

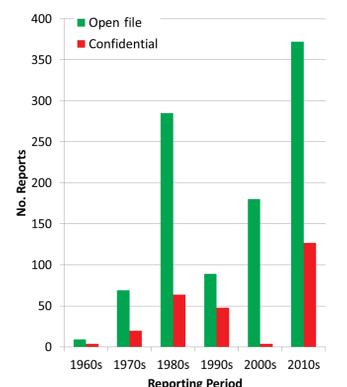
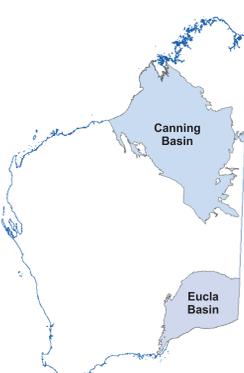
COAL IN THE EUCLA AND CANNING BASINS

The Energy Geoscience and Carbon Strategy Branch is using current and historical reports and data to document all exploration completed for coal, lignite and oil shale. The majority of reports are stored in the Western Australian Mineral Exploration (WAMEX) database, although some reports, for example those covering 1980s oil shale exploration are stored in the Western Australian Petroleum and Geothermal Information System (WAPIMS). All open-file reporting is available online via the Department of Mines, Industry Regulation and Safety (DMIRS) website.

For the entire State there are:

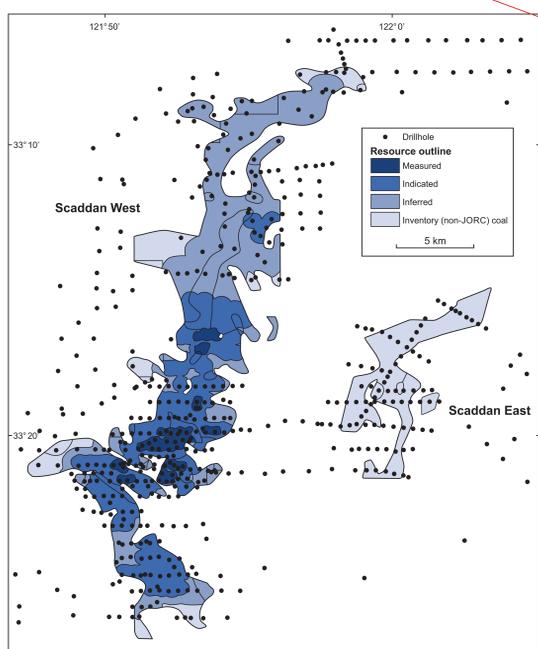
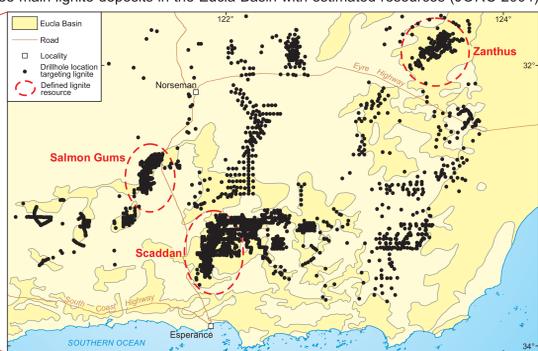
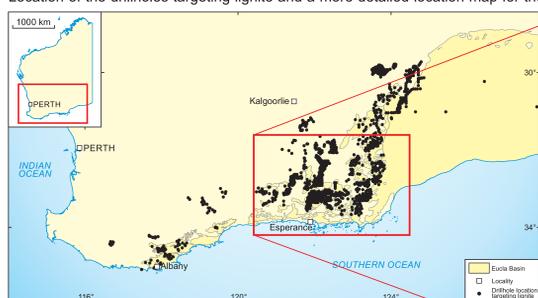
- 1270 coal reports in WAMEX and about 10 related reports in WAPIMS
- 1000 open-file reports, 270 confidential reports
- 50% of reports are pre-compulsory digital reporting (2006)
- 3860 holes relating to coal exploration identified to date

Reports range in size from a single page to a seven volume, 5218-page treatise and very in quality. Compilation has concentrated on lignite from the Eucla Basin and coal from the Canning Basin.



EUCLA BASIN

Location of the drillholes targeting lignite and a more detailed location map for the three main lignite deposits in the Eucla Basin with estimated resources (JORC 2004)



Lignite was first discovered in 1848 in the Fitzgerald River area but there was no large scale exploration until 1980 when CRA Exploration, Western Collieries and BHP delineated several prospects of varying sizes throughout the Eucla Basin. Due to low economic interest, only four tenement areas were maintained by mid-1985. Targeted exploration recommenced in the late 2000s and three deposits, Scaddan, Salmon Gums and Zanthus, have resource estimates reported according to the Joint Ore Reserves Committee (JORC) (2004) code.

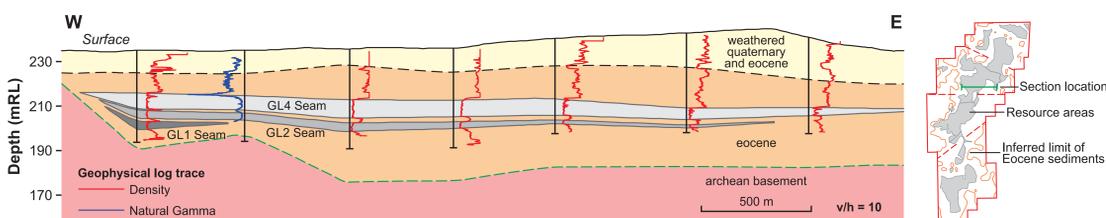
Eucla Basin lignite quality

1. High moisture content of 50–55%
2. Variable ash yield of 6–50%
3. Specific energy values of 5–12 MJ/kg
4. High sulfur content 2–5%
5. High salt (NaCl) content 1.5 – 20%
6. High oil yield 40–240 L/t with an average of 120 L/t

JORC Category	Measured (Mt)	Indicated (Mt)	Inferred (Mt)	Total (Mt)
Scaddan	80	490	470	1040
Salmon Gums		406.1	470	876.1
Zanthus			350	350

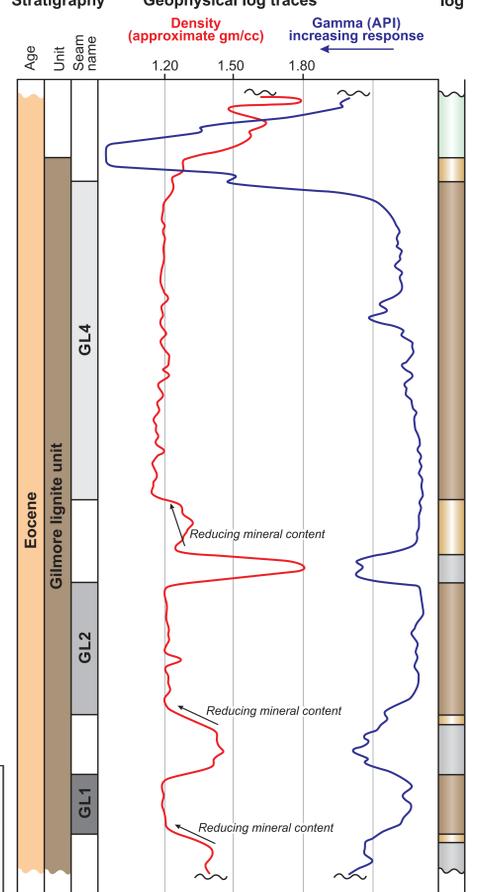
Blackham Resources upgraded resource outline and drillhole locations (ASX release 21 July 2011)

Cenozoic lignite occurs as part of a sequence of marine, marginal-marine to non-marine Eocene sedimentary paleochannel infill of the onshore western Eucla Basin. Paleochannels are widely distributed around the basin margins and have varying lengths from tens of metres to more than 30 km and depths up to 100 m. The lenticular lignite deposits are generally thickest in the centre of the paleochannels and vary between 5 and 20 m. The Eucla Basin lignites are a low-grade fuel with high moisture and low heating value. Possible uses for lignite include a fuel source for power generation, feedstock for an oil refinery (coal to liquids), gasification (coal to gas), a petrochemical feedstock and a source of montan wax. Potential utilization issues with lignite include high salt and ash content.



Schematic cross-section of a typical lignite bearing paleochannel (modified after Spitfire Oil 2009, WAMEX report A85581)

Stratigraphy Geophysical log traces Graphic log



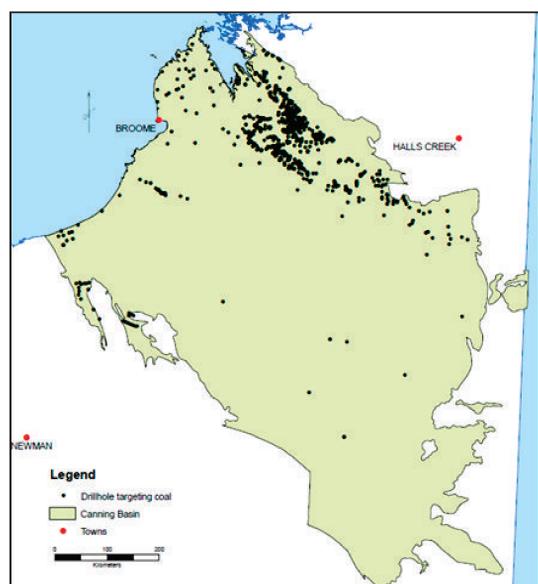
Example of a downhole geophysical log correlated to coal stratigraphy, Salmon Gums (WAMEX report A85581, Spitfire Oil 2009)



Typical portion of lignite core which is fractured along the bedding plane and shows woody plant fossils (WAMEX report A89388, Blackham Resources 2010)

CANNING BASIN

Coal seams were discovered in the Canning Basin in 1909 and were noted in petroleum wells from the mid-1950s onwards. There was considerable exploration for coal in the Fitzroy Trough from 1965 through to the early 1980s due to increase in demand for thermal coal but only a few small low-rank coal deposits were delineated. In the 1980s, there was a worldwide downturn in demand for coal. Since the early 2000s, there has been an upsurge in activity with Rey Resources, Blackfin Resources and Rio Tinto conducting extensive drilling campaigns in the Fitzroy Trough although only Rey Resources produced a JORC resource statement.

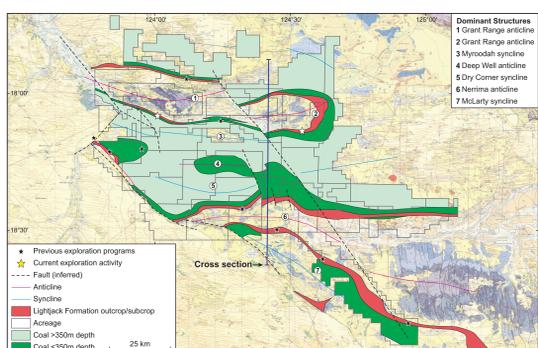


GSWA Records covering the Eucla, Canning and northern Perth Basins are due for release in June 2019. These collate available data on the geology, exploration and evaluation history. Drillhole locations and summary geological data will be included as GIS files along with references to the original data sources.

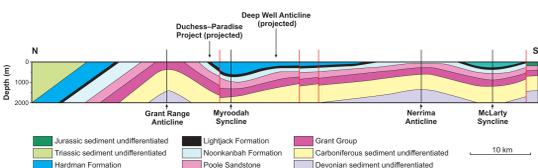
These products will allow future explorers to access historical coal exploration and evaluation information from a single source.



Coal from Duchess/Paradise area (WAMEX report A68983, Rio Tinto 2004)



Lightjack Formation outcrop (orange), with coal at depth indication by shallow (dark green) and deeper (light green) zones (WAMEX report A95923, Rey Resources 2012)



North-South cross-section (facing east) through the Rey Resources lease holdings. The coal-bearing Lightjack Formation (black) outcrops at several locations and continues at depth. Vertical exaggeration x2 (WAMEX report A95923, Rey Resources 2012)

JORC Category	Measured (Mt)	Indicated (Mt)	Inferred (Mt)	Total (Mt)
Paradise	34.6	30.3	81.9	146.8
Duchess	25.6	48.2	85.1	159.0
Total	60.2	78.5	167.0	305.8

Coal is recorded from several stratigraphic units in the Canning Basin of Permian age. The most widespread seams occur in fluvio-deltaic facies of the Upper Permian Lightjack Formation, the basal unit of the Liveringa Group, which has been the primary focus of previous exploration. Deposition of this coal took place during alternating shallow marine transgressions and regressions that allowed peat to form under estuarine or lagoonal conditions and in inter-channel swamps on fluvial deltaic fans. The Lightjack Formation contains two sub-bituminous seams vertically separated by up to 25 m. The upper 'A' (or 'P1') seam is up to 4 m thick and the lower 'B' (or 'P2') seam is about 10 m thick, but is composed of interbedded coal and stone bands, thereby reducing its economic potential.

Seam	Moisture	Volatiles	Ash	Total Sulphur	Specific Energy ²	Relative Density
	% (adb)	% (adb)	% (adb)	% (adb)	kcal/kg	g/cm ³
P1	10.6	28.5	24.8	1.51	4750	1.50
(range)	(7.1 – 17.5)	(24 – 32)	(15.4 – 39.6)	(0.7 – 3.1)	(3784 – 5446)	(1.40 – 1.68)
P2	11.1	17.9	52.5	1.44	2206	1.86
(range)	(6.7 – 16.8)	(12 – 24.8)	(26.5 – 63.2)	(0.62 – 3.69)	(1156 – 3650)	(1.62 – 2.00)

Raw coal analysis for the Duchess/Paradise resource (Rey Resources ASX release 20 August 2009)

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