Monitoring for leaky wellbores

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  • And the project team at CO2CRC Ltd, led by Paul Barraclough
Here’s the problem

Fig. 2. Schematic representation of CO₂ plume migration and possible leakage mechanisms through an abandoned wellbore. (Reprinted from Bachu and Celia (2013), modified from Gasda et al. (2004).)
Monitoring approaches

- Monitor (a) in or on the at-risk well (b) in the at-risk aquifer at some other well (c) remotely (conventional 4D seismic)
- Things to consider
  - What’s the regulatory ask?
  - How real is the risk? What’s the upside/downside?
  - What detection limit might be required, and for how long?
  - Can we get into the well (do we even know where it is)?
  - Might it be less risky to leave it alone?
  - ...less costly to drill a monitoring well?
Options we can consider

- (Focusing on free CO₂, not dissolved which is much harder)
- Atmospheric or soil gas monitoring at the surface
- Look for bubbles (offshore option)
- Instrument the at-risk well with DAS
  - Maybe it’s a well you’re drilling for the project, so that’s (relatively) easy
  - Maybe you re-enter an old well; run DAS on tubing, or cement in place as part of a well abandonment
- Measure pressure in the at-risk aquifer in another well or wells
- Run 3D seismic from time to time ($$$$)
The CO2CRC Otway site
Atmospheric Monitoring

Soil gas – process based method

Schroder et al 2016 IJGGC
Seismic methods – I, continuous VSP on DAS
Some references


Seismic methods – II, simulated acoustic log

Figure 4. CRC-3 well. Inverse amplitude of recorded P-wave versus quantity \((\rho c_p^3)^{0.5}\) estimated from the well logs.

Seismic methods – III, flow behind casing

Figure 5 Maps of RMS amplitudes (relative to the baseline amplitude in the same interval) after injection of 5,000 t, 10,000 t, and 15,000 t (left to right) calculated from the difference cubes (Figure. 4) in 24 ms window centred at 1210 ms. The red solid line shows the location of the fault that appears to be impervious to the injected fluid. Aerial location of the perforation interval in CRC 2 is shown as a grey circle.

Pressure-based methods I: earth tides

After removing injection trend
Pressure-based methods I: earth tides

Analysis by Andy Wilkins, CSIRO
Pressure-based methods II: pressure inversion

Analysis by Chris Green, CSIRO
Summary

• We have multiple ways of monitoring defective wellbores.
• The research opportunities are
  • Being precise about what we’re looking for, without setting impossible goals
  • Quantifying what we can and can’t detect by way of free CO₂
  • Cost and long-term commitment
  • Longevity of subsurface equipment, even fibers.
Thanks for your attention

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