

Queensland's unconventional petroleum potential

Shale oil and gas, tight gas and coal seam gas

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Overview

Queensland has a series of stacked sedimentary basins ranging in age from Paleoproterozoic to Quaternary (see Table 1 and Figure 1). Many of these basins may be prospective for unconventional petroleum.

Exploration for conventional petroleum began in earnest in 1960, targeting basins across Queensland. Petroleum discoveries were made in the Bowen, Surat, Cooper and Eromanga basins. These basins have become the state's key petroleum-producing regions, serviced by processing facilities and major transmission pipelines.

Significant coal seam gas (CSG) reserves have been discovered in the Bowen and Surat basins in eastern Queensland. CSG is currently the dominant sector of Queensland's petroleum industry with combined proved and probable reserves, as at 30 June 2016 were 1.1 Trillion cubic metres (41 229 PJ) with production in 2015–16 of 26 145.35 million cubic metres (979.1 PJ). CSG production will continue to grow, as it is the feedstock for three export liquefied natural gas (LNG) projects based at Gladstone. The first cargo was exported in January 2015.

For more information on conventional petroleum and coal seam gas activity in Queensland, please see the 'Queensland's Petroleum and Coal Seam Gas' brochure.

There are many examples from the history of petroleum exploration in Queensland of hydrocarbon shows within source rocks and tight reservoirs. In some areas, hundreds of wells have penetrated intervals which have consistently recorded oil or gas shows over shale, tight sandstone and coal intervals. These shows were largely ignored in the search for conventional petroleum reservoirs due to technological and economic challenges.

Exploration for shale oil and gas, tight gas and basin-centred gas in Queensland has targeted the Isa Superbasin and Georgina, Cooper, Bowen and Eromanga basins. In addition to this, a review of petroleum systems studies conducted across the state has highlighted regions and formations with source rocks that may have potential for shale oil or gas; supported by noted oil and gas shows.

Coal seam gas

Exploration for CSG in Queensland began in the late 1970s. Since then, all of the state's coal-bearing basins have attracted exploration activity. During the mid-1990s, reserves were defined in Permian coal measures in the Bowen Basin, and commercial production started from the Dawson River CSG field near Moura in 1996. From 2000, the Surat Basin became the focus of CSG exploration where significant volumes of CSG resources were discovered in the Jurassic Walloon Coal Measures. Commercial production in the Surat Basin commenced in 2006.

Exploration for CSG has also targeted the Permian coal measures of the Galilee and Cooper basins, Triassic coal measures of the Ipswich Basin, Jurassic coal measures in the Clarence-Moreton Basin, Cretaceous coal measures of the Eromanga, Maryborough and Styx basins, and the Tertiary coal measures of the Nagoorin Graben, Hillsborough and Duinga basins.

Tight gas and basin centred gas

Tight gas resources have long been known in Queensland. Historically, exploration for conventional petroleum throughout Queensland has identified formations with promising gas shows, while the reservoirs were evaluated as too tight. These basins include the Georgina, Adavale, Galilee, Cooper, Maryborough and Laura basins (Table 2). The utilisation of new drilling and completion technology resulted in renewed interest for exploring tight gas resources in sandstones of the Permian Tinowon Formation in the southwest Bowen Basin within the early 2000s. More recent exploration activity has targeted tight sands and basin centred gas in the troughs of the Bowen and Cooper basins through deep drilling campaigns.

Shale oil and shale gas

Shale oil and gas exploration is still at a very early stage in Queensland. Several formations have been identified as potential shale gas and oil targets (see Table 2). To date, exploration for shale gas and oil in Queensland has focused on the Isa Superbasin, and Georgina, Cooper and Eromanga basins.

The Geological Survey of Queensland (GSQ) has also been conducted a regional assessment of the Toolebuc Formation in the Eromanga Basin to assess its shale oil or shale gas potential.



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The Toolebuc Formation is spatially extensive and relatively shallow, making it an attractive exploration target. While current work suggests that there is a play fairway in the central Eromanga Basin, further exploration is required to determine the full potential of the Toolebuc Formation as an economic shale gas or shale oil target. For more information on this project, see the Toolebuc Formation brochure available from GSQ. GSQ Records detailing this project will be published in early 2017.

Exploration Activity

Ten wells have been drilled to examine the potential of the Nappamerri Trough in Queensland by Beach Energy and Drillsearch. These wells intersected up to 1.3 kilometres of gas saturated Permian rocks suggesting the presence of a significant new gas resource in the Cooper Basin in Queensland. Real Energy drilled two wells to examine the potential of the Patchawarra and Toolachee formations within the Windorah Trough. QGC has drilled six wells to evaluate the potential of tight sands in Permian and Triassic formations in the Taroom Trough of the Bowen Basin.

Table 1: Ages of sedimentary basins with unconventional petroleum resource potential

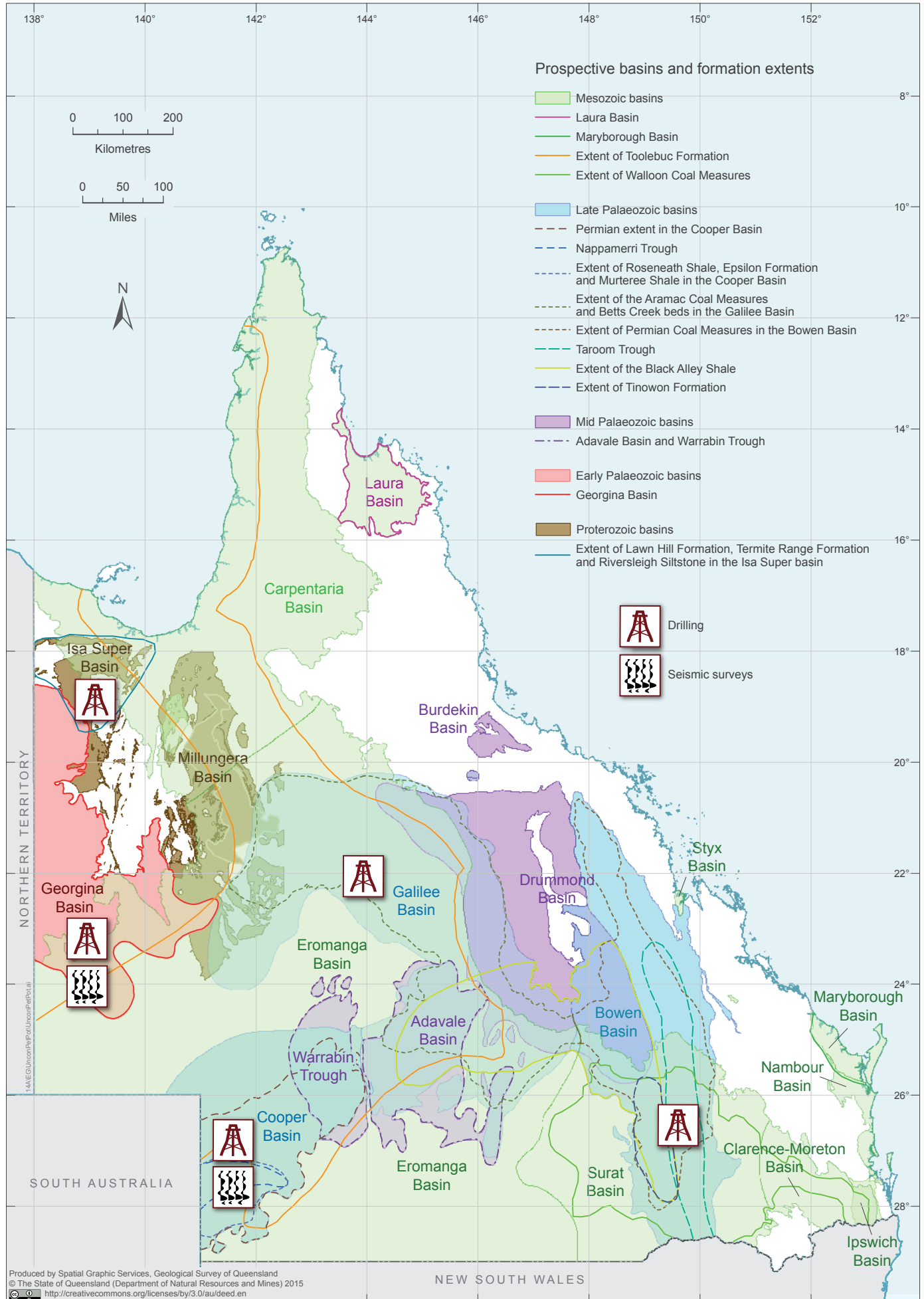
Basin	Age	Basin	Age
Laura Basin	Middle Jurassic to Early Cretaceous	Bowen Basin	Early Permian to Middle Triassic
Maryborough Basin	Late Triassic to Cenozoic	Galilee Basin	Carboniferous to Triassic
Eromanga Basin	Early Jurassic to Late Cretaceous	Adavale Basin	Early Devonian to Late Carboniferous
Surat Basin	Late Triassic to Middle Cretaceous	Georgina Basin	Neoproterozoic to Ordovician
Cooper Basin	Late Carboniferous to Middle Triassic	Isa Superbasin	Paleoproterozoic to Mesoproterozoic

Table 2: Summary of attributes — unconventional petroleum target formations in Queensland

Basin	Formation	Environment	Thickness (m)	Top Depth (m)	TOC (%)	Rv (%)	Resource Target
Laura Basin	Dalrymple Sandstone	Fluvio-deltaic	329 to 527 m	442 to 592 m	0.91 to 12.90%	0.81%	Shale gas or tight gas
Maryborough Basin	Maryborough Formation	Marginal marine to estuarine	up to 2245 m	Outcrop to 865 m	approx. 1.5%	up to 2.88%	Shale gas or tight gas
Maryborough Basin	Tiaro Coal Measures	Fluvio-lacustrine	6 to >430 m	Outcrop to 592 m	Coal	up to 3.02%	CSG or shale gas
Eromanga Basin	Winton Formation	Fluvio-lacustrine	400 to 1000 m	Outcrop to 1060 m	Coal	0.3 to 0.5%	CSG
Eromanga Basin	Toolebuc Formation	Restricted marine	20 to 45 m	Outcrop to 1640 m	0.2 to 26.1%	0.35 to 0.55%	Shale oil or shale gas
Eromanga Basin	Birkhead Formation	Fluvio-deltaic to lacustrine	up to 580 m	Outcrop to 2180 m	0.75 to 6.3%	up to 1%	Shale gas
Eromanga Basin	Westbourne Formation	Fluvio-lacustrine	70 to 130 m	Outcrop to 2046 m	0.51 to 2.18%	0.7 to 0.87%	Shale gas
Eromanga Basin	Poolowanna Formation	Fluvio-lacustrine	up to 165 m	370 to 2450 m	0.6 to 17.9%	up to 1.2%	Shale gas
Surat Basin	Walloon Coal Measures	Fluvio-lacustrine	up to 507 m	Outcrop to 1660 m	Coal	0.35 to 0.6%	CSG
Cooper Basin	Toolachee Formation	Fluvio-lacustrine	20 to 50 m	1360 to 2950 m	up to 7.2%	up to 2.4%	Shale gas or tight gas
Cooper Basin	Roseneath Shale	Lacustrine	20 to 80 m	1360 to 2530 m	1.0%	1 to 4%	Shale gas
Cooper Basin	Epsilon Formation	Prograding delta	30 to >60 m	1370 to 2625 m	3.7 to 7.5%	0.6 to 1.6%	Tight gas
Cooper Basin	Murteree Shale	Deep, freshwater lacustrine	Average of 50 m, up to 80 m	1370 to 2680 m	2.50%	1 to 4%	Shale gas
Cooper Basin	Patchawarra Formation	Fluvio-lacustrine	up to 550 m	1375 to 2990 m	Coal	up to 3.6%	Shale gas or tight gas
Bowen Basin	Bandanna Formation	Deltaic	up to 173 m	Outcrop to 2900 m	Coal	approx. 0.9%	CSG or tight gas
Bowen Basin	Baralaba Coal Measures	Fluvial	up to 556 m	Outcrop to 2982 m	Coal	0.55 to 2.1%	CSG
Bowen Basin	Moranbah Coal Measures	Fluvial	up to 760 m	Outcrop to 790 m	Coal	>1.1%	CSG
Bowen Basin	Black Alley Shale	Marine to lacustrine	up to 350 m	45 to 2030 m	0.29 to 10.18%	0.52 to 0.98%	Shale gas
Bowen Basin	Tinowon Formation	Deltaic	50 to 70 m	890 to 2830 m	–	0.52 to 0.98%	Tight gas
Galilee Basin	Aramac Coal Measures	Fluvial and peat swamp	31 to 272 m	757 to 1600 m	Coal	0.39 to 5.2%	CSG or shale gas
Galilee Basin	Betts Creek beds	Fluvial and peat swamp	50 to 210 m	approx. 900 m	Coal	0.70 to 8.75%	CSG or shale gas
Galilee Basin	Lake Galilee Sandstone	Fluvial	85 to 287 m	1055 to 2734 m	–	up to 1.77%	Tight gas
Adavale Basin	Log Creek Formation	Marine shelf	>755 m	approx. 3100 m	up to 1.55%	1.4 to 1.6%	Shale gas or tight gas
Adavale Basin	Lissoy Sandstone	Nearshore, shallow marine to restricted marine	up to 470 m	approx. 2760 m	–	1.4 to 1.6%	Shale gas or tight gas
Adavale Basin	Cooladdi Dolomite	Lagoonal to back reef	up to 85 m	approx. 2500 m	–	1.4 to 1.6%	Shale gas or tight gas
Georgina Basin	Arrinthunga Formation	Carbonate and siliciclastic shelf	138 to 835 m	64 to 726 m	up to 9.6%	up to 0.6% [§]	Shale gas or tight gas
Georgina Basin	Inca Shale	Marine	up to 133 m	Outcrop to 3216 m	up to 2.82%	CCAI* of 1 to 1.5	Shale gas or tight gas
Georgina Basin	Thorntonia Limestone	Peritidal to restricted shallow marine	13 to 104 m	Outcrop to 1960 m	up to 8.7% in NT wells	–	Shale gas or tight gas
Georgina Basin	Beetle Creek Formation	Marine	27 to >172 m	Outcrop to 1018 m	0.19 to 1.51%	CCAI* of 1 to 1.5	Shale gas
Georgina Basin	Georgina Limestone	Tidal shallow marine	>33.2 to 759 m	Outcrop to 2457 m	EOM [†] up to 2000 ppm	TAI [‡] of 2.25 to 2.50	Shale gas or tight gas
Isa Superbasin	Lawn Hill Formation	Mid to outer shelf	up to 2200 m	Outcrop to 2000 m	up to 7%	–	Shale gas
Isa Superbasin	Termite Range Formation	Turbidite fan	up to 1300 m	Outcrop to 2500 m	up to 8%	–	Shale gas
Isa Superbasin	Riversleigh Siltstone	Mid to outer shelf	up to 2900 m	Outcrop to 4500 m	up to 8%	–	Shale gas

[§]Analysis only from PGA Bradley 1, *Conodont Colouration Alteration Index, [†]Extractable organic matter, [‡]Thermal Alteration Index, TOC – total organic carbon, Rv – Vitrinite reflectance, NT – Northern Territory
Note: Statistics quoted in this brochure were compiled by the Department of Natural Resources and Mines, 2013–14.

Figure 1: Queensland basins – unconventional petroleum potential



Armour Energy has drilled two vertical wells and one horizontal well to evaluate the shale gas potential of the Proterozoic Lawn Hill Formation and Riversleigh Siltstone on the Lawn Hill Platform of the Isa Superbasin. This resulted in Australia's first horizontal multi-stage stimulation of a shale reservoir.

Two wells have been drilled to evaluate the lower Arthur Creek Formation and the Thornton Limestone in the Georgina Basin, though only one well has reached its intended target. Central Petroleum are examining at least four play types within this region; shale gas, tight gas, hydrothermal dolomite and potential conventional gas accumulations.

Pre-competitive data access

Well completion reports, analytical results, wireline log data and seismic survey data are available from the GSQ.

- Exploration reports, including well completion reports conducted as part of petroleum exploration in Queensland are available online from the QDEX Reports system
- QDEX Data provides access wireline log data packaged by well, 3D geological and geophysical models, airborne and ground geophysical data, geochemical data and seismic survey data
- The Queensland Petroleum Exploration Database (QPED) contains geological, geophysical and geochemical data collated from exploration reports. QPED can be downloaded from QSpatial
- MinesOnlineMaps can be used to view spatial information relating to Queensland's petroleum industry, including the location of exploration and production tenures, wells and seismic surveys.

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