

Australian Government Geoscience Australia

Assessing the Energy Resources Potential In Underexplored Regions: Eastern Central Australian Examples

Barry Bradshaw, Tom Bernecker, Jeremy Iwanec, Keith Bradey, David Lund, Mike Szczepaniak

Geoscience Australia



Geoscience Australia's Resource Assessment Programs



Regional-scale programs to assess the prospectivity and data/knowledge gaps of stacked basins for multiple resources, including:

- hydrocarbons (conventional & unconventional)
- geological storage of CO₂
- hydrogen (green & blue)
- groundwater
- AFER Project (EFTF Program) assessing the Pedirka, Simpson & western Eromanga basins
- TEGI Program assessing the Cooper, Adavale, Galilee, North Bowen and overlying basins (Eromanga and Eyre)



Geoscience Australia's Resource Assessment Programs



- Underpin assessments of potential environmental impacts and hazards associated with future resource developments
- Ensure regulator-supported data and information is available to enable informed decisions on resource development and land use



- Systematic assessment of multiple resources for each play interval using criteria for the relative prospectivity of the key risk elements associated with each resource
- Composite play stack maps generated through spatial analysis (stacking) of all play risk elements







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Structural Complexity

CO2 Storage Assessment – Eromanga Basin



AFER: 3 year basin study & assessment including:

- New depth-structure & isopach grids underpinned by reprocessed seismic
- Post-drill analysis of 41 wells
- Petrophysics analysis of 25 wells to date (more planned)

TEGI: 6 month assessment using existing data:

- No post-drill analysis (~5,000 wells in AOI – not practical)
- Vshale analysis from 127 wells (Norton & Rollet, 2022)
- Petrophysics data (PEPS & QPED data downloads)
- Vizy & Rollet (2022), NGMA (2002) grids

CO2 Storage Assessment – Namur-Murta Play (Eromanga Basin)



 Evidence for 'leaky' intraformational seals in underlying fluvio-lacustrine play intervals – Namur Murta best option for CO2 storage based on regional geological criteria





Regional Play-Based CO2 Storage Assessments

Residual Gas Saturation Trapping Mechanism



- Assessing the potential for large-scale (1 Mt/year or greater) geological storage projects using long-distance migration from injection sites over the flanks of structural culminations
 - residual gas saturation trapping and dissolution trapping
 - prospectivity = probability of geological success (Pg) for play
- Depleted fields excluded from assessment (identified resources vs yet to find resources)



Storage Efficiency Play Risk Element

- Where are the most suitable geological conditions for relatively high sub-surface storage capacities?
- The ideal conditions are areas where supercriticial conditions occur and porosities are high:
 - rarely an overlap of high density and high porosity in the Eromanga Basin as





Storage Efficiency Play Risk Element



Storage Efficiency Play Risk Element – Namur-Murta Play Interval



- Suitable porosities and CO₂ densities for storage occur over the Poolowanna Trough, Cooper Basin, and western parts of the Adavale Basin areas
 - Maximum Play Pg assessed as 80 to factor in relatively low CO₂ densities in the Eromanga Basin
- Elsewhere, depths are below supercritical storage depths & unlikely to be suitable for storage despite high porosities

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Injectivity Play Risk Element

- Permeability thickness is used to evaluate the play risk element of injectivity:
 - high prospectivity where k x h exceeds 100 darcy-metres
 - > moderate prospectivity k x h 10 –100 darcymetres
 - Iow prospectivity where k x h is less than 10 darcy-metres
- AFER AOI assessed using post-drill analysis and petrophysical analysis
- TEGI AOI assessed using permeability modelling together with Vshale data (Norton and Rollet, 2022)



Estimating Permeability Thickness – (Namur-Murta Play)

- Mean & median permeability data used to generate permeability vs porosity functions
- Mid and high case permeability thickness maps were then generated by applying the best fit porosity vs permeability functions to net sand thickness maps





net sand thickness

•	<10m
0	10-50m
0	50-100m
•	>100m

- Results show the range of potential permeability thicknesses in any area
 - moderate low in troughs over Cooper Basin
 - moderate to high over structural highs in Cooper Basin and above the Adavale Basin





Injectivity Risk Assessment – (Namur-Murta Play)



- Suitable permeability thicknesses for commercial scale injection are likely to occur in the play interval above much of the Cooper and Adavale basins
 - further work required to refine understanding of permeabilities in troughs (e.g. Nappamerri Trough)
- Western Eromanga Basin likely to have suitable permeability thicknesses in most areas except the Poolowanna Trough axis
 - further work required to incorporate full amalgamated sandstone section in underlying plays

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Containment Play Risk Element

>100m net shale & siltstone from fluvio-lacustrine shales & siltstones (Murta Fm) & shale-prone shallow marine shales & siltstone (Cadna-owie Fm) Play Pg = 95



<50m net shale & siltstone from sandprone shallow marine shales & siltstone (Cadna-owie Fm) **Play Pg = 50**



- Containment is evaluated based on consideration for the presence of an effective top seal using the following criteria:
 - high prospectivity where net shale & siltstone is >50m
 - > medium prospectivity where net shale & siltstone is 15 – 50m
 - low prospectivity where net shale & siltstone is <15m
- Post-drill analysis used over the AFER assessment area
- Vshale data used over TEGI assessment area

Containment Risk Assessment – (Namur-Murta Play)



- Effective containment is provided by lacustrine shales from the Murta Fm & shallow marine shales from the Cadnaowie Formation over most of the western Eromanga Basin and Cooper-Eromanga basin areas
- Seal effectiveness deteriorates to
 the north-east where the Murta
 and Cadna-owie shales thin and
 become more sand-prone
- Thick marine shales from the Wallumbilla Formation provide an effective regional seal beyond the zero edge of the Cadna-owie

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Structural Complexity Play Risk Element – Cooper-Eromanga

The structural containment risk element aims to evaluate areas where the structural architecture may be unfavourable for geological storage (potential leakage pathways) using the following criteria:

- structural depressions without faults Play Pg = 90
- > structural highs with trapped hydrocarbons Play Pg = 80
- > structural highs with dry valid structures Play Pg = 75
- > structural highs with known faults Play Pg = 50
- > open drainage cells linked to outcrop Play Pg = 50





Structural Complexity Play Risk Element



- The structural complexity of the Eromanga Basin is generally suitable for geological storage above the Cooper Basin
 - main uncertainty is faulted structural highs that haven't trapped hydrocarbons (e.g. Durham Downs Anticline)
- More uncertainty for the Eromanga Basin over the Galilee Basin area due to open drainage cells providing potential pathways to surface outcrops

Structural Complexity Play Risk Element



- The western Eromanga Basin has a favourable structural architecture for geological storage over the Poolowanna Trough
- More uncertainty over the western part of the assessment area
 - faulted structural highs along the Dalhousie-McDills Ridge (DMR)
 - open drainage cells to the surface over western flanks of the Eringa Trough

Namur-Murta Play – CO2 Geological Storage Assessment



- Stacking the 4 risk element layers shows the Namur-Murta play interval is likely to have high prospectivity for geological storage above:
 - the Cooper Basin
 - the western part of the Adavale Basin
 - the eastern and western flanks of the Poolowanna Trough

Namur-Murta Play – CO2 Geological Storage (Weakest Links)



- Weakest link map highlights some of the key risks & areas to focus further studies
- The weakest link in high prospectivity areas is generally injectivity (uncertain permeabilities) & storage efficiency (porosities often <20%)
 - address through targeted petrophysical analysis
- Structural complexity often a localised risk in high prospectivity areas
 - address through PDA & structural modelling
- Low prospectivity generally due to depths below supercritical storage, thin seals & open drainage cells

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Where To From Here?

AFER Project (Pedirka, Simpson, Western Eromanga)

- Resource assessments for hydrocarbons (conventional & unconventional) & geological storage
 - Qualitative assessment data package available end 2023
 - Quantitative assessment fact sheets June 2024

TEGI Program (Cooper, Adavale, Galilee, Nth Bowen, Eromanga)

- Resource assessments for hydrocarbons (conventional & unconventional), geological storage, & hydrogen
 - Qualitative assessment data package and fact sheets anticipated release by end 2022/23 FY
 - Contact: Dr Sarlae McAlpine (Director), Strategic Basins Section,

Geoscience Australia Sarlae.McAlpine@ga.gov.au



 $\underline{https://communities.acs.org/t5/Upcoming-Webinars/Crossroads-of-Chemistry-Decisions-Opportunities-and-Finding-your/ec-p/89085$

Acknowledgements – GA's TEGI Program Resource Assessment Specialists

Galilee & Adavale Basins

• Darren Ferdinando (now at Talon Energy Ltd)

Cooper Basin

• Robin O'Leary (now at Armour Energy)

North Bowen Basin

• Mitch Furnass (now at ExxonMobil Australia)

Hydrogen Resources

• Stephanie Rees (Geoscience Australia)

