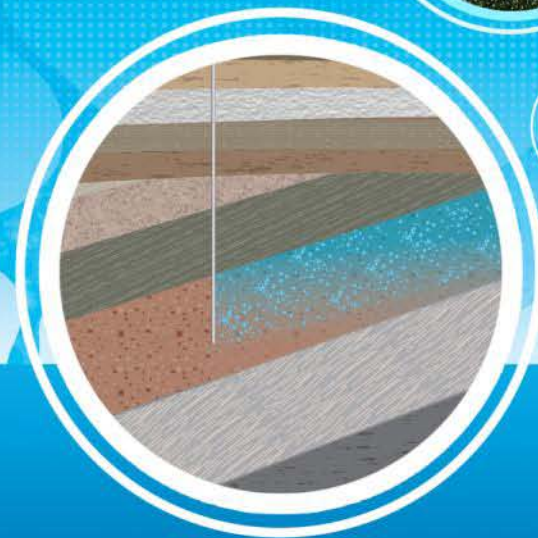


Assurance & integrity monitoring at the CO2CRC Otway Project



Presenter

Dr Mark Bunch

Cooperative Research Centre
for Greenhouse Gas
Technologies (CO2CRC)

CAGS Workshop II
Wuhan, Hubei province, China
28th October 2010

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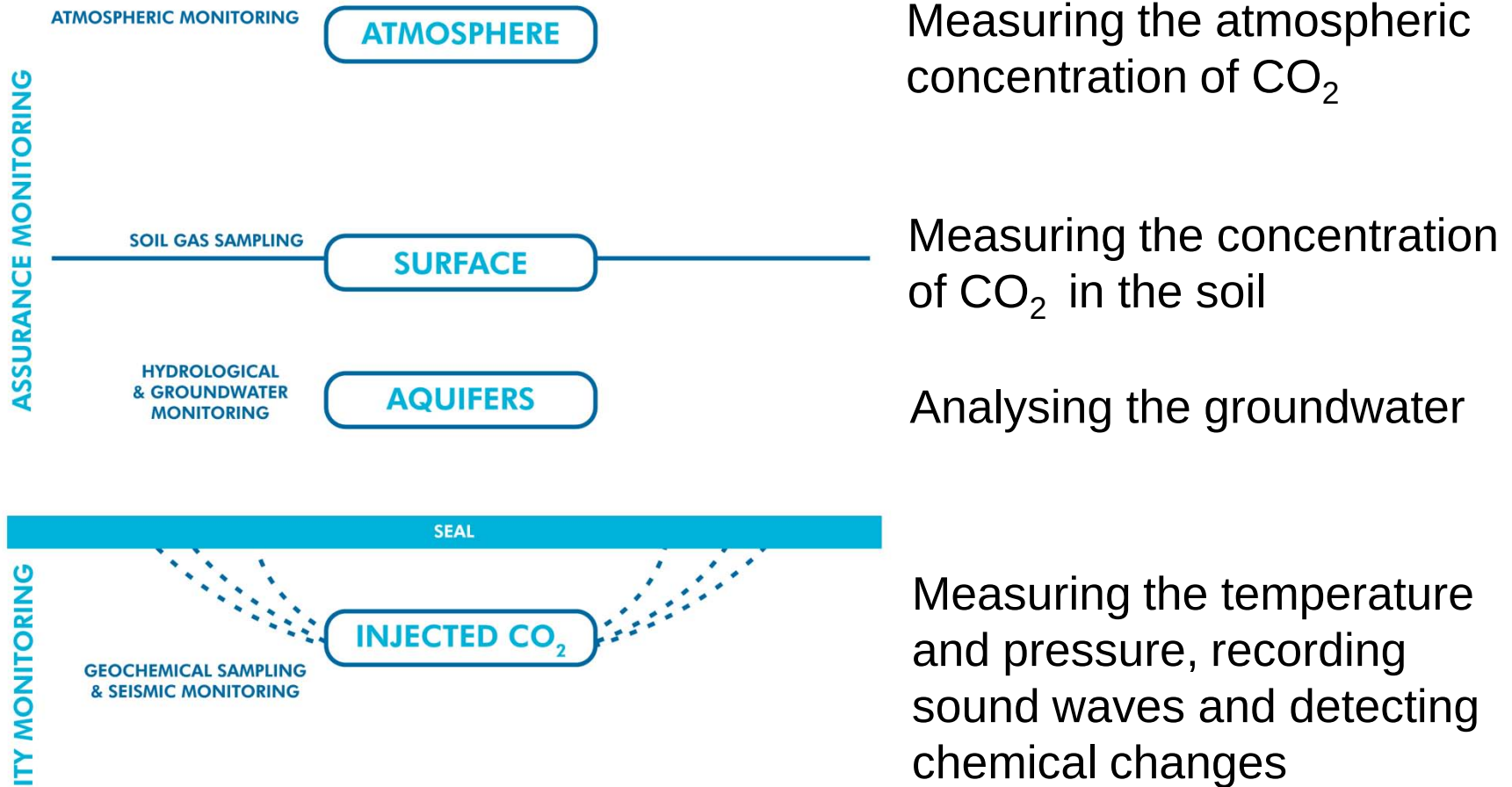
China Australia Geological Storage of CO₂

中澳二氧化碳地质封存

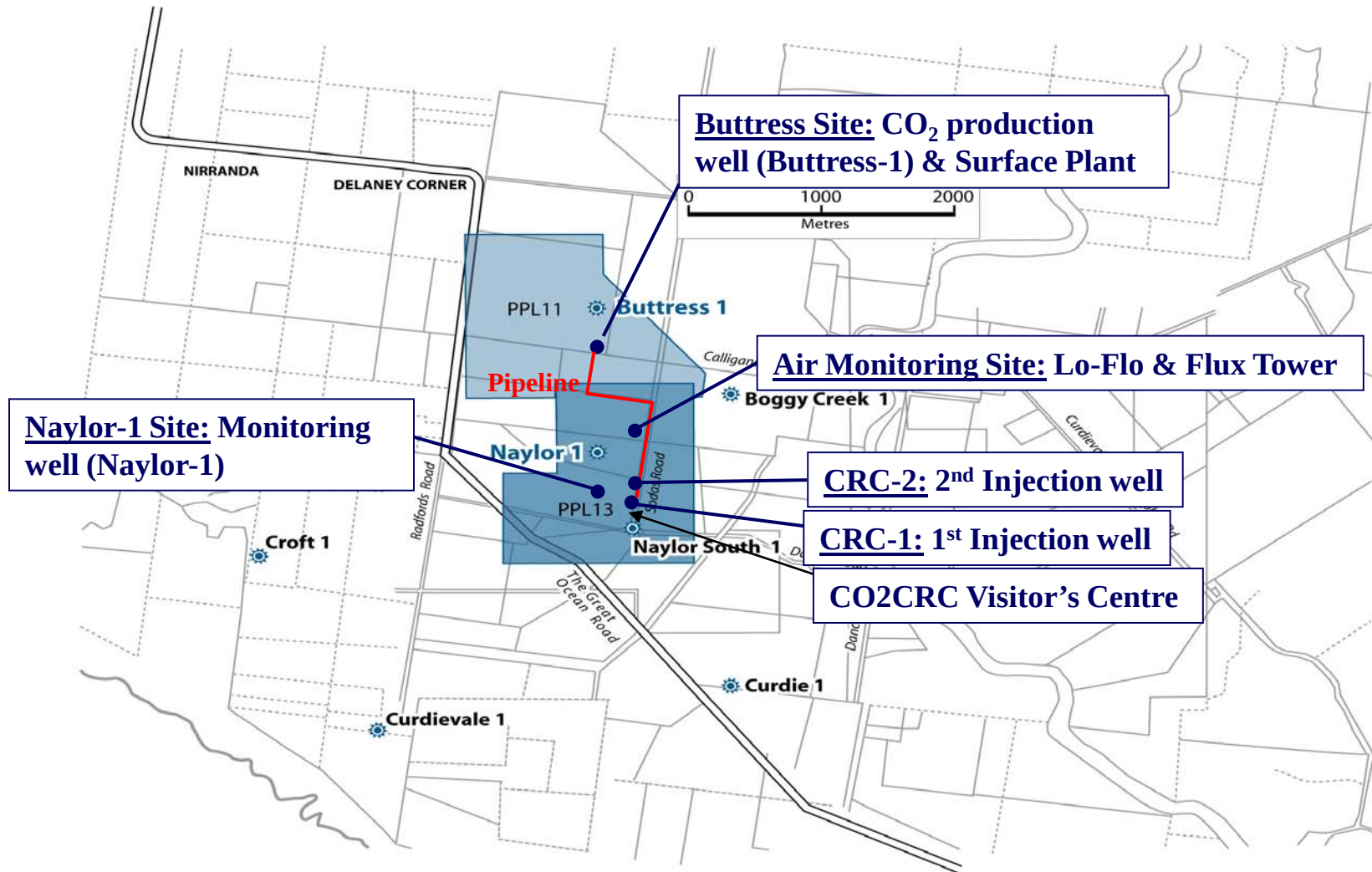
CO₂CRC



Monitoring the injected CO₂



CO2CRC Otway Project facilities



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**Lo-Flo & air
monitoring centre**

Flux Tower

Towards CRC-1 site



Air Monitoring (Lo Flo & Flux Tower)



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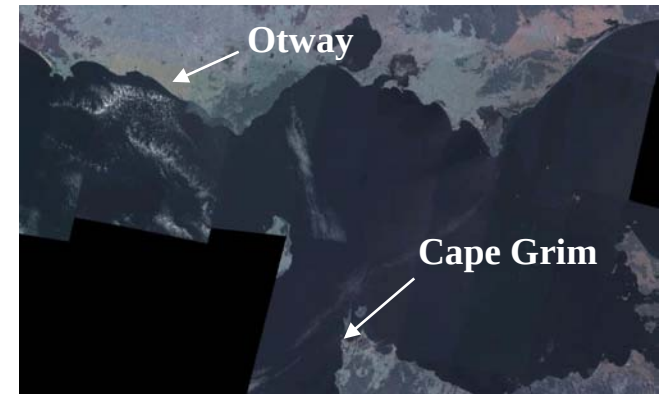
Atmospheric monitoring

Objectives:

To verify that injected CO_2 stays underground; or in the unlikely event of leakage to surface, demonstrate the capacity to detect and quantify surface leakage



Images CSIRO, CO2CRC



Monitoring using CO_2 concentration alone needs ideal conditions, so other species including CH_4 , SF_6 , CO and $^{13}\text{CO}_2$ are monitored to enhance sensitivity

D. Etheridge et al CSIRO

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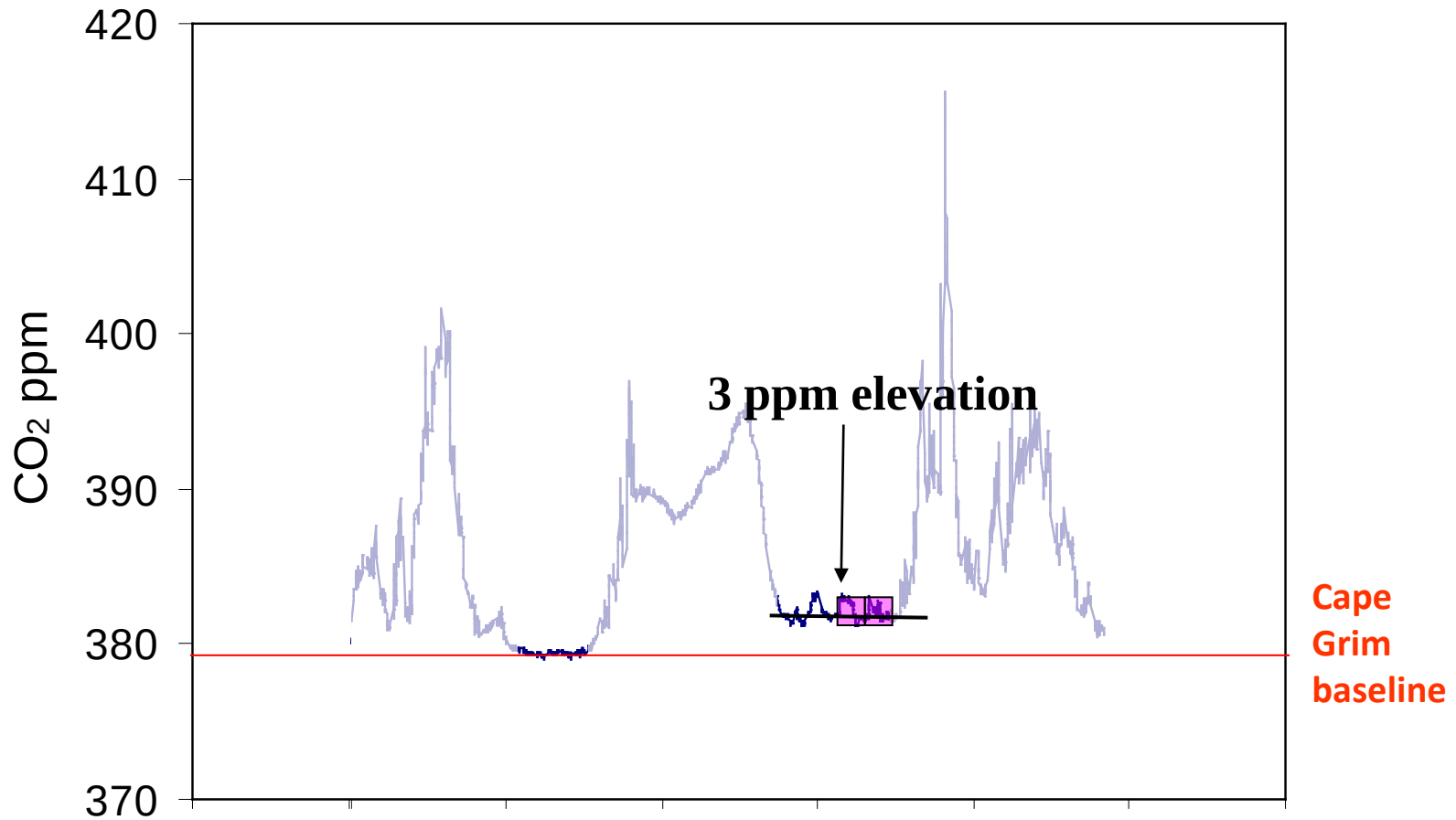
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Atmospheric monitoring



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Soil gas monitoring

Objective:

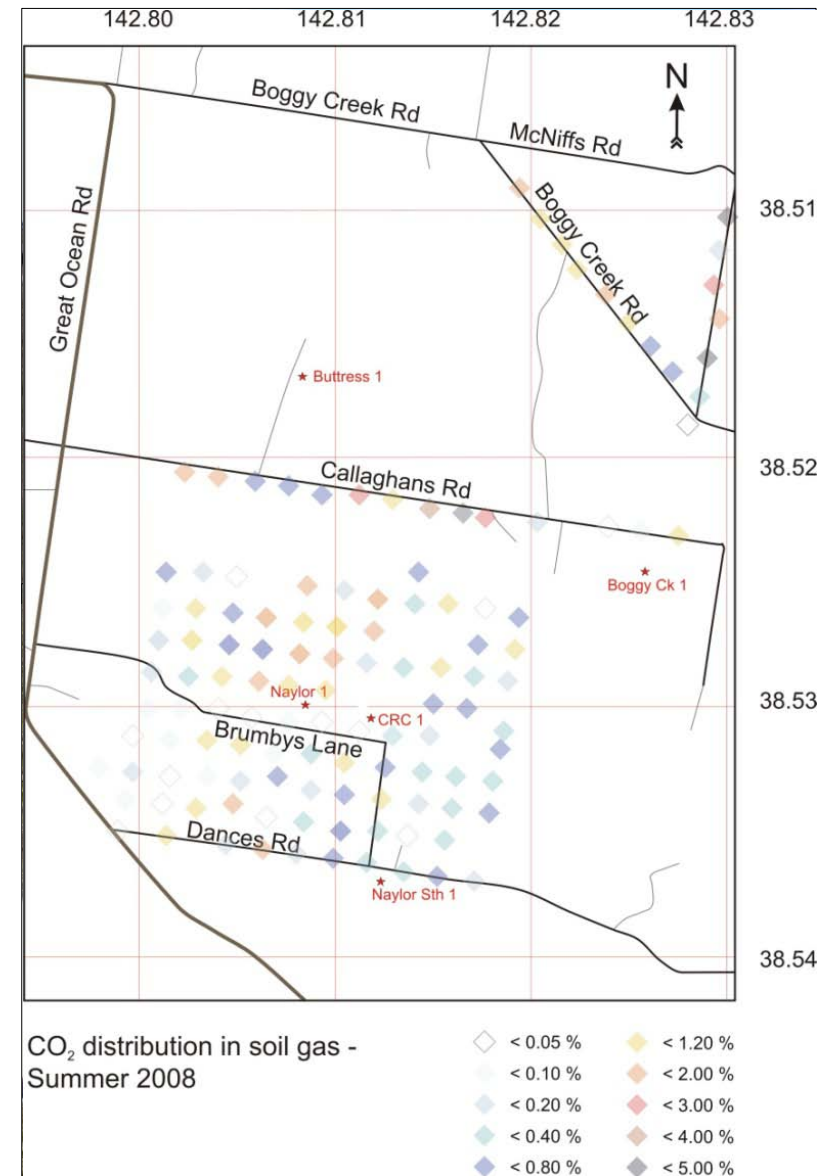
- Establish CO₂ variations within the extended area beyond the CO2CRC tenements
- Determine the likely source of origin
- Differentiate natural from injected CO₂.

Methods:

- The soil gas program extracts air from the unsaturated soil zone above the water table.
- Samples are analysed on site (portable gas chromatograph) and in the laboratory for CO₂, CH₄ and isotopes.

Frequency

- Baseline: Four surveys
- Once a year during and after the injection



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Ground water monitoring

Objective:

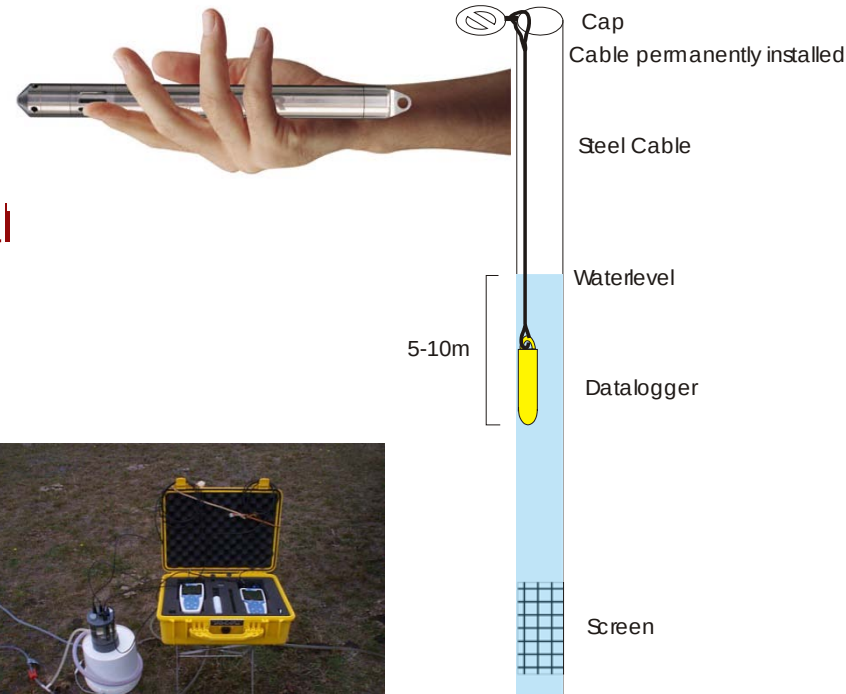
- Monitor water levels to determine seasonal variation, flow rate and direction
- Identify any chemical changes associated with possible CO₂ leakage

Methods:

- Dataloggers
- Water chemistry

Aquifers monitored:

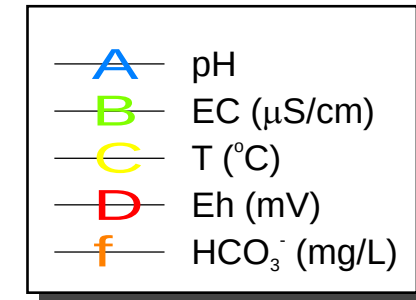
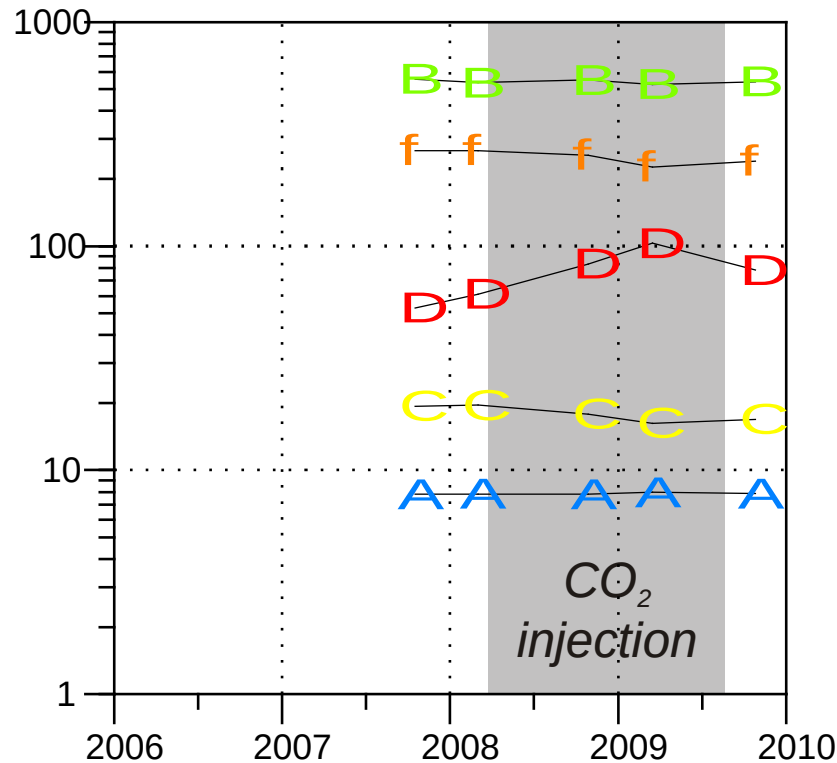
- Shallow unconfined Port Campbell Limestone,
- Deep confined Dilwyn aquifer



Example: Wannon Water Bore



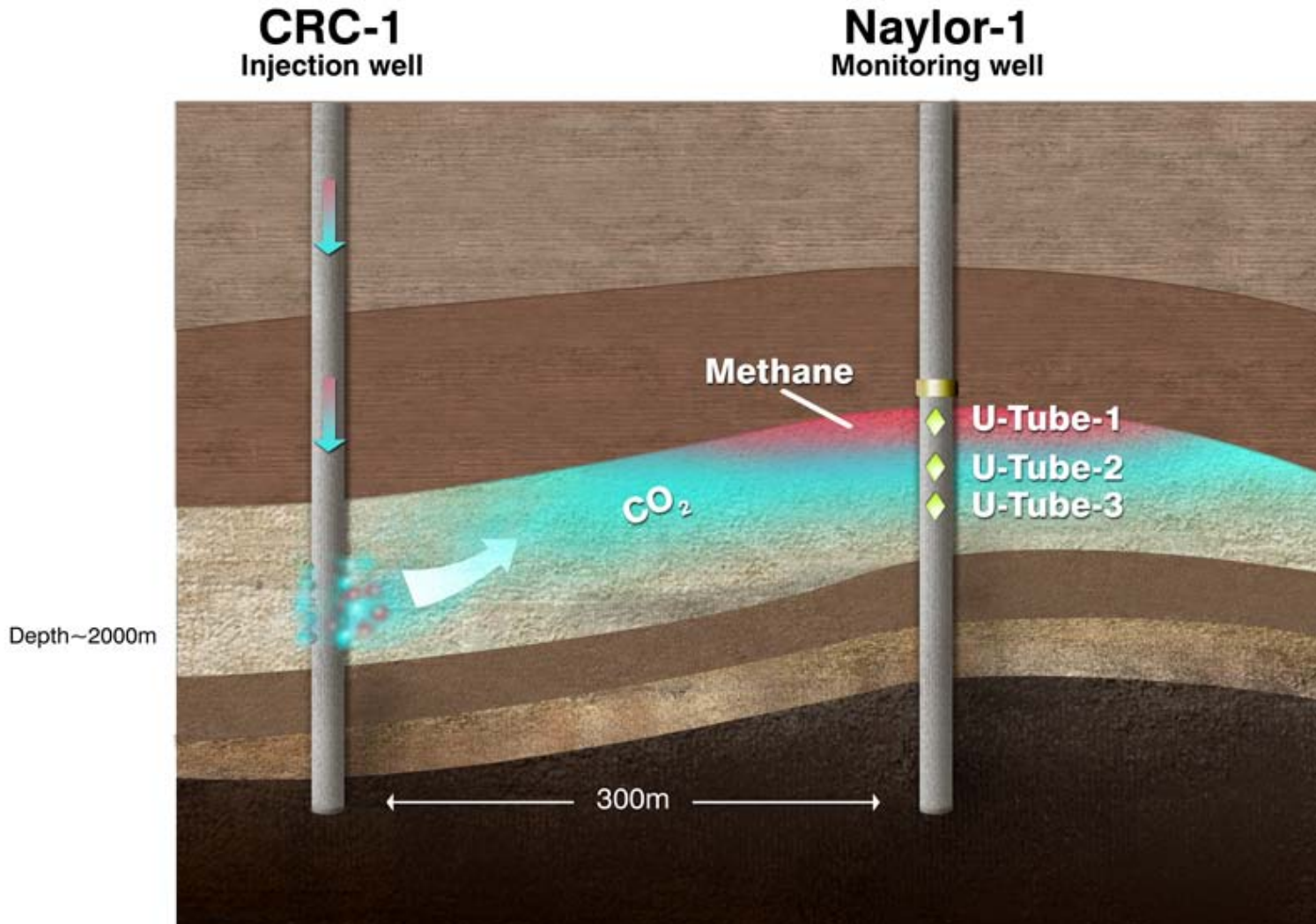
Station V



Dilwyn Formation
TD 826 m
SWL ~13.6 m



Downhole geochemical monitoring



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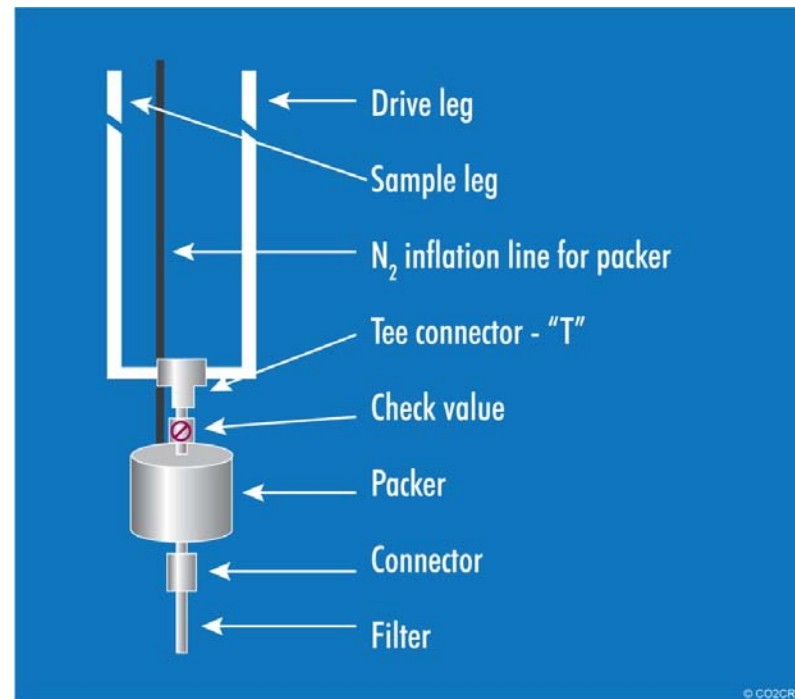
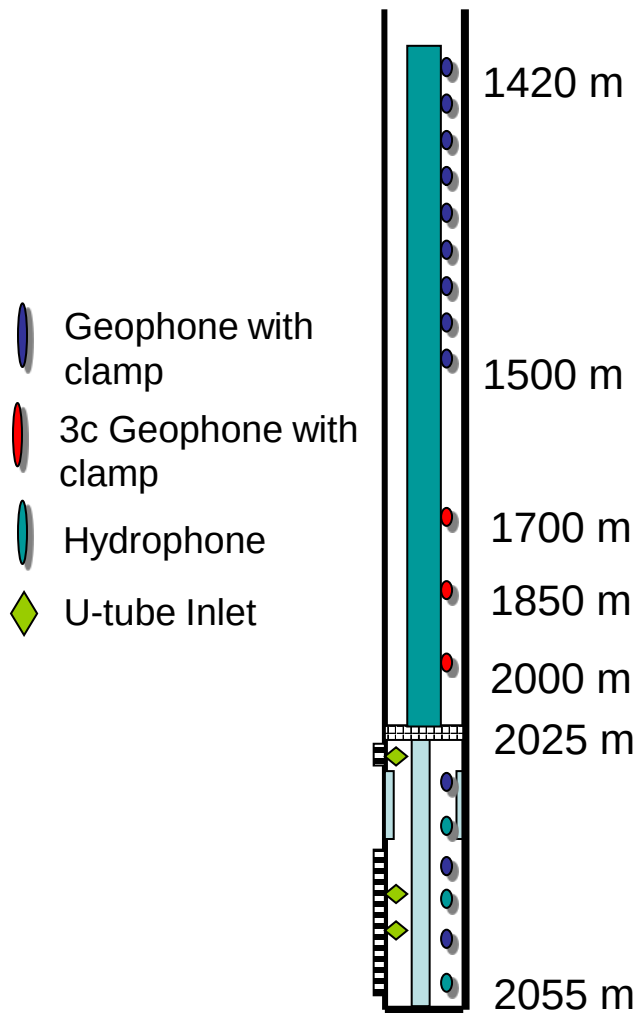


Downhole monitoring

- Fluid sampling
- Use of tracers
- Temperature and pressure



Image, CO2CRC





**U-tube surface facility
(yellow container) -
above**

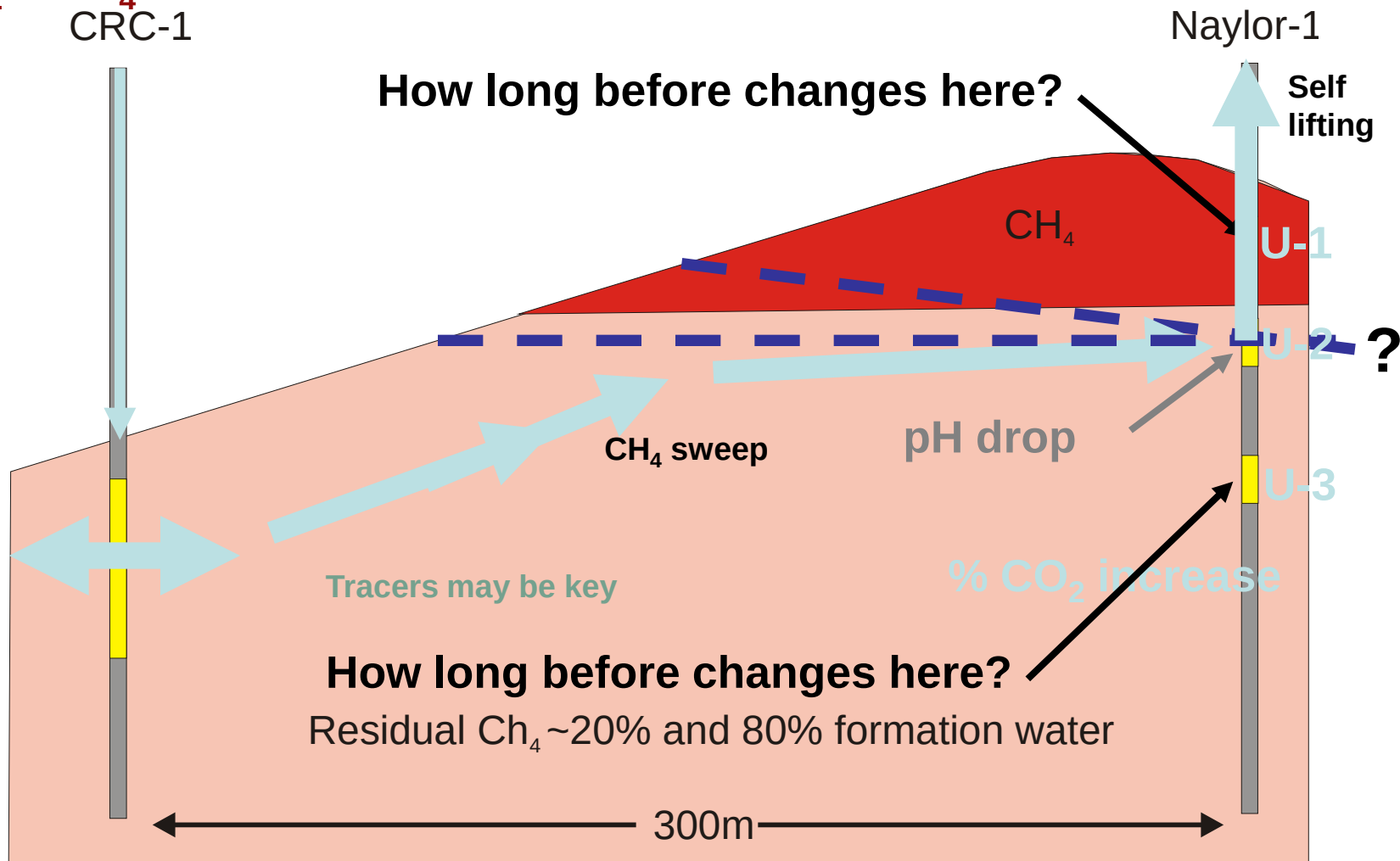
**Isotube sample
cylinder - left**

**Inside the u-tube
surface facility - right**



What should the data tell us?

$\text{CO}_2 + \text{CH}_4 + \text{Tracers}$
CRC-1



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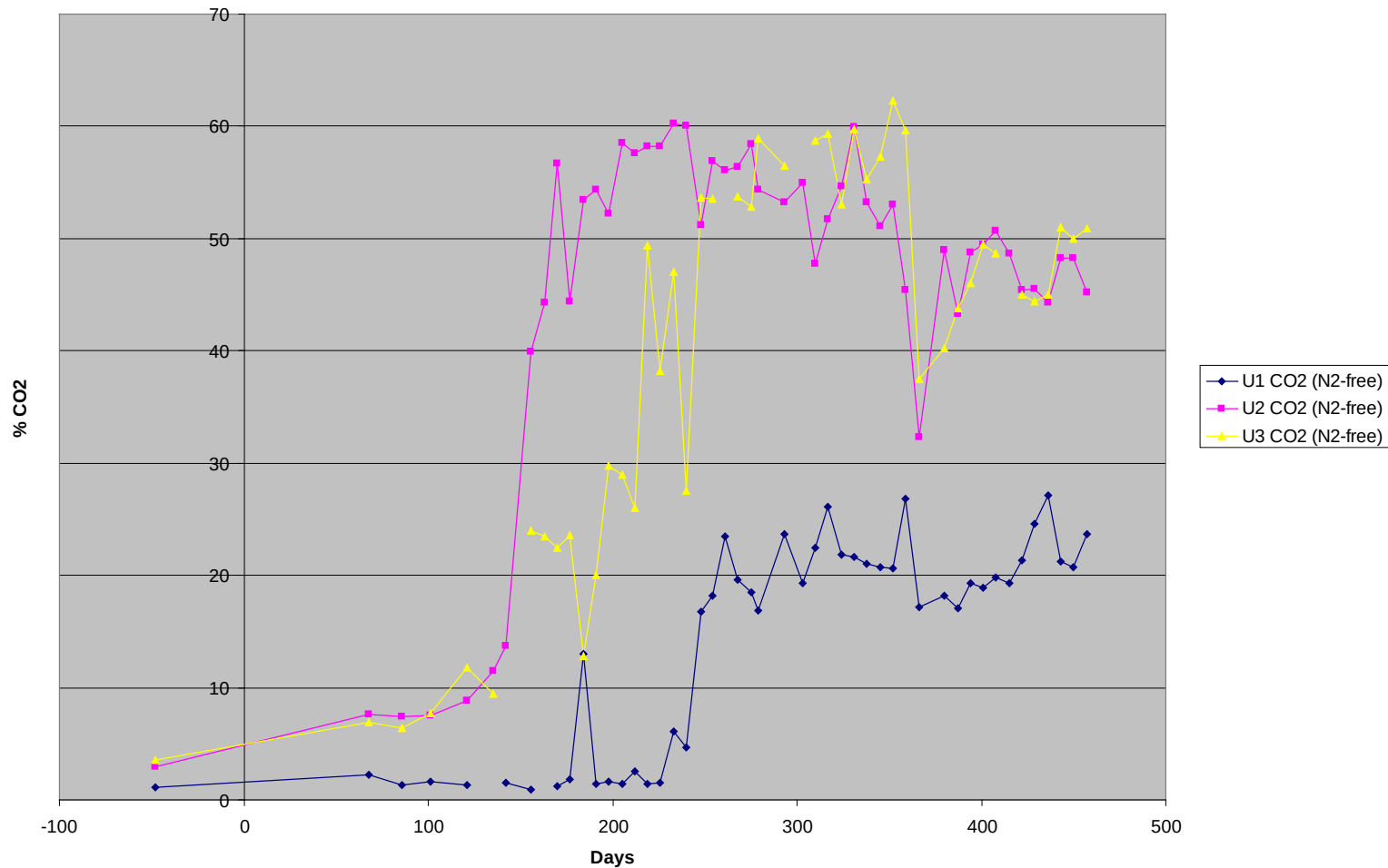
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CO₂ time series from Naylor



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Other monitoring...

- Microseismic activity, deep and shallow
 - Deep sensors never very satisfactory and have now failed
 - Shallow sensors (water well) record continuing low level of activity but cannot localize source
- Pressure sensors in monitoring well
 - Failed immediately
 - Pressure from injection well is used as a substitute but this was a big loss
- Headspace gas
 - In water wells
 - Regulatory requirement; ill-defined measurement



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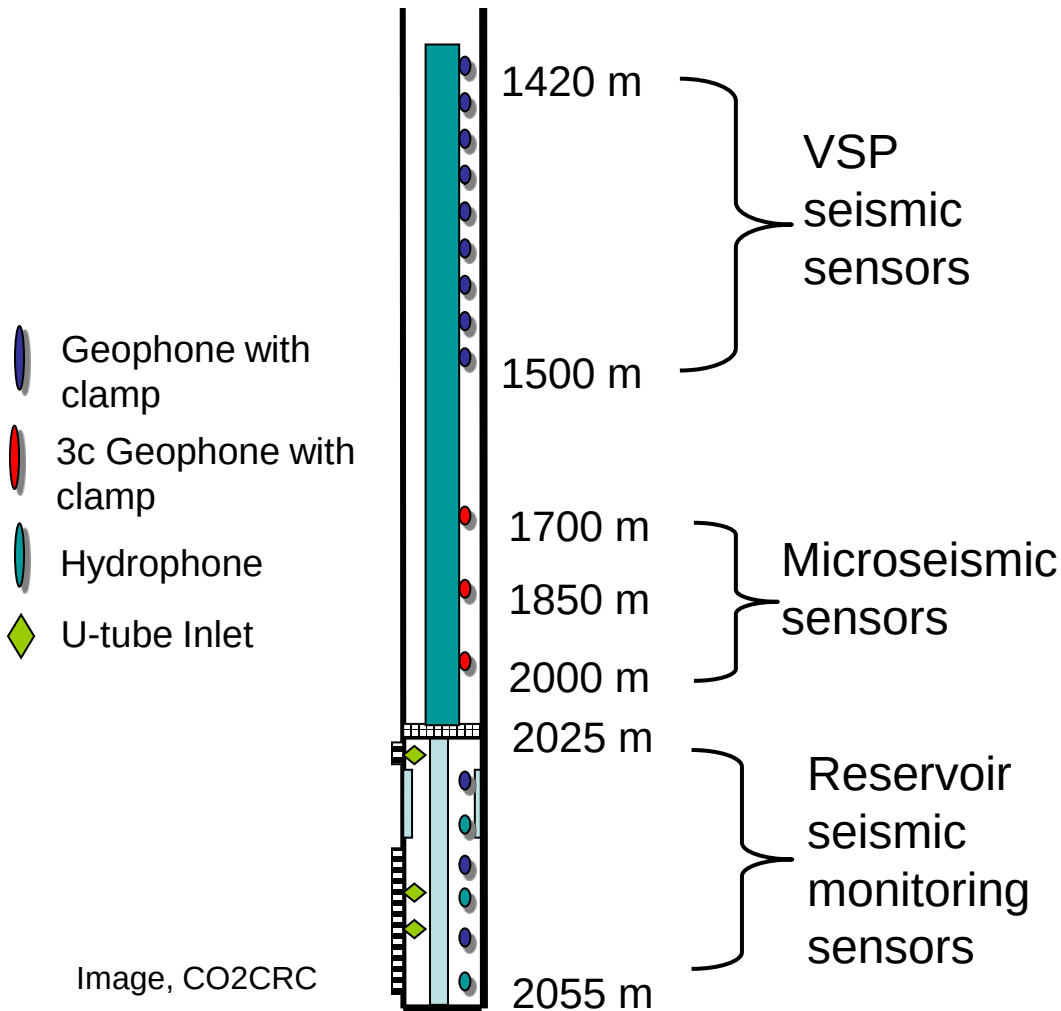


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Downhole seismic monitoring

The permanent array in the CO2CRC Otway project monitoring well



Image, CO2CRC

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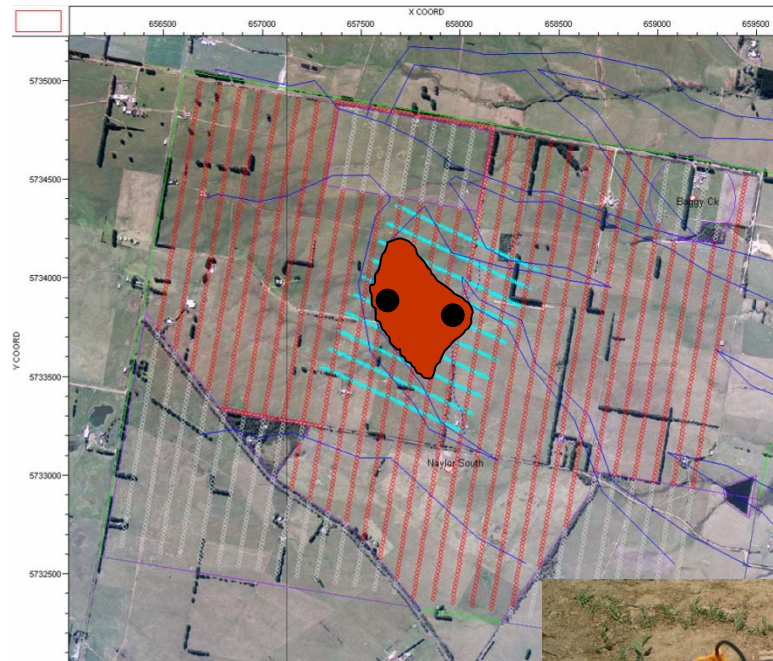


3D surface seismic

Objective: to map the migration path of CO₂ plume from injector to producer

Methods: 4D or time-lapse surveys

Repeatability of surveys before, during and after the CO₂ injection is very important for every aspect of acquisition (source and receivers positioning; source signal; hardware; time of year; processing)

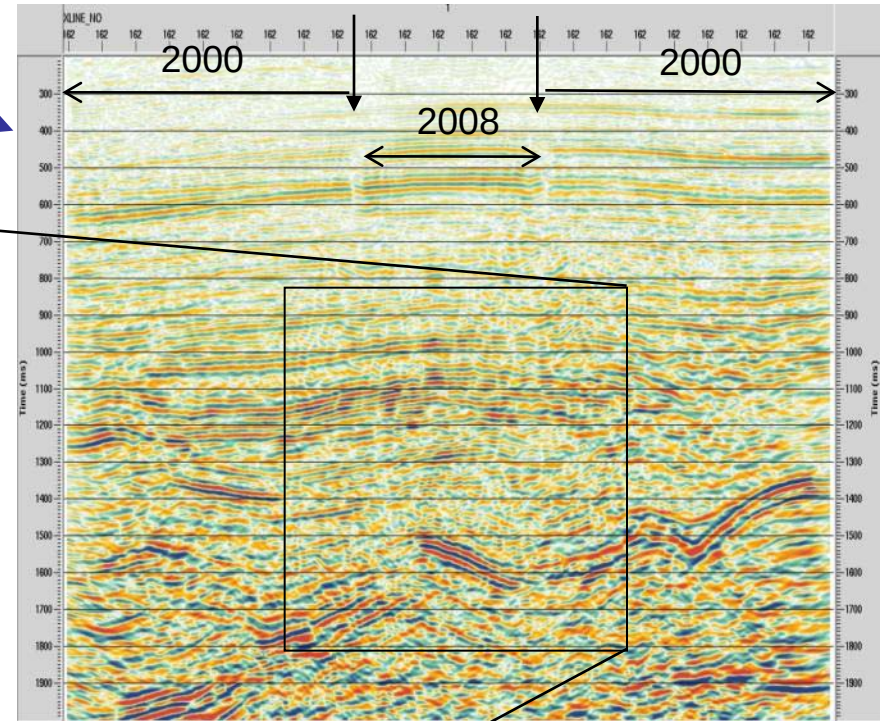
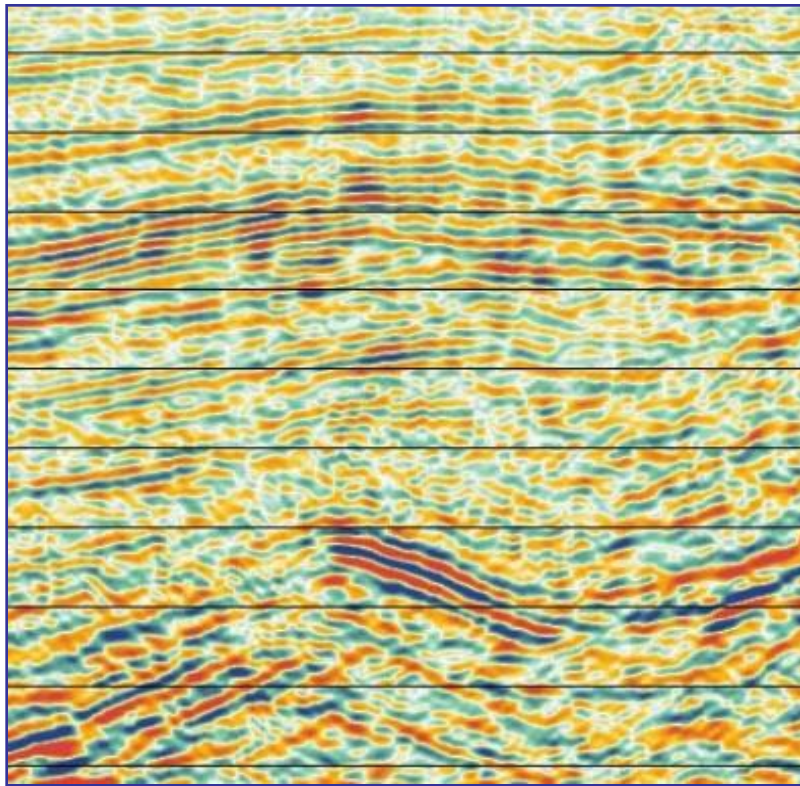


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Time-lapse studies – CO2CRC Otway Project

Updating previous seismic data
with new data from reservoir to
provide baseline data



Pevzner & Shulakova, 08

Images, CO2CRC

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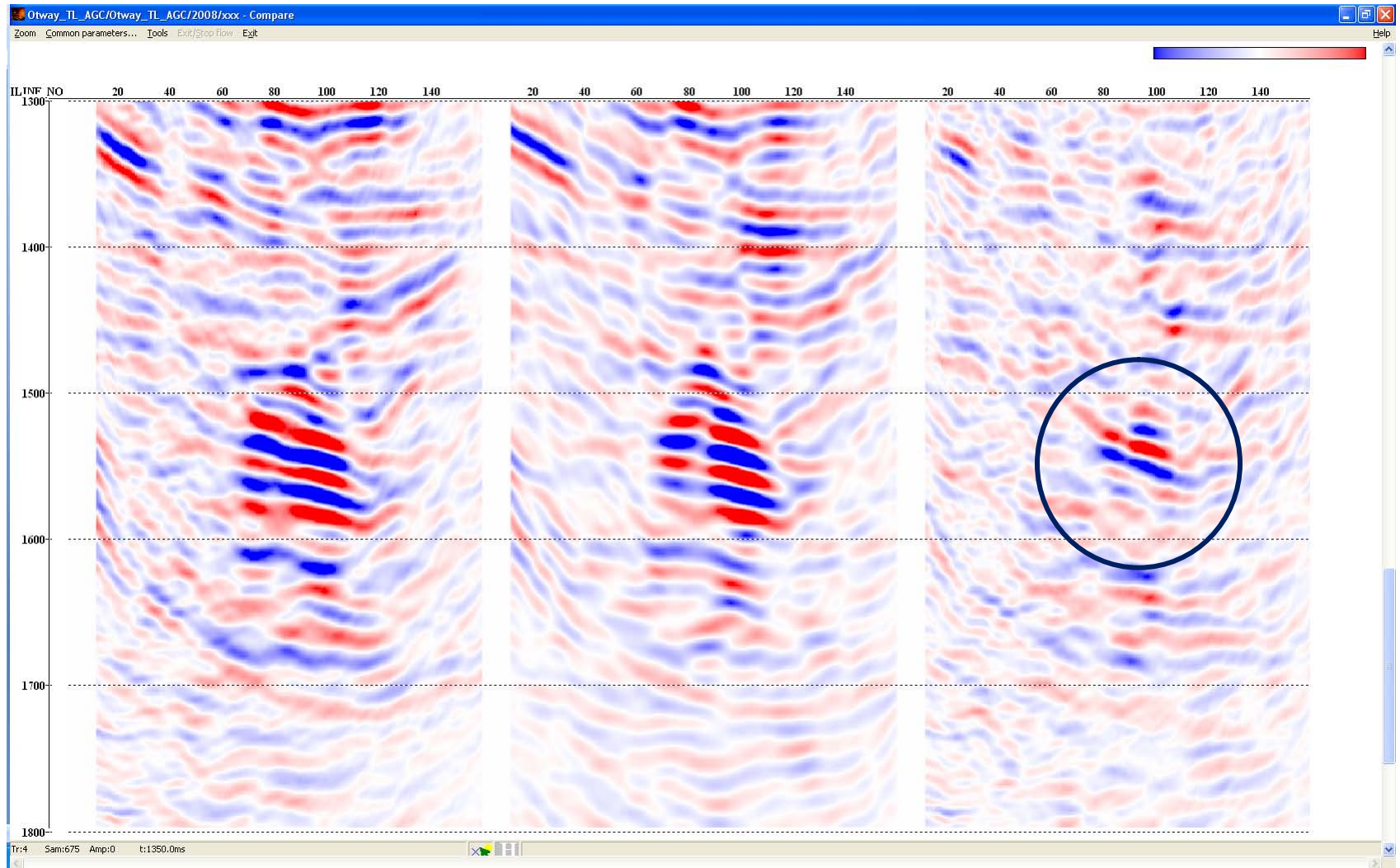
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Xline 81



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Monitoring challenges

- Technical:
 - Detection and imaging of CO₂ plume in the presence of residual gas
 - Short and long term interactions between CO₂ & residual gas
- Other constraints: (onshore)
 - Seismic acquisition (presence of wells / infrastructure) and repeatability
 - Public perception (visible footprint; impact on pasture land)



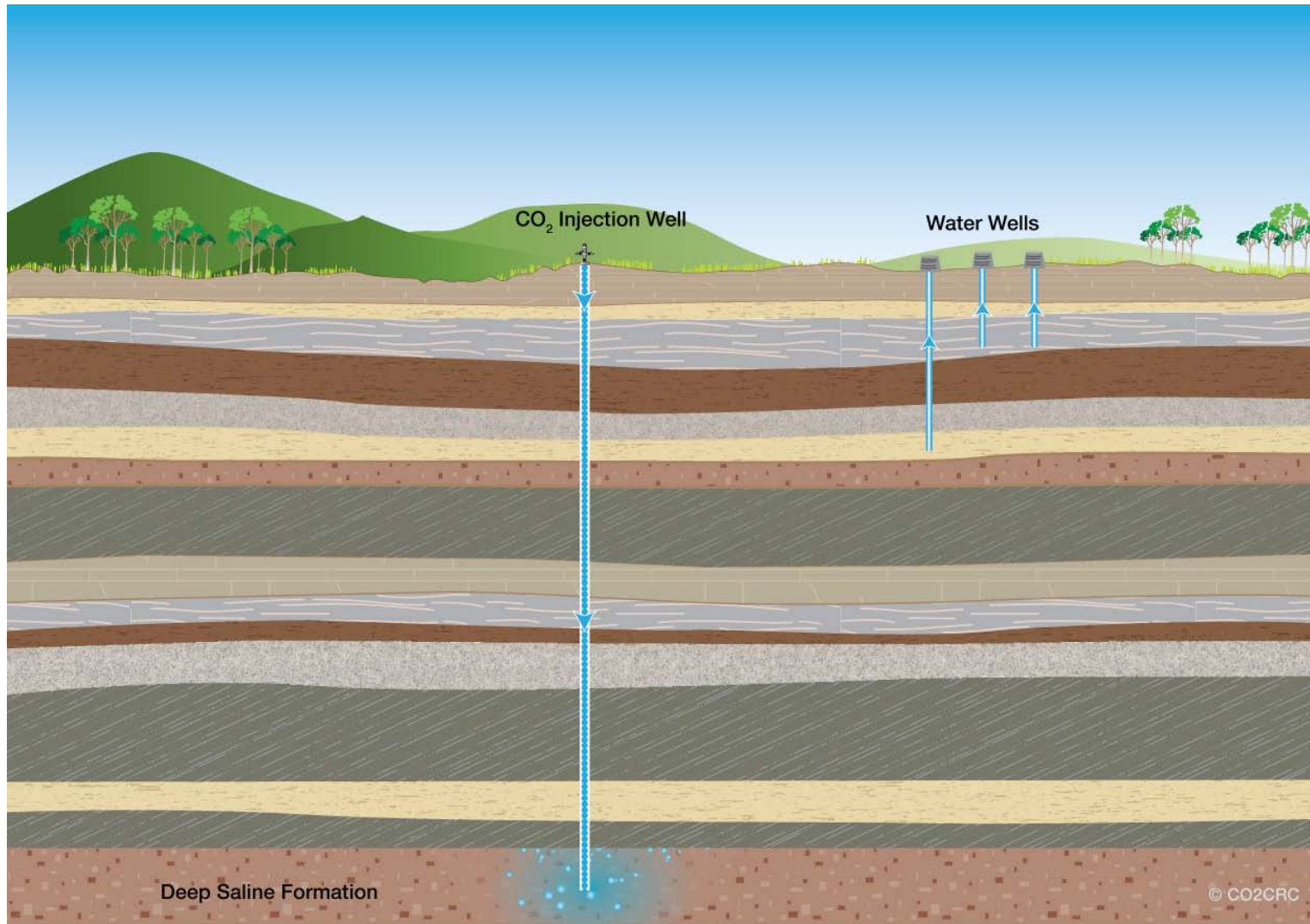
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Storage in deep saline formations



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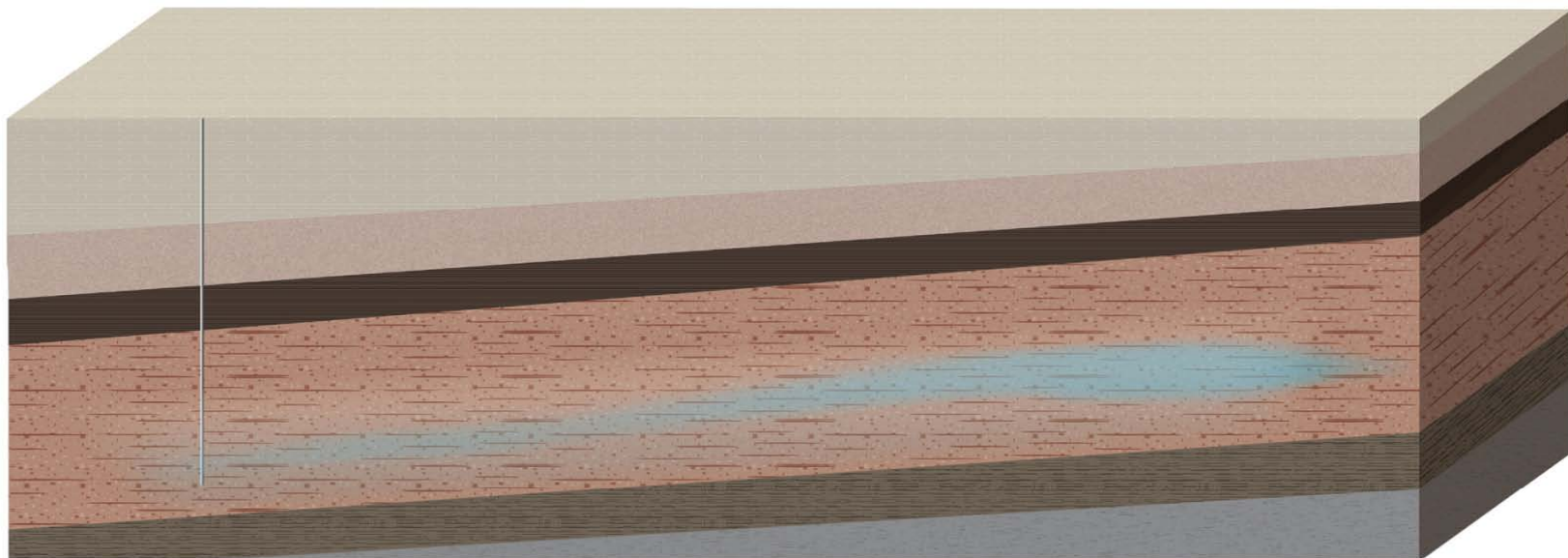
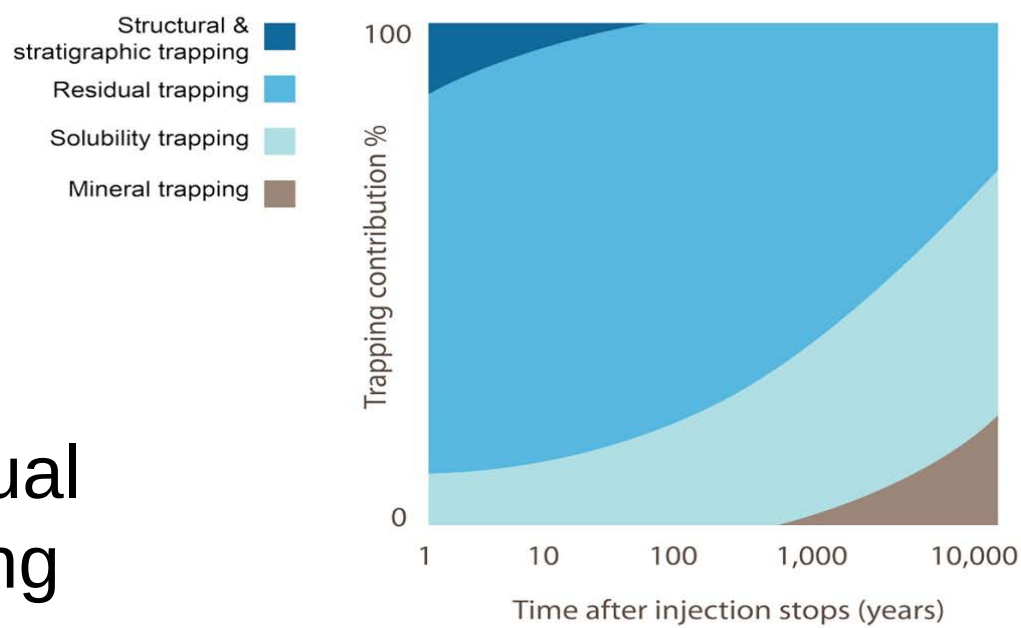
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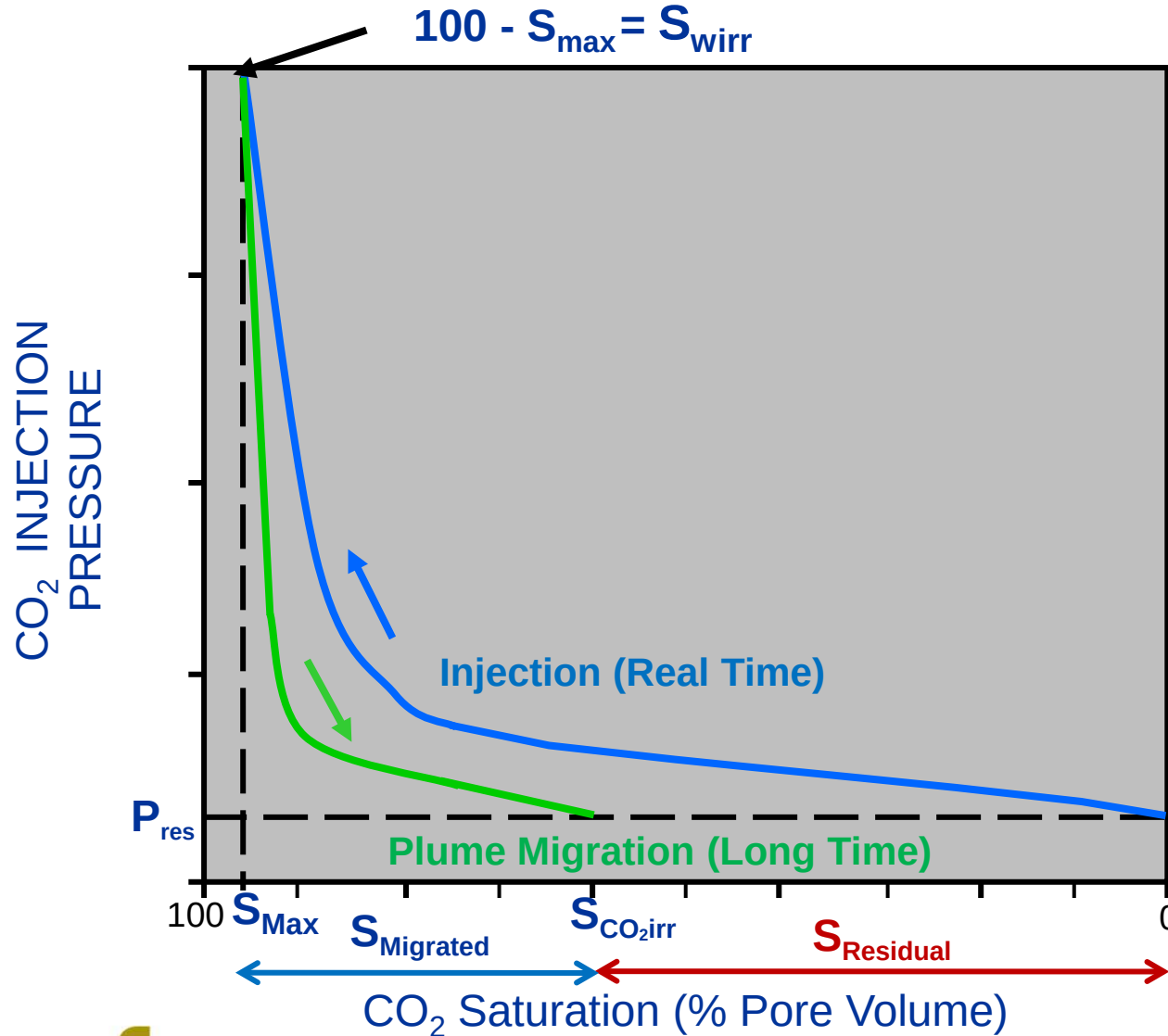


Residual trapping dominates



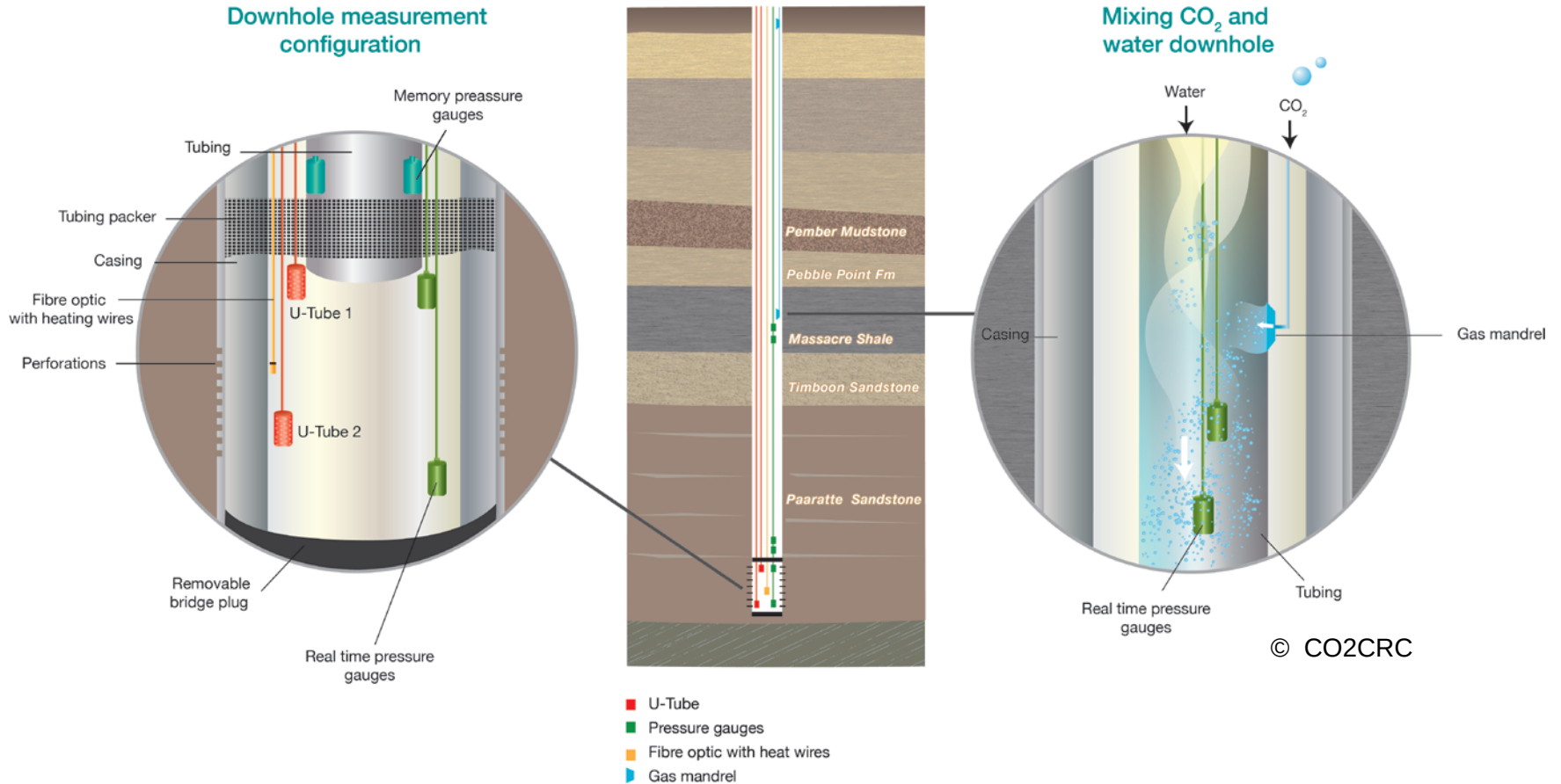
← Kilometres to tens of kilometres →

Residual CO₂ Saturation



Downhole completion at CRC-2

Residual gas saturation test (Otway Stage 2B)
CRC-2 Well



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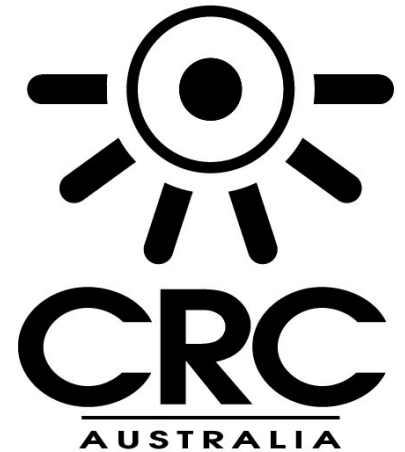


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GAS TECHNOLOGIES



Thank you

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