

WESTERN AUSTRALIA'S DIGEST OF PETROLEUM EXPLORATION, DEVELOPMENT AND PRODUCTION

PETROLEUM

IN WESTERN AUSTRALIA

APRIL 2014



Contents



Above, and on the cover: Advanced Energy Group's drill rig, the Crusader 405, on location at Ungani 3 in the Canning Basin

Photos are courtesy of Buru Energy.

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WESTERN AUSTRALIA

Opportunities to Explore

BIDS INVITED FOR ACREAGE

PETROLEUM ACREAGE

Canning Basin

Interest in the Canning Basin has revived significantly in recent years, with the oil discovery at Ungani and large resource volumes estimated for prospective shale gas plays. Global companies Mitsubishi, ConocoPhillips, Hess, PetroChina and, recently, Apache are currently participating in Canning Basin exploration.

There are four onshore release areas in the Canning Basin:

- One small block (324 km²) in the Jones Arch of the northeast Canning Basin that has a prospect mapped and is considered to have potential for oil in Lower Permian sandstones.
- A block in a platform area of the central Canning Basin with potential sub-salt and supra-salt targets for oil and gas. Its size is 2659 km².

- Two blocks situated adjacent to the southern margin of the Canning Basin that may have potential for Ordovician-sourced conventional hydrocarbons and Ordovician shale gas. The size of these blocks is 3594 km² and 2866 km².

Perth Basin

There is one release area in the Bunbury Trough of the onshore southern Perth Basin. Area size is 668 km². The area has a Permian section with likely mature source rocks and sandstone reservoir intervals. Infrastructure is nearby including the port city of Bunbury.

Bids for the release areas close on 23 October 2014.

Acreage release DVD packages are available from DMP and a web version is also available:
www.dmp.wa.gov.au/acreage_release

Acreage release packages contain relevant information about the release areas, land access and how to make a valid application for an Exploration Permit.

GEO THERMAL ACREAGE

Acreage is available for the whole of the State not covered by permits or applications. Application is by a Geothermal Special Prospecting Authority (GSPA) with Acreage Option (AO).

Companies are invited to apply for areas each with size up to 160 5'x5' graticular blocks.

Companies interested in geothermal acreage are allowed to bid for multiple areas and are expected to drill at least one well to a depth of 400 m during the first two years of obtaining a geothermal exploration permit.

Geothermal acreage information is available from DMP on the web at:

www.dmp.wa.gov.au/acreage_release

FURTHER INFORMATION

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Minister's message



Hon. Bill Marmion
Minister for Mines and Petroleum

Growing global demand for energy continues to be one of the central drivers of growth in Western Australia's oil and gas sector.

In the last decade, the State's petroleum sales have increased by an average of nine per cent each year – with much of these sales coming from liquefied natural gas (LNG) projects servicing the Asian region.

Countries such as China, Japan and South Korea are expected to significantly increase their reliance on natural gas in the coming years.

China alone is expected to increase its natural gas consumption by as much as 167 per cent in the next decade as it moves to rapidly expand its LNG plants and import capacity.

These expansions represent a remarkable opportunity for the State given China is already Western Australia's second largest petroleum exports market, after Japan.

Currently Western Australia has two operating LNG projects – the North West Shelf and Pluto – with three more under construction – Gorgon, Wheatstone and Prelude. The development of these

projects could see Australia overtake Qatar by the end of this decade as the world's largest LNG producer, lifting our global LNG supply to more than 25 per cent.

But as considerable as the State's offshore LNG resources are, there is potentially twice the amount of natural gas resources onshore.

Western Australia has an estimated 7.9 tera cubic metres (280 trillion cubic feet) of recoverable natural gas from shale and tight rock. If even a moderate percentage of these estimates are proven, onshore gas resources present a remarkable opportunity for Western Australia.

However, there are a number of challenges that will need to be addressed to ensure we make the most of those opportunities.

These challenges include escalating costs, the development of supporting infrastructure and addressing community concerns about the oil and gas process known as hydraulic fracturing, or fracking.

Whether it is hydraulic fracturing or other emerging technologies, community confidence is critical if projects are to move forward.

This is why, as lead regulator, the Department of Mines and Petroleum is working across government, the community and industry to ensure there is a clear understanding of what is required to responsibly develop Western Australia's resources.

It is not just the government that must inform and engage with the community. It is also important that companies work closely with the communities in which they operate or intend to operate.

There are many good examples throughout Western Australia of companies and communities working together. The sheer number of successful resource operations across the State is testament to this.

There is no single formula for gaining community acceptance. It is a subjective concept, and what is suitable for one community may not be for another.

One thing they do have in common though is the need for a foundation built on transparency, trust, communication and goodwill.

Executive Director's message



Jeff Haworth
Executive Director
Petroleum Division

In what is my first message as Executive Director for Petroleum, I would like to discuss the State's new objective-based draft resource management regulations and how the arrival of a new drilling rig onshore could benefit Western Australia's emerging shale and tight gas industry.

In February, the Department of Mines and Petroleum released draft Resource Management and Administration Regulations for public comment for a period of three months.

The regulations cover field development, geothermal energy projects, well construction and data submission and release.

The new objective-based regulations are the final set of regulations to be reformed under the *Petroleum and Geothermal Energy Resources Act* and will replace the more prescriptive Schedules currently in place.

It is anticipated the new regulations will come into effect later this year. They will adopt a new 'whole-of-life' approach to well construction and management to further strengthen obligations on operators to ensure wells are fit for purpose.

This approach will encourage operators to consider all potential scenarios when designing a well; for example, what if it is a dry exploration well, what if it discovers conventional oil and gas or what if it discovers shale or tight gas, etcetera.

Under the new regulations, well management plans will also need to consider baseline and ongoing water monitoring if a proposed activity is near a water resource.

These requirements will increase transparency to ensure the State's water resources are protected.

In line with increasing our transparency, the Department of Mines and Petroleum has recently released an overview document detailing its approach to the responsible regulation of Western Australia's shale and tight gas resources.

The overview, available on our website, has been developed for community members and includes information on what shale and tight gas is, where it's located in Western Australia and what exploration activities have occurred to date.

It also details the State's robust legislative framework for the industry including inter-agency assessment processes and international standards for well design.

With the industry in the early exploration and evaluation stages, Western Australia currently has four drilling rigs onshore capable of drilling to the depths required for shale and tight gas exploration.

The most recent rig to arrive in the State is the Crusader 405 drilling rig, late last year. The rig is the first of its kind in Western Australia and is a positive step towards further reducing environmental impacts for onshore drilling activities.

The rig has a smaller surface footprint than traditional rigs, resulting in less surface disturbance. It also has the ability to drill horizontally, allowing multiple wells to be drilled from one location.

Other benefits of the rig include a quieter system and easier transport as all components can be containerised.

The Crusader 405 drill rig, which can be used for conventional, shale and tight gas and oil exploration, was recently operating in the State's South West and is now in the Canning Basin.

Annual review of petroleum activities in Western Australia in 2013

Karina Jonasson
Petroleum Resource Geologist
Petroleum Division



The domestic gas meter station for the Gorgon Project will supply gas to the DBNGP

2013 Overview

This article is an overview of industry activity in Western Australia in 2013. A summary of well activities from the first half of the 2013 calendar year appears in the September 2013 edition of *Petroleum in Western Australia*.

In 2013, a total of 12 wells were drilled and 13 surveys carried out in Western Australian State Waters and onshore. Drilling activities took place in the Canning, Carnarvon and Perth Basins, with the most drilling activity in the Carnarvon Basin. Only one well was drilled offshore by Apache in the Carnarvon Basin. In addition there were several wells drilled as part of the Gorgon gas treatment plant on Barrow Island. In total, nine CO₂ injection wells will be drilled from three sites into the Dupuy Formation. Drilling activities commenced in September.

Wells drilled during the year consisted of three new field wildcat wells, two appraisal wells and three development wells. The remaining wells were a geothermal well, two water wells and a sidetrack at an existing well. Abandonment activities in 2013 included the Hovea 1 and Yardarino 1 production wells, plugged and abandoned in the Perth Basin. Offshore, the wells on the Campbell platform were abandoned in February 2013.

Exploration and Appraisal Activities

Canning Basin

As reported in the previous edition of *Petroleum in Western Australia* (September 2013), three wells were drilled in the Canning Basin, all in the first half of the year. These were Cyrene 1 (Operator Gulliver), Gibb-Maitland 1 (Operator New Standard Energy) and Yulleroo 4 (Operator Buru Energy).

A new player has entered the Canning Basin. Apache Energy announced it is farming into Buru Energy and Mitsubishi's coastal and eastern desert acreage, which includes EP 390, EP 471, EP 473 and EP 438 in the basin. The permits Apache is farming into are not the permits under the State Agreement Buru signed with the government in 2012. The permits are prospective for shale oil and gas in the Goldwyer Formation shale, as well as for conventional sandstone reservoirs.

Under the farm-in arrangement, Apache will earn a 50 per cent interest in EP 390, EP 471 and EP 473, and up to a 50 per cent interest in EP 438, in exchange for funding a \$25 million exploration program, including two wells and a 175 km 2D seismic survey, to be carried out in 2014. The interest transferred to Apache will be equally shared by Buru and Mitsubishi. Buru currently remains operator of the permits.

Buru Energy's workovers on Ungani 1 and 2 wells to isolate the underlying water zone at Ungani and try to flow dry oil were completed in December and Buru commenced an extended production test at Ungani field, which is ongoing at the time of writing.

The Crusader 405 rig was mobilised to the Canning Basin in mid-December to drill the Ungani 3 appraisal well. The rig was on location and rigging up at the end of December. Buru plans to drill three wells in 2014: a horizontal production well and two water injection wells at the Ungani field. It is hoped that the Ungani appraisal well will confirm the interpreted size of the Ungani field, anticipated to hold a recoverable resource of 1.5 GL (10 MMbbl) of oil.

New Standard Energy has taken a 100 per cent controlling interest in the Laurel project in the Canning Basin (EP 417), following the transfer of 35 per cent interest from Buru Energy, who wishes to focus on its drilling program in other permits in the Canning Basin. New Standard Energy plans to look for potential farm-in partners for future exploration drilling. The last well in the permit was Lawford 1 Deepening in 2011.

New Standard is also assessing potential partners for the Merlinleigh

project in the Canning Basin, however, the company has deferred spud of the Condon 1 well, where access roads, drill pads and water bores have been installed, to the second half of 2014.

Perth Basin

Norwest Energy carried out an evaluation program in four stages at Arrowsmith 2, beginning with flow back of the High Cliff Sandstone, followed by the Irwin River Coal Measures and two stages in the Carynginia Formation. The flow back and assessment, using a velocity string, commenced in 2013. An independent assessment of the resource at Arrowsmith, focussing on the deep unconventional gas trend east of the Beagle Ridge fault structure, found a 2C gross recoverable resource of 8.9 Gm³ (316 Bcf) of gas and 0.22 GL (1.4 MMbbl) of oil.

The only new drilling activity for the second half of the year was for CalEnergy Resources who began appraisal and workover operations at the Whicher Range field in the southern Perth Basin in October to recomplete the Whicher Range 4 well. Work involved re-entry of the existing well with the Crusader 405 rig and under-balanced drilling of a sidetrack well to a depth of 4249 m MD. The rig was

released on 17 December 2013. The Whicher Range field lies in EP 408. Whicher Range 4 flowed at a rate of 85,000 m³/d (3 MMcf/d) in 1997. Whicher Range Energy is partner in the field. The well is currently shut in.

Surveys

Surveys took place in the Bonaparte, Canning, Carnarvon and Perth Basins, and all were onshore. Beach Energy conducted an airborne geophysical survey in EP 386 in the Bonaparte Basin. Goshawk Energy had a small aeromagnetic survey in the Canning Basin under a Special Prospecting Authority (SPA). In August 2013, Key Petroleum carried out the first geochemical survey of its kind in EP 448 in the Canning Basin.

Other surveys included aeromagnetic and airborne gravity surveys in the Perth and Canning Basins, as well as two 3D and three 2D seismic surveys. An additional 2D seismic survey was conducted under an SPA in the Carnarvon Basin by Fleet Resources.

Acquisition of the Ungani 3D seismic survey in EP 391 was successfully completed in late October 2013. The survey, originally commenced in October 2012, had been halted after

a cultural heritage site was alleged to have been disturbed. The Department of Aboriginal Affairs investigated and cleared Buru and its contractors, finding no evidence of any disturbance to an Aboriginal heritage site. Buru reached an agreement with traditional owners in July 2013 on all aspects of exploration and development at Ungani and restarted clearing operations for the 3D survey. The final 3D survey covered an area of 243 km² and included the Ungani North structure where oil was encountered by drilling in 2012. Final processing of the 3D data is expected to be completed in early 2014.

Fugro carried out an aerial gravity gradiometry survey over 38,800 km² of Buru-operated Canning Basin permits in EP 428, EP 457, EP 458, EP 476, EP 472, EP 478, EP 477 and EP 474. The survey, commenced in September, was completed in December.

The Terrex crew 402 completed the 360 km Frome Rocks 2D seismic survey in Canning Basin EP 457, EP 398 and EP 428 in October-November 2013 for Buru Energy. See table 4 at the back of the magazine for a complete list of surveys in 2013.



Flaring gas while conducting pressure managed drilling at Whicher Range 4



Photo © Chevron

The Gorgon Project, on Barrow Island, now 76 per cent complete

The 860 km 2D Eucla-Gawler survey for Geoscience Australia is a deep crustal survey being shot from Haig in SE Western Australia to Tarcoola in South Australia. The line includes largely under-explored areas with mineral potential the main focus, although it borders on petroleum prospective regions of the Eucla Basin. The survey is a collaborative project between Geoscience Australia, the South Australian Department of Manufacturing, Innovation, Trade, Resources and Energy, the Geological Survey of Western Australia (GSWA) and AuScope Earth Imaging. Funding in Western Australia is partly through the GSWA Exploration Incentive Scheme. Shooting was completed in February 2014.

Production

In 2013, two facilities started producing gas for Western Australia’s domestic market.

Red Gully Gas and Condensate processing facility

The commissioning of the Red Gully gas and condensate plant in EP 398 was completed in September 2013. Empire Oil and Gas is the operator of the facility and will produce gas for Alcoa and condensate for the BP Kwinana refinery.

An extended well test continued through to the end of the year.

Macedon project

In early September 2013, the WA premier Colin Barnett officially opened the \$1.5 billion Macedon domestic gas plant in Onslow. The Macedon project, which sources gas from four offshore production wells in the Exmouth Sub-basin for the Western Australian domestic market, started production in mid-August. The Macedon field was discovered in 1992 by BHP. Gas is piped to the onshore gas treatment plant at Ashburton North, 17 km southwest of Onslow, and flows into the Dampier to Bunbury natural gas pipeline (DBNGP). The gas plant has a capacity of processing 5.7 Mm³/d (200 MMscf/d).

At the end of 2013, DMP was in discussions with Chevron regarding cessation of production from Thevenard Island fields in the Barrow Sub-basin. Affected titles are EP 357 (over Ashburton Island), and Production Licences L12 & L13. Closing of the oil producing hub facilities was given approval in January 2014. Approval for decommissioning has not yet been given.

Development

The Mondarra Gas Storage Facility expansion was completed in 2013, and now has a storage capacity of 15 PJ. Three wells access the reservoir and are used for either injection or withdrawal of gas from and into the DBNGP. Two compressors driven by gas engines deliver a gas injection capability of 70 TJ/d and withdrawal capability of 150 TJ/d. The facility can be expanded in the future by tying in additional wells, compressors and gas processing equipment. The facility is located in the northern Perth Basin, near Dongara. This facility helps improve the reliability of Domgas supplies.

Gorgon Project

A lot has been happening on Barrow Island in the latter half of 2013, and the Gorgon Project is reported to be 76 percent complete. Some of the recent significant activities include:

- The main cryogenic heat exchanger for LNG Train 1, a key part of the refrigeration process, which cools the natural gas to create LNG, has been set on its foundations.
- The process and utility modules for LNG Train 1 continue to be placed on their foundations at the plant site.

- More than 70,000 tonnes of pre-assembled racks and pre-assembled units have been constructed and shipped, and continue to be installed at the plant site. All 54 pre-assembled racks, which will transport the LNG along the materials offloading facility to the jetty, are in position.
- Blasting and painting activities are in progress on the Project's condensate tanks 1 and 3 while preparations are under way to construct the outer dome roofs on tanks 2 and 4.
- Work continues on the LNG jetty with all 56 jetty caissons now in position.
- Two CO₂ injection wells have been drilled and construction activities on the 7-km pipeline continue.
- The domestic gas meter station has now reached mechanical completion.
- The subsea structures are being installed offshore.

Wheatstone Project

Construction on the Wheatstone Project began in late 2011. The Chevron-led

project includes a two-train, 8.9 million-metric-ton-per-year LNG facility and a separate domestic gas plant. In the second half of 2013, construction works at the LNG plant progressed, including foundation work for the two LNG storage tanks. Marine facilities are under construction, including the temporary jetty and material offloading facility. Preparations for microtunnelling for the trunk line began in August. Platform construction continues at the DSME shipyard in Okpo, Korea. Erection of the top deck has commenced.

Plans for 2014

Canning Basin

Buru is planning a well program of six or more wells in 2014, plus extensive additional 2D and 3D seismic, including the 193 km Mt Fenton 2D seismic survey, to be carried out in EP 457 and 458 by the Terrex Crew 402. Buru will also carry out a more extensive 2D program along trend in the Ungani oilfield.

Buru is also planning an extended production test at Ungani North, an upgrade of production facilities at

Ungani and the construction of an oil export facility at the Port of Wyndham.

New Standard Energy is planning for one to three wells in the Canning Basin from mid-2014.

Perth Basin

AWE has plans to drill two to four wells in 2014, including Drover 1 in EP 455 and Synaphea 1 in its L1 Production Licence, to the east of the Senecio and Corybas discoveries. Appraisal/ development drilling is also being lined up.

Norwest are planning a 110 km² 3D seismic survey around the Arrowsmith project in EP 413 in Q2 2014 and based on the results, the company will plan a horizontal well (Arrowsmith 3) in the most prospective interval. Norwest will start a comprehensive modelling exercise to commercialise the Arrowsmith field.

Carnarvon Basin

New Standard Energy is planning a seismic survey for the Merlinleigh Project.

Transerv Energy has plans to drill on the Warro field in EP 321 and EP 407 in the first half of 2014.



Photo © Chevron

Platform construction is well underway for the Wheatstone Project

Petroleum and Geothermal Resource Management and Administration Regulations

Colin Harvey

Principal Legislation and Policy Officer
Petroleum Division

The first of a set of two Resource Management and Administration Regulations for petroleum and geothermal activities has been released by the Department of Mines and Petroleum for stakeholder comment along with supporting explanatory notes and guidelines.

The draft *Petroleum and Geothermal Energy Resources (Resource Management and Administration) Regulations 2014*, which cover the WA onshore petroleum sector, will be open until 30 May 2014.

When finalised, these regulations will provide a risk or objective-based management scheme for the exploration for, and production of, petroleum and geothermal energy resources.

Background

The starting point for the development for petroleum objective-based regulations was the Piper Alpha disaster in 1988. The subsequent inquiry led to recognition that safety in the petroleum industry was best addressed by a risk-based outcomes or objective-based style of regulation. In Australia there was national agreement to move to objective-based safety regulation.

In 1994 the then Australian and New Zealand Minerals and Energy Council (ANZMEC) Sub-Committee on Upstream petroleum agreed that the 1990 Schedule of Directions be converted



The Crusader 405 rig drilling Ungani 3 in the Canning Basin

into regulations. A similar Schedule applied onshore. During 1996 the first objective-based petroleum legislation commenced with the introduction of the safety case regulations.

The 1998 Minerals and Petroleum Resources Policy Statement stated that the (Federal) Government would continue with the development of objective-based regulations for management of the offshore petroleum code.

Given WA's long standing commitment to the common (petroleum) mining code (ie similar petroleum legislation

across all three jurisdictions), this was a policy direction for the State as well as the Commonwealth.

Following on from the introduction of the offshore safety regulations, the timeline for the development of objective-based legislation is:

- 1999 Commonwealth Environment regulations (WA Chaired Working Group)
- 2004 Commonwealth Well Operations Management Plan regulations (WA Chaired Working Group)

- 2006 WA Petroleum (Submerged Lands) Act 1982 Well Operations Management Plan Regulations
- 2006/2010 WA Safety regulations
- 2011 Commonwealth Resource Management and Administration Regulations (Extensive WA input due to Designated Authority/State role and recognition of importance of model)
- 2012 WA Petroleum and Geothermal Environmental Plan regulations x 3
- 2014 WA draft onshore Resource Management and Administration Regulations

Following commencement of the onshore resource management regulations, the remaining parts of the 1991 Onshore Schedule will be revoked.

WA Resource Management Regulations

A range of resource management and administration matters are covered by the regulations, including well management plans for the approval of all drilling activities (including shale and tight gas), notification and reporting of discovery of petroleum and geothermal energy resources; field development

plans and approvals of petroleum recovery.

The regulations ensure that adequate data and reports information will be provided about all aspects of exploration, discovery, development and production operations in relation to petroleum and geothermal energy resources and stipulate the confidentiality periods applicable to the technical data submitted by title holders.

This information ensures that petroleum and geothermal energy resources operations are carried out in a proper manner; in the case of operations relating to the exploration or recovery of petroleum, in accordance with good oilfield practice.

The regulations also require that operations are conducted to achieve optimum long-term recovery of petroleum and geothermal energy resources to support the safe and efficient management of the resources and assist with optimising the long-term benefits to the Western Australian community.

Complementary Legislation

The petroleum safety and environment regulations are existing complementary

legislation and should be read in conjunction with the draft resource management regulations to assist in understanding the WA petroleum legislative regime.

The second part of this set of regulations, the *Petroleum (Submerged Lands) Resource Management and Administration) Regulations 2014*, will cover submerged lands adjacent to the coast of WA and will be drafted after the public and stakeholder consultation process for the onshore regulations.

These will form the third and final part of the suite of regulations that commenced in 2010 with the introduction of two onshore safety regulations – *Petroleum and Geothermal Energy Resources (Occupational Safety and Health) Regulations 2010* and the *Petroleum and Geothermal Energy Resources (Management of Safety) Regulations 2010*. Then in 2012 onshore environment regulations commenced with *Petroleum and Geothermal Energy Resources (Environment) Regulations 2012*.

Further information

More information is available at www.dmp.wa.gov.au/RMAR or by contacting Colin Harvey, Principal Legislation and Policy Officer, Petroleum Division on 9222 3273.

New updates to chemical disclosure



Brad Jakowyna
Team Leader, Operations
Environment Division

An environmental officer inspects chemicals being stored on a petroleum site

The Department of Mines and Petroleum (DMP) recently updated its public disclosure rules for chemicals being used down-hole in petroleum activities.

Chemical disclosure is a requirement of the Petroleum Environment Regulations gazetted in August 2012 and is designed to ensure transparency in relation to chemicals being used in petroleum activities, whether offshore or onshore.

A revised version of the chemical disclosure guidelines was released in August 2013, following an extended period of stakeholder feedback and consultation.

Chemical disclosure is now moving towards a risk-based approach, which means that more information has to be provided to DMP about the chemicals being used. Petroleum operators may also be required to undertake a specific chemical risk assessment for any proposed activities where potential

impacts or risks to human health, the environment or water resources are identified.

DMP uses the chemical disclosure and risk assessment in its regulatory environmental approvals process to help determine the acceptability of a proposed petroleum activity. This may include obtaining advice from other agencies on a case-by-case basis, such as the Department of Water and Department of Health. It may also include referring the proposal to the Environmental Protection Authority where it is deemed to have significant environmental impacts or risks.

The updates include:

- adopting 'systems based' chemical disclosure, which means that disclosure is provided for each stage of a petroleum activity, ie. drilling, cementing, well maintenance and fracing stages (where appropriate);

- providing information about ecotoxicity (in relation to aquatic plants and animals) and rates of biodegradation;
- providing a chemical disclosure template for operators to use in a consistent manner; and
- releasing a guideline and fact sheet on DMP's website about chemicals in the petroleum industry.

Chemical disclosure guidelines, template and environment risk guidelines can be found at www.dmp.wa.gov.au/17202.aspx.

State areas released for petroleum exploration April 2014

Richard Bruce
Exploration Geologist
Petroleum Division



Photo © Key Petroleum

Athos 2D Seismic Survey (Canning Basin)

DMP continues to promote the petroleum potential of Western Australia's vast sedimentary basins using a specific area release system in our onshore areas.

A disk package accompanies the acreage release and contains information about the prospectivity of release areas, available data listings, land access, and how to make a valid application for an Exploration Permit.

In April 2014, DMP released a total of five blocks (Fig. 1). This release comprised four blocks in the onshore Canning Basin and one block in the onshore southern Perth Basin.

Canning Basin

- Release area L14-1 is a small block (324 km²) in the Jones Arch of the northeast Canning Basin. The Emika prospect has been mapped by a previous operator. There is considered to be potential for oil in Lower Permian sandstones. The release area lies close to the sealed Great Northern Highway and is more easily accessible than many other locations in the Canning Basin.

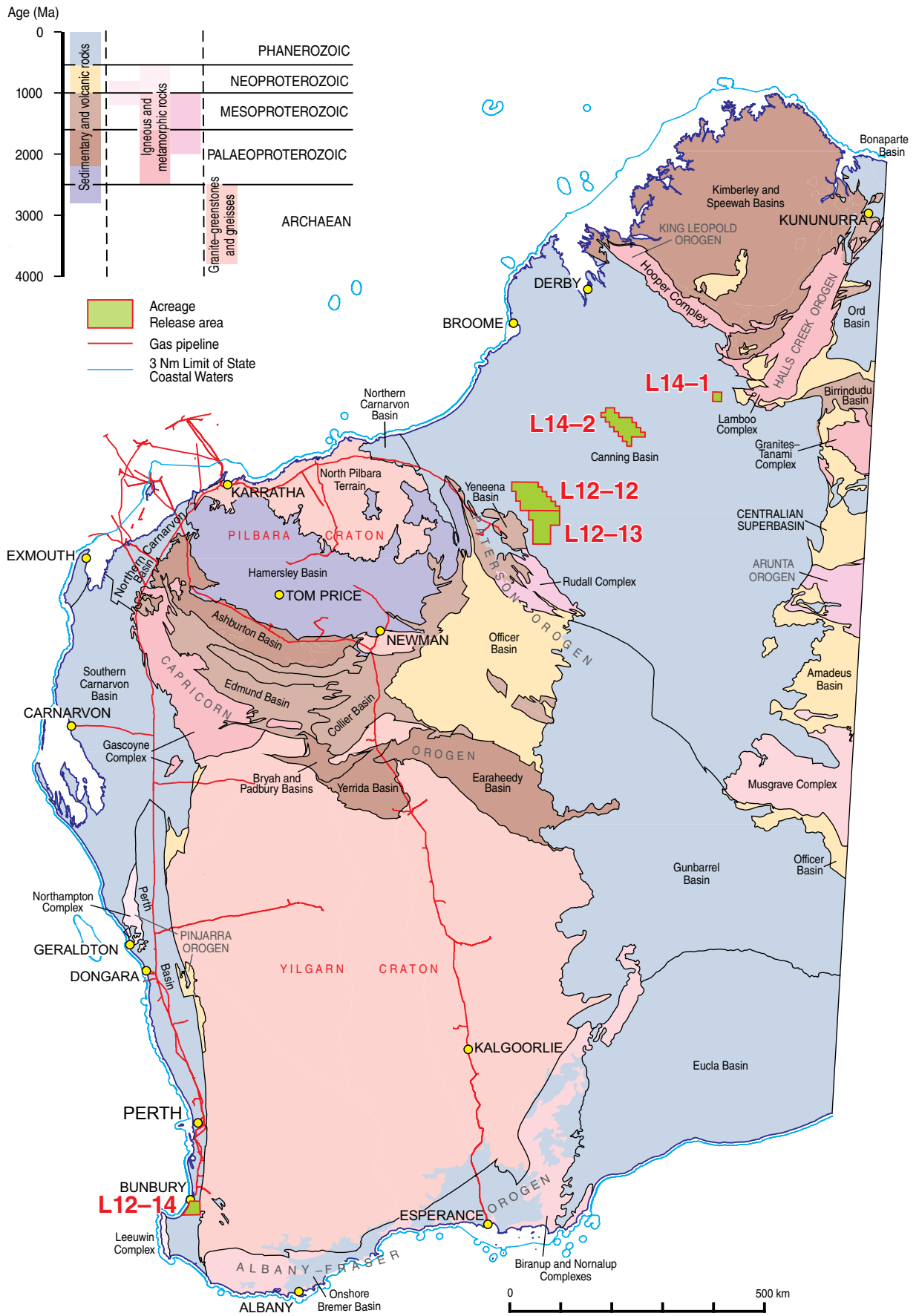
- Release area L14-2 is a block in a platform area of the central Canning Basin with potential sub-salt and supra-salt targets for oil and gas. Its size is 2659 km². The Sally May anticline comprises over 300 km² of closure and the two wells drilled so far may not have fully evaluated the whole structure for both conventional and tight gas or shale oil and gas potential.
- Release areas L12-12 and L12-13 are situated adjacent to the southern margin of the Canning Basin and may have potential for Ordovician-sourced conventional hydrocarbons and shale-gas. The size of these blocks is 3594 km² and 2866 km². These blocks lie along the lightly explored margin of the Kidson Sub-basin, where the thick Mallowa Salt thins out up-dip. Medium to long distance migration beneath a salt seal from a more mature source kitchen to the east and north may have occurred. The release areas lie less than 100 km from a gas pipeline leading to the Telfer Goldmine, one of Australia's largest operating goldmines.

Perth Basin

There is one release area, 668 km² in size, located in the Bunbury Trough of the onshore southern Perth Basin. There is excellent access to nearby infrastructure, including the port city of Bunbury. The Bunbury Trough contains a thick and mature succession of Permian coal measures and intervening sandstone units. Shows at various stratigraphic levels are suggestive of an active Permian petroleum system in the trough. The Kwinana oil refinery lies 160 km to the north, and there are significant domestic and industrial markets for gas in the region.

Work program bids for the release areas close at 4pm on Thursday 23 October 2014.

Should you require any further information or assistance, please contact Richard Bruce (08 9222 3314) of DMP's Petroleum Division or Ted Bowen (08 9222 3124) of the Geological Survey of Western Australia. All enquiries will be dealt with in strictest confidence.



RB73

29.12.13

Figure 1 April 2014 State petroleum release areas

Grant of petroleum titles

Richard Bruce
Exploration Geologist
Petroleum Division

State Awards

From 1 July 2013 to the end of December 2013, the following petroleum titles were awarded in State areas:

Petroleum Exploration Permits

In July 2013, EP 486 in the Canning Basin was awarded to Exceed Energy (Australia) Proprietary Limited. The firm two-year period includes 150 km of 2D seismic reprocessing and a 100 km 2D seismic survey to an estimated value of \$1,550,000. The remaining program includes a 150 km² 3D seismic survey, two exploration wells and a 100 km 2D seismic survey to an estimated value of \$11,950,000.

Special Prospecting Authorities with Acreage Option

In August 2013, SPA 10 AO in the Southern Bonaparte and Ord Basins was awarded to Canning Petroleum Proprietary Limited for the acquisition and analysis of hyperspectral satellite data. The SPA/AO expires on 7 February 2014. From this date the title holder has six months to apply for an Exploration Permit.

In August 2013, SPA 11 AO in the Ord Basin was awarded to Canning Petroleum Proprietary Limited for the acquisition and analysis of hyperspectral satellite data. The SPA/AO expires on 7 February 2014. From this date the title holder has six months to apply for an Exploration Permit.



Photo © Key Petroleum

Cyrene 1 well drilled in the Canning Basin

In August 2013, SPA 12 AO in the Ord Basin was awarded to Canning Petroleum Proprietary Limited for the acquisition and analysis of hyperspectral satellite data. The SPA/AO expires on 7 February 2014. From this date the title holder has six months to apply for an Exploration Permit.

Commonwealth Awards

Under the State Joint Authority, the Petroleum Division participated in the award of the following new petroleum exploration permits from the second round of the 2012 Acreage Release that closed on 9 May 2013.

Commonwealth award information was sourced from the 25 October 2013 Australian Petroleum News.

WA-495-P (released as W12-10) located offshore Western Australia approximately 360 km northwest of Exmouth, has been awarded to Shell Development (Australia) Proprietary Limited.

WA-496-P (released as W12-6) located offshore Western Australia approximately 350 km northwest of Broome has been awarded to Woodside Energy Limited and Mitsui E&P Australia Proprietary Limited.

Fast-tracked assessments



An approaching wet/cyclone season is often used by companies (as an invalid reason) to justify the need for a fast-tracked environmental assessment

Environment Division

During summer, the State's Pilbara and Kimberley regions enter their cyclone/wet season. This usually coincides with a surge in requests from companies wanting urgent 'fast-tracked' approvals, which cannot always be accommodated.

There are a range of reasons that companies push when they want 'fast-tracked' environmental approvals. These include that the company will lose access to machinery, are paying standby costs, have a cyclone/wet season approaching, or the company has changed their priorities. This is poor project planning and is akin to pushing your way to the front of the queue at the supermarket checkout. It's clearly not acceptable and impacts upon companies that are doing the right thing.

There are environmental assessment timeframes in place which, for petroleum activities, relate to a 30 calendar day assessment period. The aspirational aim is to have all applications determined within the target timeframe. An initial review is made on submission to identify complex applications to ensure these are not delayed. The Department of Mines and Petroleum (DMP) publishes quarterly performance figures against these assessment timeframes on its website.

All environmental applications are processed in the order in which they are

received. However, timeframes can slip when companies submit applications that do not follow the regulatory requirements, are deficient, or missing information. This inevitably results in assessment officers requesting additional information from companies.

A reasonable timeframe will be provided for companies, to respond to requests for additional information. When the company has failed to provide the requested information within the requested timeframe, the Department of Mines and Petroleum will terminate the assessment and reject the application. When no timeframe is stated in the request for additional information, the application will be rejected if the company has failed to provide the information within 12 weeks of the date of the request.

This iterative process of getting applications to the required standard results in the assessment 'clock' stopping. Likewise, formal referral to other government agencies also stops the 'clock'. Some companies do not consider these factors when submitting their applications and panic when their anticipated assessment timeframes are exceeded.

However, there may be rare occasions when exceptional circumstances occur that require a project approval to be 'fast-tracked', including:

- addressing a public safety hazard;
- to prevent significant environmental harm from occurring;
- in response to an emergency event;
- to address an administrative error previously made by DMP.

Any company request to 'fast-track' an environmental assessment must be submitted in writing to Dr Phil Gorey, Executive Director Environment, Department of Mines and Petroleum, with a valid reason.

New safety equipment improves efficiency and safety during pipeline construction – application at the West Angelas pipeline

Wal Trelecki
Area Manager – Petroleum Pipelines, Iron Ore
Rio Tinto



Photo © RTIO

Walter Law (DMP) and Wal Trelecki (RTIO) with the Deckhand® attachment

The Rio Tinto Iron Ore (RTIO) West Angelas Petroleum (Gas) Pipeline and Stations (WAPPL) saw the use of a device, a Deckhand®, that eliminated the hazards associated with the unloading of rock jacket and concrete weight coated pipe such as working at height and working in the line of fire.

In the past rock jacket and concrete weight coated pipe could only be unloaded with the use of traditional lifting methods, such as sling with end hooks and tag lines which also introduced working at height issues when rigging the pipe.

RTIO infrastructure Project Manager Terry Humphrey saw the use of the Deckhand® as a win/win for RTIO and the KT-OSD

JV. “Minimising the requirement for working at heights and in the prevention of working in the line of fire of suspended loads are two of Rio Tinto’s priority safety initiatives.

The Deckhand® provided a significant contribution to the elimination of these two hazards on the pipeline project. As an added benefit the Deckhand® proved to be significantly more efficient than the traditional method of manually slinging and handling of the line pipe. The use of the Deckhand® provided a win/win opportunity for Rio Tinto’s safety performance and KT-OSD JV’s desire to minimise construction time and hence costs”, Terry said.

The WAPPL was designed and constructed by the KT-OSD JV, a joint venture by Monadelphous KT Pipelines and OSD Pipelines. Monadelphous KT Pipelines was responsible for the pipeline construction and they introduced the use of the Deckhand®, as a major safety initiative which also improved the efficiency of the stringing process.

The Deckhand® uses NASA developed technology to provide positive control of pipeline lengths with a full range of movement and has never been used in the pipeline industry in Australia in this application. The Deckhand® can be installed on any excavator dependent on size of pipe.



Photo © RTIO

The Deckhand® being used for the first time in Australia to construct the West Angelas pipeline



Photos © RTIO

Top left: Close up of the Deckhand®. Top right: Lifting the pipeline into place. The Deckhand® has helped lay 85 km of gas transmission pipeline. Bottom: The West Angelas petroleum (gas) pipeline will transport gas from the Goldfields Gas Pipeline to Rio Tinto's new gas fired power station in the Pilbara

Curtly geochemical soil survey

EP 448, Canning Basin, Western Australia

Brooke Marshall
Key Petroleum

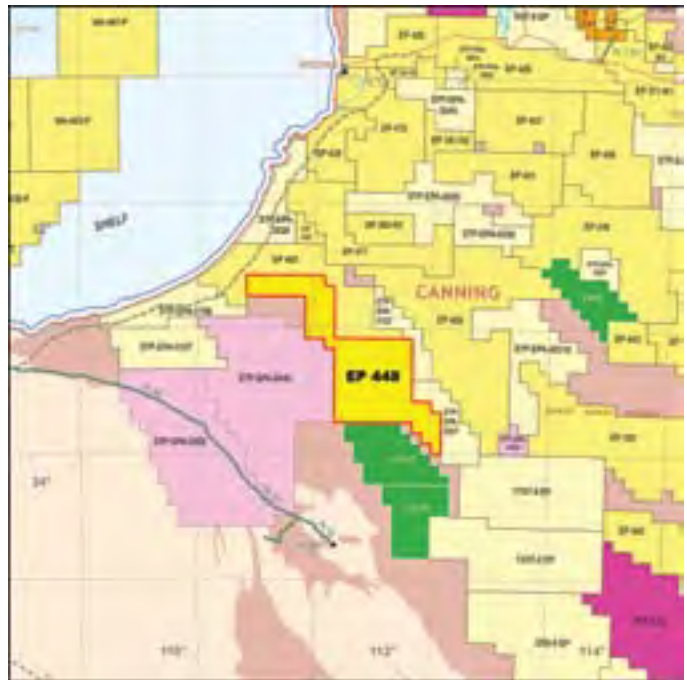


Figure 1 Location of EP 448 in Canning Basin

Discovering oil in a hostile and remote frontier block is no mean feat but Key Petroleum Limited is pursuing a historic milestone with a planned drilling program in a section of WA's Canning Basin where no wildcat well has been drilled before.

With limited road access, the EP 448 permit covers 8500 km² and lies within the Great Sandy Desert (see map). Explorers have made concerted efforts in the past to discover oil and gas in the Canning but only a few wells have been drilled in this particular area with a

scattering of seismic lines courtesy of WAPET some 50 years ago.

Not until recently has anyone ventured into EP 448 with the objective of drilling for prospective unconventional and conventional oilfields believed to exist from seismic interpretations depicting large structures mapped in Ordovician sediments and the Nita, Goldwyer and Bongabinni Formations.

To target prospective oil, Key used innovative techniques to gather new information, integrated with existing

data, to de-risk and identify drillable prospects; the essential element being the implementation of a specifically designed geochemical survey to pinpoint active petroleum systems.

In October 2013, Key commenced the largest geochemical survey ever conducted in this part of the Canning. Dubbed the Curtly Geochemical Soil Survey, which follows the Company's cricketing-named prospects and permits, it targeted strategically located areas following seismic lines and tracks accessible only by helicopter.

Covering a 2000 km² area, specialist geochemical analysts spent five days collecting surface hydrocarbon micro seepage samples in temperatures exceeding 50 degrees celsius.

Yet despite the harsh terrain and difficult conditions, results exceeded expectations and the outcome will see Key ramping up its drilling efforts once a full integration and assessment of data has been carried out on prospects and leads collated.



Left: Helicopter access was required for the collection of soil samples

The survey, in conjunction with the available seismic, aeromagnetic and well data, identified new leads and plays over the permit, detecting what is believed to be a new fairway of shallow oil prospects on trend over a source kitchen labelled the “Darriwell Sub-basin”. This was reflected in high geochemical anomalies and elevated ethane readings over mapped leads in a section to the north of the “Ambrose Low”, considered to overlie petroleum source areas.

Based on these results, the Company has refocussed its exploration strategy into a conventional shallow oil drilling program around four material prospects; Patterson, Griffiths, Griffiths South and Griffiths North. Two are planned to be drilled this year.

Key’s Managing Director Kane Marshall said he was delighted with the outcome of the survey and the resulting prospectivity upgrade of the block. “The results are more than encouraging and have far surpassed

our expectations for a frontier block,” Mr Marshall said.

“The survey certainly has played a crucial role in furthering our knowledge of the petroleum source areas within the permit and by integrating these results with seismic and nearby well data we can focus our attention on specific mapped sections to de-risk and refine the best possible locations for drilling in addition to refining potential unrisks in-place recoverable oil volumes over particular areas.”



Photo © Key Petroleum

Aerial view of landscape typical of the permit area

Neutron imaging: a lost technique

Mike Middleton

General Manager Resources
Petroleum Division



The neutron radiography facility at the Nuclear Energy Corporation of South Africa experimental reactor

Introduction

Neutron radiography and tomography have emerged over the past twenty-five years as a viable method to image fluids within the pore space of rocks (Jasti *et al.*, 1987; Middleton and Pázsit, 1998; Hilson, 2000; Middleton *et al.*, 2001a; Middleton *et al.*, 2001b; Middleton *et al.*, 2006). The application of neutrons to imaging the distribution of hydrogen-rich fluids in porous media is based on the ability of hydrogen to attenuate neutrons more effectively than most rock-forming minerals. This technique may prove useful for imaging water or petroleum in porous rock samples, and be a useful petrophysical analytical technique.

Neutrons are ideal for detecting water concentration, due to the high attenuation of neutrons by hydrogen, in porous or semi-porous media. Problems, which involve the determination of water concentration in porous media, are particularly amenable for neutron radiography analysis. In this context, water concentration in porous media is important in groundwater studies, petroleum reservoir studies, studies of geothermal systems, the understanding of water absorption in building materials, and more recently in mineral exploration and processing applications.

Beyond these applications, neutron analysis of flawed and corroded aircraft parts has emerged as a valuable tool to support conventional non-destructive testing (NDT) techniques. Such investigations, using neutron radiography of aircraft parts, have been active in the United States, Canada and South Africa for over two decades. In 2001, an Australian Research Council (ARC)

grant enabled this informal collaboration to establish a semi-portable neutron imaging system in Perth, Western Australia, but unfortunately this was thwarted by a number of unforeseeable circumstances.

This article presents some of the positive outcomes of neutron imaging that were achieved in that period. It was not a distinct research program, but a journey to discovery by a number of academics and brave, supporting industry colleagues with considerable foresight to investigate possible industry advances. One day, the proponents hope something positive might result from the investigations.

Neutron Imaging

In overview, neutron radiography presents a powerful, non-destructive testing method, which in many new areas of application remains to be evaluated. It has proven to be most

valuable where water detection, in concentrations greater than approximately 0.1 percent of the total volume, is required. This concentration is not a limitation on the technique, but only current applications. It has been demonstrated to be a powerful tool to detect natural substances containing bound-water and neutron-attenuating minerals, such as clay, glauconite and the various water-rich, iron-bearing minerals (e.g. goethite). It is also acknowledged that a shortcoming of neutron radiography is its inability to identify structural features less than about 10 microns, which is largely a result of current limitations in neutron-image detection media.

The set-up is shown in schematically in Figure 1. A beam of neutrons, either thermal (slow) or fast, is aimed at an object, and a radiographic image of the object is detected by an imaging medium. The image will show how

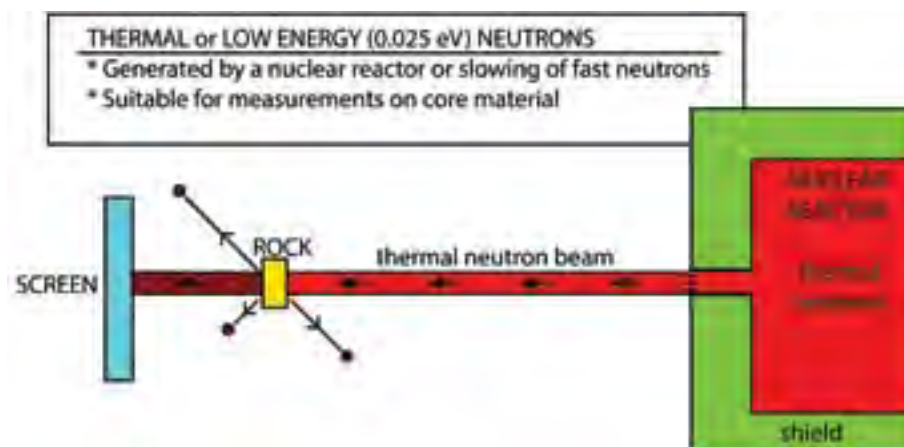


Figure 1 Schematic set-up of the neutron imaging technique for thermal (slow) neutrons from a nuclear reactor. A similar technique was developed for fast neutrons, generated by a source similar to that used in the wireline neutron logging tool.

Table 1 Neutron attenuation coefficient (μ), and typical density (ρ) for various substances. Note that quoted values for μ are for total thermal neutron attenuation, due both to neutron scattering and capture.

Substance	μ (cm^2g^{-1})	ρ (g cm^{-3})
Hydrogen (atom)	25	-
Water	2.3	1.00
Heavy Water	0.55	1.20
Hydrocarbon (Liquid)	2-4	~0.85
Air	~0.5	0.0013
Carbon (Coal)	0.4	1.40
Quartz	~0.08	2.65
Glauconite	0.14	~2.3
Quartz Sandstone ($\phi=20\%/H_2O$)	0.65	2.32
Greensand ($\phi =23\%/H_2O$)	0.39	2.00
Hematite	0.76	~5.1
Goethite	1.65	~ 4.2
Limonite	1.76	~ 3.8
Iron Ore (porous)	0.40-0.95	3.0-4.0

neutrons are attenuated by the object and can be quantitatively assessed by analysis of the image. Notably, the two elements that attenuate neutrons the most are hydrogen and cadmium. The presence of the element hydrogen in liquids within a rock is of most interest for petroleum purposes.

Theoretical considerations show that two physical properties of rocks attenuate neutrons (1) the rock's neutron attenuation coefficient (μ), and (2) the rock's density (ρ). Table 1 shows values of these physical properties for various substances and minerals. The product of the two physical properties ($\mu\rho$) is a good indication of neutron attenuating ability. A large number of experiments were carried out between 1996 and 2006 to detect water and oil movement within porous rocks. These were successful and results similar to NMR imaging were achieved. Similarly, rocks containing organic matter and iron ore with bound water content were successfully imaged. The purpose of this article is to show some pictorial examples of these studies.

Examples

In keeping with the aim of this article, examples of the neutron radiographs of rocks are shown in figures 2 to 8. The purpose is more to present a pictorial atlas of how neutron radiography may improve geological, petrophysical and engineering knowledge of porous rocks and water-bearing minerals. It also records an historical development of the technique from 1996 to 2007.

Fluid Flow in Porous Sandstones

Figure 2a shows an original radiograph of oil being imbibed into an air-filled sandstone core (Middleton *et al.*, 1997). The graph in Figure 2b shows a water front moving through the rock at various times after beginning of injection from experiments of the same period (1996-1997 at the Budapest experimental reactor, Hungary). A good approximation of the porosity and gas-water permeability of the rock can be estimated from these data. The derived calculations have been substantiated by standard SCAL measurements.

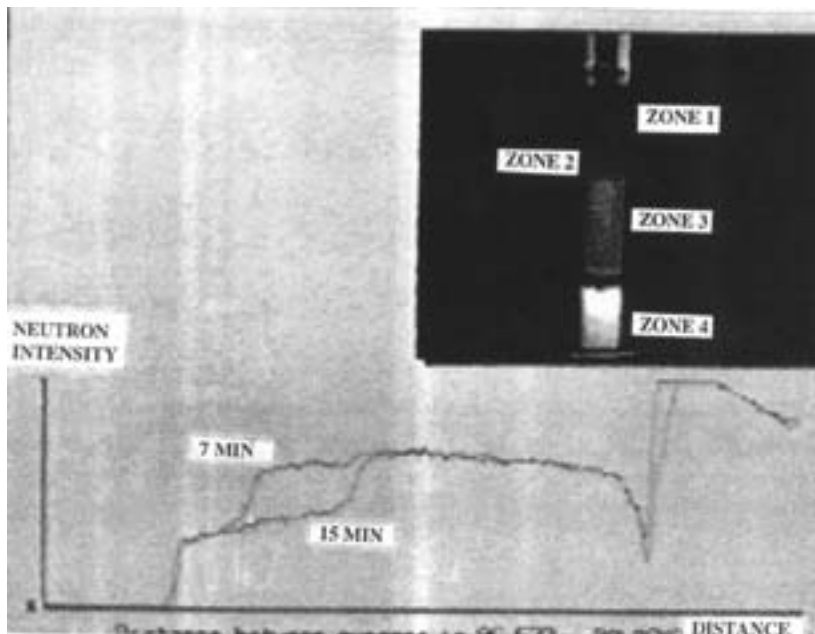


Figure 2a Historical photograph of an early neutron radiography experiment carried out in Budapest in 1996.

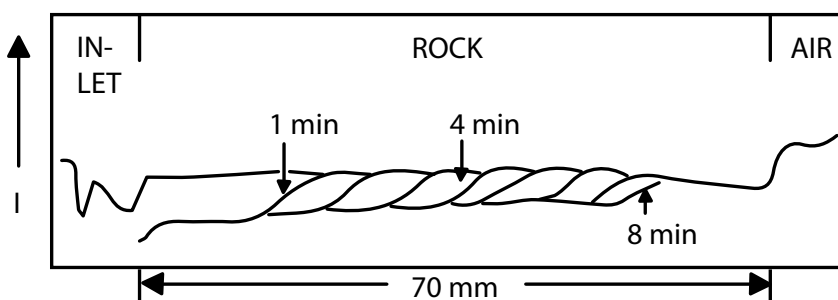


Figure 2b Graph showing neutron intensity as water is introduced to a dry sandstone (Visingsö Sandstone, Sweden) core of porosity about 17%. The experiment was carried out in 1996. The front is identified at 1 minute, 4 minutes and 8 minutes after fluid flow commenced.

Mardie Greensand

Images of Mardie Greensand, described by Jodie Hilson (2000), are shown in figures 3 and 4. Unique structures within the sample can be seen. The example shown in Figure 3 shows the effect of burrowing within the sample imaged. The example in Figure 4 shows images of various stages for spontaneous imbibition into a Mardie Greensand sample from the Roller 1 well. Initially the sample is imaged dry, then after spontaneous imbibition for 1 hour, and finally when fully saturated. In this latter case, the colours of the neutron image are calibrated quantitatively to the quantity $\mu\rho$ (refer also to Table 1). Water saturation (S_w) can be successfully determined from these images.

Iron-rich minerals

The work by Middleton *et al.* (2006) shows that the mineral content of iron ore with mixed mineral composition (Figure 5) can be identified with neutron images.

Canning Basin Tar/Kerogen

Images of tar and kerogen have been obtained from cores from the Grant Formation in the Canning Basin (Middleton *et al.*, 2007). Images from five samples are shown in Figure 6.

Spontaneous Imbibition Studies

A number of studies have been carried out to investigate the phenomenon of spontaneous imbibition (Middleton *et al.*, 2005). Figures 7 and 8 are reproduced from this study, which had the aim of quantifying the process and to investigate the physics and engineering principles involved in spontaneous imbibition.

Conclusion

Analysis by neutron imaging can provide information on porosity, liquid saturation, permeability, pore-throat distribution and lithology. Studies of sufficient detail have been carried out between 1996 and 2007 to demonstrate the success and usefulness of this technology to describe the petrophysical properties of many rocks relevant to the petroleum industry.

The challenge is to advance this technology within the petroleum industry. One of the corporate objectives of the Department of Mines and Petroleum is to develop a growing attention and adoption of new technologies to support the mining and petroleum industries. Description and examples of new technologies, such as neutron imaging, support this goal.

THE NEUTRON IMAGE

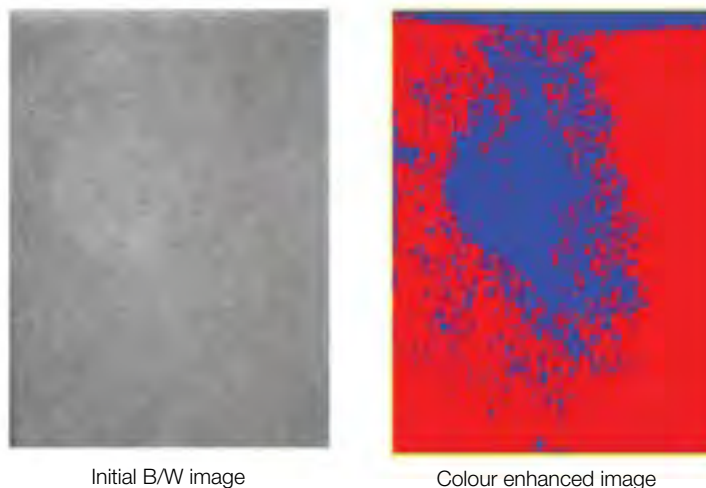


Figure 3 Sample of Mardie Greensand with a burrow. A black & white and colour enhanced neutron radiograph is shown. The colour enhanced image shows the burrow in blue.

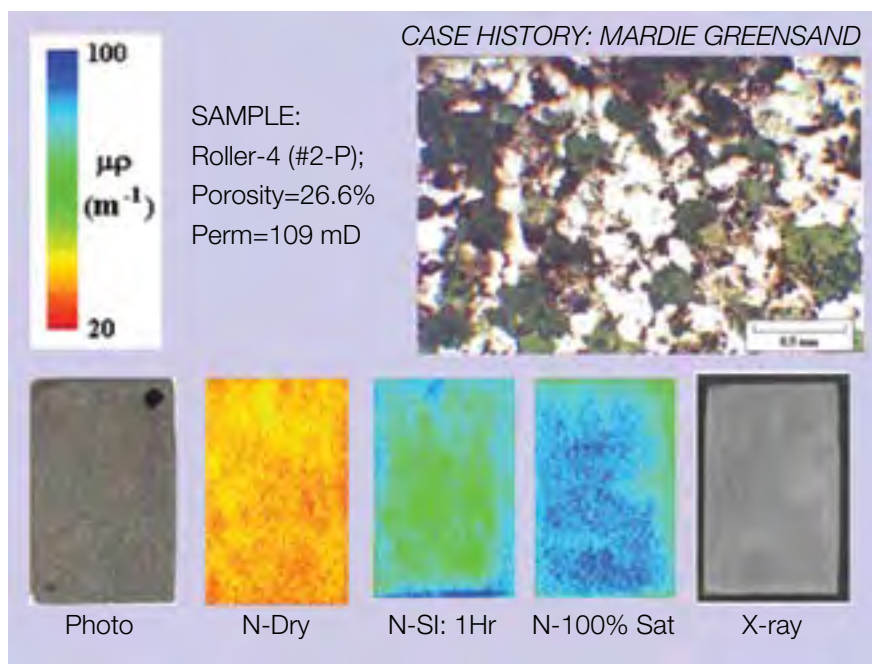


Figure 4 Sample of Mardie Greensand from the well Roller 1. The dry neutron image is red-orange ($\mu\rho \sim 30 \text{ m}^{-1}$), partially saturated rock is light blue-green ($\mu\rho \sim 60 \text{ m}^{-1}$), and the fully saturated rock is approaching dark blue ($\mu\rho \sim 90 \text{ m}^{-1}$).

Note: Pixelation of these images is a limitation of the neutron and x-ray imaging method of the day. Each pixel has the dimensions of 100 micrometres x 100 micrometres

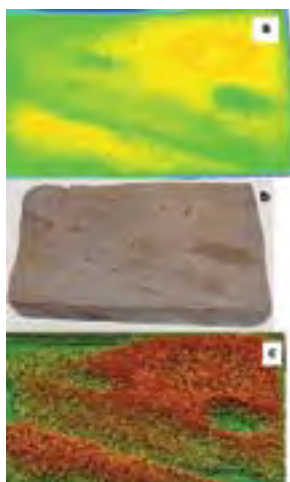


Figure 5 Marra Mamba ore from the West Angelas deposit in Western Australia. Image (a) is a colour enhanced neutron radiograph of the ore shown in the photograph depicted in image (b). Image (c) is a pixel enhanced image, which helps to define clearly the presence, and relationship, of the two major mineral types within the sample. The yellow-red regions represent regions of low neutron attenuation (hematite), while the green areas represent the regions of higher neutron attenuation (goethite and limonite). The iron-rich minerals exhibit different neutron attenuation due to different bound-water content.



PHOTO

NEUTRON

(1) FAULT ZONE

PHOTO

NEUTRON

(2) WORRAL FORMATION

PHOTO

NEUTRON

(3) PILLARA FORMATION

NEUTRON

X-RAY

(4) GRANT SANDSTONE
FULL TAR CONTENT

NEUTRON

X-RAY

(5) GRANT SANDSTONE
PARTIAL TAR CONTENT

Figure 6 Rocks from the Canning Basin with neutron and X-ray radiographs showing internal structure, where red in the neutron image indicates hydrocarbon (kerogen or residual oil) and red in the X-ray image indicates denser than normal mineralogy

Note: Pixelation of these images is a limitation of the neutron and x-ray imaging method of the day. Each pixel has the dimensions of 100 micrometres x 100 micrometres

NEUTRON ANALYSIS OF SPONTANEOUS IMBIBITION

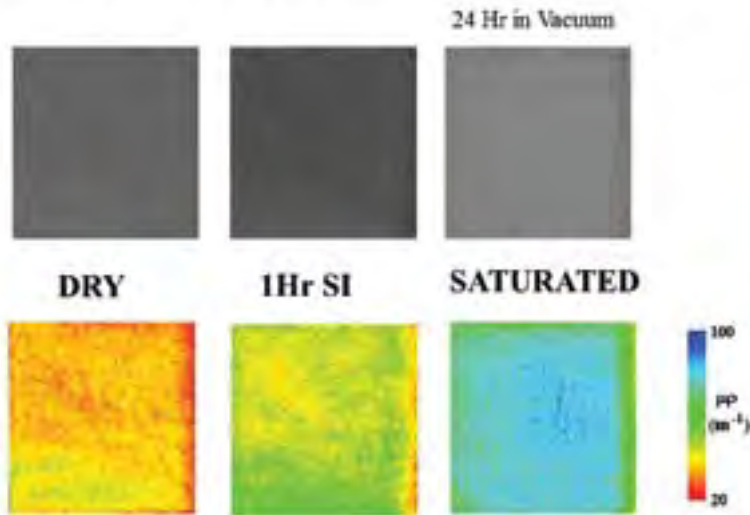


Figure 7 Images of porous rock undergoing spontaneous imbibition under atmospheric pressure. The images are related to the physical quantity $\mu\rho$ (see Table 1).

Note: Pixelation of these images is a limitation of the neutron and x-ray imaging method of the day. Each pixel has the dimensions of 100 micrometres x 100 micrometres

NEUTRON ANALYSIS OF SPONTANEOUS IMBIBITION

Comparison: 1Hr SI & 100% saturated

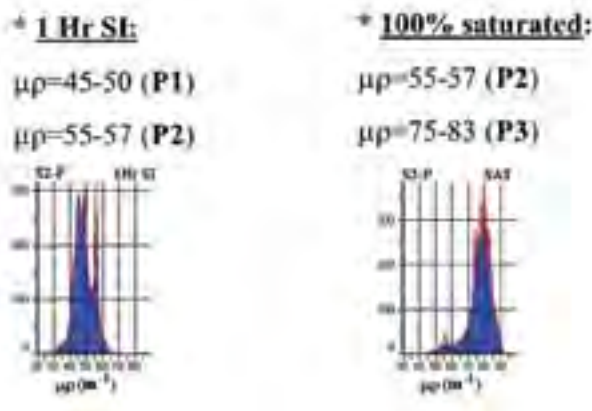


Figure 8 The distribution of pixels of dimension ca. 100 μm to the physical quantity $\mu\rho$. The distribution (or populations P1, P2 and P3) of $\mu\rho$ at 1 hour is markedly different from the distribution at full saturation. This provides information on how different pore throats are influenced by water influx over time.

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Middleton, M.F., de Beer, F., Haines, P. and Mory, A., 2007, Evaluation of tar deposits using neutron tomography, Canning Basin, Western Australia, Exploration Geophysics, Proceedings of the 19th Geophysical Conference and Exhibition, Perth, Western Australia, November 2007.

The Petroleum and Geothermal Register (PGR) Drilling Management module – Phase 2 implemented

Hazel Harnwell
Manager Compliance
Petroleum Division



Staff involved in development and testing of PGR Drilling module

On 2 December 2013, Phase 2 of the Petroleum Division's PGR Drilling Management module went live.

This development is in preparation for the new *Resource Management and Administration Regulations* and will ensure internal users consistently assess, approve and monitor well activities. It will be the first time that technical data for all drilling activities will be captured and stored in a central location.

Staff in the Petroleum Division's Resources Branch can now track and record the complete life cycle of a well on receipt of submissions for:

- Completion
- Hydraulic Fracturing
- Injection Test
- Intervention
- Management of Change
- Suspension
- Vary Well Bore – Offshore
- Vary Well Bore – Onshore
- Well Test
- Workover
- Abandonment

Data links directly to a related petroleum or geothermal title and previously approved Application to Drill, providing a 'cradle to grave' view on the life cycle of a well and related activities.

Using integrated workflows and DMP's electronic Communications Manager, the Resources Branch can directly assess, in PGR, referrals for new drilling applications received from the division's Petroleum Tenure and Land Access Branch.

Included is functionality allowing applications to be put on hold for multiple reasons when assessments are pending mandatory feedback or approval from other jurisdictions (e.g. matters relating to Native Title, environmental protection etc.). Both the Resources and Petroleum Tenure and Land Access Branches can place an assessment or application on or off-hold in accordance with DMP's approvals reporting requirements. It is anticipated that this functionality will be further enhanced and more widely implemented when PGR workflows are linked to the department's Safety Reporting System (SRS) and Environment Assessment and Regulatory System (EARS) in the future.

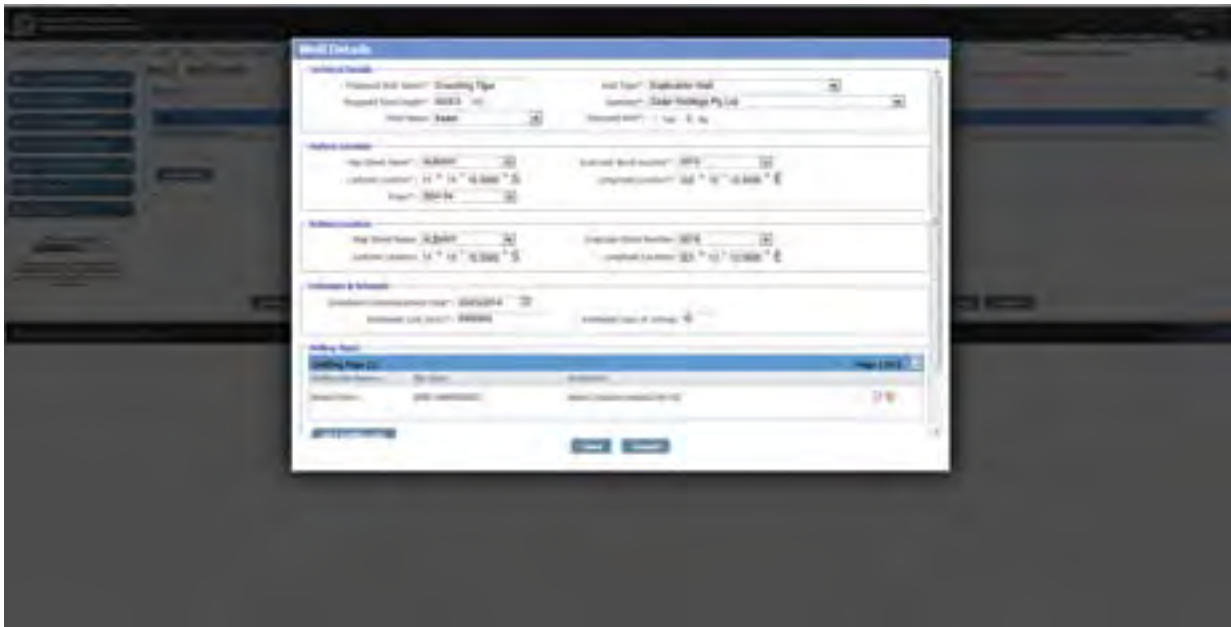
The module was introduced on-time and on-budget with development running concurrently with new PGR development. This is due to the outstanding efforts of the Resources Branch and Information Services Branch PGR Development Team

who spent many hours undergoing intensive development, testing and training to achieve this milestone. The process involved developing workflow templates and checklists for each activity. Current work practices and procedures were reviewed and revised to ensure that they appropriately reflect legislative and business requirements.

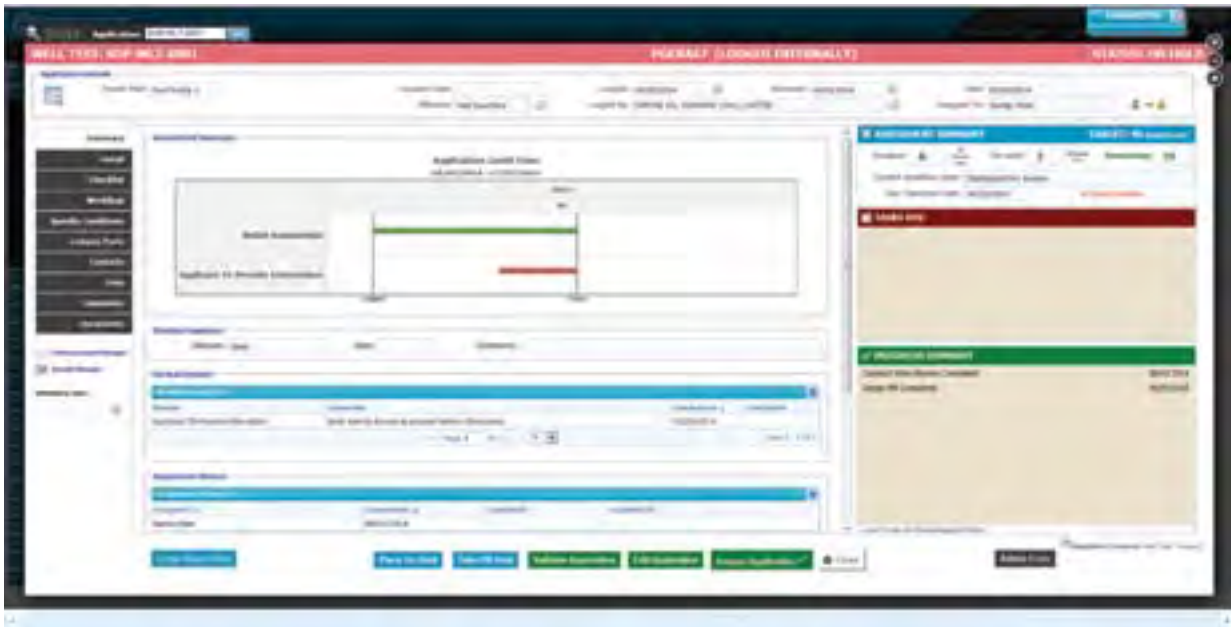
Future enhancement to the module will include the ability to record the outcome of audits carried out by Petroleum Division technical officers on matters relating to well monitoring, metering and chemicals. Nonconformities identified will be recorded along with any follow up action.

Development ran concurrently with other ongoing PGR development. It required staff, in addition to their normal tasks, to undertake stringent testing programs to ensure that each of the functions performed as required.

Executive Director of the Petroleum Division, Jeff Haworth, said that PGR has taken a major step to improving the transparency of Petroleum Division activities. It will provide a robust assessment process for matters relating to well integrity. "Implementation of



External view of PGR's Drilling Management module



An internal view of the Drilling Management module: well test submission

the Drilling Management Phase 2 module will ensure that submissions for well activities are dealt with in a consistent and timely manner. Future development will provide technical officers in the Resources Branch with the ability to record outcomes of site inspections in the one system. This will prove invaluable once implemented”, Jeff said. “Having all related data available from one central location will reduce the time taken to search for information and related activities”.

In July 2013, the Petroleum Division’s ageing EPR system was decommissioned after data and functionality was fully migrated into PGR. The EPR system was over 14 years old and lacked the capability to expand to deal with emerging technologies or legislative changes.

So what can be expected for PGR in the not too distant future? A lot more work and development is required for its continued growth

and enhancement. With any new development, PGR development participants are required to review and document current work practices and procedures to ensure they remain compliant with legislation and streamlined to prevent duplication of processes.

Greater emphasis will be placed on resource management issues and automating approval processes in a paperless environment.

TABLE 1. 2013 PRODUCTION BY FIELD AND CUMULATIVE PRODUCTION WA ONSHORE AND STATE WATERS AS AT 31 DECEMBER 2013

Field	Operator	2013 Production by Field			Cumulative Production			Permit
		Oil	Condensate	Gas	Oil	Condensate	Gas	
		kL	kL	10 ³ m ³	kL	kL	10 ³ m ³	
Agincourt	Apache	13,304.8	50.1	2,894.2	559,603.42	4,269.61	41,873.22	TL/1
Albert	Apache	3,214.4	242.1	7,117.3	77,419.80	379.80	16,674.10	TL/6
Bambra	Apache	19,648.4	186.2	15,026.8	403,023.10	158,301.20	1,362,609.30	TL/1
Barrow Island	Chevron	300,609.0	0.0	32,994.3	51,204,658.93	0.00	5,407,368.71	L1H
Beharra Springs	Origin	0.0	146.4	13,937.9	0.00	24,357.53	2,293,909.30	L11
Beharra Springs N	Origin	0.0	44.1	4,168.3	0.00	2,056.34	210,398.26	L11
Blina	Buru Energy	27.0	0.0	0.0	298,725.15	0.00	0.00	L6
Boundary	Buru Energy	32.0	0.0	0.0	21,212.14	0.00	0.00	L6
Corybas	AWE	0.0	109.7	6,103.3	0.00	342.40	18,546.33	L2
Crest	Chevron	343.0	0.0	1,526.0	275,808.00	108.00	65,773.00	L12, L13
Dongara	AWE	542.8	0.0	15,971.9	195,612.78	49,681.21	12,943,461.67	L1, L2
Double Island	Apache	2.0	0.0	1.1	708,512.10	2,943.10	59,150.70	TL/9
Gingin West	Empire	0.0	1,010.8	52,339.1	0.00	1,010.79	52,339.06	EP389
Harriet	Apache	41.6	0.0	79.8	8,232,695.10	61,226.35	1,510,761.58	TL/1
Hovea	AWE	0.0	0.0	25.2	1,170,005.35	251.09	104,855.44	L1
Lee	Apache	309.1	9,118.4	62,325.3	313.50	119,212.30	788,360.20	TL/1
Linda	Apache	0.0	6,120.0	42,185.8	0.00	301,453.80	1,205,096.00	TL/1
Little Sandy	Apache	163.2	0.5	83.3	95,352.90	491.64	15,989.80	TL/6
Mohave	Apache	6,654.2	62.7	1,743.5	174,510.90	648.50	40,788.10	TL/6
Pedirka	Apache	1,173.1	6.2	486.8	341,249.50	1,373.10	45,924.50	TL/6
Red Gully	Empire	0.0	6,576.8	21,147.9	0.00	6,576.80	21,147.87	EP389
Redback	Origin	0.0	259.3	138,106.5	0.00	691.74	450,091.91	L11
Roller	Chevron	26,611.0	0.0	11,433.0	7,211,390.00	0.00	793,215.00	TL/7
Rose	Apache	3,342.4	1,239.7	14,318.1	6,383.50	210,146.40	1,052,087.90	TL/1
Saladin	Chevron	60,523.0	0.0	26,407.0	15,645,337.00	0.00	1,811,653.00	TL/4
Simpson	Apache	649.9	271.5	325.1	857,914.57	14,570.99	90,524.45	TL/1
South Plato	Apache	12,757.6	9.0	503.9	717,546.10	908.60	52,287.00	TL/6
Sundown	Buru Energy	95.0	0.0	0.0	74,207.18	0.00	0.00	L8
Tarantula	Origin	0.0	175.7	15,850.7	0.00	4,102.83	331,300.40	L11
Ungani	Buru Energy	6,442.0	0.0	11.4	18,537.00	0.00	15.81	EP 391
Victoria	Apache	1,573.5	10.9	416.6	62,587.50	481.20	11,790.70	TL/6
West Cycad	Apache	1,281.9	10.9	409.5	218,676.00	546.80	36,990.60	TL/9
West Terrace	Buru Energy	13.0	0.0	0.0	39,602.35	0.00	0.00	L8
Wonnich	Apache	0.0	2,556.1	27,898.1	0.00	479,450.13	4,856,471.08	TL/8
Yammaderry	Chevron	0.0	0.0	13,442.0	858,332.0	0.0	142,396.0	TL/4
Total		459,353.9	28,207.1	529,279.5	89,469,215.9	1,445,582.3	35,833,851.0	

TABLE 2A. PETROLEUM RESERVES ESTIMATES BY BASIN FOR WA STATE ONSHORE, STATE WATERS AND TERRITORIAL WATERS, AS AT 31 DECEMBER 2012 (METRIC UNITS)

Basin	Oil		Sales Gas		Condensate	
	GL		Gm ³		GL	
Category 1	P50	P90	P50	P90	P50	P90
Canning	0.000	0.000	0.000	0.000	0.000	0.000
Carnarvon	6.710	1.450	1.590	0.830	0.130	0.060
Perth	0.010	0.000	0.18	0.120	0.000	0.000
Total	6.72	1.45	1.77	0.95	0.13	0.06
Category 2	P50	P90	P50	P90	P50	P90
Carnarvon	0.930	0.520	0.500	0.380	0.000	0.000
Total	0.93	0.52	0.50	0.38	0.00	0.00
Category 3	P50	P90	P50	P90	P50	P90
Canning	0.000	0.000	0.000	0.000	0.000	0.000
Perth	0.000	0.000	0.960	0.270	0.000	0.000
Total	0.00	0.00	0.96	0.27	0.00	0.00
Category 4	P50	P90	P50	P90	P50	P90
Canning	0.050	0.020	2.740	0.710	0.620	0.150
Carnarvon	6.100	1.290	9.500	4.390	0.000	0.000
Perth	0.000	0.000	5.500	5.500	0.000	0.000
Total	6.15	1.31	17.74	10.60	0.62	0.15
GRAND TOTAL	13.80	3.28	20.97	12.20	0.75	0.21

TABLE 2B. PETROLEUM RESERVES ESTIMATES BY BASIN FOR WA STATE ONSHORE, STATE WATERS AND TERRITORIAL WATERS, AS AT 31 DECEMBER 2012 (FIELD UNITS)

Basin	Oil		Sales Gas		Condensate	
	MMbbl		Bcf		MMbbl	
Category 1	P50	P90	P50	P90	P50	P90
Canning	0.000	0.000	0.000	0.000	0.000	0.000
Carnarvon	42.180	9.120	56.230	29.270	0.830	0.380
Perth	0.080	0.020	6.210	4.150	0.000	0.000
Total	42.26	9.14	62.44	33.42	0.83	0.38
Category 2	P50	P90	P50	P90	P50	P90
Carnarvon	5.850	3.250	17.570	13.570	0.000	0.000
Total	5.85	3.25	17.57	13.57	0.00	0.00
Category 3	P50	P90	P50	P90	P50	P90
Canning	0.000	0.000	0.000	0.000	0.000	0.000
Perth	0.000	0.000	33.940	9.430	0.020	0.010
Total	0.00	0.00	33.94	9.43	0.02	0.01
Category 4	P50	P90	P50	P90	P50	P90
Canning	0.290	0.110	96.660	24.990	3.900	0.950
Carnarvon	38.360	8.110	335.310	154.850	0.000	0.000
Perth	0.000	0.000	194.230	194.230	0.000	0.000
Total	38.65	8.22	626.20	374.07	3.90	0.95
GRAND TOTAL	86.76	20.61	740.15	430.49	4.75	1.34

NOTES

Canning Basin reserves are too small to measure.

Category 1 comprises current reserves of those fields which are producing hydrocarbons or have been declared commercial (FFDP approved and FID).

Category 2 comprises estimates of recoverable reserves which are held under Retention Leases and have not yet been declared commercially viable.

Category 3 comprises estimates of contingent resources which are held in other licences and have been declared commercially viable but may or may not have a FFDP and have not yet reached FID.

Category 4 comprises estimates of contingent resources which are held in other licences and have not yet been declared commercially viable and are not held under a Retention Lease.

Reserves estimates for 2013 have not yet been submitted by industry to DMP.

TABLE 3. PETROLEUM WELLS IN WESTERN AUSTRALIA – ONSHORE AND STATE WATERS 2013

Well Name	Class	On Off	Title	Operator	Latitude	Longitude	Gnd Elev/ Water Depth (m)	RT/ KB (m)	Spud Date	TD Date	Rig Release Date
CANNING BASIN											
Cyrene 1	NFW	On	EP 438	Gulliver	122.401	-18.276	47	5	13/12/2012	21/01/2013	24/02/2013
Gibb-Maitland 1	NFW	On	EP 450	New Standard	124.641	-20.996	296	9	5/12/2012	16/01/2013	7/02/2013
Yulleroo 4	EXT	On	EP 436	Buru	122.878	-17.823	47	6	19/01/2013	2/03/2013	17/03/2013
CARNARVON BASIN											
Barrow F24B MB	DEV	On	L 1H R2	Chevron	115.383	-20.833	35	7	20/04/2013	8/05/2013	14/05/2013
Barrow F55A MB	DEV	On	L 1H R2	Chevron	115.390	-20.846	19	7	26/05/2013	19/06/2013	23/06/2013
Barrow G48B MB	DEV	On	L 1H R2	Chevron	115.367	-20.841	50	7	20/12/2012	7/02/2013	17/02/2013
Barrow WSW 8B	Water	On	L 1H R2	Chevron	115.382	-20.819	50	7	4/03/2013	3/04/2013	9/04/2013
Barrow WSW 8C	Water	On	L 1H R2	Chevron	115.382	-20.819	50	7	28/02/2013	20/03/2013	9/04/2013
Taunton 5H	EXT	Off	TL/2 R1	Apache	115.107	-21.325	38	18	14/04/2013	25/04/2013	29/06/2013
PERTH BASIN											
Mt Ridley 1	Geothermal	On	GEP 38	Green Power	122.093	-33.298	*	*	13/06/2013	25/06/2013	28/06/2013
Warradarge 1	NFW	On	DR 11	Titan Energy	115.259	-29.873	86	5	27/03/2013	20/04/2013	27/04/2013
Whicher Range 4 ST1	Sidetrack	On	EP 408 R2	CalEnergy	115.368	-33.840	132	8	1/12/2013	8/12/2013	16/12/2013

Several wells were drilled on Barrow Island as part of the Gorgon project but are not shown. These wells were not drilled under the Petroleum Acts.

* Ground elevation and Rotary Table data not available

**TABLE 4. 2013 SURVEYS IN WESTERN AUSTRALIA
– STATE ONSHORE, STATE WATERS AND TERRITORIAL WATERS**

Survey Name	Class	On Off	Title	Operator	Commenced	Completed	2D/ Line km @ 31/12/2013	3D km ² @ 31/12/2013
BONAPARTE BASIN								
2012 Bonaparte Airborne Geophysical Survey	AEROMAG	On	EP 386 R3	Beach Energy	24/01/13	18/03/13	15,732	
CANNING BASIN								
2013 EP449 Airborne Gradiometry Survey	GRAVITY	On	EP 449	Hess Exploration	26/08/13	4/09/13	3250	
EP448 Geochemical Survey	GEOCHEM	On	EP 448	Key Petroleum	23/10/2013	29/10/2013		
Fitzroy Aeromagnetic Impulse Survey	AEROMAG	On	SPA 7 AO	Goshawk Energy	10/06/13	11/06/13	900	
Frome Rocks 2D S.S.	2D	On	EP 457, 391 R2, 428	Buru Energy	27/10/13	21/11/13	360	
Southern Canning Airborne Gravity Survey	GRAVITY	On	EP 428,457, 458, 472, 474, 477, 478	Buru Energy	28/09/13	30/11/13	45,797	
Ungani 3D S.S. Resumption	3D	On	EP 391 R2, 428	Buru Energy	6/09/13	24/10/13		241
CARNARVON BASIN								
South Carnarvon 2D S.S.	2D	On	SPA 8 AO	Fleet Resources	25/04/13	4/05/13	142	
PERTH BASIN								
AGG-HRAM 2013 survey	AEROMAG	ON	SPA 16 AO	Finder Exploration	02/12/2013	09/12/2013	1773	
Badgingarra 2D S.S.	2D	On	EP 447, 407 R1	Green Power Energy	4/04/13	22/04/13	212	
Launer 2D S.S.	2D	On	EP 430, 321 R4, 420	Empire Oil & Gas	28/03/13	4/04/13	56	
Murgoo Gravity Survey	GRAVITY	On	SPA 9 AO	Palatine Energy	16/07/13	N/A		
Wannamal 3D S.S.	3D	On	EP 389 R2	Empire Oil & Gas	29/05/13	9/06/13		74

Classification

2D	2D Seismic Survey
3D	3D Seismic Survey
AEROMAG	Aeromagnetic Survey
GEOCHEM	Geochemical Survey
GRAVITY	Gravity Survey

TABLE 5. LIST OF PETROLEUM AND GEOTHERMAL TITLES AND HOLDERS IN WESTERN AUSTRALIA AS AT 8 JANUARY 2014

**PETROLEUM (SUBMERGED LANDS) ACT 1982
Special Prospecting Authority with Acreage Option**

Title	Registered Holders
SPA 9 AO	Green Rock Energy Limited Palatine Energy Pty Ltd

**PETROLEUM (SUBMERGED LANDS) ACT 1982
Exploration Permit**

Title	Registered Holders
TP/7 R4	Apache Oil Australia Pty Ltd Santos (BOL) Pty Ltd Tap (Shelfal) Pty Ltd Hydra Energy (WA) Pty Ltd
TP/8 R4	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
TP/15 R2	Westranch Holdings Pty Ltd
TP/23 R1	Apache Northwest Pty Ltd
TP/25	Finder No 3 Pty Limited

**PETROLEUM (SUBMERGED LANDS) ACT 1982
Pipeline Licence**

Title	Registered Holders
TPL/1 R1	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
TPL/2 R1	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
TPL/3 R1	Apache Oil Australia Pty Ltd Santos (BOL) Pty Ltd Tap (Shelfal) Pty Ltd Hydra Energy (WA) Pty Ltd
TPL/4 R1	Apache Oil Australia Pty Ltd Santos (BOL) Pty Ltd Tap (Shelfal) Pty Ltd Hydra Energy (WA) Pty Ltd
TPL/5 R1	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
TPL/6 R1	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
TPL/7 R2	Apache Oil Australia Pty Ltd Santos (BOL) Pty Ltd Tap (Shelfal) Pty Ltd Hydra Energy (WA) Pty Ltd
TPL/8	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd

TPL/9 R1	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
TPL/10	Mobil Exploration & Producing Australia Pty Ltd Inpex Alpha Ltd BHP Billiton Petroleum (Australia) Pty Ltd
TPL/11	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
TPL/12	Apache Oil Australia Pty Ltd Santos (BOL) Pty Ltd Apache East Spar Pty Ltd Apache Kersail Pty Ltd
TPL/13	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Apache Oil Australia Pty Ltd Santos (BOL) Pty Ltd Apache East Spar Pty Ltd Apache Kersail Pty Ltd
TPL/14	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
TPL/15	Japan Australia LNG (MIMI) Pty Ltd Shell Development (Australia) Proprietary Limited BP Developments Australia Pty Ltd Woodside Energy Ltd Chevron Australia Pty Ltd BHP Billiton Petroleum (North West Shelf) Pty Ltd
TPL/16	Japan Australia LNG (MIMI) Pty Ltd Shell Development (Australia) Proprietary Limited BP Developments Australia Pty Ltd Woodside Energy Ltd Chevron Australia Pty Ltd BHP Billiton Petroleum (North West Shelf) Pty Ltd
TPL/17	Apache Northwest Pty Ltd Santos (BOL) Pty Ltd
TPL/18	Roc Oil (WA) Pty Limited AWE Oil (Western Australia) Pty Ltd ARC (Offshore PB) Limited
TPL/19	Woodside Burrup Pty Ltd Tokyo Gas Pluto Pty Ltd Kansai Electric Power Australia Pty Ltd
TPL/20	Apache Northwest Pty Ltd Santos Offshore Pty Ltd
TPL/21	Shell Development (Australia) Proprietary Limited Mobil Australia Resources Company Pty Limited Chevron (TAPL) Pty Ltd Tokyo Gas Gorgon Pty Ltd Osaka Gas Gorgon Pty Ltd Chubu Electric Power Gorgon Pty Ltd
TPL/22	Shell Development (Australia) Proprietary Limited Mobil Australia Resources Company Pty Limited Chevron (TAPL) Pty Ltd Tokyo Gas Gorgon Pty Ltd Osaka Gas Gorgon Pty Ltd Chubu Electric Power Gorgon Pty Ltd

TABLE 5. LIST OF PETROLEUM AND GEOTHERMAL TITLES AND HOLDERS IN WESTERN AUSTRALIA AS AT 8 JANUARY 2014

TPL/23	BHP Billiton Petroleum (Australia) Pty Ltd Apache PVG Pty Ltd
TPL/24	Shell Development (Australia) Proprietary Limited Mobil Australia Resources Company Pty Limited Chevron (TAPL) Pty Ltd Tokyo Gas Gorgon Pty Ltd Osaka Gas Gorgon Pty Ltd Chubu Electric Power Gorgon Pty Ltd
TPL/25	Shell Development (Australia) Proprietary Limited Chevron (TAPL) Pty Ltd Apache Julimar Pty Ltd KUFPEC Australia (Julimar) Pty Ltd Kyushu Electric Wheatstone Pty Ltd

**PETROLEUM (SUBMERGED LANDS) ACT 1982
Production Licence**

Title	Registered Holders
TL/1 R1	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
TL/2 R1	Apache Oil Australia Pty Ltd Santos (BOL) Pty Ltd Tap (Shelfal) Pty Ltd Hydra Energy (WA) Pty Ltd
TL/3 R1	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
TL/4 R1	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
TL/5 R1	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
TL/6 R1	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
TL/7	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
TL/8	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
TL/9	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
TL/10	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd

**PETROLEUM (SUBMERGED LANDS) ACT 1982
Retention Lease**

Title	Registered Holders
TR/1 R2	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
TR/3 R2	Apache Northwest Pty Ltd
TR/4 R1	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
TR/5 R1	Shell Development (Australia) Proprietary Limited BP Developments Australia Pty Ltd Woodside Browse Pty Ltd Japan Australia LNG (MIMI Browse) Pty Ltd PetroChina International Investment (Australia) Pty Ltd
TR/6	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd

**PETROLEUM AND GEOTHERMAL ENERGY RESOURCES ACT 1967
Drilling Reservation**

Title	Registered Holders
DR 11	Titan Energy Ltd

**PETROLEUM AND GEOTHERMAL ENERGY RESOURCES ACT 1967
Exploration Permit**

Title	Registered Holders
EP 61 R7	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
EP 62 R7	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
EP 104 R5	Gulliver Productions Pty Ltd Indigo Oil Pty Ltd Pancontinental Oil & Gas NL Phoenix Resources PLC FAR Ltd ARC Energy Pty Limited
EP 110 R5	Pancontinental Oil & Gas NL Strike Energy Western Australia Pty Limited
EP 129 R5	Buru Energy Limited
EP 307 R5	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
EP 320 R4	Origin Energy Developments Pty Limited ARC (Beharra Springs) Pty Ltd

TABLE 5. LIST OF PETROLEUM AND GEOTHERMAL TITLES AND HOLDERS IN WESTERN AUSTRALIA AS AT 8 JANUARY 2014

EP 321 R3	Latent Petroleum Pty Ltd Alcoa of Australia Limited	EP 428	Buru Energy Limited Diamond Resources (Canning) Pty Ltd
EP 325 R3	Rough Range Oil Pty Ltd Advent Energy Ltd Strike Energy Western Australia Pty Limited Bow Energy Pty Ltd	EP 430	Empire Oil Company (WA) Limited
EP 357 R3	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd	EP 431	Buru Energy Limited Diamond Resources (Fitzroy) Pty Ltd
EP 358 R3	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd	EP 432	Empire Oil Company (WA) Limited Allied Oil & Gas Plc ERM Gas Pty Ltd
EP 359 R2	Pace Petroleum Pty Ltd Lansvale Oil & Gas Pty Ltd Rough Range Oil Pty Ltd Bounty Oil & Gas NL Phoenix Resources PLC	EP 433 R1	Pace Petroleum Pty Ltd Lansvale Oil & Gas Pty Ltd
EP 368 R3	Westranch Holdings Pty Ltd Empire Oil Company (WA) Limited	EP 434 R1	Pace Petroleum Pty Ltd Lansvale Oil & Gas Pty Ltd Rough Range Oil Pty Ltd
EP 371 R1	Buru Energy Limited Diamond Resources (Canning) Pty Ltd	EP 435 R1	Rough Range Oil Pty Ltd Bounty Oil & Gas NL Australian Oil Company No 3 Pty Limited
EP 381 R3	Whicher Range Energy Pty Ltd	EP 436	Buru Energy Limited Diamond Resources (Fitzroy) Pty Ltd
EP 386 R3	Onshore Energy Pty Ltd	EP 437	Empire Oil Company (WA) Limited Key Petroleum (Australia) Pty Ltd
EP 389 R2	Empire Oil Company (WA) Limited Wharf Resources PLC ERM Gas Pty Ltd	EP 438	Gulliver Productions Pty Ltd Indigo Oil Pty Ltd Buru Energy Limited Diamond Resources (Canning) Pty Ltd
EP 390 R2	Buru Energy Limited Diamond Resources (Canning) Pty Ltd	EP 439	Indigo Oil Pty Ltd Vigilant Oil Pty Ltd Falcore Pty Ltd Rough Range Oil Pty Ltd Longreach Oil Limited Jurassica Oil & Gas Plc
EP 391 R2	Buru Energy Limited Diamond Resources (Fitzroy) Pty Ltd	EP 440 R1	Empire Oil Company (WA) Limited
EP 407 R1	Latent Petroleum Pty Ltd Alcoa of Australia Limited	EP 441 R1	Apache Northwest Pty Ltd
EP 408 R2	Whicher Range Energy Pty Ltd CalEnergy Resources (Australia) Limited	EP 443	New Standard Onshore Pty Ltd ConocoPhillips (Canning Basin) Pty Ltd
EP 412 R2	Rough Range Oil Pty Ltd Bounty Oil & Gas NL	EP 444 R1	Rough Range Oil Pty Ltd
EP 413 R2	Norwest Energy NL Bharat PetroResources Limited ARC Energy Pty Limited	EP 447	GCC Methane Pty Ltd
EP 416 R1	Empire Oil Company (WA) Limited Allied Oil & Gas Plc ERM Gas Pty Ltd	EP 448	Gulliver Productions Pty Ltd Indigo Oil Pty Ltd United Orogen Limited
EP 417 R1	Buru Energy Limited New Standard Onshore Pty Ltd	EP 449	Hess Australia (Canning) Pty Limited
EP 424	Pancontinental Oil & Gas NL Strike Energy Western Australia Pty Limited	EP 450	New Standard Onshore Pty Ltd ConocoPhillips (Canning Basin) Pty Ltd
EP 426	Westranch Holdings Pty Ltd Empire Oil Company (WA) Limited Allied Oil & Gas Plc ERM Gas Pty Ltd	EP 451	New Standard Onshore Pty Ltd ConocoPhillips (Canning Basin) Pty Ltd
		EP 453 R1	Goshawk Energy (Lennard Shelf) Pty Ltd
		EP 454	Empire Oil Company (WA) Limited
		EP 455	Titan Energy Ltd ARC Energy Pty Limited
		EP 456	New Standard Onshore Pty Ltd ConocoPhillips (Canning Basin) Pty Ltd

TABLE 5. LIST OF PETROLEUM AND GEOTHERMAL TITLES AND HOLDERS IN WESTERN AUSTRALIA AS AT 8 JANUARY 2014

EP 457	Rey Resources Ltd Buru Fitzroy Limited
EP 458	Rey Resources Ltd Buru Fitzroy Limited
EP 460	Indigo Oil Pty Ltd Vigilant Oil Pty Ltd Falcore Pty Ltd Rough Range Oil Pty Ltd Longreach Oil Limited Jurassica Oil & Gas Plc
EP 461	Indigo Oil Pty Ltd Vigilant Oil Pty Ltd Falcore Pty Ltd Rough Range Oil Pty Ltd Longreach Oil Limited Jurassica Oil & Gas Plc
EP 464	Exceed Energy (Australia) Pty Ltd
EP 465	Australia Zhongfu Oil Gas Resources Pty Ltd
EP 466	Rough Range Oil Pty Ltd
EP 467	ERM Gas Pty Ltd
EP 468	Officer Petroleum Pty Ltd
EP 469	Warrego Energy Pty Ltd
EP 470	Energetica Resources Pty Ltd
EP 471	Buru Energy Limited Diamond Resources (Canning) Pty Ltd
EP 472	Buru Energy Limited Diamond Resources (Canning) Pty Ltd
EP 473	Buru Energy Limited Diamond Resources (Canning) Pty Ltd
EP 474	Buru Energy Limited
EP 475	Energetica Resources Pty Ltd
EP 476	Buru Energy Limited Diamond Resources (Canning) Pty Ltd
EP 477	Buru Energy (Acacia) Pty Ltd Diamond Resources (Canning) Pty Ltd
EP 478	Buru Energy Limited Buru Energy (Acacia) Pty Ltd
EP 479	Empire Oil & Gas NL ERM Gas Pty Ltd
EP 480	Empire Oil & Gas NL ERM Gas Pty Ltd
EP 481	New Standard Onshore Pty Ltd
EP 482	New Standard Onshore Pty Ltd
EP 483	Finder No 3 Pty Limited
EP 484	Dynasty Metals Australia Ltd
EP 485	Dynasty Metals Australia Ltd
EP 486	Exceed Energy (Australia) Pty Ltd

**PETROLEUM AND GEOTHERMAL ENERGY RESOURCES ACT 1967
Geothermal Exploration Permit**

Title	Registered Holders
GEP 1	Green Rock Energy Limited The University of Western Australia
GEP 2	Green Rock Energy Limited
GEP 5	Granite Power Limited
GEP 6	Granite Power Limited
GEP 8	CSIRO
GEP 13	New World Energy Limited
GEP 14	New World Energy Limited
GEP 15	New World Energy Limited
GEP 16	New World Energy Limited
GEP 17	New World Energy Limited
GEP 18	New World Energy Limited
GEP 19	New World Energy Limited
GEP 20	New World Energy Limited
GEP 21	New World Energy Limited
GEP 22	AAA Energy Pty Ltd
GEP 23	Mid West Geothermal Power Pty Ltd
GEP 24	Mid West Geothermal Power Pty Ltd
GEP 25	Mid West Geothermal Power Pty Ltd
GEP 26	Mid West Geothermal Power Pty Ltd
GEP 27	Mid West Geothermal Power Pty Ltd
GEP 28	Mid West Geothermal Power Pty Ltd
GEP 30	New World Energy Limited
GEP 31	New World Energy Limited
GEP 32	New World Energy Limited
GEP 33	New World Energy Limited
GEP 34	New World Energy Limited
GEP 35	New World Energy Limited
GEP 36	New World Energy Limited
GEP 37	Greenpower Energy Limited
GEP 38	Greenpower Energy Limited
GEP 41	Mid West Geothermal Power Pty Ltd
GEP 42	GT Power Pty Ltd
GEP 43	Kagara Ltd

TABLE 5. LIST OF PETROLEUM AND GEOTHERMAL TITLES AND HOLDERS IN WESTERN AUSTRALIA AS AT 8 JANUARY 2014

**PETROLEUM AND GEOTHERMAL ENERGY RESOURCES ACT 1967
Production Licence**

Title	Registered Holders
L 1 R1	Origin Energy Developments Pty Limited Arc Energy Limited APT Parmelia Pty Ltd
L 2 R1	Origin Energy Developments Pty Limited ARC Energy Pty Limited
L 4 R1	ARC Energy Pty Limited
L 5 R1	ARC Energy Pty Limited
L 6 R1	Buru Energy Limited
L 7 R1	ARC Energy Pty Limited
L 8 R1	Buru Energy Limited
L 9 R1	DBP Services Co Nominees Pty Limited
L 10 R1	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
L 11	Origin Energy Developments Pty Limited ARC (Beharra Springs) Pty Ltd
L 12	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
L 13	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
L 14	Geary, John Kevin Norwest Energy NL Origin Energy Developments Pty Limited Roc Oil (WA) Pty Limited ARC Energy Pty Limited
L 15	Gulliver Productions Pty Ltd Indigo Oil Pty Ltd Pancontinental Oil & Gas NL Buru Energy Limited FAR Ltd
L 16	Rough Range Oil Pty Ltd Bounty Oil & Gas NL Australian Oil Company No 3 Pty Limited
L 17	Buru Energy Limited
L 1H R2	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd

**PETROLEUM AND GEOTHERMAL ENERGY RESOURCES ACT 1967
Retention Lease**

Title	Registered Holders
R 1 R1	Gulliver Productions Pty Ltd Indigo Oil Pty Ltd Pancontinental Oil & Gas NL Phoenix Resources PLC FAR Ltd ARC Energy Pty Limited
R 2 R1	Shell Development (Australia) Proprietary Limited BP Developments Australia Pty Ltd Woodside Browse Pty Ltd Japan Australia LNG (MIMI Browse) Pty Ltd PetroChina International Investment (Australia) Pty Ltd
R 3 R1	Oil Basins Limited
R 4	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
R 5	Apache Oil Australia Pty Ltd OMV Australia Pty Ltd

**PETROLEUM AND GEOTHERMAL ENERGY RESOURCES ACT 1967
Pipeline Licence**

Title	Registered Holders
PL 1 R1	APT Parmelia Pty Ltd
PL 2 R1	APT Parmelia Pty Ltd
PL 3 R1	APT Parmelia Pty Ltd
PL 5 R1	APT Parmelia Pty Ltd
PL 6 R3	ARC Energy Pty Limited
PL 7 R1	Buru Energy Limited
PL 8 R1	Robe River Mining Co Pty Ltd Mitsui Iron Ore Development Pty Ltd Sumitomo Metal Australia Pty Ltd Nippon Steel Australia Pty Limited North Mining Limited
PL 12 R1	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
PL 14 R1	Apache Oil Australia Pty Ltd Santos (BOL) Pty Ltd Tap (Shelfal) Pty Ltd Hydra Energy (WA) Pty Ltd
PL 15 R1	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd
PL 16	DBP Services Co Nominees Pty Limited
PL 17	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd

TABLE 5. LIST OF PETROLEUM AND GEOTHERMAL TITLES AND HOLDERS IN WESTERN AUSTRALIA AS AT 8 JANUARY 2014

PL 18	Origin Energy Developments Pty Limited ARC (Beharra Springs) Pty Ltd	PL 47	DBNGP (WA) Transmission Pty Limited
PL 19	DBP Services Co Nominees Pty Limited	PL 48	Energy Generation Pty Ltd
PL 20	DBP Services Co Nominees Pty Limited	PL 52	APT Parmelia Pty Ltd
PL 21	Santos Offshore Pty Ltd Mobil Australia Resources Company Pty Limited Chevron Australia Pty Ltd Chevron (TAPL) Pty Ltd	PL 53	APT Parmelia Pty Ltd
PL 22	APA (Pilbara Pipeline) Pty Ltd	PL 54	APT Pipelines (WA) Pty Limited Regional Power Corporation
PL 23	APT Parmelia Pty Ltd	PL 55	Global Advanced Metals Wodgina Pty Ltd
PL 24	Southern Cross Pipelines Australia Pty Limited Southern Cross Pipelines (NPL) Australia Pty Ltd Alinta DEWAP Pty Ltd	PL 56	APA (WA) ONE Pty Limited
PL 25	Southern Cross Pipelines Australia Pty Limited	PL 57	Australian Gold Reagents Pty Ltd
PL 26	Southern Cross Pipelines Australia Pty Limited	PL 58	Japan Australia LNG (MIMI) Pty Ltd Shell Development (Australia) Proprietary Limited BP Developments Australia Pty Ltd Woodside Energy Ltd Chevron Australia Pty Ltd BHP Billiton Petroleum (North West Shelf) Pty Ltd
PL 27	Southern Cross Pipelines Australia Pty Limited	PL 59	Esperance Pipeline Co. Pty Limited
PL 28	Southern Cross Pipelines (NPL) Australia Pty Ltd	PL 60	Gas Transmission Services WA (Operations) Pty Ltd
PL 29	Apache Oil Australia Pty Ltd Santos (BOL) Pty Ltd Apache East Spar Pty Ltd Apache Kersail Pty Ltd	PL 61	APT Parmelia Pty Ltd
PL 30	Apache Oil Australia Pty Ltd Santos (BOL) Pty Ltd Apache East Spar Pty Ltd Apache Kersail Pty Ltd	PL 62	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Harriet (Onyx) Pty Ltd
PL 31	APA (Pilbara Pipeline) Pty Ltd	PL 63	Gas Transmission Services WA (Operations) Pty Ltd
PL 32	APT Pipelines (WA) Pty Limited	PL 64	Origin Energy Developments Pty Limited ARC Energy Pty Limited
PL 33	APT Pipelines (WA) Pty Limited	PL 65	Norilsk Nickel Wildara Pty Ltd Dalrymple Resources Pty Ltd
PL 34	Newmont Yandal Operations Pty Ltd	PL 67	Hamersley Iron Pty Ltd
PL 35	Plutonic Operations Limited	PL 68	Gas Transmission Services WA (Operations) Pty Ltd
PL 36	Australian Pipeline Limited	PL 69	DBNGP (WA) Nominees Pty Limited
PL 37	Norilsk Nickel Cawse Pty Ltd	PL 70	Roc Oil (WA) Pty Limited AWE Oil (Western Australia) Pty Ltd ARC (Offshore PB) Limited
PL 38	APA (Pilbara Pipeline) Pty Ltd	PL 72	EDL NGD (WA) Pty Ltd
PL 39	Origin Energy Pipelines Pty Limited	PL 73	Redback Pipelines Pty Ltd
PL 40	DBNGP (WA) Nominees Pty Limited	PL 74	EDL LNG (WA) Pty Ltd
PL 41	DBNGP (WA) Transmission Pty Limited	PL 75	ERM Neerabup Pty Ltd EIT Neerabup Power Pty Ltd
PL 42	Kufpec Australia Pty Ltd Apache Northwest Pty Ltd Apache Oil Australia Pty Ltd Santos (BOL) Pty Ltd Apache East Spar Pty Ltd Apache Kersail Pty Ltd	PL 76	APA Group
PL 43	APT Pipelines (WA) Pty Limited Regional Power Corporation	PL 77	Sino Iron Pty Ltd
PL 44	APT Parmelia Pty Ltd	PL 78	Hamersley Iron Pty Ltd
PL 45	APT Parmelia Pty Ltd	PL 80	Latent Petroleum Pty Ltd
PL 46	APT Parmelia Pty Ltd	PL 81	Apache Northwest Pty Ltd
		PL 82	APA (Pilbara Pipeline) Pty Ltd
		PL 83	ATCO Gas Australia Pty Ltd

TABLE 5. LIST OF PETROLEUM AND GEOTHERMAL TITLES AND HOLDERS IN WESTERN AUSTRALIA AS AT 8 JANUARY 2014

PL 84	Shell Development (Australia) Proprietary Limited Mobil Australia Resources Company Pty Limited Chevron (TAPL) Pty Ltd Tokyo Gas Gorgon Pty Ltd Osaka Gas Gorgon Pty Ltd Chubu Electric Power Gorgon Pty Ltd	PL 93	Shell Development (Australia) Proprietary Limited Mobil Australia Resources Company Pty Limited Chevron (TAPL) Pty Ltd Tokyo Gas Gorgon Pty Ltd Osaka Gas Gorgon Pty Ltd Chubu Electric Power Gorgon Pty Ltd
PL 85	Shell Development (Australia) Proprietary Limited Mobil Australia Resources Company Pty Limited Chevron (TAPL) Pty Ltd Tokyo Gas Gorgon Pty Ltd Osaka Gas Gorgon Pty Ltd Chubu Electric Power Gorgon Pty Ltd	PL 94	DBNGP (WA) Nominees Pty Limited
PL 86	Apache Northwest Pty Ltd Santos Offshore Pty Ltd	PL 95	DBNGP (WA) Nominees Pty Limited
PL 87	BHP Billiton Petroleum (Australia) Pty Ltd Apache PVG Pty Ltd	PL 96	Empire Oil Company (WA) Limited Wharf Resources PLC ERM Gas Pty Ltd
PL 88	BHP Billiton Petroleum (Australia) Pty Ltd Apache PVG Pty Ltd	PL 97	Mitsui Iron Ore Development Pty Ltd Sumitomo Metal Australia Pty Ltd Nippon Steel Australia Pty Limited Rio Tinto Limited
PL 89	Crosslands Resources Ltd	PL 98	Esperance Pipeline Co. Pty Limited
PL 90	BHP Petroleum (Australia) Pty Ltd Apache PVG Pty Ltd	PL 99	Shell Development (Australia) Proprietary Limited Chevron (TAPL) Pty Ltd Apache Julimar Pty Ltd KUFPEC Australia (Julimar) Pty Ltd Kyushu Electric Wheatstone Pty Ltd
PL 91	DBNGP (WA) Nominees Pty Limited	PL 100	DBNGP (WA) Nominees Pty Limited
PL 92	Shell Development (Australia) Proprietary Limited Mobil Australia Resources Company Pty Limited Chevron (TAPL) Pty Ltd Tokyo Gas Gorgon Pty Ltd Osaka Gas Australia Pty Ltd Chubu Electric Power Gorgon Pty Ltd	PL 101	DBNGP (WA) Nominees Pty Limited

Please consult DMP's online Petroleum and Geothermal Register for the most current information on Titles and Holdings.

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