eReport

Issue 23, July 2019

ANLEC R&D Report Summaries

The following reports are available from the ANLEC R&D website:

Surat Basin

Gas ratios of significant use for environmental CCS monitoring

This project examined robustness and cost-effectiveness in method and instrument development for near-surface monitoring. This was accomplished in three steps: a) developing an updated gas ratio matrix for methane-rich sites; b) testing a methodology for quantifying surface emissions using a gas ratio methodology, and c) identifying factors that may limit precision of the quantitative method. The project also provides a technical and economic performance assessment of sensing systems for gas measurement methods on an industrial scale. Researchers concluded that when significant methane exists, such as coal seam gas leakage, an updated matrix which substitutes CO_2+CH_4 for the CO_2 variable in the plots is extremely useful.

This work also tested a methodology for quantifying surface emissions using a dynamic flux chamber with helium sweep gas, together with a Gas Chromatograph, to measure all gases of interest to the process. Two years of data from commercially available sensors deployed at the Glenhaven site were assessed. It found instrumental artefacts resulted in false positives. A recommendation was made for further development and application of Raman scattering technology for implementing gas monitoring and verification that includes monitoring of nitrogen concentrations.

More information: Optimising a process-based approach for near-surface leakage assessment

Headspace monitoring technology not mature enough for monitoring wellbore fluid

Several operators and US state regulators have noted sampling of well headspace is less error-prone than direct water sampling. This project sought to assess whether headspace gas concentration is a simpler and more reliable proxy for dissolved gas concentrations in wellbore fluid. The idea is to use it as an early guide to the presence of CO_2 in any monitoring well prior to the deployment of more sophisticated M&V techniques. Researchers developed analytical methods to study elements of the semi-open system of a gas-water-wellbore, and determine what factors control the headspace gas concentrations. They found that deep monitoring wells will not see dissolved CO_2 within the headspace interval in a reasonable amount of time. The study suggests not to instrument deep wells with headspace gas probes. It recommends only temperature and pressure sensors with deep fluid gathering using U-Tube technology. In the case of shallow, near surface, wells, it is considered that headspace monitoring solely is not a reliable methodology.

More information: Headspace gas monitoring to infer dissolved gas concentrations

Baseline CO_2 concentration model and anomaly thresholds for identifying and investigating CO_2 leakage

A measurement, monitoring and verification (MMV) program for atmospheric CO2 at Queensland's Surat Basin CCS demonstration project must be able to distinguish between natural variations and project related activities. This research developed a robust modelling framework that can be applied to near surface MMV programs. A statistical framework was used to distinguish natural variations in environmental CO_2 data from anomalies that may arise from a CCS project. They present results for setting the anomaly threshold, suggesting an anomaly threshold of 415 ppm, during the mid-morning—

late-afternoon diurnal low, for a sustained period of five days as an appropriate trigger for further investigation.

More information: Anomaly detection threshold setting for environmental baseline

Mid shoreline sandstone identified as a potential good quality storage reservoir above the primary Precipice Sandstone reservoir

The Hutton Sandstone is the first significant regional aquifer above the proposed CO_2 target storage reservoir in the Surat Basin. It can therefore act as a second reservoir in the event of plume migration. Researchers in this project used outcrop mapping, 3D imaging, hyperspectral mapping, borehole wireline and core, seismic data and geostatic models to characterise the Hutton Sandstone. They found three sandstone intervals with potential as good quality reservoirs. The report concludes that the mid shoreline sandstone interval was the strongest candidate of the three, regarding connectivity and predominance of clean sandstone in this interval. This was particularly true within the sandy corridor running NE-SW, where the West Wandoan 1 well is located.

More information: Regional geological study of the Hutton Sandstone

Algorithms developed for improved accuracy of modelling CO_2 dissolution in formation water

Predictions of the dissolution of CO_2 into the formation water are sensitive to spatial dimensions. The use of a large grid overestimates dissolution during the injection period, while underestimating the long-term dissolution by inhibiting convective mixing. The project used a pore-scale model of CO_2 distribution to match observations in cores and examine how to implement it at field-scale. The coupling of geochemical reactions to the convective flow was also considered. Geochemical reactions can increase the dissolution flux by a factor of up to three. Three-dimensional simulations of convective mixing in anisotropic and small-scale heterogeneous models have verified the average dissolution rate. Importantly, when modelling enhanced dissolution due to convective CO_2 mixing, these results suggest that a heterogeneous model of the Precipice Sandstone can be adequately approximated with an anisotropic homogeneous model with effective vertical permeability. The results obtained in this project can be implemented in simulation software to improve the modelling of both short and long-term behaviour of injected carbon dioxide.

More information: CO_2 solubility for dynamic modelling

Gippsland Basin

CO_2 flow modelling for thermal and geomechanical effects of injection in the Gippsland Basin

This research project aimed to refine the predictions of previous studies in the Kookaburra site of the Gippsland Basin. It uses more detailed numerical simulations where additional physical effects are coupled to the flow simulations and predictions of dissolution and residual trapping generally agreed with previous modelling results. The effect of coupling the multiphase flow behaviour to both thermal and geomechanical effects was also examined. This was evaluated using the MOOSE (Multiphysics Object-Oriented Simulation Environment) platform developed by Idaho National Laboratory. The code was first benchmarked against an analytical solution for radial injection of a cold fluid (here CO_2) into a warmer elastic reservoir through a vertical well and very good agreement was found. The key finding was that a pressure increase due to injection causes an initial upward movement of the reservoir-caprock interface on the mm scale. Howerver, at later times there is a downward movement of the interface due to contraction upon cooling by the injected CO_2. The inclusion of more detailed physics, such as the coupling to geomechanical effects, does not alter the key findings that CO_2 injection into the Gippsland basin geology has low potential for geomechanical issues.

More information: Alternative Dynamic Modelling for Structural and Aquifer Traps

Gippsland Basin seabed features better characterised with new scenario models

The project analysed the nature, origin and biological significance of unusual seabed features in the near-shore of Victoria's Gippsland Basin. Researchers conducted field studies and analysis to understand the dynamic seabed processes and their linkages with biotic communities. The results proved that seabed features observed across the study site were not due to saline brine seepage but represent seafloor dunes formed by long-shore currents. This report has summarised major findings from the literature review undertaken at the start of the project to gain an understanding of the study area for the field activities and analysis of data collected. The collection of detailed seafloor characterisation data has permitted the classification of habitats and an understanding of the dynamic nature of the seabed sediments. The collection and interpretation of a large biological community data set represents the most comprehensive data collections over the study area. The data sets and insights gained as a result in the Gippsland region and study area will form a valuable baseline which will inform future monitoring programs.

More information: Seabed processes in the Nearshore Gippsland Basin

---

Southern Perth Basin

Characterising sources of reservoir heterogeneity in the Wonnerup Member, Southern Perth Basin

One of the most significant uncertainties for safe storage in the Southern Perth Basin's Lesueur Formation is predicting vertical flow rate of buoyant CO_2 through the Wonnerup Member. This project characterised sources of reservoir heterogeneity in the Wonnerup Member, looking at their impact on injectivity, vertical migration and containment of CO_2 via integrated reservoir characterisation and reservoir simulations. Core analysis, using Computerised Tomographic (CT) images, indicates existence of strong permeability anisotropy in the horizontal direction which can impact flow behaviour. The study also produced an interpretation of the facies, using unsupervised machine learning techniques, from well log signatures over intervals without core. Results of this study show quartz overgrowth and pore-filling kaolinite significantly reduce the permeability with increasing depth. Researchers concluded that the results are encouraging for the Lesueur as a potential storage site and uncertainties can be further resolved through new data collection.

More information: The influence of heterogeneity and diagenesis on injectivity and containment in the Wonnerup Member

---

ANLEC R&D is a member of the following IEA implementing agreements. For access to their reports, please contact admin@anlecrd.com.au

IEA Clean Coal Centre Reports

1. Barnes, I (2019). "HELE technologies in Japan and South Korea"
2. Zhang, Z (2019). "Support mechanisms for cofiring biomass with Coal"

IEAGHG R&D Program Reports

1. IEAGHG (2019) Sustainability in Petrochemicals
2. IEAGHG (2019) Towards Zero Emissions CCS in Power Plants Using Higher Capture Rates or Biomass
3. IEAGHG (2019) Review of Fuel Cell Technologies with CO_2 Capture for the Power Sector