Australia's National Science Agency

SURFACE AND GROUNDWATER

GISERA | Gas Industry Social and Environmental Research Alliance

Assessment of sub-surface faults as potential connectivity pathways in Narrabri, NSW

This scientific research project assessed sub-surface faults in the proposed Narrabri gas project development area in NSW, to improve understanding of regional geological formations and structures and their relationship with important groundwater resources.

Key points

- This research project addresses community, industry and government concern about potential groundwater impacts associated with proposed gas development activity.
- This project used an integrated scientific approach that combines historical evidence, geophysical techniques and environmental tracers.
- Study results help to minimise uncertainty around the presence or otherwise of faults and other geological structures within or near the Narrabri gas project area.
- Faults can form barriers or conduits to groundwater flow depending on fault zone properties.
- Outcomes from this study can help to improve the accuracy of future Narrabri region groundwater models.

This research was commissioned in response to community concern around the potential for onshore gas development in the nearby Pilliga State Forest to affect environmental values including biodiversity, groundwater quality and quantity, and groundwater dependent ecosystems.

Santos has been granted approval for progressive development of a coal seam gas field over 20 years with up to 850 gas wells and ancillary infrastructure, including gas processing and water treatment facilities.

Finding faults

Geological structures (e.g. faults) exist in most sedimentary basins around the world where coal or gas resources are developed.

To assess the potential impacts of gas resource developments on water resources, it is important to understand the role of sub-surface architecture and geological structures.

This study used an integrated scientific approach to determine if any fault zones exist within or near the Narrabri gas project area.

Using a combination of historical evidence, geophysical techniques and environmental tracers CSIRO researchers assessed the potential for identified faults and geological formations to either connect or isolate deep coal seam gas target formations with Great Artesian Basin hydrogeological formations, shallow aquifers or surface water systems.

CSIRO | Australian Government Department of Industry, Science, Energy and Resources | Queensland Government | NSW Government | Supported by Government of South Australia | Northern Territory Government | Australia Pacific LNG | QGC | origin | Santos

Previous studies

Previously there have been conflicting views on whether faults extend to the surface in the Jurassic formations of the Surat Basin in the Narrabri region of NSW, and whether they can form “seal bypass structures”.

A seal bypass structure is a fault or other type of geological structure (e.g. igneous intrusion) that creates a connecting pathway that may allow groundwater or gas to move between geologic formations.

Most previous studies argue that faulting is largely absent in the Surat Basin strata in NSW and suggest that faults are unlikely to have a significant influence on shallow groundwater systems in the Narrabri area.

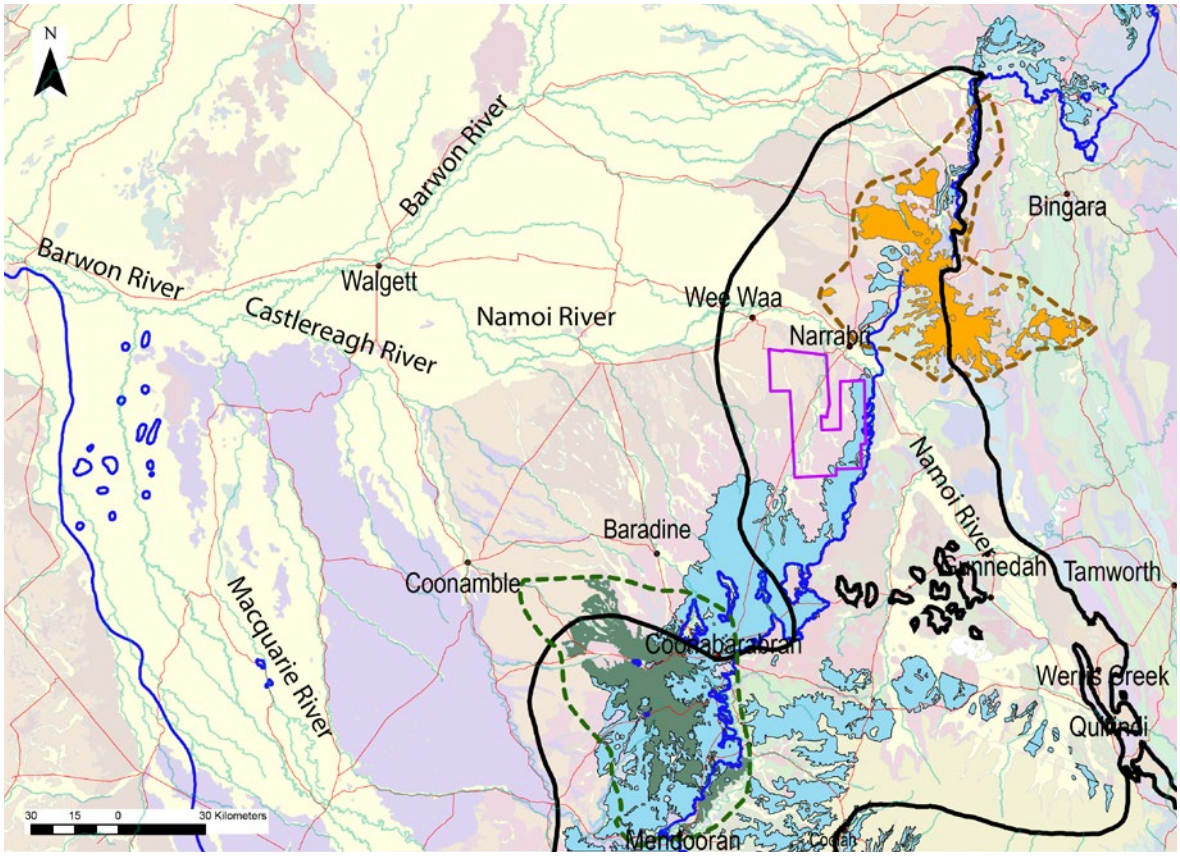
The results of this research provide further multiple lines of evidence that support this view – that faults are unlikely to have a significant influence on shallow groundwater systems in the Narrabri area – particularly in the eastern and southern regions of the study area.

Some geological structures likely form local connectivity pathways north-west of and outside the proposed gas development area.

Research results

Previous CSIRO reports identified fault connectivity in the region as a knowledge gap. This report used geophysics and hydrochemistry to build a more detailed picture of surface layer geology:

- Geophysics indicate the presence of some faults and fractures which could act as potential pathways for movement of water and gas but no prima facie evidence for this connectivity was observed.
- Hydrochemistry and tracers indicate that throughout the east and south of the proposed CSG development area aquitard extent and integrity limits the potential for vertical connectivity.
- Hydrochemistry and tracers also indicate some geological structures likely form local connectivity pathways north-west of and outside the proposed development area.
- Mixing calculations – which take Pilliga Sandstone aquifer groundwater samples “downstream” north-west of the proposed development area – suggest the increase in salinity in the Pilliga Sandstone is more likely due to mixing from deeper formations located beneath the Pilliga Sandstone and above the target CSG formations in the Gunnedah Basin.



This graphic show the various and complex sub-surface features, reflecting the volcanic nature of the region.

Researchers used low-impact vehicle surveys and other non-intrusive geophysical techniques to produce high resolution images of sub-surface structures.

Study methodology

This project used an integrated scientific approach that draws on historical evidence and previous studies, geophysical mapping techniques, and environmental tracers to estimate groundwater movement and source.

The study builds on previous research in this region to focus on specific areas where faults or volcanic intrusions are likely to be present.

Researchers used low-impact and non-intrusive geophysical techniques to produce high resolution images of sub-surface structures.

Use of two independent geophysical methods helped reduce uncertainties associated with each method.

Groundwater samples were assessed using selected environmental tracers to detect contributions from deeper aquifers which may indicate connectivity between deep and shallow systems.

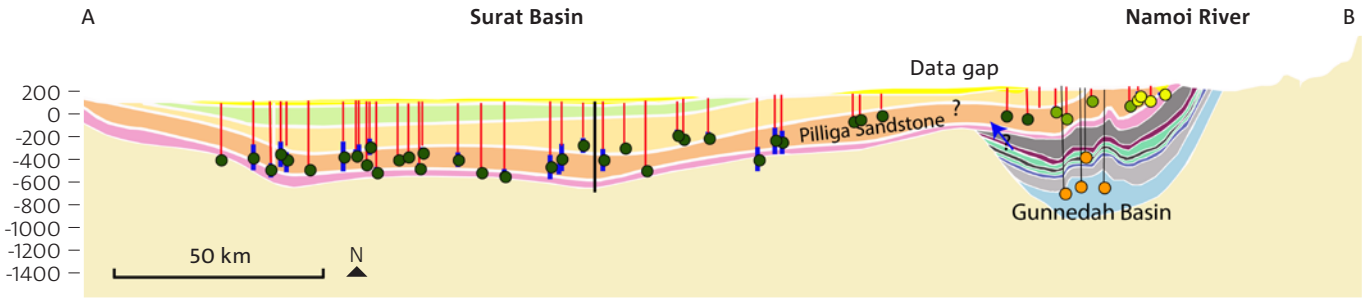
What are environmental tracers?

Some compounds that occur naturally in groundwater can be used to determine the origin and age of groundwater because their concentrations vary in a predictable way over time.

Environmental 'tracers' such as tritium, carbon-14, chlorine-36 and helium are commonly used to identify the presence of groundwater that is 'young' (<50 years), 'old' (1000–10,000 years), or 'very old' (>20,000 years).

The concentrations of these tracers in groundwater are extremely small, occur naturally in groundwater and pose no human health risk.

The graphic below represents results of a series of groundwater samples taken from the Pilliga Sandstone aquifer designed to measure changes in electrical conductivity, which indicates changes in salinity.



Surat Basin
- Alluvium
- Rolling Downs Group
- Bungil, Mooga and Orallo (BMO)
- Pilliga Sandstone
- Purlawaugh Formation (base of Surat Basin)

Gunnedah Basin
- Napperby Formation
- Digby Formation
- Black Jack Group
- Hoskissons Coal (secondary CSG target)
- Watermark Formation
- Porcupine Formation
- Maules Creek Formation (primary CSG target)
- Pre-Surat/pre-Gunnedah Basins strata differentiated

- Groundwater bore
- Groundwater bore screen
- Exploration/stratigraphic well

Hydrochemical cluster (median EC)
- Cluster 1 (11,085 µS/cm)
- Cluster 2 (121 µS/cm)
- Cluster 3 (550 µS/cm)
- Cluster 4 (972 µS/cm)

The Nandewar Ranges, approximately 30 km east of Narrabri. The Nandewar volcanics contribute to the unique geology of the Narrabri region.

Next steps

GISERA's NSW Regional Research Advisory Committee, which is majority-controlled by independent and community-based members, has approved further research in the Narrabri region.

This new project will further improve knowledge of groundwater systems and refine the conceptual understanding of potential for hydrogeological connectivity pathways between shallow aquifers (including the Pilliga Sandstone and alluvial aquifers) and the deep Gunnedah Basin formations (including the CSG target units).

This will involve a multi-disciplinary approach that combines existing data with targeted acquisition of new hydrochemistry, geochemistry, and geophysical survey data, including an airborne electromagnetic survey.

This airborne survey will enhance the understanding of geological structures and the geometry of Surat and upper Gunnedah basins strata from ground surface to a depth of around 400 m, an area that to date has not been comprehensively surveyed.

The outcome of this project will include the generation of high-resolution 3D realisations of the subsurface that aim to represent continuous geological structures that will provide additional information on the potential for connectivity pathways between the CSG target units and adjacent groundwater systems.

More information

Read the final report

https://doi.org/10.25919/exee-za89

Find out more about the project

https://gisera.csiro.au/project/assessment-of-faults-as-potential-connectivity-pathways/

More details about the Great Artesian Basin and coal seam gas

https://gisera.csiro.au/more-information/frequently-asked-questions/the-great-artesian-basin-and-coal-seam-gas/

Other GISERA research into ground and surface waters

https://gisera.csiro.au/research/surface-and-groundwater/

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