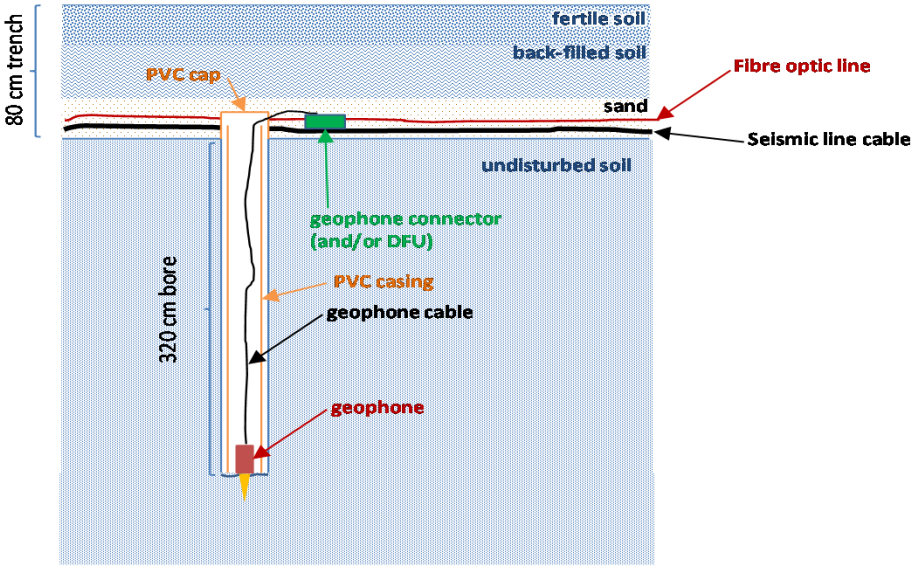
3.Verify stabilisation of the plume in the saline formation using time lapse seismic.

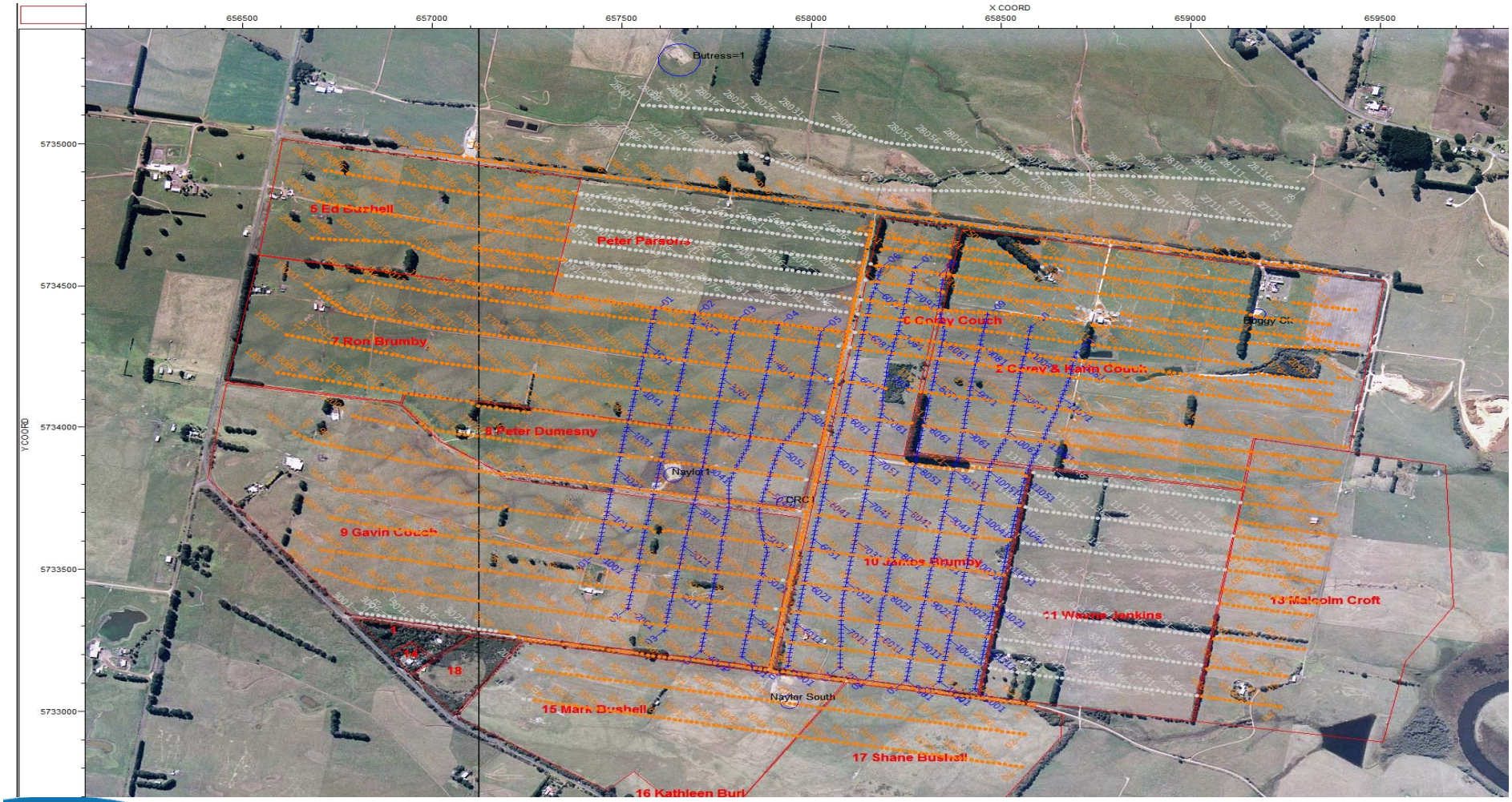
Surface Monitoring



Active & Passive seismic

- Buried seismic receiver array (908 single component geophones & 34 km fibre optic cable)
- Repeat (Vibroseis) & permanent seismic sources

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5 Ed Bushell
Peter Parsons
7 Ron Brumby
8 Peter Dumesny
Naylor 1
CRC 1
9 Gavin Couch
10 James Brumby
11 Wayne Jenkins
13 Malcolm Croft
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14
18
Naylor South
15 Mark Bushell
17 Shane Bushell
16 Kathleen Burl
Boggy Ck

Downhole Monitoring

CRC-2

Completions

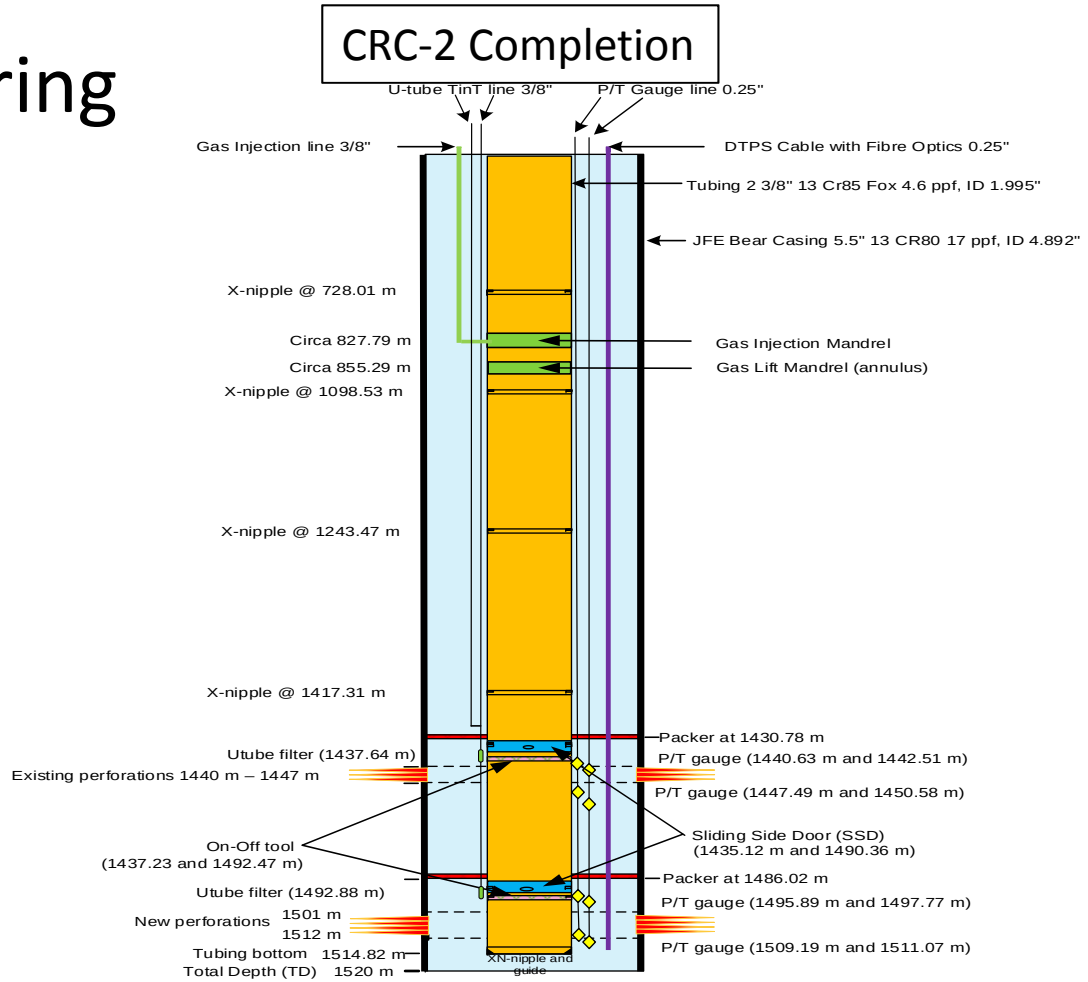
- Injection interval and above zone isolations (SSDs)
- Gas injection and lift mandrels

Monitoring tools

- Permanent pressure & temperature
- U-tube (tube in tube)
- Fibre Optic - DTS & acoustic

CRC-1

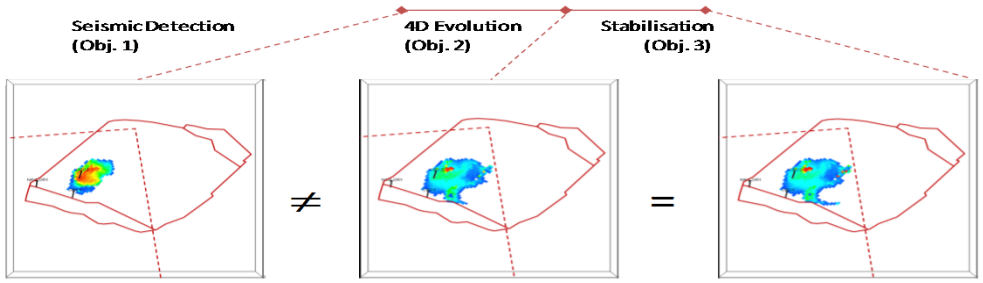
- Seismic geophones (VSP)



Monitoring plan

Activity	2013	2014				2015				2016			2017		2018		2019		2020
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	H2	H1	H2	H1	H2	H1	H2	H1
Approvals		◆	Spend auth.		◆	FID			◆	Inject auth.									
Phase 4 - Execution																			
CRC-2 Workover						▭													
Receiver Installation						▭													
Pit const. & seis source install.						▭			▭										
CRC-2 Sgr Test						▭													
Phase 5 - Operate Pt. 1																			
VSP + 3D seismic baseline acq.									▭										
Injection (15kt @ 110t/day)										▭	▭								
VSP + 3D seismic acq. (5kt)										▭									
VSP + 3D seismic acq. (10kt)										▭	◆ Objective 1								
VSP + 3D seis. acq. (end inject.)											▭								
Phase 6 - Operates Pt. 2																			
3D seis. acq. (1 yr. post inject.)													▭ ◆	Objective 2					
3D seis. acq. (2 yr. post inject.)															▭ ◆	Objective 3			
Required Site Closure																			◆

◆ Key Milestones
▭ Planning / Ops Mgmt. Activity
▭ Activity relating to well operations
▭ Activity relating to seismic monitor



Stage 2 - Anticipated Outcomes

- ✓ Methodology for near well characterisation of CO_2 storage
- Demonstrated capability of time lapse seismic for imaging a CO_2 plume
  - Quantified comparison of seismic techniques for the monitoring of CO_2 plume migration
- Method for the prediction of plume stabilization
  - Verification of stabilisation using seismic and pressure monitoring in conjunction with plume modelling
  - Enhanced capability to utilise short term monitoring to calibrate long term model predictions

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Participants

Supporting Partners