CO2CRC COOPERATIVE RESEARCH CENTRE FOR GREENHOUSE GAS TECHNOLOGIES

Reducing greenhouse gas emissions to the atmosphere

Otway Demonstration Quantitative Risk Assessment Case Study

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Adapted from: Watson, M. 2007. Risk associated with the proposed Otway Basin Pilot Project (CO2CRC Otway Project): Quantitative risk assessment with newly acquired data and updated interpretation, CRC for Greenhouse Gas Technologies, Canberra. CO2CRC ID Number RPT07-787

IEA GHG R&D Programme Joint Networks Meeting
New York, USA
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CRC


Supporting participants: Australian Gov Departments | Australian National University | LBNL I ARC | CANSYD | Meiji University | The Process Group | University of Queensland | Newcastle University | USDoE

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CO2CRC

CO2CRC Otway Project, Victoria

Description – Australia's only operational storage project, involving demonstration of geological storage of CO_2 and monitoring and verification of the behaviour of the stored CO_2.

Storage – Depleted gas field at 2000m depth

- ***Storage Commence*** – April 2, 2008
- ***Storage Rate –*** 100,000 tonnes total over 1-2 years (Stage 1)

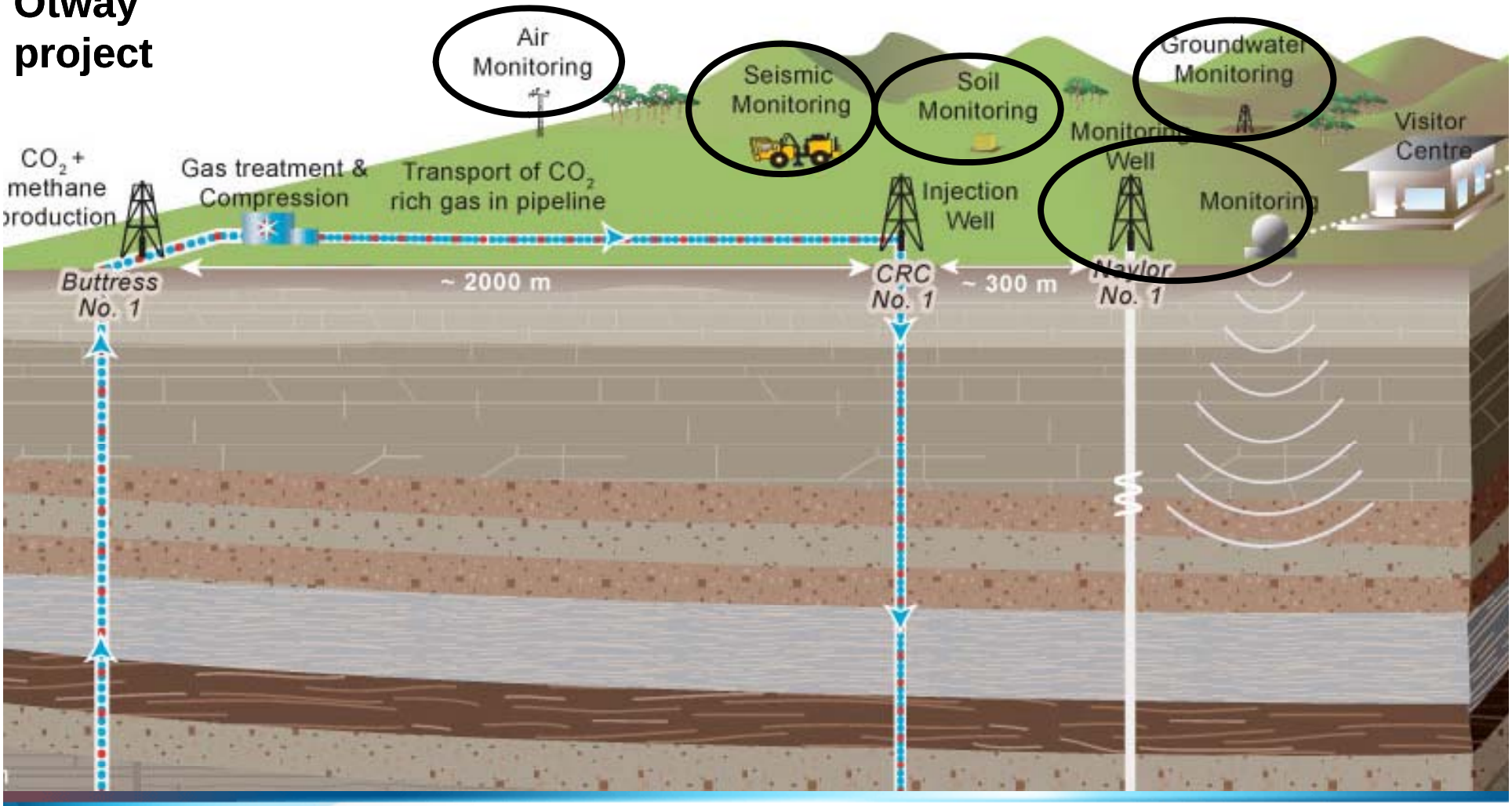
Cost – $A 40M plus

Partners – CO2CRC, Industry, Government and Researchers (Universities, CSIRO, GA, LBNL, ARC, GNS, KIGAM),

Participating countries **Australia, New Zealand, USA, Korea, Canada**

Operating Company

Monitoring and verification: key components of the Otway project



Otway QRA Risk Methodology

- **URS's trademark RISQUE methodology in conjunction with CO2CRC expertise to come up with a quantified risk assessment.**
- **Risk process was a structured 2 day workshop (July 2007).**
- **An expert panel was used and regulators were in attendance for learnings, which aided project approvals.**
- **Expert panel considered the data gathered since the 2005 initial risk assessment and updated the risk assessment for the pilot project.**
- **Concentrated on containment in (and leakage from) intended storage site and not leakage into overlying formations or surface**

CO2CRC Otway Project has provide important learnings on Regulatory issues

Onshore activities are regulated in Australia by the State authorities, but there is currently no CCS legislation in place. Therefore to enable the Otway Project to proceed, CO2CRC has worked with the Victorian State regulators, to meet statutory environmental, health and safety standards relevant to a CCS project, using existing legislation including:

- ***Petroleum legislation***
- ***Water legislation***
- ***RD&D provisions of the EPA***
- ***Planning scheme exemptions***
- ***Compulsory land acquisition***
- ***Health and safety***
- ***Biodiversity legislation (EPBC)***

RISQUE Method* Explained

*(Risk Identification and Strategy using Quantitative Evaluation)

- **Quantitative:** Risk = Probability x Cost (measured in some common currency)
- **Use Expert Panel:** eg. Geology, Geophysics, Geomechanics, Geochemistry, Simulations, Hydrogeology, RA Technology
- **Panel identifies:**
- risk events, their likelihood, and costs
- options, their costs and benefits
- **Assess each potential alternative:**
- Estimate risk quotient
- Estimate risk cost (reasonable cost due to risk event)
- Determine benefit – cost
- **Use outputs to formulate strategy**

*Described in book: Triple Line Risk Management

The Risk Register (1)

Permeable zones in seals	**Risk of leakage through the pore space of the seals.**
Faults through seals	**Based on known faults in seals and fault types (compressive regime or opposite). 3-D seismic used to identify evidence of this.**
Injection and monitoring wells	**The primary source of leakage for sequestration projects – leakage up the casing of wells – may get above seals into other aquifers, or worst case may get to surface.**
Regional scale over pressurisation	**The potential reactivation of faults and fractures as a result of injection of CO2 and overpressurisation that could occur during injection.**

The Risk Register (2)

Local scale over pressurisation	**Development of near well bore fractures that would allow loss of CO2 as a result of CO2 injection.**
Exceeding the spill point of the storage site	**The risk that the identified structure has less capacity than thought and the spill point is exceeded.**
Earthquake induced fractures	**Earthquake causes fault apertures to open leading to short term high leakage rates and long term low leakage rates.**
Incorrectly predicting the migration direction	**The chance that the CO2 plume moves in a direction other than predicted and leaks.**

Results

At a planning confidence level of 80% it was seen that:

- **No single risk event exceeded acceptable risk quotient.**
- **Total risk events quotient less than acceptable target (1% leakage over 1000 years) (LOW RISK)**

Major risk events are:

- **Leakage from existing faults**
- **Leakage from wells – in particular damage to cement.**

Consequence Analysis

Final step – analyse the consequence of leakage from primary containment.

- **Leakage into secondary containment would have negligible impact to human health, safety, the environment or to any natural resources in the area.**
- **Risk of leakage from secondary containment considered almost impossible*.**
- **Risk of leakage into freshwater aquifers or to surface considered almost impossible.**
- **Migration of heavy metals out of primary containment considered almost impossible.**

* Almost impossible – 1 in 10^{-6}

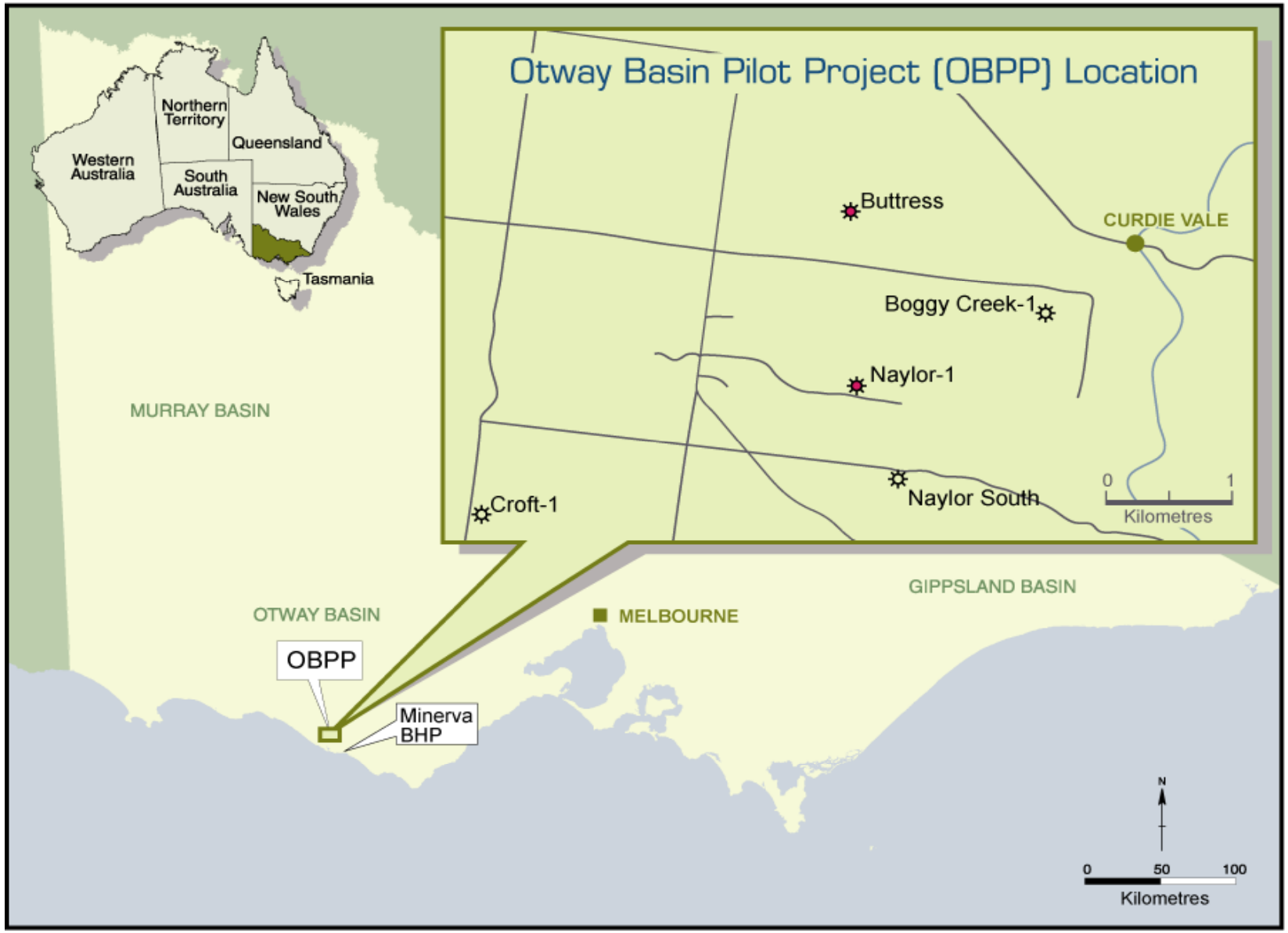
Acknowledgements

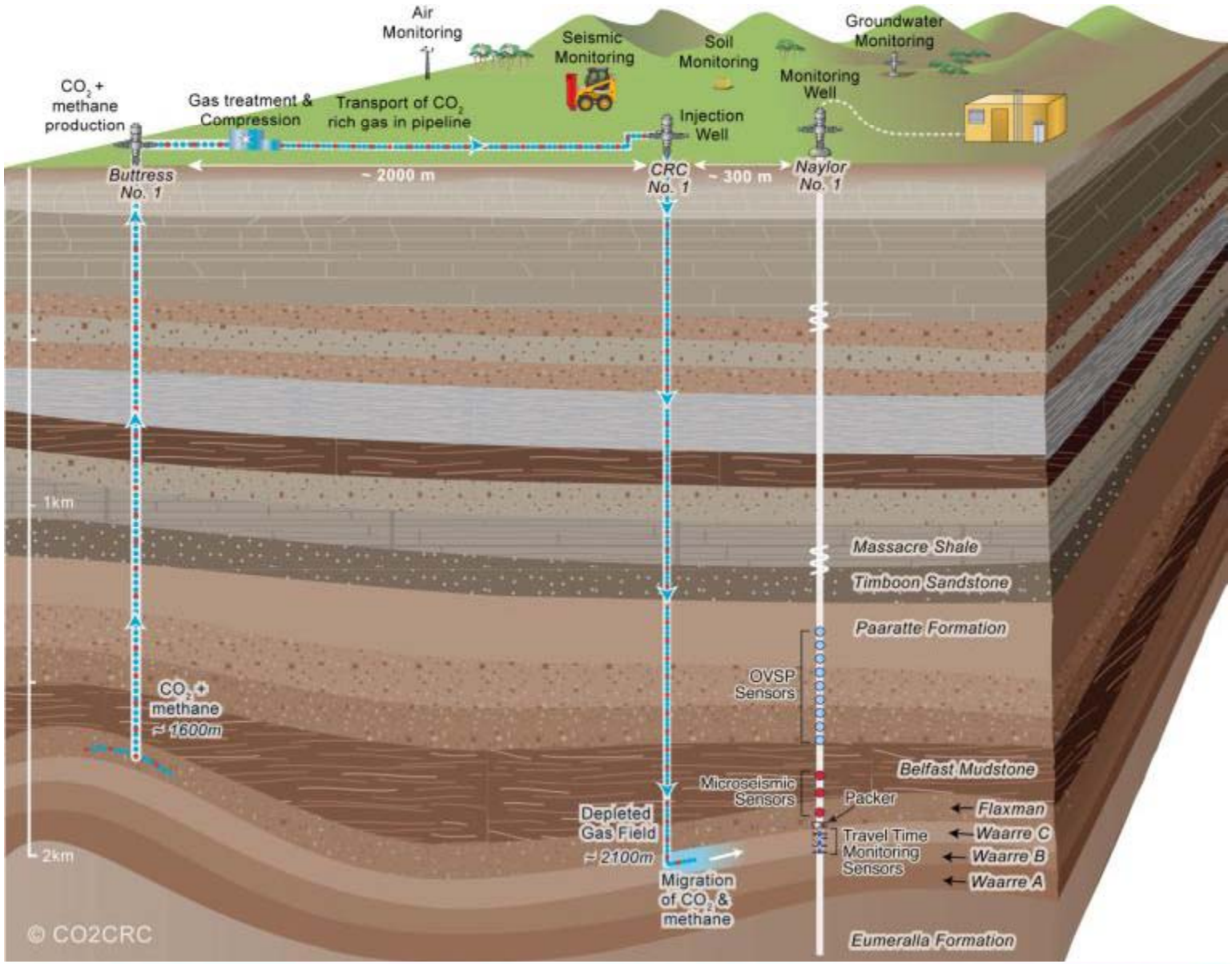
- **CO2CRC Study team – Max Watson, Andy Rigg, the Expert Panel & Adrian Bowden (URS)**
- **CO2CRC Sponsors and Research Collaborators:**

Context

Otway Basin Pilot Project

- **CO2 sourced from a nearby CO2-rich gas field (Buttress) and transported via pipeline to the injection site (CRC-1) located to the east of and downdip from a depleted gas field (Naylor) in the Port Campbell region of the onshore Otway Basin.**
- **The injection volume is fixed at 3 MMscf/d for a period of 2 years for a total of 100,000t stored.**
- **The single well used as the injector is the CRC-1 well, located ~300m from the crest of the structure. The existing Naylor-1 well is the monitoring well. Both wells to be in contact with the CO2 plume throughout the 'risked' 1000 year period.**


Otway Basin Pilot Project (OBPP) Location
Northern Territory
Queensland
Western Australia
South Australia
New South Wales
Tasmania
Buttress
CURDIE VALE
Boggy Creek-1
Naylor-1
Naylor South
Croft-1
0
1
Kilometres
MURRAY BASIN
GIPPSLAND BASIN
OTWAY BASIN
MELBOURNE
OBPP
Minerva
BHP
N
0
50
100
Kilometres


Air Monitoring
Seismic Monitoring
Soil Monitoring
Groundwater Monitoring
Monitoring Well
CO_2 + methane production
Gas treatment & Compression
Transport of CO_2 rich gas in pipeline
Injection Well
Buttress No. 1
~ 2000 m
CRC No. 1
~ 300 m
Naylor No. 1
1km
Massacre Shale
Timboon Sandstone
Paaratte Formation
OVSP Sensors
CO_2 + methane ≈ 1600m
Belfast Mudstone
Microseismic Sensors
Packer
Flaxman
Waarre C
Waarre B
Waarre A
Travel Time Monitoring Sensors
Depleted Gas Field ≈ 2100m
Migration of CO_2 & methane
2km
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Eumeralla Formation