Australia's National Science Agency

GROUND AND SURFACE WATERS

GISERA | Gas Industry Social and Environmental Research Alliance

Petroleum systems modelling – Surat and Bowen basins, Queensland

CSIRO scientists will collate existing data on the prevalence of gas in water supplies and water monitoring bores in aquifers underlying the Walloon Coal Measures, and will investigate the sources of gas to determine if they could be affected by coal seam gas (CSG) activities.

This project, conducted through CSIRO's Gas Industry Social and Environmental Research Alliance (GISERA), will provide an evidence base to allow for the prediction of likely gas concentrations in water bores across the Surat Basin, and how that 'gassiness' may change over time – including as a result of CSG development.

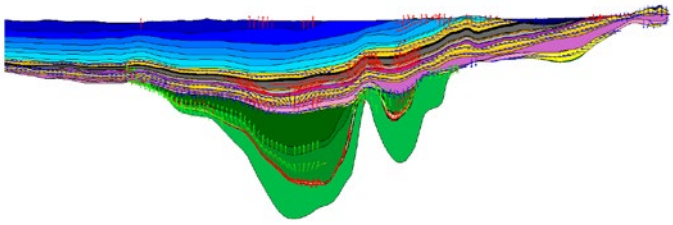
CSIRO will liaise with the Centre for Natural Gas at the University of Queensland (UQ), the Office of Groundwater Impact Assessment (OGIA), Qld Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development, and other and CSG stakeholders to access existing data on geology, hydrogeology and groundwater systems that has been gathered through previous studies.

Petroleum system modelling

A key aspect of this project is simulating the petroleum system of the Surat and Bowen basins. The petroleum in the Bowen Basin is largely sourced from Permian coal and marine source rocks and that in the Surat Basin from Jurassic coal. Sandwiched between the source rock packages are the Hutton and Precipice sandstones which are two significant hydrocarbon (oil and gas) reservoirs and groundwater aquifers.

To investigate the hydrocarbon generation history 3D petroleum systems modelling will be conducted. The modelling will investigate the quantities of hydrocarbons generated and expelled from the source rocks, how they migrated from the source rocks to reservoirs and their distribution in the Precipice and Hutton aquifers, including the concentration of dissolved methane in groundwater.

The key variables that impact the hydrocarbon distribution including the thermal maturation kinetics of the organic matter, timing of hydrocarbon generation, hydrocarbon migration and leakage mechanisms, and gas dissolution processes in aquifers will be tested. Multiple scenarios of these will be simulated to represent the concentration of methane observed in the Hutton and Precipice sandstones at various geological times, including prior to CSG development in the Surat Basin.



A cross section showing hydrocarbon migration pathways. The modelling will test various geological and migration scenarios.

Banner image (above): A natural spring in an outcrop of Precipice Sandstone in the Surat Basin.

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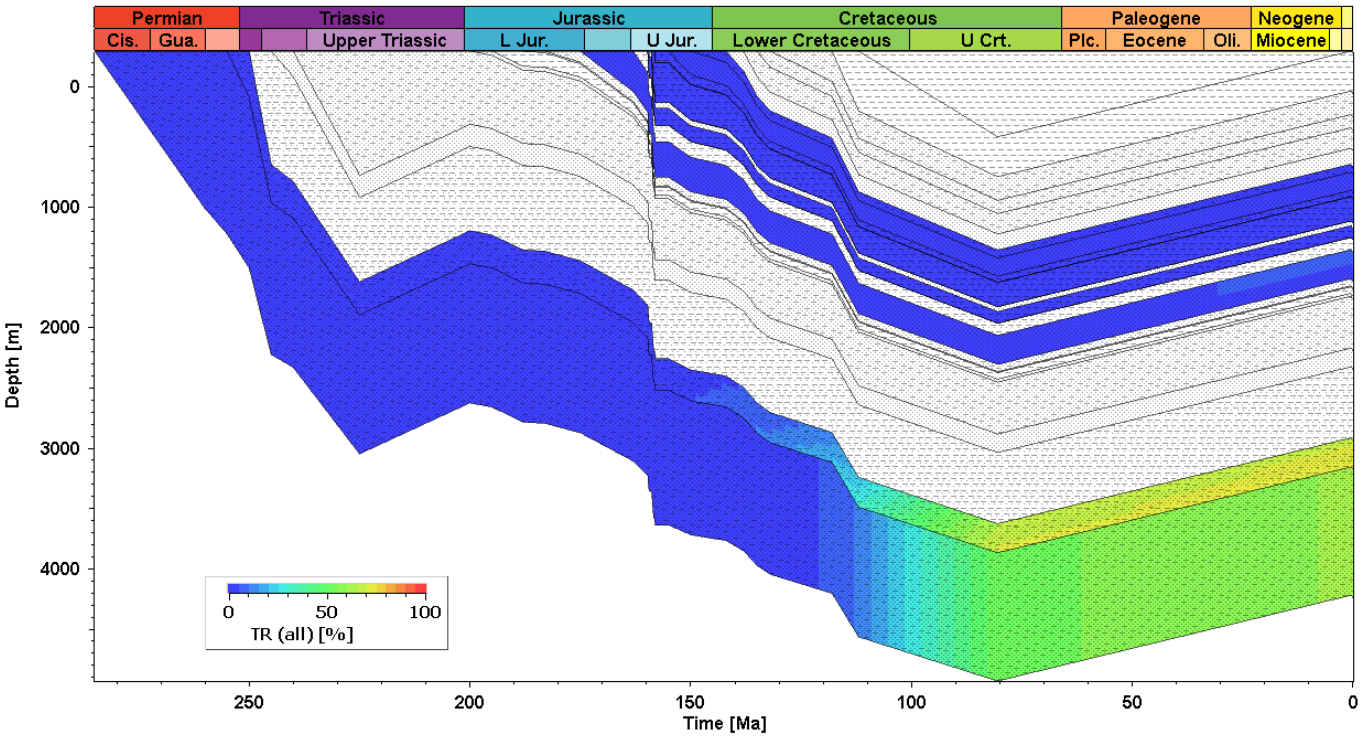

A burial history model for centre of the Surat and Bowen basins. Colour coding indicates the proportion of organic matter in the source rocks that has been thermally transformed (TR) to hydrocarbons. X-axis indicates time in million years ago (Ma).

Advanced modelling tool

The 3D petroleum systems modelling software package being used for this project is commonly used by leading energy companies to understand the distribution of hydrocarbons in basins worldwide. The software combines data from seismic, geophysical logs, temperature, pressure and other geological information to model the evolution of a sedimentary basin and key elements of its petroleum system. It includes advanced fluid migration methods (e.g. Darcy, buoyancy driven invasion percolation, advection) to simulate hydrocarbon and water flow within the basin. Properties such as volumes of hydrocarbons at reservoir and surface conditions, gas/oil ratios (GOR) and gas concentration in groundwater can be simulated and further analysed to investigate its behaviour during water, gas and oil extraction from wells drilled across the basin.

Gas generation scenarios

Gas can be generated due to deep burial and heating (thermogenic processes) and microbial metabolization (biogenic processes at lower temperatures) of organic matter. Thermogenic gas generation will be modelled and tested using various kinetics published for coal and terrigenous organic matter derived from land plants as well as organic matter derived from marine fauna. Biogenic gas generation will be modelled using a biomethane reaction formula, which is a function of organic matter content, burial depth and temperature. Multiple scenarios will be tested and, where measured data are available, outputs of the simulations will be calibrated against temperature, thermal maturity (vitrinite reflectance) and hydrocarbon properties observed in wells drilled across the basin.

Resolving key questions

The petroleum systems model produced during this project will be a simplified model where the model architecture is based on the regional geological model adopted from OGIA (Office of Groundwater Impact Assessment). For the purpose of this project such a simplified regional model is considered sufficient to investigate the provenance of hydrocarbons encountered in the sandstone aquifers.

Outputs from these simulations will allow us to evaluate if the Hutton and Precipice sandstones received gas from source rocks in the Bowen and Surat basins over geological time. This will help resolve whether the Hutton Sandstone including its groundwater was charged with gas as a result of geological processes and, if so, when in its geological history – that is, prior to CSG development from coal in the Surat Basin.

More information

Find out more about this project.

Learn about other GISERA studies in Queensland.

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