

**PROSPECTIVITY OF STATE  
ACREAGE RELEASE AREA L10-1,  
LENNARD SHELF, CANNING BASIN**



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## Introduction

The Canning Basin of northern Western Australia is a large, predominantly onshore sedimentary basin covering an area of about 595 000 km<sup>2</sup>. It preserves a long and complex multi-phase depositional history extending from the Early Ordovician to the Cretaceous, and is currently underexplored for petroleum resources despite containing several small producing oilfields. Overviews of basin geology and hydrocarbon systems may be found in Kennard et al. (1994), and Carlsen and Ghorri (2005). The Canning Basin is subdivided into a series of troughs, sub-basins, platforms, shelves, and terraces bounded by generally northwest-trending syndepositional fault systems. Release Area L10-1 (4091 km<sup>2</sup>) is situated on the Lennard Shelf (Figs 1 and 2). The western end of L10-1 lies over the coast of King Sound. Surface outcrop, mainly of Permian and Devonian age, is limited in the release area.

The coastal port town of Derby is situated about 25 km to the southwest of L10-1, with access to the area afforded via a number of secondary community and homestead roads, and tracks linked to the unsealed Gibb River Road. The sealed Great Northern Highway lies parallel to the release area, and about 40 km to the south. An oil pipeline connects the nearby Blina oilfield to a loading facility on this highway.

The Lennard Shelf has had a long history of oil exploration. The 1919 report of an oil show in a water bore led to the drilling of several exploratory wells by the Freney Kimberley Oil Company between 1922 and 1941. Meda 1, drilled to the southeast of L10-1 by West Australian Petroleum (WAPET) in 1958, recovered about 28 litres of oil from a Carboniferous reservoir during drillstem tests, proving for the first time the existence of a petroleum system, although the results from the follow-up well Meda 2 were disappointing. The modern phase of petroleum exploration began in the 1970s, with the first commercial discovery, Blina 1, being made by Home Energy in 1981. This led to the drilling of seven additional wells in the Blina oilfield, and the subsequent discovery of the Lloyd, Boundary, West Terrace, and Sundown oilfields, all lying in a northwest-trending belt immediately south of L10-1, and the West Kora 1 oil, Point Torment 1, and Stokes Bay 1 gas wells, which lies to the southwest of L10-1.

## Regional geology and stratigraphy

Canning Basin tectonic subdivisions are shown in Figure 1. Regional basin stratigraphy is summarized in Figure 4, and Devonian to Triassic stratigraphy of the Lennard Shelf is presented in Figure 5. The Lennard Shelf contains up to 4 km of mainly Devonian and younger strata, whereas the Fitzroy Trough to the south is filled with up to 15 km of Early Ordovician and younger sedimentary rocks. The outer (southern) section of the Lennard Shelf, sometimes referred to as the Laurel Downs Terrace, is slightly thicker than the main part of the shelf to the north, and is structurally controlled by a complex series of northwest- and northeast-trending fault systems. Although generally widespread in the Canning Basin, Ordovician and Silurian strata are absent from most of the Lennard Shelf due to pre-Middle Devonian tectonism and erosion, such that Middle Devonian and younger strata unconformably onlap Proterozoic basement. However, thick remnants of Ordovician strata are present locally in grabens beneath the Lennard Shelf (e.g. as intersected in Blackstone 1), and although not previously intersected in wells drilled in L10-1, Ordovician rocks may be present locally in these areas. During the Middle to Late Devonian, extension and subsidence led to the flooding of the Lennard Shelf area by a shallow sea, in which a complex of carbonate reefs formed on fault-controlled structural highs surrounded by basinal facies. Fossil reefs are exposed to the northeast of L10-1, although in the subsurface the reef trend extends west into L10-1, then southeastward around an embayment to the Blina area (Middleton, 1991). Subsurface Devonian reef facies were intersected in Meda 1 and 2, Canegrass 1, Hawkstone Peak 1, and Napier 2 and 4 near the release area. Inter-reef facies were intersected in Napier 1 and 5. Fluvial to deltaic conglomerates, derived from the northeast, underlie and interfinger with the reef complexes in some areas, and were intersected in Napier 1 and 5, and Hawkstone Peak 1. The reef complexes are overlain by uppermost Devonian to Lower Carboniferous shallow-marine carbonates and fine clastic rocks of the Fairfield Group, and interbedded sandstone and mudstone of the deltaic to fluvial Lower Carboniferous Anderson Formation. An angular unconformity separates the Anderson Formation from uppermost Carboniferous to Lower Permian non-marine glaciogenic clastics of the Grant Group, overlain in turn by shallow-marine through to fluvio-deltaic sediments of Early to Late Permian age (Poole Sandstone, Noonkanbah Formation and Liveringa

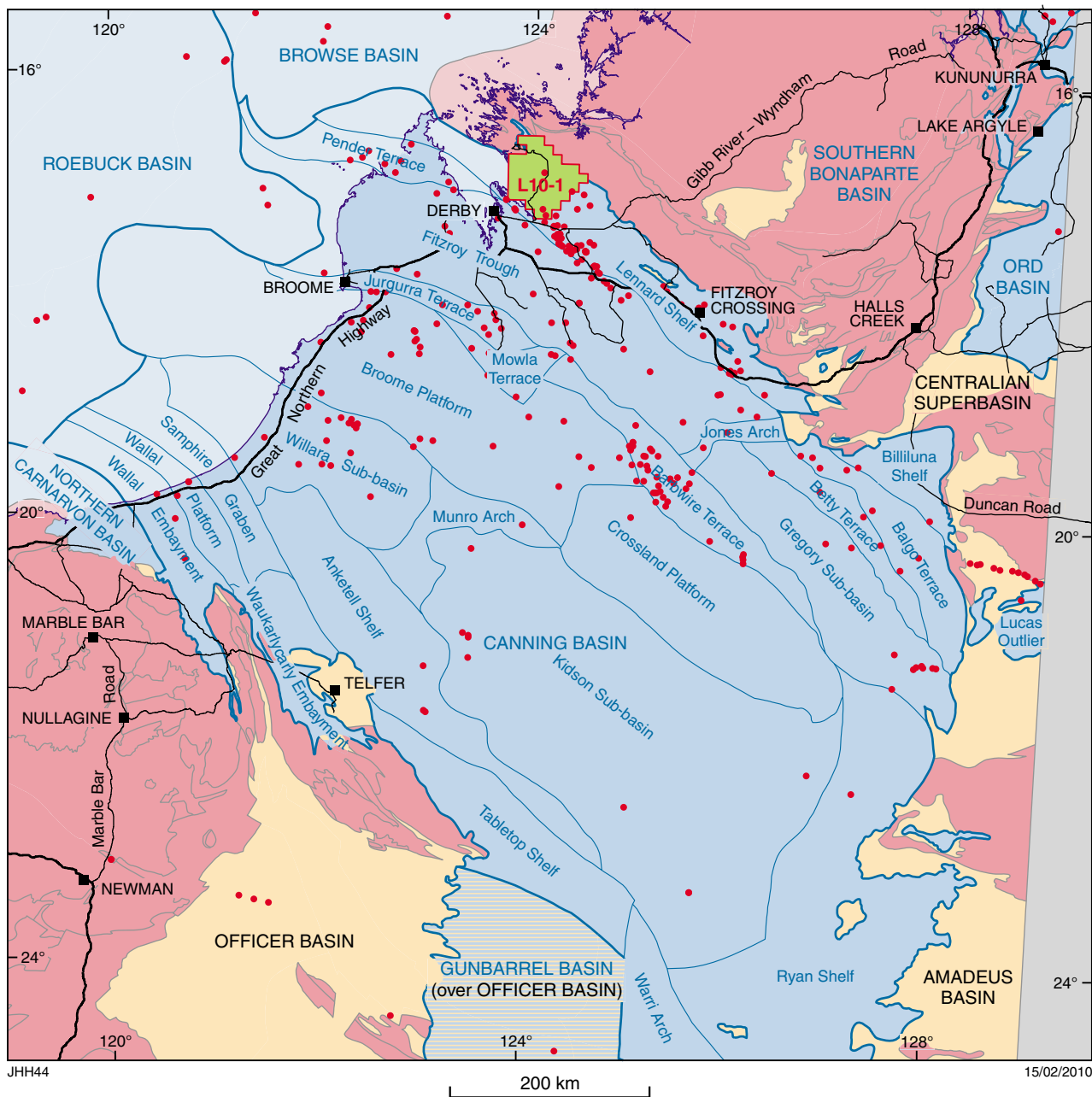
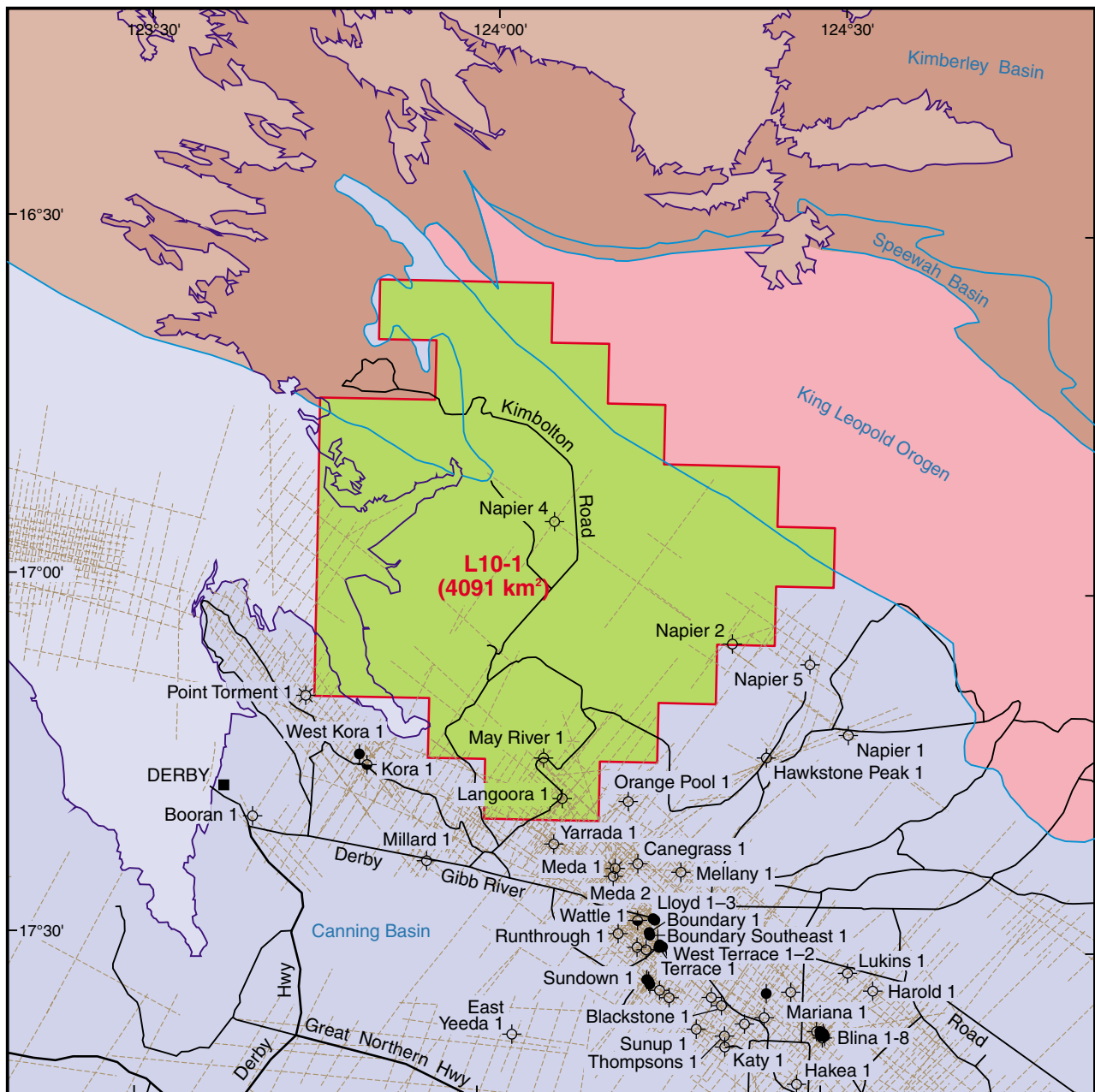


Figure 1. Map of the Canning Basin, showing major basin subdivisions and location of May 2010 Acreage Release Areas

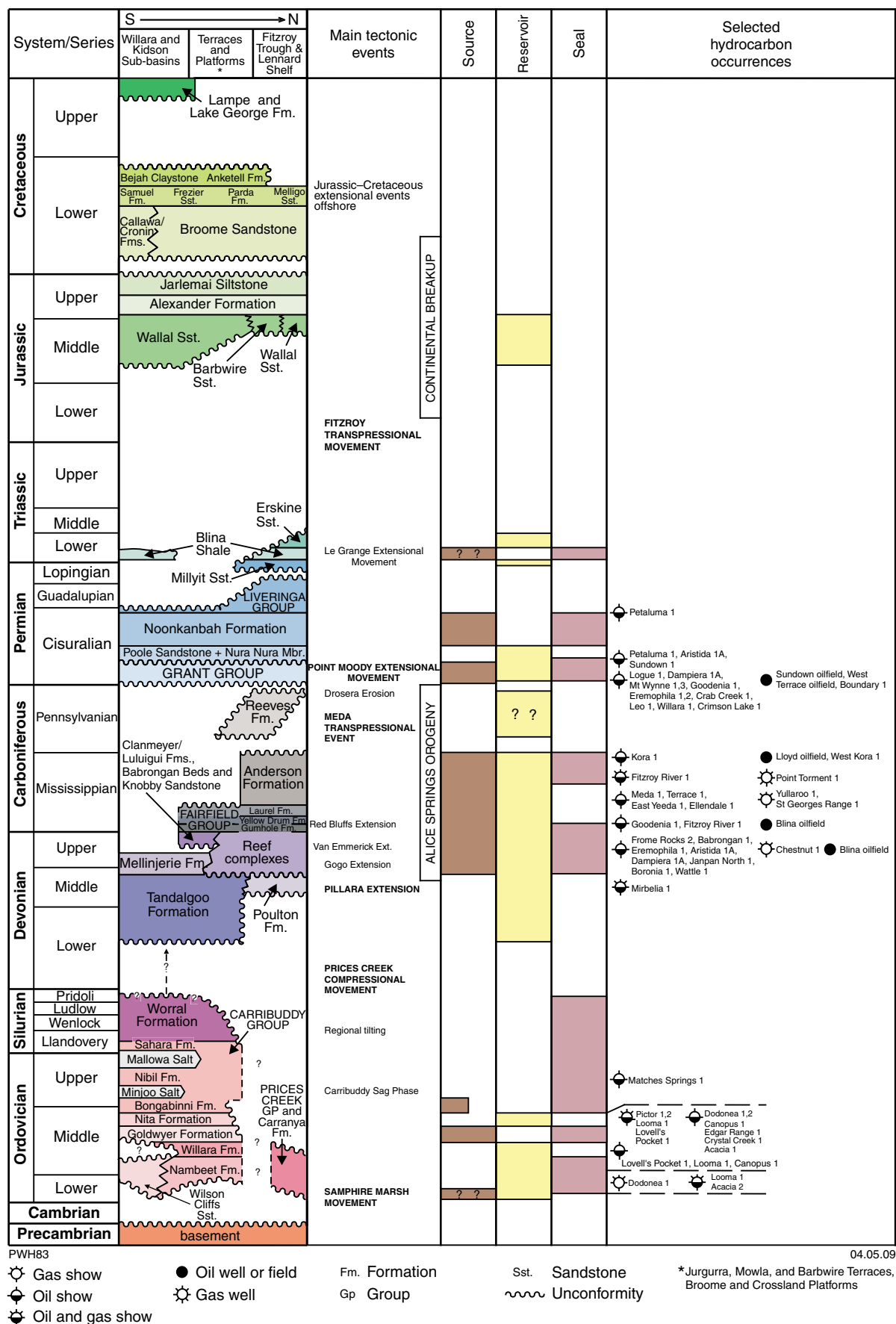


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- |   |                                      |   |                      |
|---|--------------------------------------|---|----------------------|
| ★ | Petroleum well, significant oil show | —   | Major road           |
| ✱ | Petroleum well, significant gas show | —   | Minor road           |
| ⊙ | Petroleum well, dry                  | —   | Basin subdivision    |
| ● | Oilfield                             | - - -   | Seismic line         |
| ● | Oil well, suspended                  | —   | Coast                |
| ✱ | Gas well, suspended                  | <span style="border: 1px solid red; padding: 2px;">L10-1</span> | Acreage Release Area |
| ⊗ | Stratigraphic hole                   | ■   | Townsite             |

Figure 2. Acreage release area L10-1, showing location of seismic lines, petroleum exploration wells, and access roads



**Figure 3. Generalized stratigraphy of the Canning Basin with major petroleum elements and occurrences indicated (modified after D'Ercole et al., 2003; Haines, 2009)**

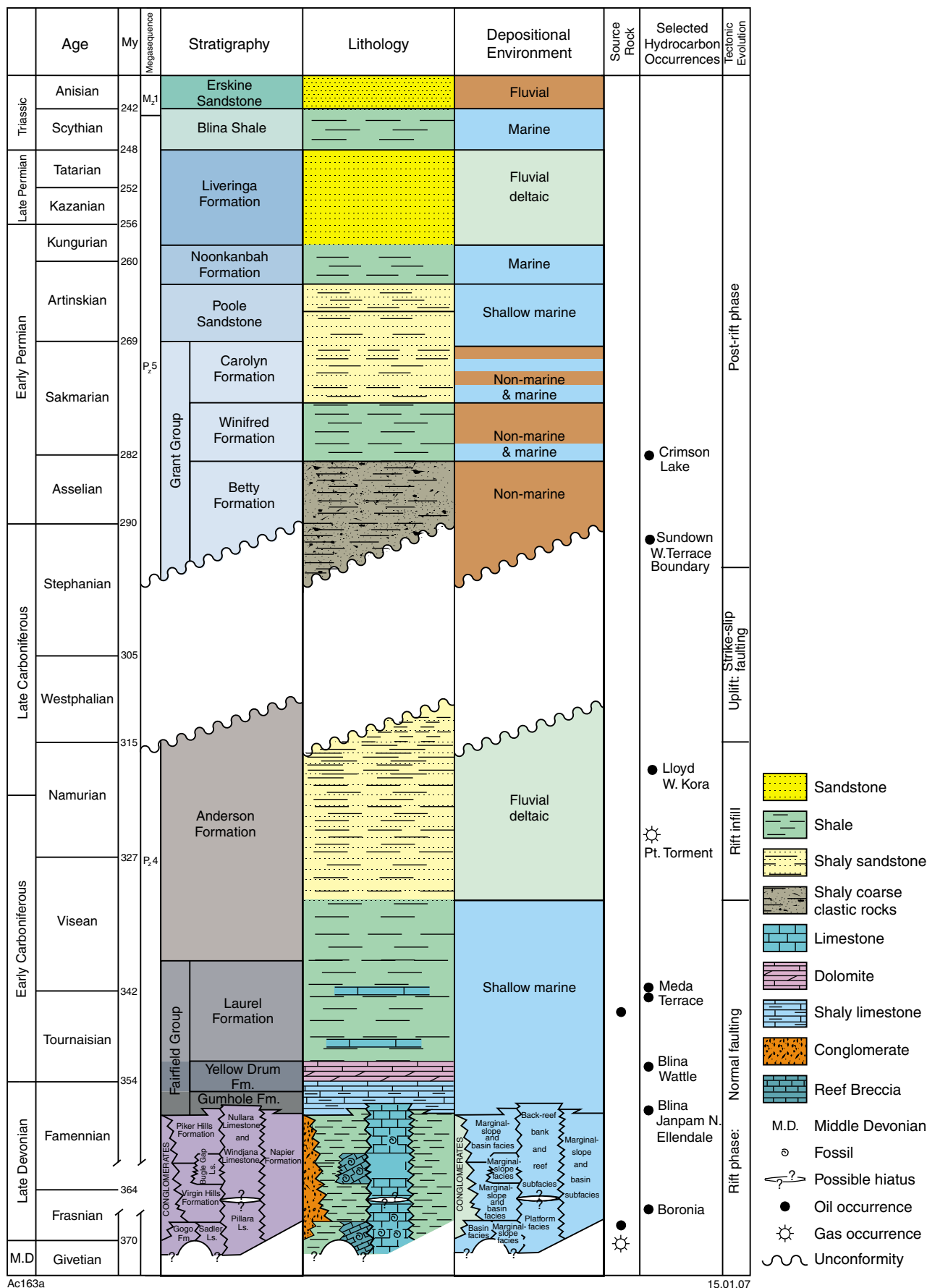


Figure 4. Devonian to Triassic stratigraphy and petroleum occurrences of the Lennard Shelf (after Crostella, 1998)

**Table 1. Petroleum exploration wells within, and selected wells adjacent to, L10-1. Data extracted from Western Australian Petroleum Information Management System (WAPIMS) and well completion reports**

Well	Latitude S	Longitude E	Operator	Year	Class	Status	TD (m)	Elevation (m)	TD age	Oil shows <sup>wo</sup>	Gas shows <sup>wo</sup>
<b>Wells in L10-1</b>											
Langoora 1	17°18'07.2"	124°06'54"	WAPET	1962	NFW	SUSP	1 617	24 DF	Precambrian	Nil	Nil
May River 1	17°14'45.6"	124°05'09.6"	WAPET	1967	NFW	P&A	1 678	20 RT	Precambrian	Nil	Nil
Napier 2	17°04'51.6"	124°21'25.2"	Lennard	1969	NFW	P&A	1 607	86 RT	Precambrian	Poor (PB)	Poor (MG)
Napier 4	16°54'54"	124°05'38.4"	Lennard	1970	STR	P&A	965	91 KB	Precambrian	Nil	Nil
<b>Selected adjacent wells</b>											
Blackstone 1	17°35'09.6"	124°21'10.8"	WAPET	1967	NFW	P&A	3 050	65 RT	Ordovician	Nil	Poor (MG)
Blina 1	17°37'22.8"	124°30'14.4"	Home Energy	1981	NFW	O	2 498	62 RT	Devonian	Producer	Poor (MG)
Boundary 1	17°29'09.6"	124°14'42"	Petsec	1990	NFW	SUSP O	1 670	46 KB	Carboniferous	Producer	Nil
Canegrass 1	17°23'24"	124°13'37.2"	Bow Valley	1993	NFW	P&A	2 007	38 KB	Precambrian	Nil	Poor (MG)
Hawkstone Peak 1	17°14'20.4"	124°24'36"	WAPET	1972	NFW	P&A	1 188	52 DF	Precambrian	Nil	Nil
Lloyd 1	17°27'57.6"	124°15'00"	Home Energy	1987	NFW	O	2 001	44 KB	Devonian	Producer	Poor (MG)
Meda 1	17°23'56.4"	124°11'31.2"	WAPET	1958	NFW	P&A O	2 685	30 DF	Precambrian	Excellent (O,F)	Excellent (MF)
Meda 2	17°24'36"	124°11'27.6"	WAPET	1959	NFW	P&A	2 325	30 DF	Devonian	Poor (O,F)	Poor (MG)
Napier 1	17°12'14.4"	124°31'40.8"	Lennard	1969	STR	P&A	1 801	74 KB	Precambrian	Poor (PB)	Nil
Napier 5	17°06'25.2"	124°28'12"	Lennard	1970	STR	P&A	1 658	74 KB	Precambrian	Nil	Nil
Orange Pool 1	17°18'14.4"	124°12'39.6"	Home Energy	1981	NFW	P&A	1 171	31 RT	Precambrian	Nil	Nil
Point Torment 1	17°09'54"	123°44'20.39"	Anzoil	1992	NFW	G	2 130	17 KB	Devonian	Good	Producer
Stokes Bay 1	17°08'23.7"	123°42'32.4"	Gulliver	2007	NFW	SUSP G	2 755	18 KB	Devonian	Producer	Nil
Sundown 1	17°33'03.6"	124°14'34.8"	Home Energy	1982	NFW	SUSP O	2 736	46 KB	Devonian	Producer	Nil
West Kora 1	17°14'42"	123°49'04.8"	ESSO	1984	NFW	SUSP O	2 606	15 KB	Devonian	Excellent (O)	Poor (MG)
West Terrace 1	17°30'21.6"	124°15'36"	Home Energy	1985	NFW	O	1 250	36 KB	Carboniferous	Producer	Nil

**NOTES:** (a) Shows summarized from well completion reports (O: oil, PB: pyrobitumen, F: fluorescence, MG: mud gas show, MF: measured gas flow)

TD	Total depth	P&A	Plugged and abandoned	WAPET	West Australian Petroleum Pty Ltd	Bow Valley	Bow Valley (Australia) Ltd
NFW	New field wildcat	O	Oil well	Lennard	Lennard Oil NL	Anzoil	Anzoil NL
STR	Stratigraphic hole	DF	Drill floor	Home Energy	Home Energy Co. Ltd	Gulliver	Gulliver Productions Pty Ltd
G	Gas well	RT	Rotary table	Petsec	Petroleum Securities Energy	ESSO	Esso Australia Pty Ltd
SUSP	Suspended	KB	Kelly bushing				



Group). A final marine transgression in the Early Triassic led to deposition of the Blina Shale, which is overlain locally by the fluvial Erskine Sandstone.

## Petroleum prospectivity

Hydrocarbon shows are widespread on the Lennard Shelf, with economic accumulations of oil in the Blina, Lloyd, Boundary, West Terrace and Sundown oilfields immediately southeast of L10-1, and suspended oil well West Kora 1 and gas well Point Torment 1 southwest of this release area (Crostella, 1998; Jonasson, 2001). Petroleum exploration wells previously drilled in L10-1, along with selected wells from closely adjacent areas, are detailed in Table 1. Available seismic data is indicated on Figure 2. Geochemical data point to the presence of two main regional source rock units in this area, namely the Middle–Late Devonian Gogo Formation, a basinal shaly unit deposited adjacent to, and contemporaneously with, the reefs, and the Lower Carboniferous shallow-marine Laurel Formation of the Fairfield Group. In the majority of cases, oil can be typed to the latter formation, although no exhaustive characterization has been carried out to date (Crostella, 1998). Within the Lennard Shelf, the Laurel Formation is mostly immature, whereas the deeper Gogo Formation has reached maturity over wider areas. However, long distance migration from sites of deeper burial in the adjacent Fitzroy Trough, mainly via the northeast-trending transfer fault zones, is considered a likely scenario relating to the known oil accumulations (Crostella, 1998). These faults, including the Meda, Sundown, Blackstone, and Mount Percy Transfer Zones (see Middleton, 1991; Crostella, 1998) extend to the southeast of L10-1. Although not demonstrated, the possibility of lateral migration of Ordovician-sourced oils into Lennard Shelf traps should also be considered. Known oil accumulations are reservoirised in a number of different stratigraphic units ranging from Late Devonian to Early Permian in age (Fig. 4). At Blina (the largest oilfield in the basin), oil has mainly accumulated in fracture porosity within Upper Devonian reef carbonates, with smaller reserves in dolomites of the overlying Fairfield Group. A number of other wells have oil shows in these settings. Fracturing is probably related to the mid Late Carboniferous Meda transpressional event (Crostella, 1998). Younger reservoirs are mainly in clastic rocks and include sandstone horizons in the Anderson Formation (Lloyd oilfield, West Kora 1 oil well, Point Torment 1 gas well), and sandstone in the basal Grant Group (Sundown, West Terrace, and Boundary oilfields). Shales within the Fairfield Group, Anderson Formation and Grant Group provide adequate seals, respectively, but effective seals are unlikely above the middle of the Grant Group (Crostella, 1998). Traps identified to date include fault-controlled anticlines and flower structures, and gentle drape closures over reef structures. The likelihood of classic Lennard Shelf-style oil and gas plays is greatest towards the southwestern margins of L10-1, where greater sediment thicknesses and similar structural styles can be demonstrated.

## References

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Most of the references listed above are available on the Western Australia Petroleum Acreage Release, May 2010 CD, as PDF files.