

**PROSPECTIVITY OF STATE
ACREAGE RELEASE AREAS L10-4
AND L10-5, BLAKE SUB-BASIN,
OFFICER BASIN**

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Introduction

L10-4 (30 795 km²) and L10-5 (30 097 km²) are located in central Western Australia. They straddle the Hamersley Basin, eastern Collier Basin, and Blake Sub-basin of the Officer Basin, with most of the release area falling into the latter sub-basin (Fig. 1). The Blake Sub-basin lies east and southeast of the mining town of Newman in the Pilbara region. The area is largely uninhabited, the only settlement being an outcamp at Poondawari on the GUNANYA 1:250 000 map sheet. The outcamp is linked by a graded track to the Jigalong Community, 90 km to the west, which is just outside the northwest margin of the sub-basin. Although a few pastoral leases lie along the margins of the sub-basin, the majority of the region is vacant Crown Land.

The sealed Great Northern Highway lies west of the Blake Sub-basin and links Meekatharra in the south with Newman and Port Hedland to the north. The Talawana–Windy Corner graded track crosses the northern part of the sub-basin, and graded pastoral station tracks on the Balfour Downs, Weelarrana, Kumarina, Marymia, and Glen-Ayle stations give access to the western and southern margins. The Canning Stock Route traverses the sub-basin from northeast to southwest, and is a well-travelled four-wheel drive track allowing access to the eastern half of the sub-basin. Additional minor tracks also exist, providing access to other parts of the sub-basin (Williams, 1992). Recently flown monochrome, 1:50 000 scale aerial photography and Landsat TM imagery covering the sub-basin is available from Landgate; however, the most detailed and most recent imagery is from Google Earth. Cross-country access is similar to that in the Canning Basin, although the average height of sand dunes is lower in the Blake Sub-basin. Potable water has been found in water bores in the south of the sub-basin and is inferred to be present throughout the region. Fuel and supplies are available at Wiluna, Meekatharra, Newman, and the Capricorn and Kumarina Roadhouses.

There are no meteorological stations within the Blake Sub-basin, but estimates based on data from nearby Bureau of Meteorology stations indicate that the area is arid, with its maximum rainfall in summer during monsoonal rains. The sub-basin has a tolerable working climate for all exploration activities. The Blake Sub-basin lies in the Little Sandy Desert, one of the most remote parts of Western Australia.

The Blake Sub-basin is part of the large, Neoproterozoic, episutural Officer Basin, and is a frontier area for hydrocarbon exploration. It contains up to 8 km of clastic, carbonate, and (in the east) evaporitic sedimentary rocks. Mafic dykes, sills, and flows, with ages of c. 755 and 510 Ma, intrude and overlie the succession. The first petroleum exploration activity in this sub-basin was in 1995. As no seismic data have been acquired, hydrocarbon prospectivity is assessed from mineral and petroleum exploration drilling, and regional-scale surface geological mapping. Results from the Lancer 1 section, drilled some 60 km to the east, are particularly useful to interpreting prospectivity in the area (Haines et al., 2004a,b).

Available data suggest that source-rock quality is the region's major exploration risk, although further investigation of the sub-basin is warranted. Minor oil shows (fluorescence with solvent cut) recorded in Spearhole Formation sandstones from the northwest of the Blake Sub-basin suggest that oil has been generated, and has migrated into potential reservoirs in this region. Each of the four depositional sequences recognized in the sub-basin (Depositional Sequence 1 of Williams (1992) is now regarded as part of the Late Mesoproterozoic Salvation Group and Collier Basin; Hocking et al., 2000) contain potential reservoir rocks, observed in outcrop as friable to silicified (both surficially and at depth) sandstones. The McFadden Formation and Durba Sandstone are interpreted as containing the best-quality reservoirs, but both are at very shallow depths or outcropping. Artesian water flowed from the Boondawari Formation in Lancer 1, indicating the presence of a confined aquifer, and therefore significant reservoir potential. Indications of evaporitic environments from the Mundadjini and Skates Hills Formations suggest that seals may be provided by evaporites and mudstones, whilst shales and diamictites in the Boondawari Formation could also provide seals.

Structural closures, including both fold and fault traps for migrating hydrocarbons, may be provided by Neoproterozoic to Cambrian rocks. Large, gentle anticlinal and synclinal structures can be seen along both sides of Durba Hills, and cauliflower-like outcrop patterns, reminiscent of evaporate expulsion, can be seen east of Lake Disappointment (Hocking et al., 2005). A large semi-detailed gravity survey in the eastern part of the Blake Sub-basin revealed major folds, faults, and halokinetic structures (including salt diapirs) in the areas. Potential source rocks include the marine mudstones of

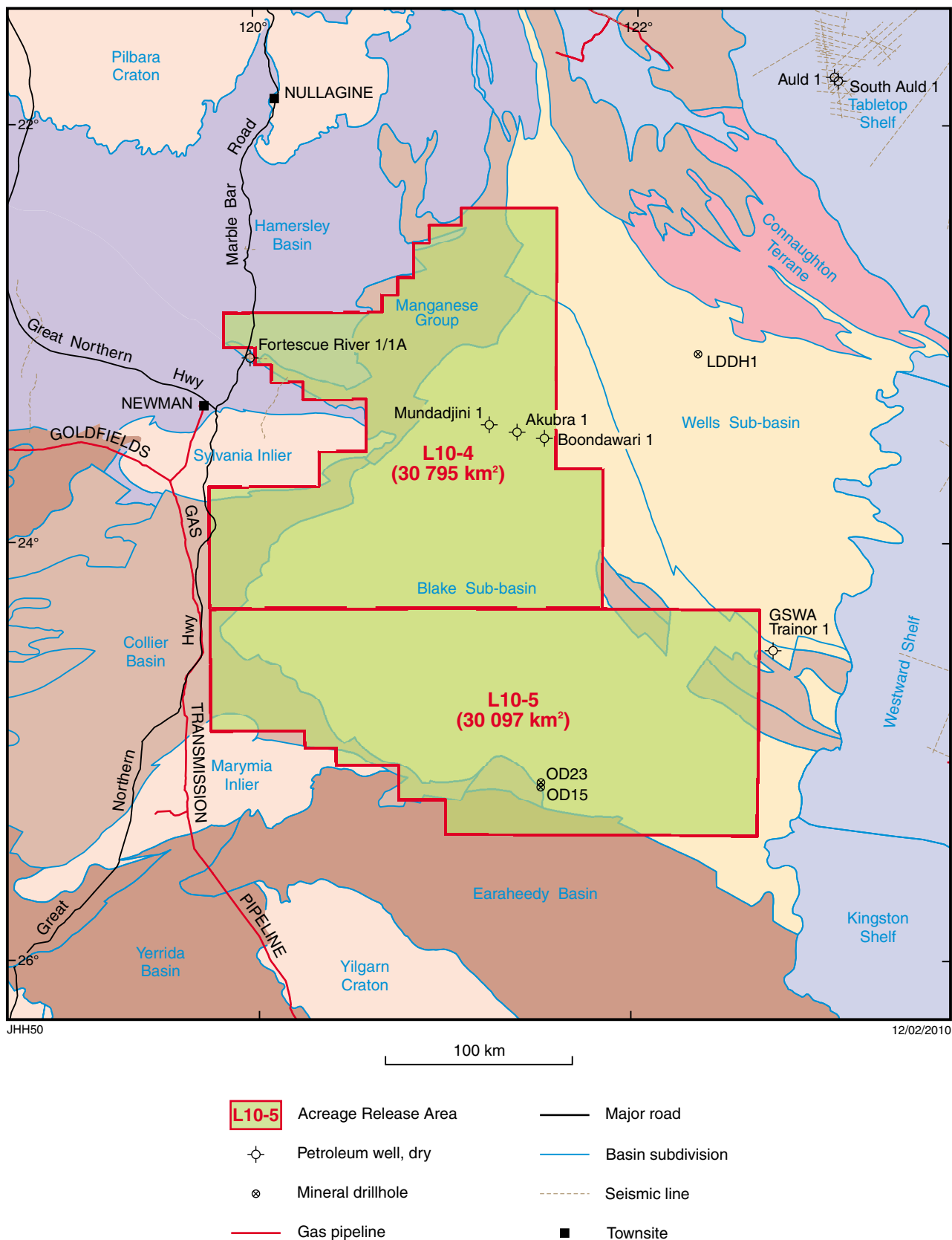


Figure 1. Acreage Release Areas L10-4 and L10-5, showing location of the seismic lines, petroleum exploration wells, significant mineral holes, and access roads.

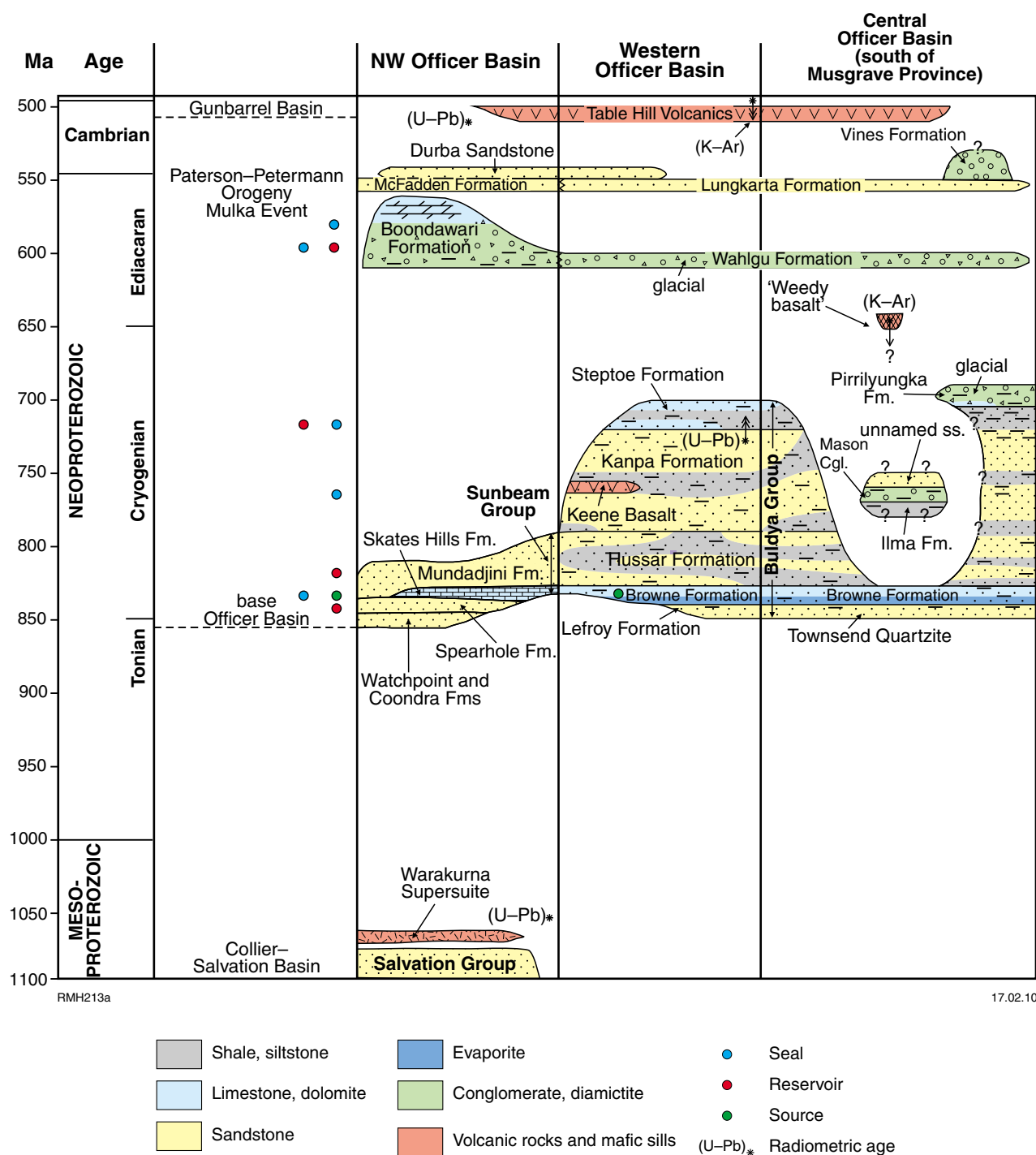


Figure 2. Generalized stratigraphy of the Officer Basin

the Skates Hills and Mundadjini Formations, which are associated with stromatolitic dolomites and evaporites, and shales in the underlying Late Mesoproterozoic Manganese and Collier Groups. Rare outcrops of black mudstones from other units, such as the Boondawari Formation, also suggest source potential. The Geological Survey of Western Australia has drilled one stratigraphic hole (GSWA Trainor 1) to assess the source potential of Neoproterozoic sedimentary rocks in the Blake Sub-basin, and another hole a short distance to the east (Lancer 1) to

investigate Neoproterozoic stratigraphy and hydrocarbon potential. In Trainor 1, five of the six Quadrio Formation (interpreted as the Cornelia Formation in the well report) samples, analysed for Total Organic Carbon between 362 and 491 m, exceeded 0.5%, but also showed a high level of maturation with, at best, dry gas generating potential. The age of the Quadrio Formation has since been re-assessed as Mesoproterozoic, and therefore older than the Late Mesoproterozoic Collier and Salvation Groups (Hocking et al., 2000). Maturity data, which are very sparse due to

Table 1. Petroleum exploration wells and significant mineral holes within, and adjacent to, L10-4 and L10-5. 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 ^(a)	Gas shows ^(a)
Wells in L10-4											
Akubra 1	23°29'20.4"	121°22'41.6"	Amadeus	1997	STR	P&A	181	530 RT	Proterozoic	Nil	Nil
Boondawari 1	23°31'05.6"	121°31'18.8"	Amadeus	1997	STR	P&A	1 367	490 RT	Proterozoic	Nil	Nil
Mundadjini 2	23°27'13.5"	121°13'52.1"	Amadeus	1997	STR	P&A	599	500 RT	Proterozoic	Nil	Nil
Selected adjacent wells											
Fortescue River 1/1A	23°07'51.2"	119°58'23.9"	Multiplex	1985	STR	P&A	2 177	478 KB	Precambrian	Poor (PB)	Nil
LDDHI	23°06'40.1"	122°19'44.2"	Normandy	1993	MIN	P&A	701	Unknown	Neoproterozoic	Poor (PB)	Nil
Wells in L10-5											
OD15	25°11'18.3"	121°30'38.6"	Jubilee	1996	MIN	P&A	162	Unknown	Proterozoic	Poor (PB)	Nil
OD23	25°09'57.0"	121°30'45.0"	Jubilee	1996	MIN	P&A	219	Unknown	Proterozoic	Poor (PB)	Nil
Selected adjacent wells											
GSWA Lancer 1	25°02'44.5"	123°45'20.1"	GSWA	2003	STR	P&A	1 501	450 DF	Mesoproterozoic	Nil	Nil
GSWA Trainor 1	24°31'31.9"	122°44'28.1"	GSWA	1995	STR	P&A	709	455 DF	Neoproterozoic	Nil	Nil

NOTES: (a) Shows summarized from well completion reports (PB: pyrobitumen)

TD Total depth
STR Stratigraphic hole
MIN Mineral hole
DF Drill floor

P&A Plugged and abandoned
RT Rotary table
KB Kelly bushing

Amadeus
Multiplex
Normandy
Jubilee
GSWA

Amadeus Petroleum NL
Multiplex Construction Pty Ltd
Normandy Mining Ltd
Jubilee Oil NL
Geological Survey of Western Australia

limited drilling, are inferred using the Thermal Alteration Index of organic matter. These analyses indicated maturity in two waterbores within the southeast of the sub-basin, and a mineral drillhole in the north of the region, to be roughly at the base of the oil window and top of the gas window. Rock cuttings from a waterbore in the southwest of the sub-basin are overmature for hydrocarbon generation, but as this bore intersected mafic intrusives, it may not be representative of maturity for the region. The Lancer 1 well, located 115 km east of L10-5's eastern boundary, intersected good reservoir rocks, but found no suitable source rocks.

Regional geology and stratigraphy

The northwestern Officer Basin, formerly named the 'Savory Basin', is the largest part of the basin without extensive Phanerozoic cover. In this area, the Sunbeam Group (Buldya Group correlative, ~850–800 Ma), Boondawari Formation (glacigene Wahlgu Formation correlative, ~600 Ma), Disappointment Group (Lungkarta Formation partial correlative, ~550–600 Ma), and Durba Sandstone (~540–550 Ma) are recognized individually, following the abandonment of the 'Savory Group'. Basal sandstone units initially thought to be part of the Officer Basin have been excised and placed within the Salvation Group (~1070–?1200 Ma). The Tarcunyah Group of the Paterson Orogen may correlate with the Buldya and Sunbeam Groups but is structurally separated from it and commonly more deformed. The Lamil and Throssell Range Groups of the Yeneena Basin may also be related to the Officer Basin succession, but are separated from the latter by the Vines–Southwest–McKay fault system; sedimentary rocks in the Lamil and Throssell Range Groups are more deformed than the northern Officer Basin succession (Fig. 2).

Reported hydrocarbon shows and oil seep

Amadeus Petroleum recorded minor oil shows in cores from Mundadjini 1 and Boondawari 1. In Mundadjini 1 at 361.02 m (top of the Spearhole Formation), a 3 mm thick zone had 10% moderate white fluorescence with slow solvent cut. This show was in a granular sandstone with visually estimated porosity of about 10%. In Boondawari 1 at 353.64 m (within the Spearhole Formation), a broken surface of sandstone had 40% moderate yellow-white fluorescence with slow solvent cut. Visually estimated porosity was about 5%. Because the fluorescing surface was broken during the drilling process, this show could have resulted from contamination. A second show occurs in Boondawari 1 at 496.3 m (within the Spearhole Formation), where a 1 cm thick zone had 5% dull yellow fluorescence with slow solvent cut in a conglomerate with visually estimated porosity of about 10%. Mineral holes OD15 and OD23, drilled by Jubilee Gold Mines NL on NABBERU in the Scorpion Group (~1620 Ma), and intruded by Warakurna Supersuite dolerite sills about 50 km south

of the Blake Sub-basin, encountered bitumen and trace oil in vugs in dolomite.

Minor bitumen is present as a vein in mudstones of the Tarcunyah Group at 662.3 m in drillhole LDDH1 on GUNANYA (Fig. 1). A sample was analysed by gas chromatography (Ghori, 1998) and confirmed that the bitumen is natural.

Lancer 1, drilled about 60 km east of the sub-basin, encountered very good reservoir rocks in the Hussar, Wahlgu and Browne formations, but no shows (Haines et al., 2004).

In the Hamersley Basin, Fortescue River 1A (drilled by Multiplex) intersected asphalt at 945 m in a dolomite, and noted fluorescence with a drilling break at 1585 m, again within a dolomite.

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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.