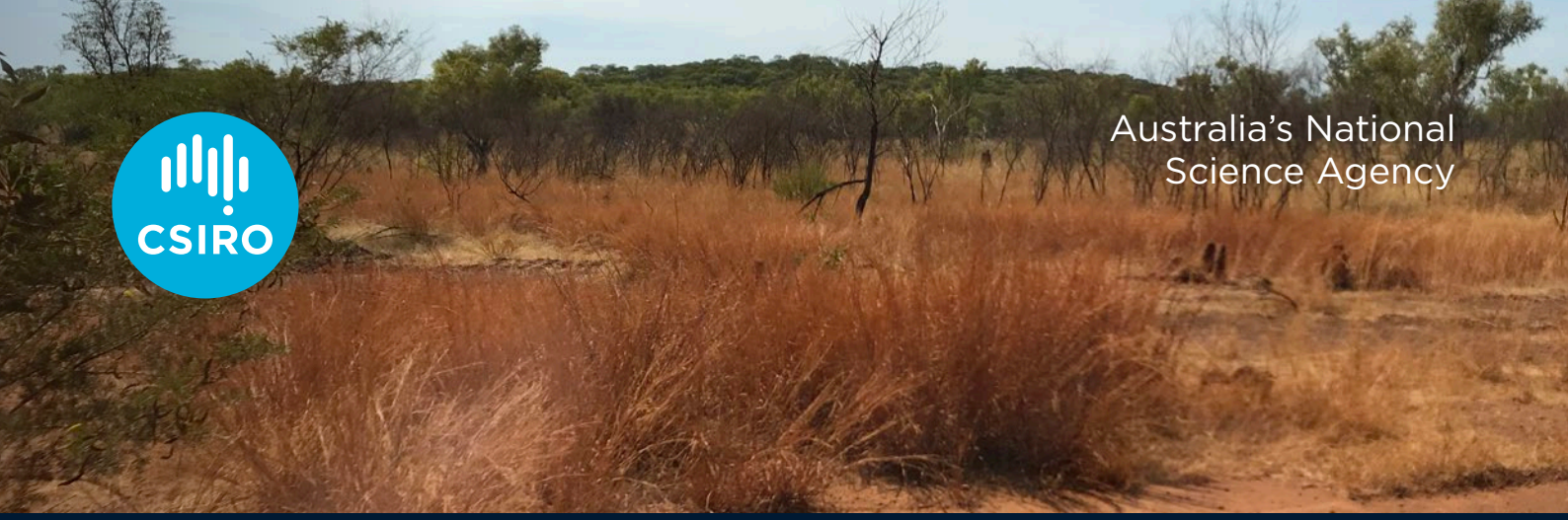


Australia's National Science Agency

LAND AND INFRASTRUCTURE

GISERA | Gas Industry Social and Environmental Research Alliance

Beetaloo Basin shale: long-term competency after decommissioning

Researchers have completed a project to assess the self-sealing competency of shale formations and explore their potential to create a natural barrier that reduces the risk of contaminants entering the environment.

Key points

- Data from other parts of the world indicates that shale formations self-seal over time and create a natural barrier against hydrocarbon fluid movement.
- CSIRO researchers assessed the ability of shale formations in the Beetaloo Basin to self-seal or 'creep' over time after well decommissioning.
- Researchers explored techniques to accelerate and enhance creep deformation, and undertook modelling to help predict well integrity issues.
- The project addresses community concerns about environmental contamination and builds on previous work focused on the integrity of plugged and decommissioned wells.

This project, conducted through CSIRO's Gas Industry Social and Environmental Research Alliance (GISERA), improves our understanding of how decommissioned wells in the Beetaloo Basin maintain their integrity over the long term.

Researchers undertook a comprehensive literature review of shale creep mechanisms; an exploration of techniques to enhance creep deformation in shales; scientific analysis and geo-mechanical tests of shale samples; and the development of a leakage calculator to evaluate the risks of hydrocarbon fluid escape.

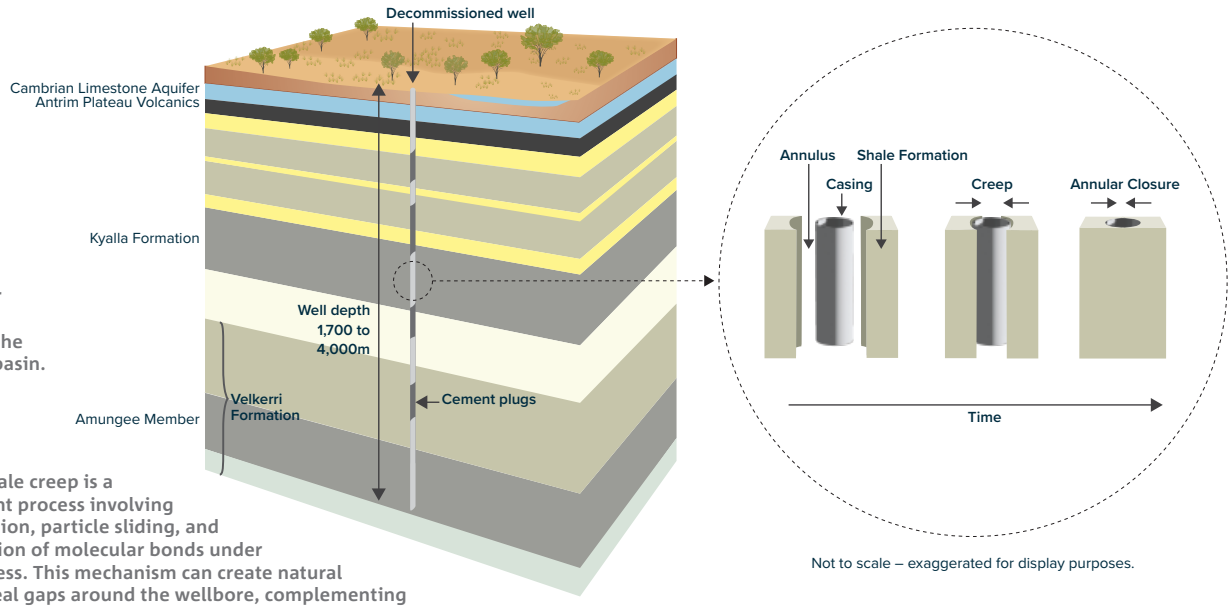
The project outcomes will help address community concerns in the region about the potential for decommissioned wells to become potential sources of contaminants, and will help provide an evidence base for informed decision making by industry stakeholders.

The Beetaloo Sub-basin

The Beetaloo Sub-basin lies southeast of Katherine in the Northern Territory and spans approximately 30,000 square kilometres. One of the most promising areas for shale gas production in Australia, it contains an estimated gas resource of 178,200 petajoules (PJ).

In 2018, GISERA partnered with the NT Government to deliver independent and transparent research on gas development. This includes improving community understanding about the potential impacts of hydraulic fracturing on groundwater.

The results of this project provide key information to help assess long-term risks after gas production has ceased and wells are decommissioned.



Left: The major subsurface formations of the Beetaloo Sub-basin.

Inset, right: Shale creep is a time-dependent process involving mineral distortion, particle sliding, and the redistribution of molecular bonds under continuous stress. This mechanism can create natural barriers that seal gaps around the wellbore, complementing existing decommissioning measures.

Shale creep and the potential for self-sealing

After gas wells have reached the end of their serviceable life, the final stage of the well life cycle is to seal and decommission the wells. Traditionally, wellbore barriers in decommissioned wells are constructed by employing annular cement, steel casing and cement plugs to provide complete zonal isolation.

The engineering properties of the materials used in casing and cement are well understood; however, the characteristics of the geological formations are variable.

Numerous field observations from around the world have shown that some shale formations creep into open spaces – such as a well annulus – and self-seal over time. This gradual process of movement is known as 'creep incidents.'

When this creeping process takes place, the shale creates a highly effective natural barrier against hydrocarbon fluid movements, trapping formation fluids and acting as a seal. This significantly reduces the risk of contaminants entering the environment.

The creep rate depends on several rock property characteristics. The magnitude of the creep deformation is also dependent on a range of factors, including mineralogy, applied temperature, pressure and chemistry of the fluids to which the shale is exposed.

This GISERA project was designed to develop a better understanding of the potential for creep behaviour in the shale formations of the Beetaloo Basin; and to explore techniques for stimulating that process.

Project findings

The first task of the research program was a literature review, which confirmed that shale can serve as a highly effective barrier material. Researchers also identified a range of best practice approaches to implement into the design of their own laboratory experiments to characterise creep properties.

Shale samples from the Beetaloo Basin were extracted, analysed, and prepared for testing.

Geo-mechanical tests to investigate the effects of pore fluid chemistry on creep behaviour revealed that dry samples exhibited greater stiffness and brittleness, while samples treated with chemical solutions became more ductile.

This indicates that chemical solutions can significantly soften shale, making it more flexible and viscous, which is beneficial for inducing creep deformation and establishing effective 'self-sealing' barriers during well decommissioning.

It should be noted that these results are somewhat constrained by the limited number of samples tested – and this may impact the extent to which the findings can be generalised.

Finally, the project team developed a well leakage calculator to assess the potential risks and magnitudes of hydrocarbon fluid escape through different leakage pathways from decommissioned wells.

The calculator uses analytical fluid flow models, and incorporates a creep model, to provide a predictive capability specific to the Beetaloo Basin. This useful tool to help support informed decision making will be available on the GISERA website.

More information

Please contact CSIRO enquiries on 1300 363 400
or email gisera@csiro.au

Read more about this project

Learn about other GISERA research in the Northern Territory

Further information | 1300 363 400 | gisera@csiro.au | gisera.csiro.au

GISERA is a collaboration between CSIRO, Commonwealth and state governments and industry established to undertake publicly-reported independent research. The purpose of GISERA is to provide quality assured scientific research and information to communities living in gas development regions focusing on social and environmental topics including: groundwater and surface water, greenhouse gas emissions, biodiversity, land management, the marine environment, and socio-economic impacts. The governance structure for GISERA is designed to provide for and protect research independence and transparency of research.

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