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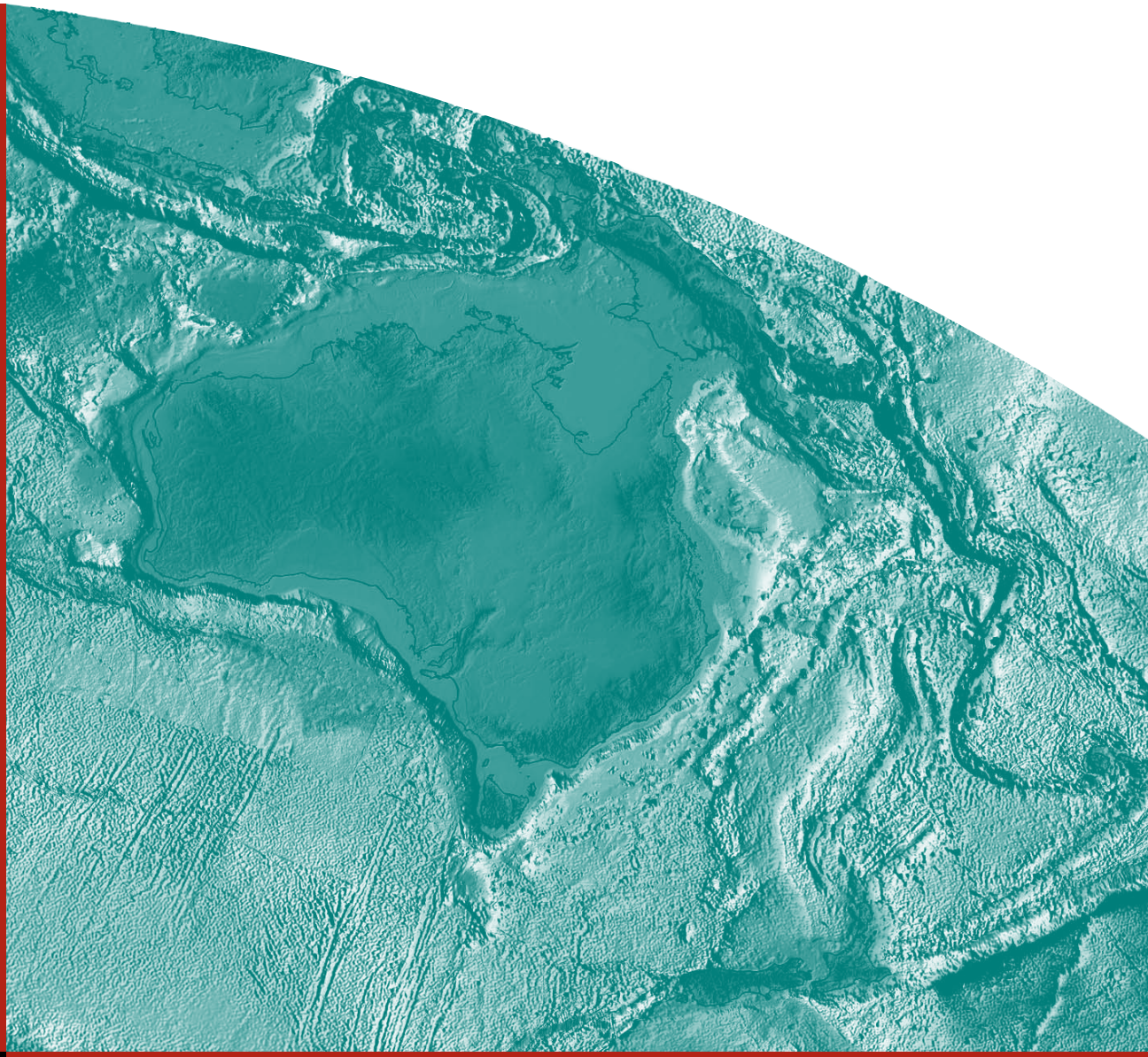

Petroleum Prospectivity of the Northern Australian Marine Region

GEOSCIENCE AUSTRALIA
RECORD 2009/04

by

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Australian Government
Geoscience Australia

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EXECUTIVE SUMMARY

The northern marine region of Australia has been selected by the Department of the Environment, Water, Heritage and the Arts (DEWHA; with statutory and policy responsibility for MPAs) as a possible location for the establishment of marine parks. This report examines the petroleum prospectivity of the proposed region, with an assessment undertaken by Geoscience Australia. The northern marine assessment region is located offshore on the northern shelf of Australia, extending from the NT/WA state boundary to the Torres Strait. Geographically the region encompasses three provinces; the Timor Sea, the Arafura Sea and the Gulf of Carpentaria (**Figure 1**). These areas were assessed separately due to their different geological histories, sedimentary fill and associated prospectivity.

A risk-based approach was used during the assessment process, capturing either the presence or absence of essential petroleum systems elements, the associated likelihood of a petroleum accumulation and the current knowledge level for the region (**Tables 1 and 2**). A confidence level was also assigned for the resulting classification.

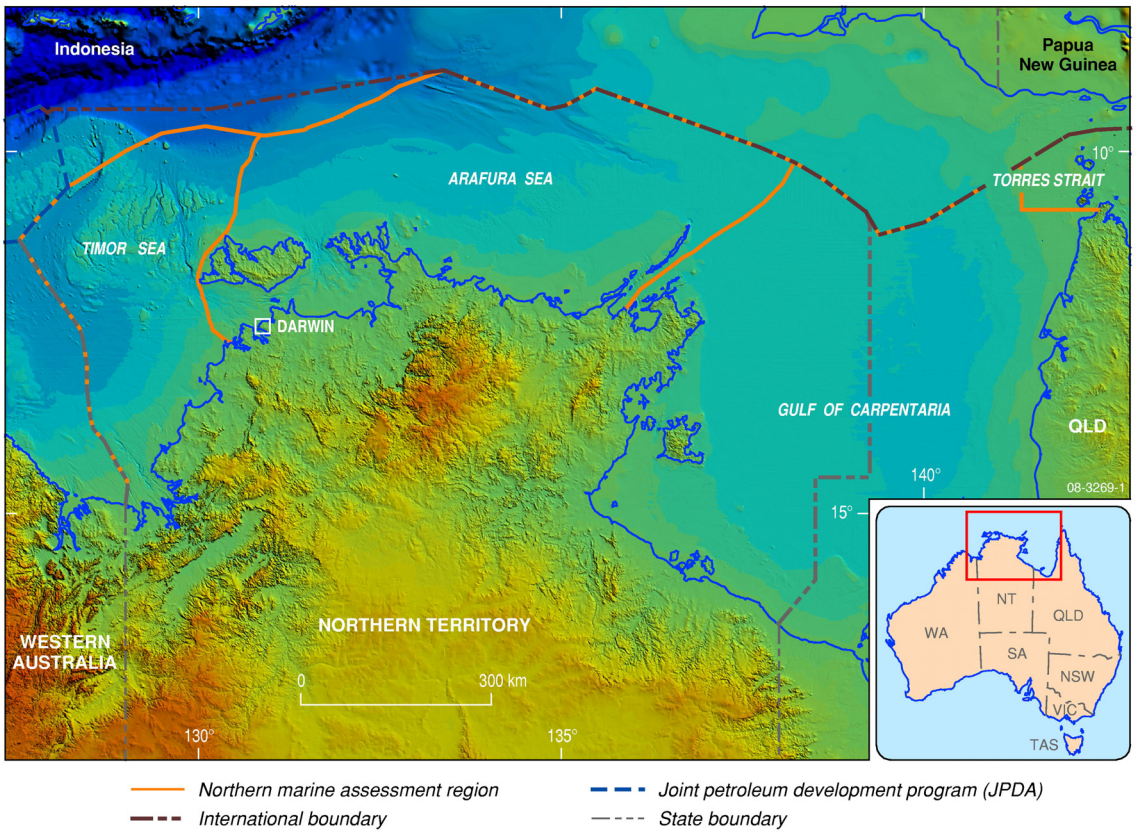

Figure 1: *Petroleum prospectivity assessment regions for the northern offshore Australian margin. The orange border marks the limits of DEWHA's area of interest. This line does not extend to all international boundaries due to the presence of disputed territories in some areas.*

Assessment results show that the provinces differ markedly in regards to exploration maturity and associated data coverage. The Timor Sea is located in the western part of the assessment area (**Figure 1**) where it overlies the Bonaparte Basin, a mature exploration region containing established oil and gas fields. There is a high level of knowledge and data coverage for this area. This is reflected in many of the assessment units being classified as Prospective-1 (hydrocarbon accumulations identified) with a high level of confidence (**Tables 1 and 2, Figure 2**). Differences in prospectivity for the Timor Sea region assessment units are largely due to geological differences, such as the location of major structural elements or age of sediments, rather than changes in data coverage.

The Arafura Sea and Gulf of Carpentaria provinces are in a frontier setting with no field discoveries and low levels of knowledge and limited data availability. In the Arafura Sea, the most prospective areas are categorised as Prospective-2 (**Tables 1 and 2, Figure 2**). These areas have the potential to contain hydrocarbon accumulations because one or several petroleum systems elements are present, including sediment thicknesses capable of generating hydrocarbons. This is supported by direct and interpreted indirect hydrocarbon indicators in available datasets such as oil and gas shows, SAR (Synthetic Aperture Radar) anomalies and seismic anomalies. The most prospective areas in the Gulf of Carpentaria are Prospective-4 at best, defined by the limits of the Bamaga Basin. This is the only mapped potential hydrocarbon source in this region (**Tables 1 and 2, Figure 2**). The assessment units in these latter two frontier areas are defined based on the location of major basin structures and variations in data coverage, particularly in seismic data and well control. Despite the frontier setting of these areas, no offshore region was classified as having no petroleum prospectivity.

Table 1. Summary of prospectivity classifications for the northern marine assessment region.

Assessment Area	Name	Classification	Overall Likelihood of Hydrocarbon Occurrence	Confidence
Timor Sea	Calder Graben	Prospective – 1	1.0000	High
	Petrel Sub-basin	Prospective – 1	1.0000	High
	Troubadour Terrace	Prospective – 1	1.0000	High
	Malita Graben	Prospective – 2	0.4480	Mod-High
	Sahul Platform	Prospective – 2	0.5760	High
	Darwin Shelf	Prospective – 4	0.0800	Mod
Arafura Sea	Northern Arafura	Prospective – 2	0.2520	Mod
	Northern Money Shoal	Prospective – 2	0.2700	Mod-High
	Goulburn Graben	Prospective – 3	0.1500	High
	Eastern Arafura	Prospective – 6	0.0080	Low
	Southern Money Shoal	Prospective – 6	0.0040	Low
	Southern Ramp	Prospective – 6	0.0250	Low
Gulf of Carpentaria	Bamaga Basin	Prospective – 4	0.0360	Mod
	Western Gulf –Bamaga	Prospective – 5	0.0240	Mod
	McArthur Basin	Prospective – 6	0.0025	Low
	Weipa Region	Prospective – 6	0.0240	Mod
	Western Gulf	Prospective – 6	0.0060	Mod

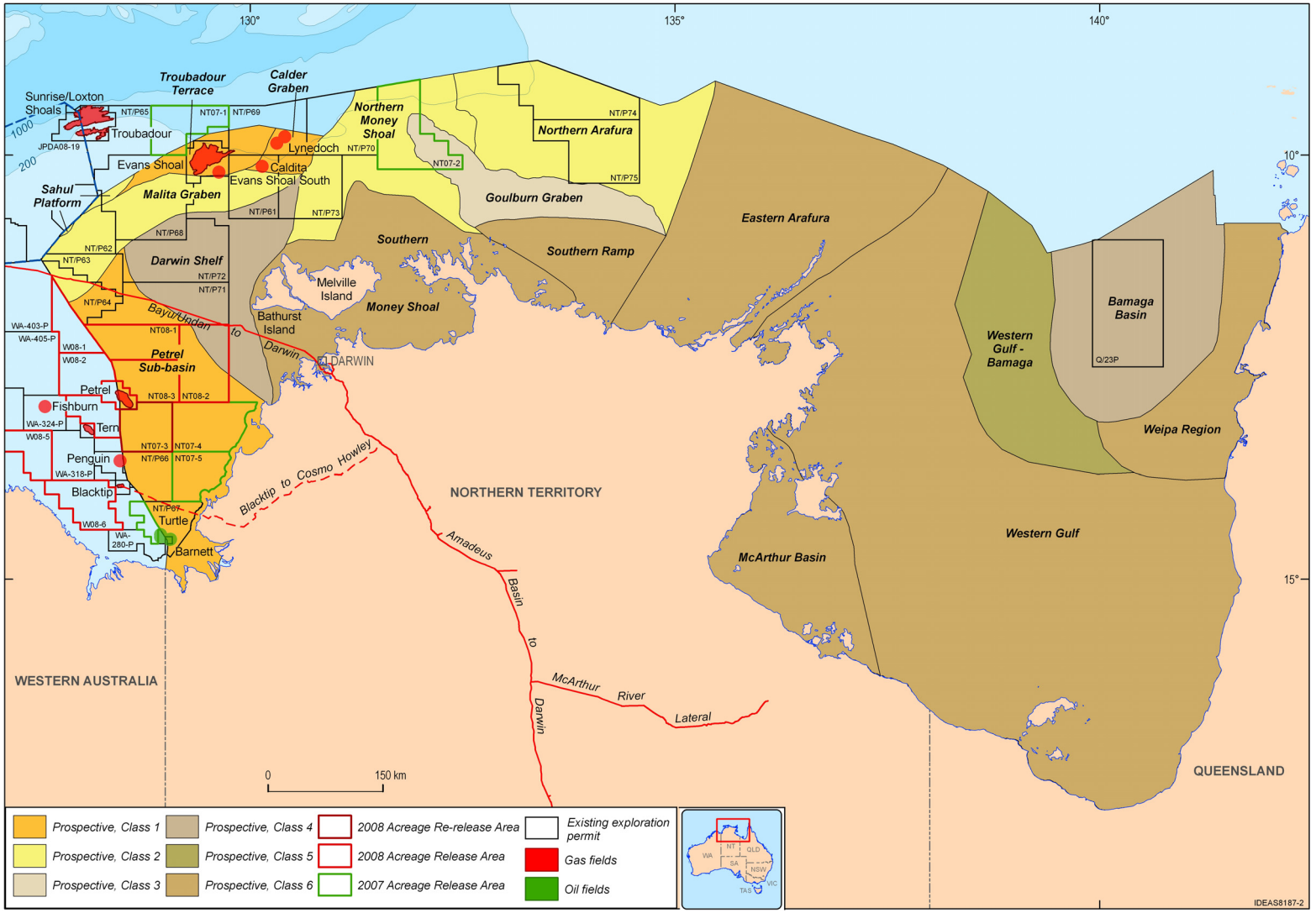

Figure 2: *Petroleum prospectivity map for the northern marine assessment region.*

1. INTRODUCTION

The northern marine region of Australia (**Figure 1**) has been selected by the Department of the Environment, Water, Heritage and the Arts (DEWHA; with statutory and policy responsibility for MPAs) as a possible location for the establishment of marine parks. This report examines the petroleum prospectivity of the proposed region, with an assessment undertaken by Geoscience Australia. Petroleum prospectivity refers to an areas potential to generate and trap hydrocarbons.

The northern marine assessment region is located offshore on the northern shelf of Australia, extending from the NT/WA state boundary to the Torres Strait, covering approximately 625,000 km^2 in water depths up to 1000 m. Geographically the region encompasses three main provinces; the Timor Sea, the Arafura Sea and the Gulf of Carpentaria (**Figure 1**). These provinces encompass a number of major sedimentary basins including: the Bonaparte, the Arafura, the Money Shoal and the Carpentaria basins (**Figures 3, 6 and 10**). The provinces were assessed separately due to different geological development histories and sedimentary fill.

A risk-based approach was used during the assessment process, capturing either the presence or absence of essential petroleum systems elements and the current knowledge level for the region (**Tables 1 and 2**). A confidence level was assigned for the resulting prospectivity classification.

2. METHODOLOGY

Geoscience Australia has a well established assessment methodology which has been used previously for the Southeast region (Bradshaw, 2003), the South Tasman Rise region (Struckmeyer and Blevin, 2003), and the Lord Howe Rise region (Bradshaw et al., 2003) prospectivity assessments. Further detail of the assessment process can be accessed through these reports. The same methodology was used for the northern marine assessment region.

The northern marine region assessment was initiated with a detailed analysis and compilation of pre-existing data for the area. The amount of information available for the geological provinces varied because the Timor Sea region is an established hydrocarbon province, where as the Arafura Sea and the Gulf of Carpentaria are frontier regions. The datasets used for this study included previous literature, regional maps and exploration data, such as well data, field outlines, seismic data and potential field data.

Each assessment province was analysed individually at a regional scale, accessing compiled data and expert knowledge through a series of workshops held at GA. The assessment was conducted using a risk-based approach (outlined below) and each map element represents a major change in either a key petroleum systems element or knowledge level. The end result comprises a ranking scheme ranging from non-prospective to prospective, and a value for the likelihood of a hydrocarbon accumulation. Confidence levels were captured for each assessment (low, medium and high) and also for the resulting map boundaries (e.g. accuracy of 1–10 km, 10–100 km, >100 km). Economic effects and factors were not taken into account for the assessment.

2.1 CLASSIFICATION SCHEME

Each area was assessed based on two main categories, 'prospective' and 'non-prospective'. 'Prospective' areas are interpreted to have some possibility of containing a hydrocarbon accumulation. 'Non prospective' areas are interpreted to have no potential to host petroleum accumulations. These two categories have been further sub-divided based on level of knowledge for the region and risk (**Table 2**). Thus, as the level of knowledge about an area changes and the risk factors can be more confidently evaluated, the classification may be changed accordingly. There are six classes within the 'Prospective' category, and two classes within the 'Non-Prospective' category. The risk rating methodology is shown in **Section 2.2**.

Table 2. Prospectivity classification scheme

Classification		Description
Prospective	**1**	Hydrocarbon accumulation identified.
	2	Hydrocarbon accumulations are likely based on identified petroleum systems, plays, prospects or leads.
	3	Hydrocarbon generation and migration as indicated in wells or from indirect evidence (e.g. seeps, seismic anomalies).
	4	Potential for hydrocarbon accumulations based on sediment thickness and evidence for potential trapping mechanisms in seismic data.
	5	Potential for hydrocarbon accumulations with low ranking for at least one key factor (hydrocarbon generation and migration, sealed-reservoirs, valid traps) in areas with good well control.
	6	Potential for hydrocarbon accumulations with low ranking for at least one key factor (hydrocarbon generation and migration, sealed-reservoirs, valid traps) in areas with no well data.
Non-Prospective	**7**	No potential for hydrocarbon accumulations based on the absence of at least one key factor (hydrocarbon generation and migration, sealed-reservoirs, valid traps) in areas with low sediment build-up.
	8	No potential for hydrocarbon accumulations based on the absence of all key factors (hydrocarbon generation and migration, sealed-reservoirs, valid traps) in areas of shallow basement and volcanic build-ups.

2.2 RISKING SCHEME

The Geoscience Australia risking scheme assesses prospectivity in relation to essential petroleum systems elements and the likelihood of a hydrocarbon accumulation occurring in the area. Determining the likelihood of the occurrence of a hydrocarbon accumulation has been conducted by assessing three key risk factors, hydrocarbon generation and migration, sealed reservoirs and valid traps. Each factor was assigned a value between 0 and 1 (with '0' denoting the lack of an essential feature). These values are then multiplied to give a total assessment value for the area. The higher the assessment value the higher the likelihood of a hydrocarbon accumulation in the area.

Established exploration provinces were assessed using values between '0' and '1' for each of the key factors whereas frontier basins were risked over a smaller range of typically <0.4. The rationale used is that frontier basins cannot be ranked as high as basins with proven or likely petroleum systems, but not as low as basins where hydrocarbons are known not to exist. Future work in these basins would likely change the prospectivity value.

Risk Factors

Hydrocarbon generation and migration

The hydrocarbon generation and migration risk element is the likelihood that potential source rocks are present, and that hydrocarbons subsequently generated and migrated from these source rocks as they became thermally mature. If a measurable quantity of hydrocarbons has been recovered from a basin, then the chance of generation and migration is rated as = 1. The likelihood of generation and migration will then progressively decrease as there is decreasing evidence for the presence of mature source rocks, less direct evidence for hydrocarbons (e.g., remote sensing evidence and seismic anomalies), and increasingly long-range migration required to charge the basin from a distant mature source area. Frontier basins are assessed by the basin fill thickness, with thicker sediment fill increasing the chance of the presence of mature source rocks, regional tectonostratigraphic models, and direct or indirect evidence for hydrocarbons. Hydrocarbon generation and migration is only assessed as known not to occur (rating is = 0) when there is clear evidence that mature source rocks are absent based on either well data or insufficient sediment fill (<2 km), and there is no possibility for long range migration from other source areas.

Sealed reservoir

The sealed reservoir risk element is the likelihood that reservoir quality rocks and effective seals are present and are favourably juxtaposed. If hydrocarbons are known to occur within sealed reservoirs, then this risk element is rated as = 1. The likelihood of sealed reservoirs then decreases as the quality of seals and reservoirs are known to decrease, and as sealed reservoirs become increasingly intraformational and localised in their extent. Frontier basins are assessed by the basin fill thickness, with thicker sediment fill increasing the chance of sealed reservoirs, and constraints from regional depositional models. The sealed reservoirs risk element is only assessed as known to not occur (rating is = 0) when there is either direct evidence from well data that seals or reservoirs are absent, or no sediment fill is evident (e.g., a volcanic province).

Valid trap

The valid trap risk element is the likelihood that traps were present during the main phases of hydrocarbon charge, and have subsequently been preserved. If hydrocarbons are known to be trapped within a basin, then this risk element is rated as = 1. The likelihood of valid traps then decreases as there is less evidence for traps with closure, decreasing evidence for favourable timing of traps versus hydrocarbon charge, and increasing evidence for breaching of traps (e.g., through fault reactivation or erosion). Frontier basins are assessed by the degree to which potentially favourable structural and stratigraphic traps can be observed on seismic sections, and based on indications of favourable timing from regional tectonic models. The valid trap risk element is only assessed as known not to occur (rated as = 0) if there is either direct evidence from well data that timing is unfavourable, no possible trapping mechanism can be identified, or there is clear evidence that all traps have been breached.

3. RESULTS OF PROSPECTIVITY ASSESSMENTS

3.1 THE TIMOR SEA

The Timor Sea assessment region is located on the northern portion of the Northwest Shelf of Australia and is underlain by the eastern portion of the Bonaparte Basin (**Figure 3**). This is an established hydrocarbon province with a number of commercial oil and gas discoveries (e.g. Bayu-Undan, Buffalo, Challis, Evans Shoal, Jabiru, Laminaria/Corallina, Puffin and Sunrise/Troubadour) and significant remaining potential for future discoveries.

The Cambrian to Recent Bonaparte Basin extends over 320,000 km^2 across offshore and onshore NW Australia (**Figure 3**). It lies in water depths of up to 1000 m. The basin was formed as a result of rifting events in the Palaeozoic (Late Devonian–Early Carboniferous NW-trending and Late Carboniferous– Early Permian NE-trending) and Mesozoic (Late Jurassic NW-trending). It contains up to 15 km of fluvio-marine siliciclastic and carbonate sediments.

The complex evolution of the basin is reflected in the number of structural elements and their different orientations with some reflecting the earlier rifting activity, trending NW, and some reflecting the later rifting episodes, trending NE or NW. For the purposes of this assessment the eastern Petrel Sub-basin, Darwin Shelf, Malita and Calder grabens, Sahul Platform and Troubadour Terrace were examined (**Figure 3**).

The Bonaparte Basin was assessed to be a mature exploration region containing established oil and gas fields. There is a high level of knowledge and data coverage for this area. This is reflected in many of the assessment units being classified as Prospective-1 (hydrocarbon accumulations identified) with a high level of confidence (**Table 3, Appendix 1** and **Figures 4** and **5**). Differences in prospectivity for the Timor Sea region assessment units are largely due to geological differences, such as the location of major structural elements or age of sediments, rather than changes in data coverage.

Table 3. Prospectivity classifications for the Timor Sea region

Assessment Area	Name	Classification	Overall Likelihood of Hydrocarbon Occurrence	Confidence
Timor Sea	Calder Graben	Prospective – 1	1	High
	Petrel Sub-basin	Prospective – 1	1	High
	Troubadour Terrace	Prospective – 1	1	High
	Malita Graben	Prospective – 2	0.448	Mod-High
	Sahul Platform	Prospective – 2	0.576	High
	Darwin Shelf	Prospective – 4	0.08	Mod

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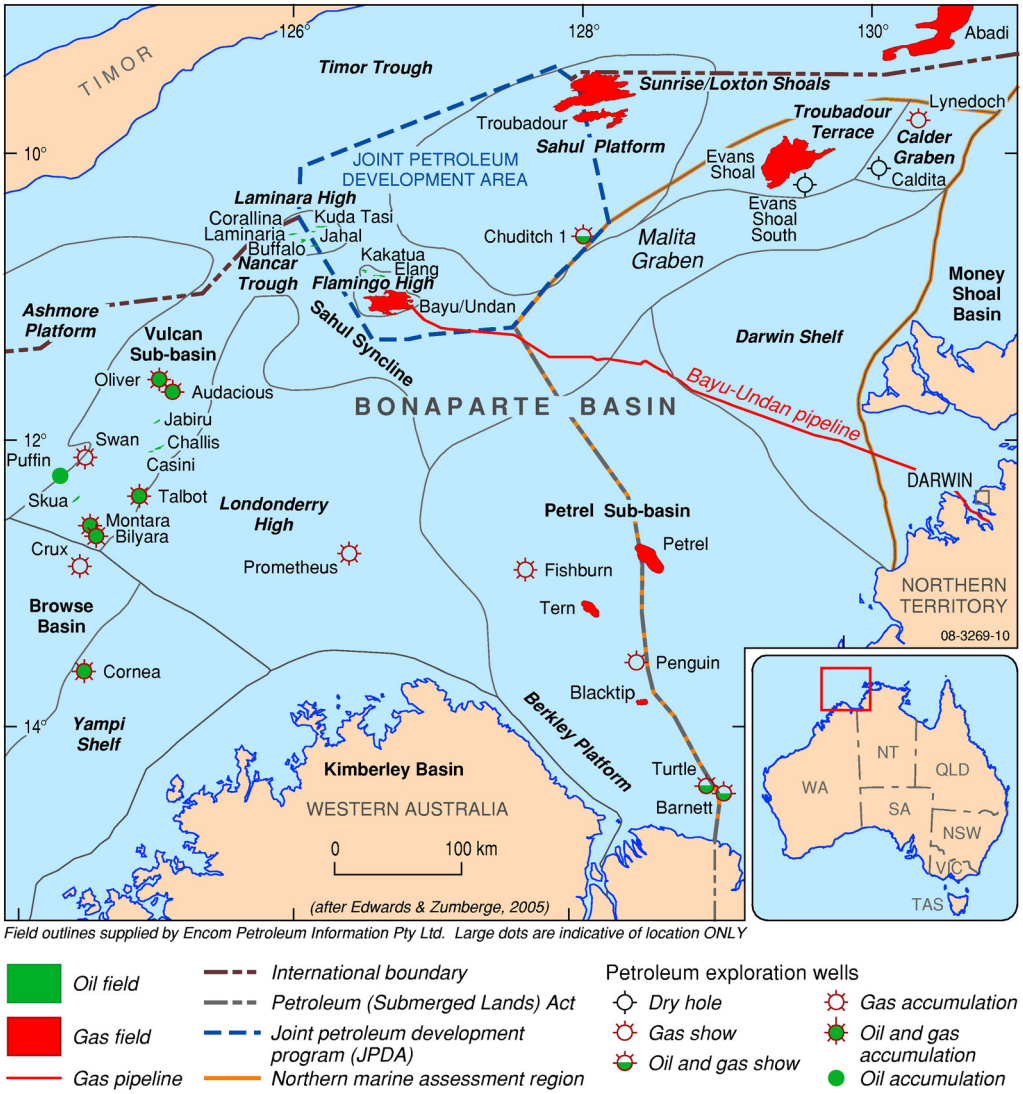

Figure 3: *The Timor Sea region showing structural elements and petroleum discoveries of the Bonaparte Basin.*

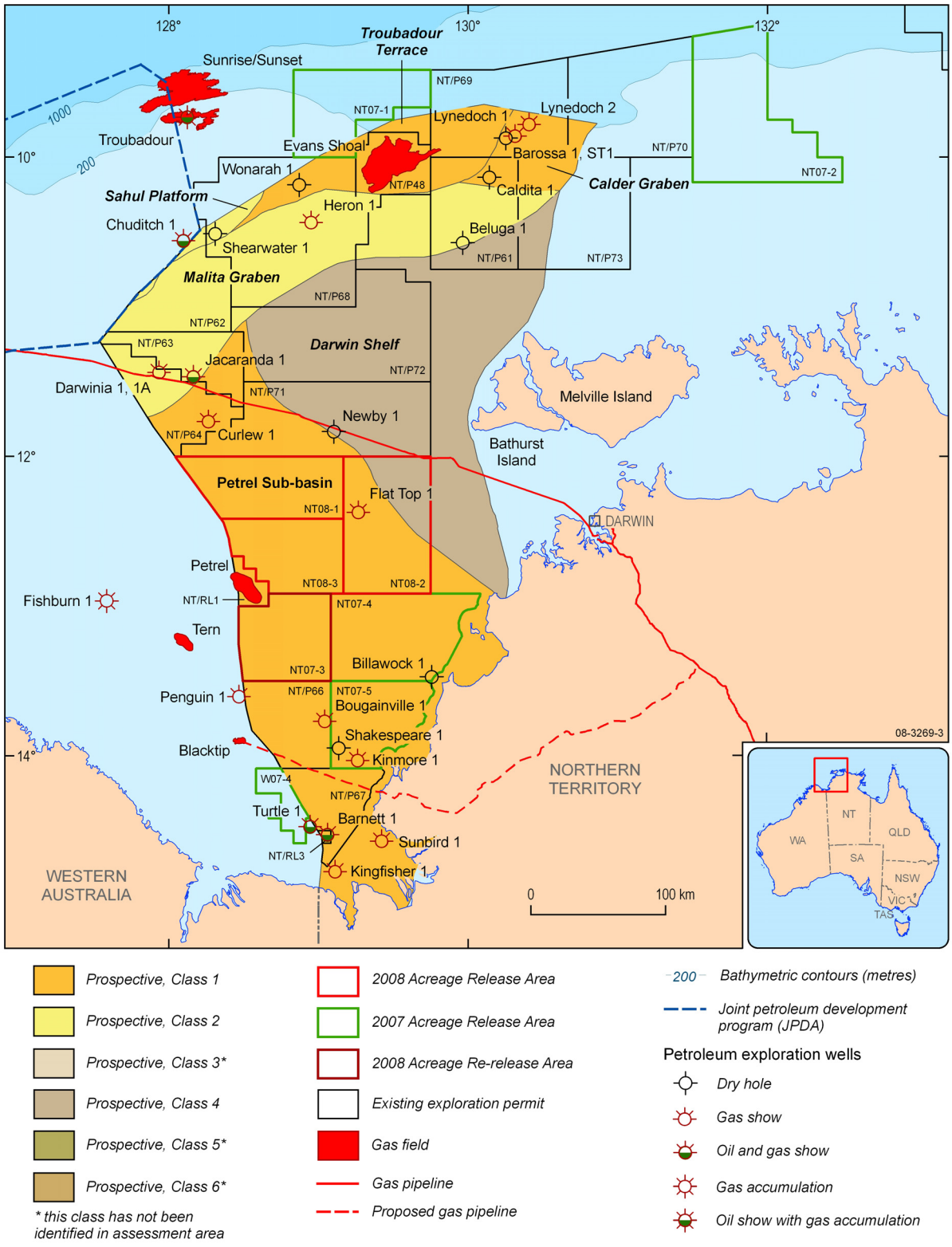

Figure 4: *Petroleum prospectivity map for the Timor Sea assessment region.*

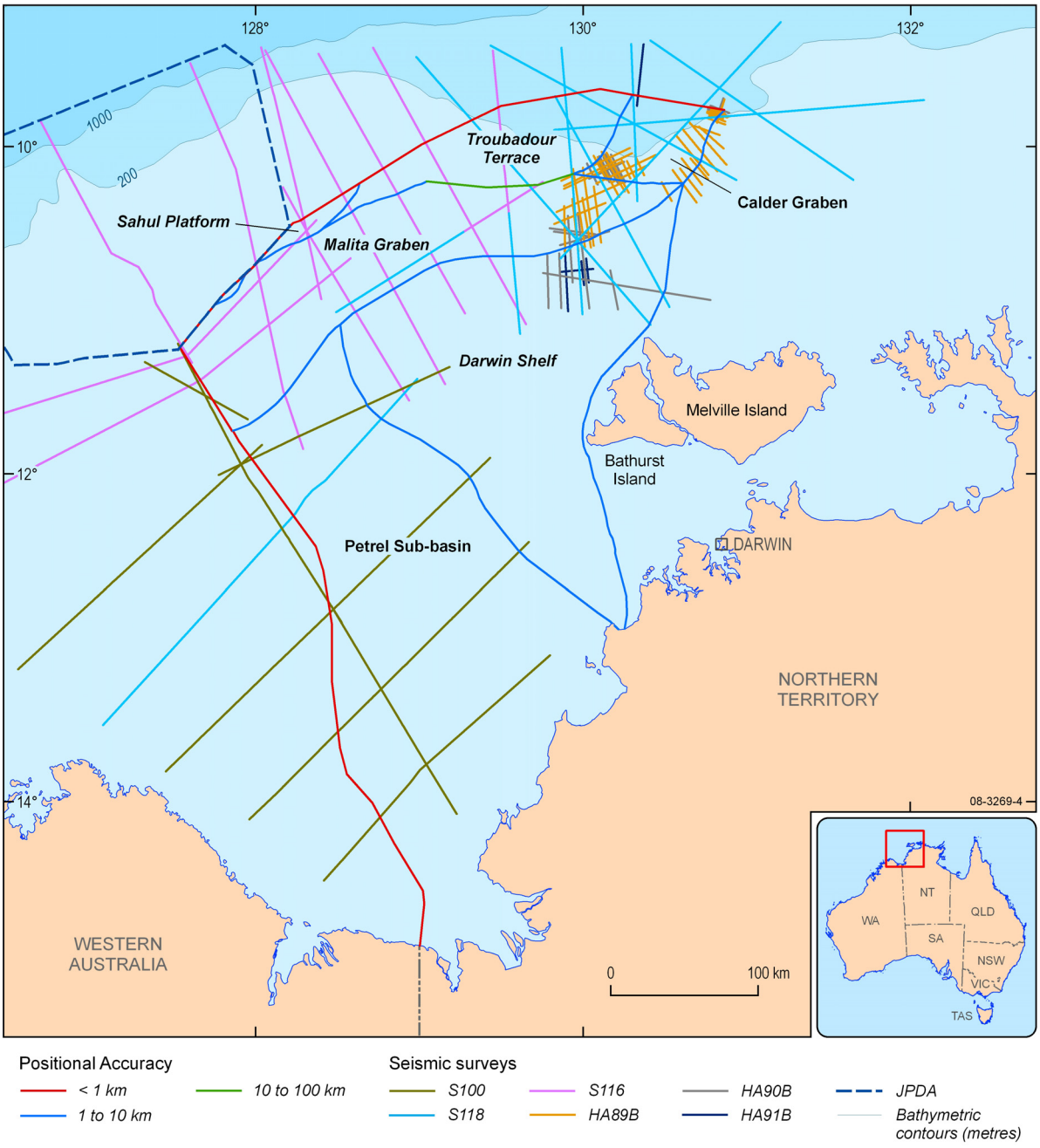

Figure 5: *Positional accuracy of boundaries for petroleum prospectivity areas in the Timor Sea assessment region. Seismic coverage of regional surveys is shown but the area is also well covered by industry seismic.*

Calder Graben – Prospective-1

The 'Calder Graben' assessment area encompasses part of the Calder Graben geological province of the Bonaparte Basin (**Figure 4**). The graben contains a thick section of up to 10 km of Mesozoic to Cainozoic sediments which are likely to be underlain by Late Palaeozoic sediments of unknown thickness.

There are proven hydrocarbons in the area, with a number of gas discoveries (**Figure 3**) including Lynedoch, Barossa (flowed 30 million cubic feet per day, SANTOS 2006b) and Caldita (2.9 tcf of gas; DPIFM 2007). The accumulations are hosted in Jurassic sandstones and confirm the presence of effective source, reservoir and seal units and traps. Jurassic coaly source rocks are high quality and have reached sufficient depths of burial to generate large amounts of hydrocarbons. They may also provide a potential source kitchen for the neighbouring Troubadour Terrace. The area also contains regionally extensive Cretaceous seals.

Four wells have been drilled in the area since 1973 (**Table 4)**. There is also comprehensive regional seismic coverage (**Figure 5**). Much of this assessment area is currently under exploration permit (**Figure 4**). There are four current permits: NT/P61 (Conoco Phillips, expires 13/08/2008 'renewing'), NT/P69 (ConocoPhillips, expires 9/10/2011), NT/P70 (Aust Oil and Gas Corp, expires 9/10/2011) and NT/P73 (Alpha Oil and Natural Gas, expires 26/03/2013).

Table 4: Wells in the 'Calder Graben' assessment area.

Well	Company	Year	Result
Barossa-1/ST1	ConocoPhillips Exploration	2005	Gas accumulation
Caldita-1	ConocoPhillips Exploration	2005	Gas accumulation
Lynedoch-1	Shell Dev	1973	Gas indications
Lyendoch-2	Shell Dev	1998	Gas show

Petrel Sub-basin – Prospective-1

The 'Petrel Sub-basin' assessment area is defined by the NT/WA border and the limits of the Petrel Sub-basin (Bonaparte Basin). The sub-basin contains a thick (>15 km) section of mostly Palaeozoic and thinner Mesozoic sediments and is underlain by Proterozoic crystalline basement and Proterozoic sediments of the Kimberley Basin.

The area is well explored and contains proven hydrocarbon accumulations. Both the Petrel gas field (permit NT/RL1, Santos, expires 7/07/2011) and the Barnett oil field (permit NT/RL3, Drillsearch Energy, expires 18/03/2006 'renewing') are within the assessment area (**Figure 4**). The Petrel field contains initial reserves of 5.9 million barrels of oil/condensate and 1.29 trillion cubic feet of gas (DoIR/DPIFM, 2007). The Barnett field contains initial reserves of 2.7 million barrels of oil (DPIFM, 2007). The assessment area is also in the vicinity of the Blacktip and Tern gas fields which are within the same geological province, but fall outside the assessment area. The hydrocarbons have been sourced from, hosted and trapped in Permian and Carboniferous sediments. There is also potential for hydrocarbons in the Jurassic section, particularly to the north where the Petrel Sub-basin borders the Malita Graben, which contains Jurassic source and reservoir rocks. A number of wells have been drilled in the area (shown in **Table 5)**. There is also seismic coverage (**Figure 5**). The assessment area also contains essential infrastructure for the Bayu-Undan and Blacktip developments with the main gas pipelines passing through the area (**Figures 3 and 4**)

A number of exploration permits are held within the area including: NT/P63 (National Oil and Gas, expires 19/06/2010), NT/P64 (National Oil and Gas, expires 19/06/2010), NT/P66 (Nexus Energy, expires 25/06/2009), NT/P67 (Santos, expires 14/09/2009), NT/P71 (National Oil and Gas, expires 7/08/2012) and NT/P72 (National Oil and Gas, expires 7/08/2012). NT/P63, NT/P64, NT/P71 and NT/P72 are all located in the northern part of the assessment area, extending onto the Darwin Shelf (NT/P71 and NT/P72) and the Malita Graben (NT/P63, NT/P64 and NT/P72). NT/P66 and NT/P67 are located in the southern part of the assessment unit (**Figure 4**).

Three areas for exploration were released in 2007 (NT07-3, NT07-4 and NT07-5) and bidding closed in April 2008. NT07-3 was re-released in 2008 (bids closed 9/10/2008) and NT07-4 and NT07-5 are under application. These areas are located in the southern part of the assessment area (**Figure 4**).

Table 5: Wells in the "Petrel Sub-basin" assessment area. Note: this list only contains exploration wells.

Well	Company	Year	Result
Barnett-1	Aust Aquitane Petroleum	1985	Oil accumulation
Billawock-1	BHP Petroleum	1992	Oil indications
Bougainville-1	Aust Aquitane Petroleum	1972	Gas indications
Curlew-1	Arco Australia Ltd.	1975	Gas show and oil indications
Flat Top-1	Aust Aquitane Petroleum	1970	Gas indications
Kingfisher-1	Teikoku Oil	1994	Oil and gas indications
Kinmore-1	Aust Aquitane Petroleum	1974	Oil and gas indications
Petrel-1	Arco Australia Ltd.	1969	Gas accumulation
Shakespeare-1	Woodside Petroleum of Australia Ltd.	2003	Oil indications
Sunbird-1.	Teikoku Oil	1994	Oil and gas indications

Troubadour Terrace – Prospective-1

The 'Troubadour Terrace' assessment area encompasses the southern part of the Troubadour Terrace, a component of the Sahul Platform geological province of the Bonaparte Basin. This is an area of relatively shallow basement overlain by up to 3 km of Mesozoic to Recent sediments.

The Troubadour Terrace is considered a viable area for exploration on the Sahul Platform with known hydrocarbons. The giant Evans Shoal gas field (permit NT/P48, Santos, expires 24/12/2012) is located in the centre of the area (**Figure 4**) and contains initial reserves of 8.3 trillion cubic feet of gas (DPIFM, 2007).

The occurrence of known accumulations confirms the presence of sufficient source, reservoir and seal units and traps in dominantly Jurassic sediments, although there is some potential in the Late Palaeozoic. It is not clear whether the hydrocarbons were sourced from either the neighbouring Malita Graben source kitchen or from sediments of the Troubadour Terrace. Recent geochemical studies have linked Troubadour Terrace Mesozoic sediments to hydrocarbons discovered on the Sahul Platform (Longley et al., 2002).

Two exploration wells have been drilled in the area as well as a number of wells associated with the Evans Shoals field (**Table 6)**. There is also regional seismic coverage over the area (**Figure 5**). The assessment area is currently covered by exploration permits (**Figure 4**). They include: NT/P61 (Conoco Phillips, expires 13/08/2008 'renewing'), NT/P68 (Arafura Petroleum, expires 22/02/2010), NT/P69 (ConocoPhillips, expires 9/10/2011) and NT/P76 (SIPC Australia P/L, expires 27/03/2014).

Table 6: Well in the 'Troubadour Terrace' assessment area. Note: this list only contains exploration wells.

Well	Company	Year	Result
Evans Shoal 1	BHP Petroleum	1988	Gas accumulation
Wonarah-1	Shell Dev	1998	Dry

Malita Graben – Prospective-2

The 'Malita Graben' assessment area encompasses the greater part of the Malita Graben geological province of the Bonaparte Basin. This graben contains a thick section of up to 10 km of Mesozoic to Cainozoic sediments. These are likely underlain by Permo-Carboniferous sediments.

The assessment area contains good quality Jurassic coaly source rocks and provides a source kitchen for the surrounding platforms (the Sahul Platform/Troubadour Terrace and potentially the Darwin Shelf). High quality Jurassic reservoirs have been identified from well sections (e.g. Heron-1; **Figure 4**) and the area contains regionally extensive Cretaceous seals. All wells drilled in the area are listed in **Table 7**. There is regional seismic coverage (**Figure 5**) and mapped prospects in the area. The assessment area also contains essential infrastructure for the Bayu-Undan development with the main gas pipeline passing through the area (**Figure 4**).

The assessment area is currently almost completely covered by exploration permits (**Figure 4**). Held permits include: NT/P48 (Santos, expires 24/12/2012), NT/P61 (Conoco Phillips, expires 13/08/2008 'renewing'), NT/P62 (National Oil and Gas, expires 19/06/2010), NT/P63 (National Oil and Gas, expires 19/06/2010), NT/P64 (National Oil and Gas, expires 19/06/2010), NT/P68 (Arafura Pet, expires 22/02/2010), NT/P72 (National Oil and Gas, expires 7/08/2012) and NT/P73 (Alpha Oil and Natural Gas, expires 26/03/2013).

Table 7: Wells in the 'Malita Graben' assessment area.

Well	Company	Year	Result
Beluga-1	BHP Petroleum	1991	Oil indication
Darwinia-1/1A	Tricentral Oil and Gas Corp	1972	Dry
Heron-1	Arco Australia Ltd.	1972	Gas indication
Jacaranda-1	Tricentral Oil and Gas Corp	1984	Oil indication

Sahul Platform – Prospective-2

The 'Sahul Platform' assessment area is located on the southeastern edge of the Sahul Platform geological province of the Bonaparte Basin. The platform is an area of relatively shallow basement with 3–5 km of overlying Mesozoic to Recent sediments. Only a small part of this geological province lies within the assessment area, but prospectivity can be gauged from the whole geological province which continues to the NW.

There are known hydrocarbons in the province with both the giant Greater Sunrise gas field (approximately 65 km to the NW of the assessment area) and the Chuditch gas accumulation (approximately 3.5 km to the west; **Figure 4**). Greater Sunrise contains initial reserves of 299 million barrels of condensate and 8 trillion cubic feet of gas (DPIFM, 2007). The occurrence of known accumulations confirms the presence of sufficient source, reservoir and seal units and traps in dominantly Jurassic age sediments, although there is some potential in the Late Palaeozoic. Hydrocarbons may migrate from the neighbouring Malita Graben Jurassic source kitchen or from in-situ generation, with recent geochemical studies linking the Troubadour Terrace (Sahul Platform) Mesozoic sediments to hydrocarbons discovered on the Sahul Platform (Longley et al., 2002).

Only one well has been drilled in the assessment area (**Table 8**). There is also regional seismic coverage (**Figure 5**). The area is currently held under two exploration permits; NT/P62 (National Oil and Gas, expires 19/06/2010) and NT/P68 (Arafura Pet, expires 22/02/2010), which cover the whole assessment unit (**Figure 4**).

Table 8: Well in the 'Sahul Platform' assessment area.

Well	Company	Year	Result
Shearwater-1	Arco Australia Ltd.	1974	Oil indication

Darwin Shelf – Prospective-4

The 'Darwin Shelf' assessment area encompasses, and is defined by, the limits of the Darwin Shelf geological province of the Bonaparte Basin. The area contains up to 2 km of Jurassic to Recent sediments overlying Proterozoic basement.

Prospectivity in the region relies on hydrocarbon migration from surrounding source kitchens due to thin sediment cover on the shelf. Migration could occur from the neighbouring Petrel Sub-basin (from Carboniferous and Permian sources) and the Malita Graben (from Jurassic sources). Migrated hydrocarbons could be reservoired and trapped in Jurassic sediments. There are potentially stratigraphic and structural traps, with some structuring through-out the area. The Darwin Shelf is currently not well explored with only one exploration well drilled (**Table 9**). The well was dry and final assessment concluded that the well did not test a valid trap. The assessment area contains essential infrastructure for the Bayu-Undan development with the main gas pipeline passing through it (**Figure 4**).

There is poor seismic coverage in the southern area of the assessment area but coverage improves towards the north (**Figure 5**). There are a number of exploration permits held within this region including: NT/P48 (Santos, expires 24/12/2012), NT/P61 (Conoco Phillips, expires 13/08/2008 "renewing"), NT/P68 (Arafura Pet, expires 22/02/2010), NT/P71 (National Oil and Gas, expires 7/08/2012), NT/P72 (National Oil and Gas, expires 7/08/2012) and NT/P73 (Alpha Oil and Natural Gas, expires 26/03/2013; **Figure 4**).

Table 9: Well in the 'Darwin Shelf' assessment area.

Well	Company	Year	Result
Newby-1	Aust Aquitane Petroleum	1969	Dry

3.2 THE ARAFURA SEA

The Arafura Sea assessment area is located on the northern margin of Australia and is underlain by a geologically complex region. It contains a number of stacked basins including the Money Shoal, Arafura and McArthur basins (**Figure 6**). Despite shallow water depths, with a maximum depth of 230 m, the region is under-explored. A total of nine wells have been drilled, all within the Arafura Basin (**Figure 7**). This region has been the main focus of petroleum exploration in the Arafura Sea assessment area.

The Arafura Basin extends from onshore Northern Australia into Indonesian waters covering approximately 200,000 km^2 in Australian waters. The basin contains up to 15 km of late Neoproterozoic to Early Permian sediments and formed in response to NW–SE extension in the late Neoproterozoic (Struckmeyer et al., 2006). Structurally, the Arafura Basin consists of a southern and northern part, divided by the Goulburn Graben (**Figure 6**). All exploration drilling in the basin has been restricted to the Goulburn Graben (**Figure 7**)., where large structures combined with a thick sedimentary section (up to approximately 10 km of Arafura Basin sediments) provided exploration targets The area to the north and east of the Goulburn Graben (**Figure 6**) also contains thick sediments but is untested. To date, no commercial discoveries have been made within the Arafura Basin.

The Arafura Basin unconformably overlies the Palaeoproterozoic to Mesoproterozoic McArthur Basin in the south and east, and the highly deformed Archaean–Palaeoproterozoic Pine Creek Inlier in the west. In turn, it is overlain by the Mesozoic to Recent Money Shoal Basin (**Figure 6**). Sediments of the Money Shoal Basin onlap the Arafura Basin section from the west, forming a time-transgressive sediment wedge. The base of this wedge ranges in age from Middle Jurassic in the west, to Late Cretaceous in the east.

The Arafura Sea region was assessed as a frontier setting with no field discoveries and low levels of knowledge and limited data availability. In the Arafura Sea, the most prospective areas are categorised as Prospective-2 (**Table 10, Appendix 1** and **Figures 8** and **9**). These areas have the potential to contain hydrocarbon accumulations because one or several petroleum systems elements are present, including sediment thicknesses capable of generating hydrocarbons. This is supported by direct and interpreted indirect hydrocarbon indicators in available datasets such as oil and gas shows, SAR anomalies and seismic anomalies.

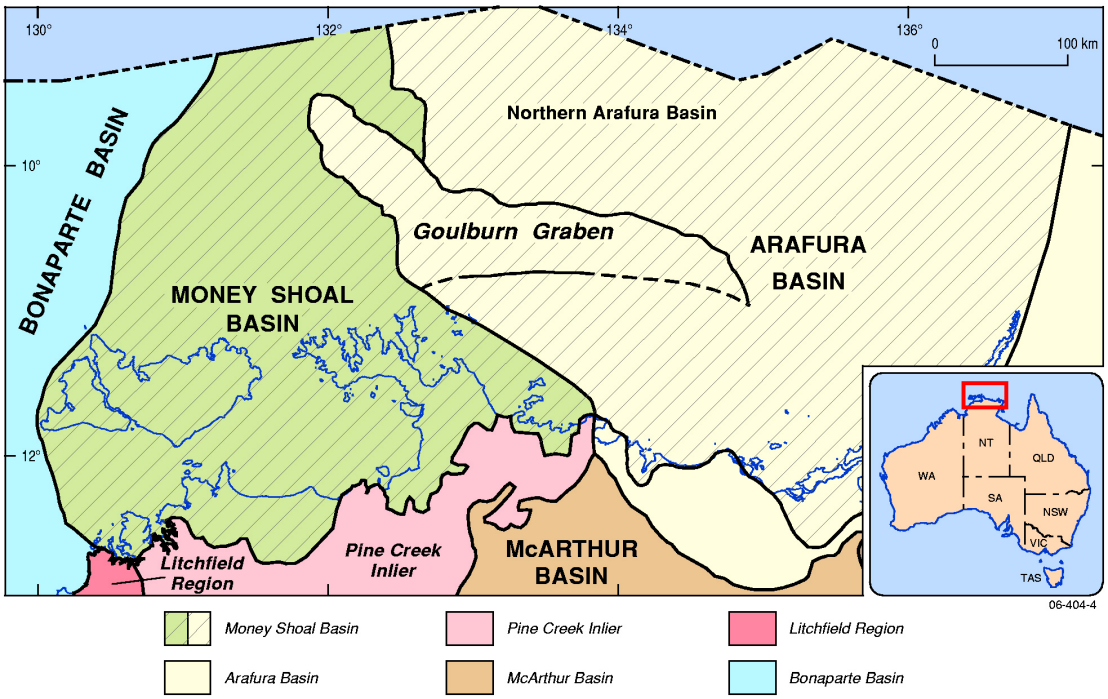

Figure 6: *Basin elements of the Arafura Sea (Struckmeyer, 2006).*

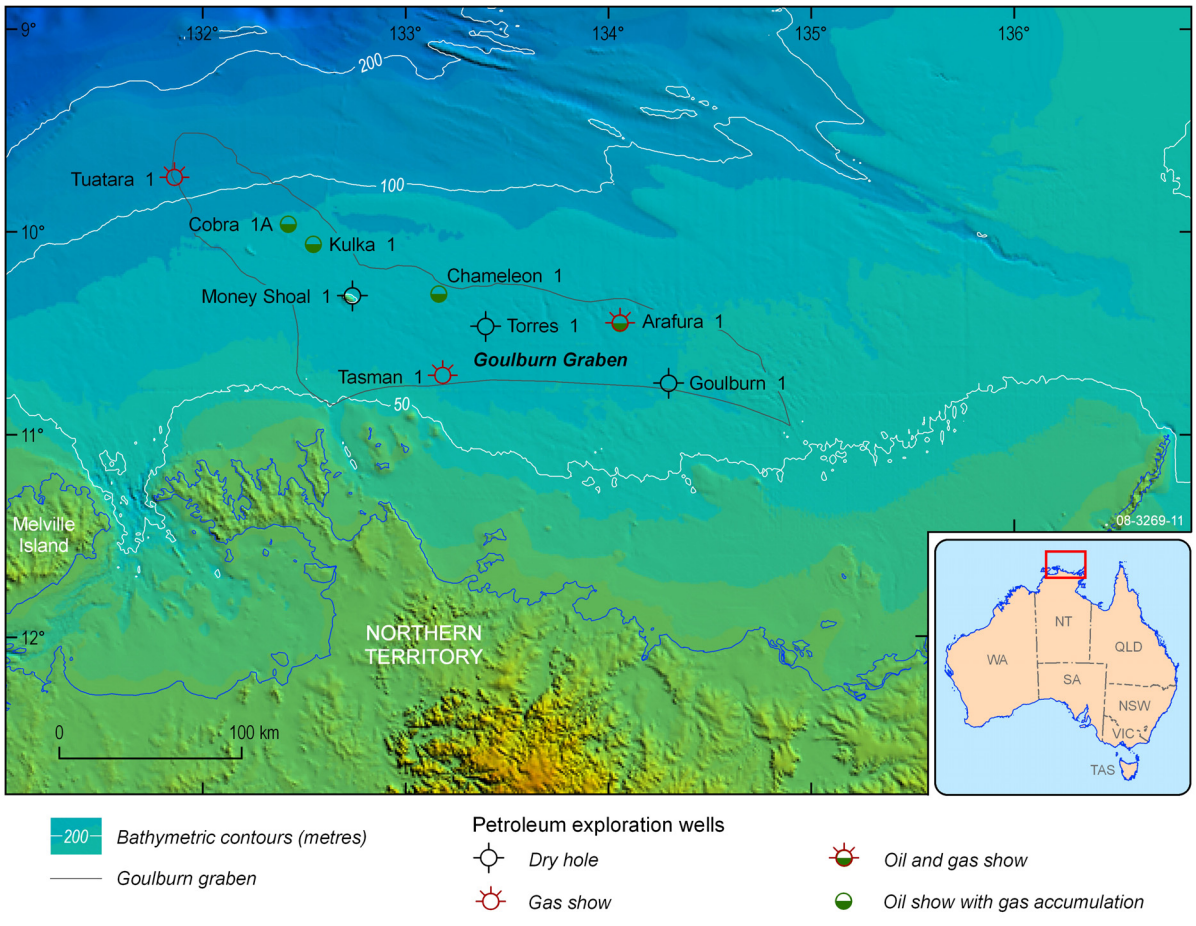

Figure 7: *Petroleum exploration wells drilled in the Arafura Basin (after Struckmeyer, 2006).*

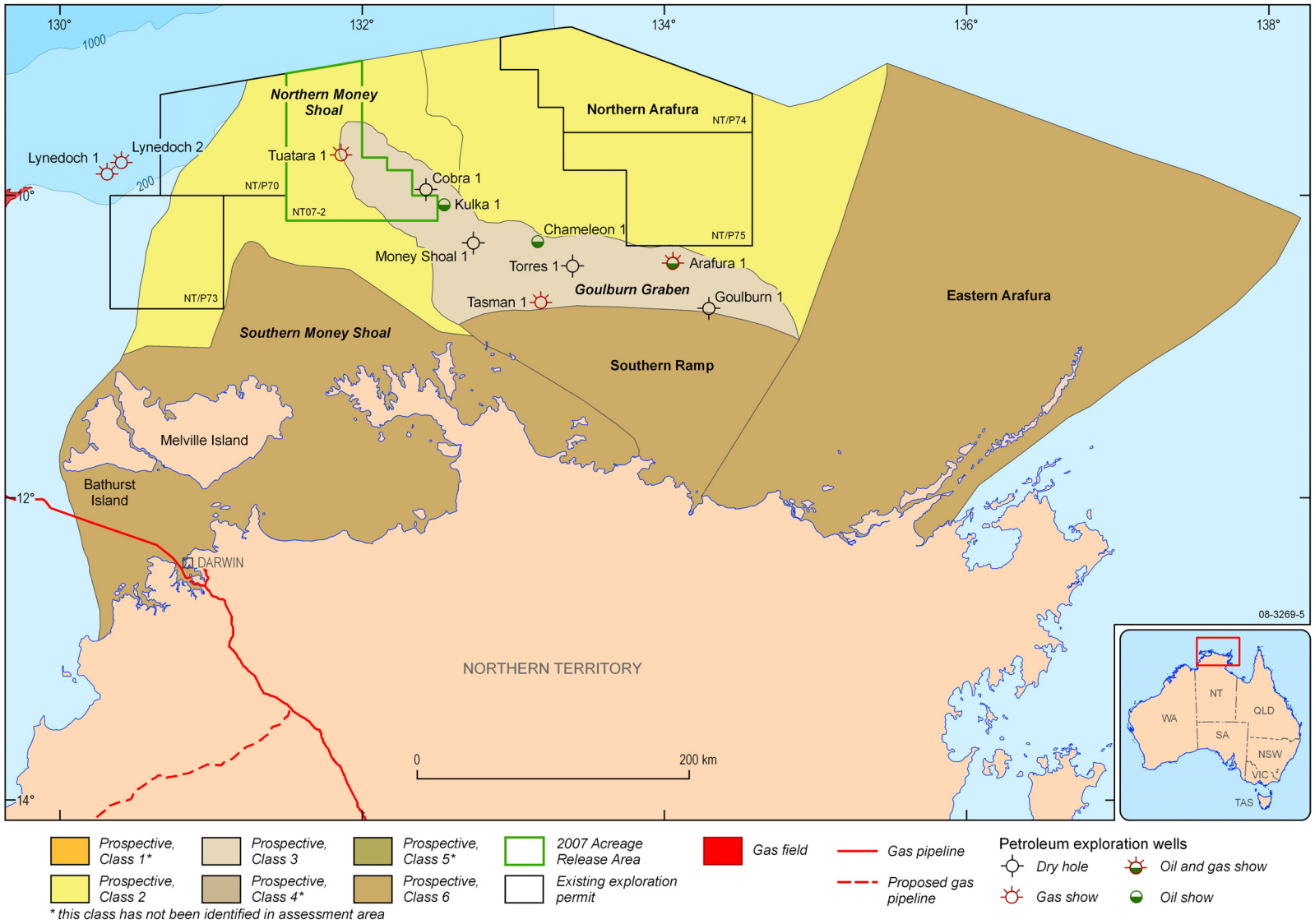

Figure 8: *Petroleum prospectivity map for the Arafura Sea assessment region.*

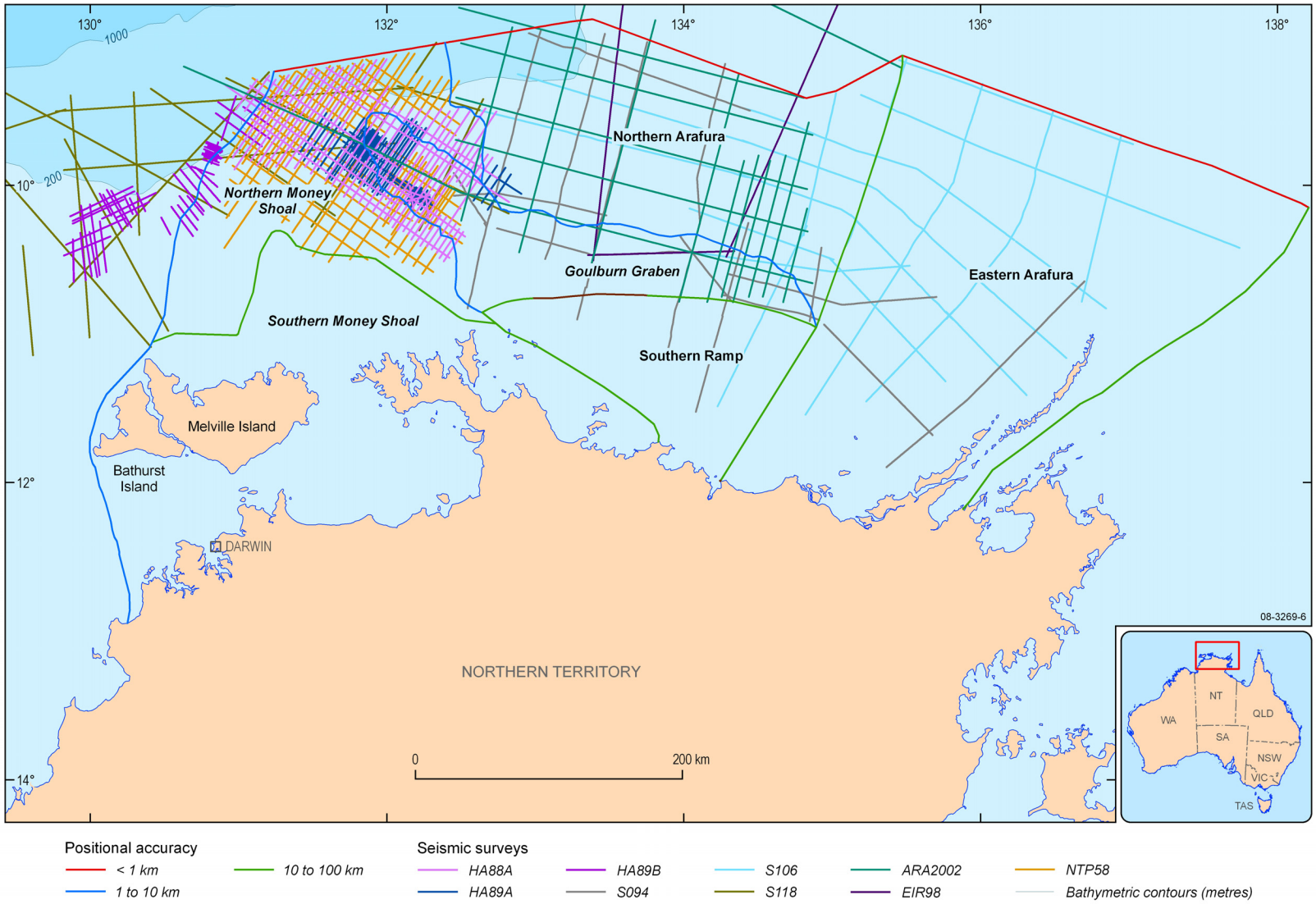

Figure 9: *Positional accuracy of boundaries for petroleum prospectivity areas in the Arafura Sea assessment region. Seismic coverage is also shown.*

Table 10. Prospectivity classifications for the Arafura Sea assessment area.

Assessment Area	Name	Classification	Overall Likelihood of Hydrocarbon Occurrence	Confidence
Arafura Sea	Northern Arafura	Prospective – 2	0.252	Mod
	Northern Money Shoal	Prospective – 2	0.270	Mod-High
	Goulburn Graben	Prospective – 3	0.150	High
	Eastern Arafura	Prospective – 6	0.008	High
	Southern Money Shoal	Prospective – 6	0.004	Low
	Southern Ramp	Prospective – 6	0.025	Low

Northern Arafura – Prospective-2

The 'Northern Arafura' area contains the main Arafura Basin depocentre, with up to 15 km of Neoproterozoic to Palaeozoic sediments, overlain by up to 4 km of Mesozoic to Cenozoic (Money Shoal Basin) sediments.

This region is considered to be the most prospective part of the Arafura Basin. There is currently no well control, but indirect evidence for hydrocarbons in the region has been described from interpretation of SAR (synthetic aperture radar), seafloor (e.g. pockmarks), water column (e.g. possible gas plumes) and seismic data (bright amplitudes; Logan et al., 2006; Struckmeyer, 2006a; Struckmeyer, 2006b). Good quality potential Palaeozoic and Jurassic–Cretaceous source, reservoir and seal rocks have been intersected by wells in the neighbouring Goulburn Graben and have been mapped across the northern area. Palaeozoic carbonate and sandstone reservoir quality is believed to be better in this region, compared to the Goulburn Graben, due to less burial and diagenesis destroying reservoir porosity. Unfavourable timing of hydrocarbon expulsion in relation to trap formation identified in the Goulburn Graben is less of an issue due to less erosion breaching pre-existing accumulations. Potential structural and stratigraphic traps have been identified on the regional seismic grid (**Figure 9**).

Four petroleum exploration areas (NT06-1 to NT06-4) were released in 2006 and closed on the 10th May 2007 (**Figure 8**). Two of these permits, NT06-3 and NT06-4, were awarded to Samson International. The permits have been renamed NT/P74 and NT/P75 and expire on the 11/07/2013. The remaining two permits were re-released and not awarded.

Northern Money Shoal – Prospective-2

The Northern Money Shoal area contains up to approximately 4.5 km of Mesozoic to Cenozoic sediments (Money Shoal Basin) which overlies Proterozoic Pine Creek Inlier basement.

The Northern Money Shoal area is likely to contain hydrocarbon accumulations either sourced in-situ or migrated from the neighbouring Arafura and Bonaparte source kitchens. The Money Shoal Basin sediments form a thickening wedge, with Jurassic source rocks likely to become more mature to the west as overburden increases. In-situ sourcing of hydrocarbons is thus more likely in the western part of the area. There are no wells within the assessment unit but known good quality Jurassic regional sources, reservoirs and Cretaceous seal units based on wells in adjacent areas have been mapped across the area.

A range of potential stratigraphic traps for hydrocarbon accumulations has been inferred from seismic. **Figure 9** shows that seismic coverage across the assessment area is extensive.

There are currently two exploration permits held in the region, NT/P70 (Aust Oil and Gas Corp, expires 9/10/2011) and NT/P73 (Alpha Oil and Natural Gas, expires 26/03/2013). NT/P70 and NT/P73 both lie in the western part of the assessment area and extend into the Bonaparte Basin (**Figure 8**).

Goulburn Graben – Prospective-3

The 'Goulburn Graben' area forms a central feature in the Arafura Basin. It contains up to 10 km of Neoproterozoic to Palaeozoic sediments (Arafura Basin), overlain by up to 4 km of Mesozoic to Cenozoic sediments (Money Shoal Basin).

The thick sedimentary fill and large structures lead to this region being the focus of petroleum exploration, with extensive seismic coverage in the western part of the area and regional coverage in most of the area (**Figure 9**). A total of nine wells have been drilled since 1971. The wells are listed in **Table 11** and shown in **Figure 8.** There are proven hydrocarbons in the region, with the best drilling result to date being an oil and gas show at Arafura-1. Geochemical analyses link these hydrocarbons to a Cambrian source rock. The Devonian and Permo-Carboniferous coaly units also have some source potential.

Excellent quality sandstone reservoirs and mudstone seals have been intersected in the Jurassic–Cretaceous Money Shoal Basin sediments. Potential sandstone and carbonate reservoirs and mudstone and limestone seals also occur in the Palaeozoic Arafura Basin section, but their quality is more variable. The graben underwent oblique inversion in the Triassic that has created numerous anticlinal trap structures in the region.

The Triassic inversion event resulted in the erosion of up to 3.5 km of Arafura Basin sediments, potentially breaching early formed hydrocarbon accumulations. The main hydrocarbon generation and expulsion event was prior to this episode, therefore the timing of generation in relation to trap formation is the main risk in the region.

There is currently one exploration permit held in the region, NT/P75 (Samson International, expires 11/07/2013; **Figure 8**).

Table 11: Wells in the 'Goulburn Graben' assessment area.

Well	Company	Year	Result
Arafura-1	Petrofina Exploration Australia	1983	Oil and gas show
Chameleon-1	BHP Petroleum	1991	Oil indications
Cobra-1A	BHP Petroleum	1993	Oil indications
Goulburn-1	Petrofina Exploration Australia	1986	Oil shows
Kulka-1	Diamond Shamrock Oil Co	1984	Oil indications
Money Shoal-1	Shell Development	1971	Oil indications
Tasman-1	ESSO Exploration and Production	1983	Oil indications
Torres-1	ESSO Exploration and Production	1983	Gas traces
Tuatara-1	BHP Petroleum	1990	Oil and gas indications

Eastern Arafura – Prospective-6

The 'Eastern Arafura' region is a frontier area with poor quality regional seismic data and no exploration wells. It contains an eastward thinning wedge of up to approximately 6 km of Neoproterozoic to Palaeozoic Arafura Basin sediments overlying Proterozoic McArthur Basin basement. Potential Palaeozoic siliciclastic and carbonaceous source, reservoir and seal rocks intersected in wells in the Goulburn Graben have been mapped in this region on a poor quality regional seismic grid **(Figure 9)**. These data indicate that there is mild structuring in the region providing potential traps for hydrocarbon accumulations.

Southern Money Shoal – Prospective-6

The 'Southern Money Shoal' area contains less than 3 km of Mesozoic to Cenozoic sediments (Money Shoal Basin) overlying Proterozoic Pine Creek Inlier basement. There is no seismic coverage (**Figure 9)** or well data in this region, so the extent of source, reservoir and seal rocks in this area is uncertain and has to be inferred, based on their presence in neighbouring regions. Due to the thinness of Money Shoal Basin sediments, in-situ sourcing is unlikely. Hydrocarbon accumulations in this region would require long range migration from neighbouring source kitchens, such as the Bonaparte and Arafura basins. Traps are likely to be stratigraphic.

Southern Ramp – Prospective-6

The 'Southern Ramp' area is a mildly structured north dipping ramp. The sedimentary fill comprises approximately 4.5 km of Neoproterozoic to Devonian Arafura Basin sediments overlain by up to approximately 1 km of Mesozoic to Cenozoic Money Shoal Basin sediments. In the southern part of the region there is no Money Shoal Basin cover, with Arafura Basin sediments outcropping on the seafloor. Some potential Palaeozoic siliciclastic–carbonaceous sources, reservoirs and seals identified by wells in the Goulburn Graben can be mapped in this region on very sparse regional seismic data **(Figure 9)**. This data shows minor to no trapping mechanisms for any expelled hydrocarbons.

3.3 THE GULF OF CARPENTARIA

The Gulf of Carpentaria is located on the northern margin of Australia and contains three stacked basin elements, the Karumba (Cainozoic), Carpentaria (Mesozoic) and Bamaga (Palaeozoic) basins (**Figure 10**)**.** Despite shallow water depths of less than 70 m, the region is under-explored with only one well located offshore, Duyken-1. Most geological knowledge of the region is derived from onshore wells, which contains some evidence of petroleum prospectivity such as oil and gas shows (**Figure 12**).

The Carpentaria Basin forms the main potential petroleum province in the region, extending across most of the gulf and onshore, covering approximately 560 000 km^2. The feature is saucer shaped, formed by lithospheric sag in the Jurassic and contains up to 2 km of mostly Mesozoic sedimentary fill (Thomas et al., 1991). The basin contains four main features (**Figure 11**)**;** the Weipa, Western Gulf, Staaten and Boomarra sub-basins as defined by McConachie et al. (1990). These basin elements are defined principally by variations in stratigraphy.

The Carpentaria Basin is overlain by the Karumba Basin which is a broad, saucer shaped depression (**Figure 10**)**** containing up to 0.3 km of sediment (Passmore et al., 1992). This is generally not considered an exploration target. The Carpentaria Basin is underlain by a number of basins/depressions which are poorly delineated but commonly contain a thick sedimentary fill. The age of these basins is poorly constrained but Palaeozoic/Proterozoic sediments are likely. These basins are currently undrilled with unknown petroleum potential. The Bamaga Basin is one of the largest of these structures, covering approximately 26 000 km^2. It is located in the north east of the assessment area (**Figure 10**)**** and contains up to about 5 km of sediment. This stratigraphy is believed to be analogues to Palaeozoic sediments in the Arafura Basin and Proterozoic sediments of the McArthur Basin (Passmore et al., 1993), both of which contain petroleum prospectivity.

The Gulf of Carpentaria was assessed as a frontier setting with no field discoveries and low levels of knowledge and limited data availability. The most prospective areas in the Gulf of Carpentaria are Prospective-4 at best, defined by the limits of the Bamaga Basin. This is the only mapped potential hydrocarbon source in this region (**Table 12** and **Figures 12** and **13**). The assessment units in these latter two frontier areas are defined based on the location of major basin structures and variations in data coverage, particularly in seismic data and well control.

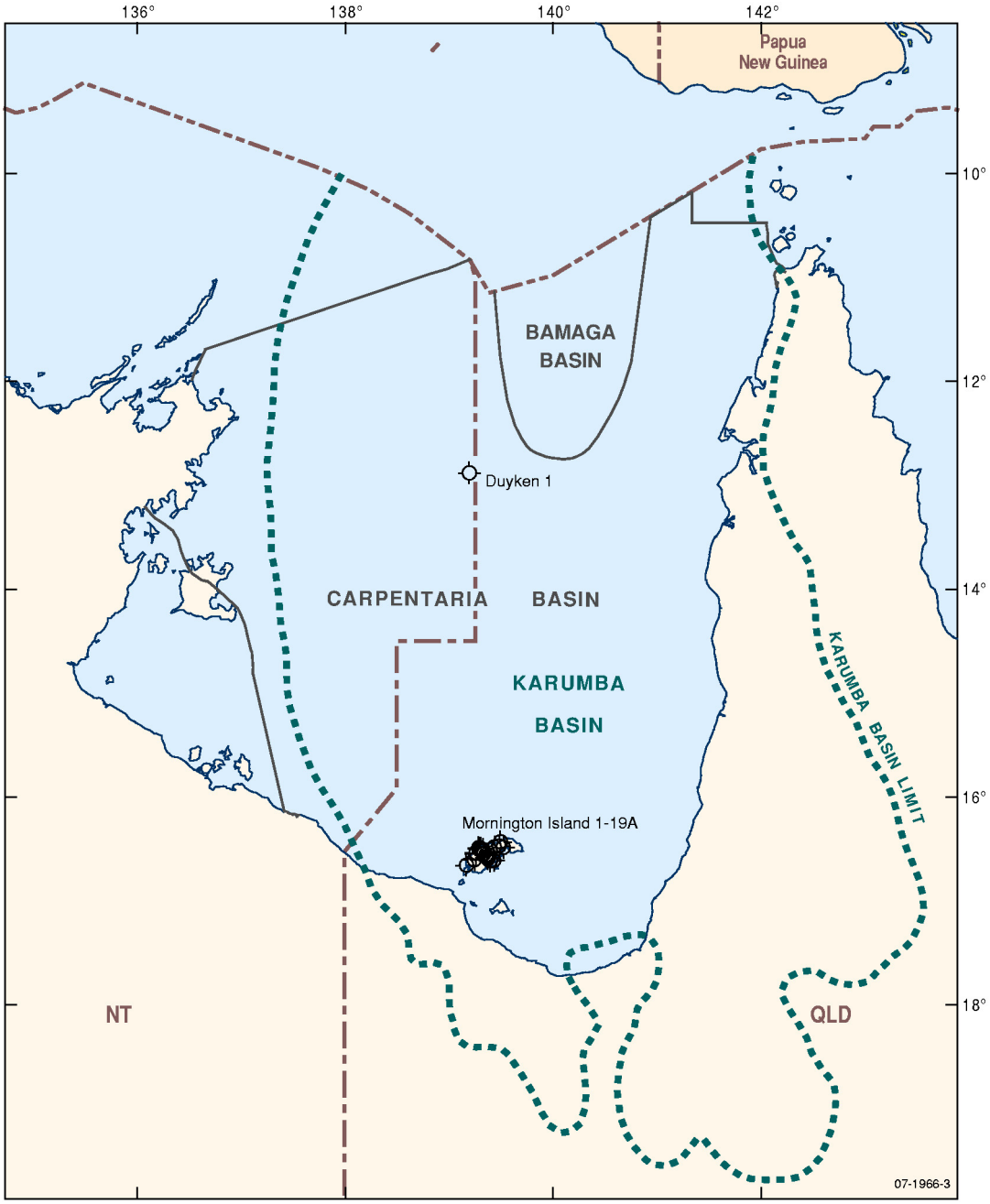

Figure 10: *Mapped basins in the Gulf of Carpentaria region. Karumba and Bamaga basins outline sourced from Passmore (1992).*

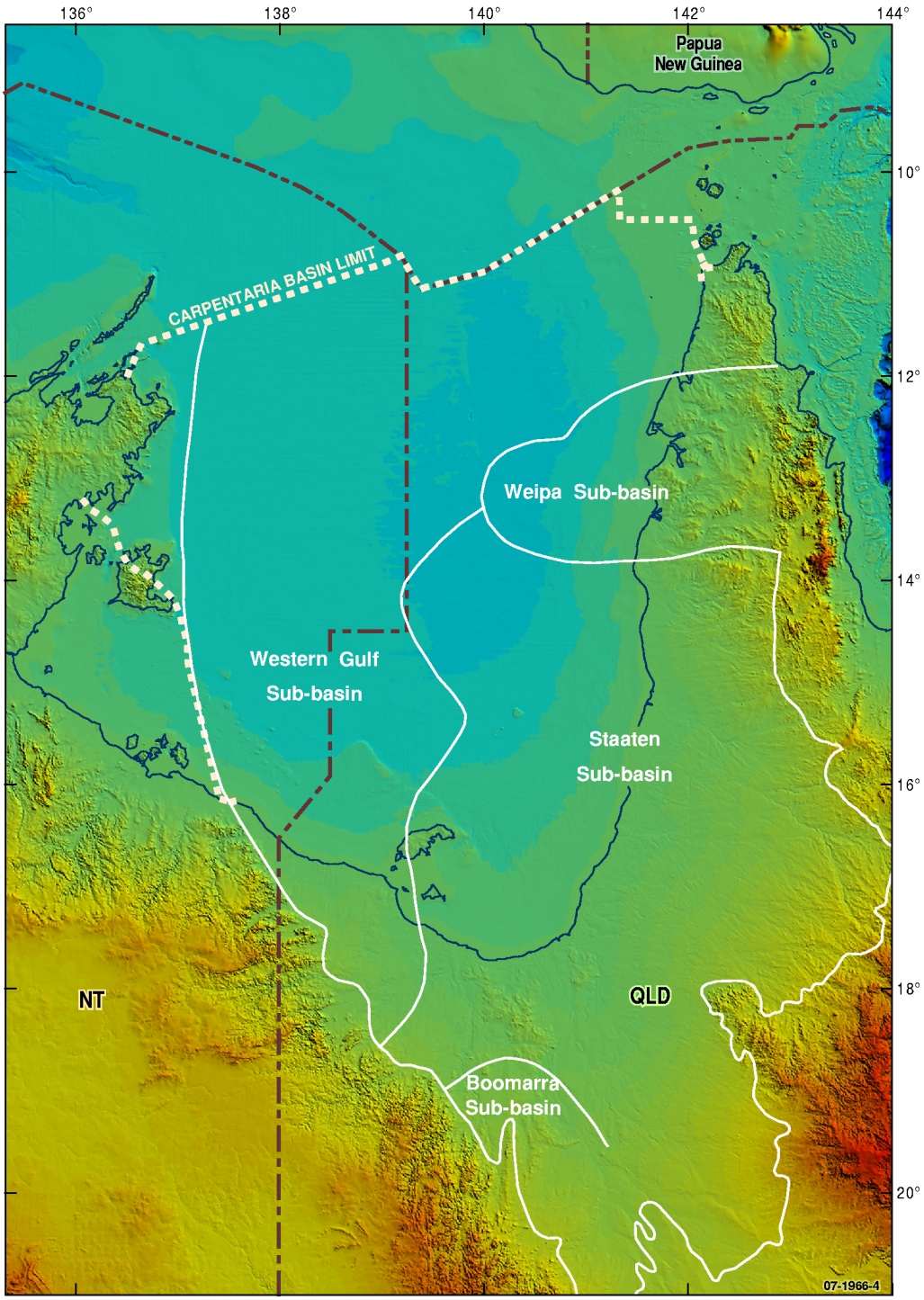

Figure 11: *Sub-basins of the Carpentaria Basin (after McConachie et al., 1990).*

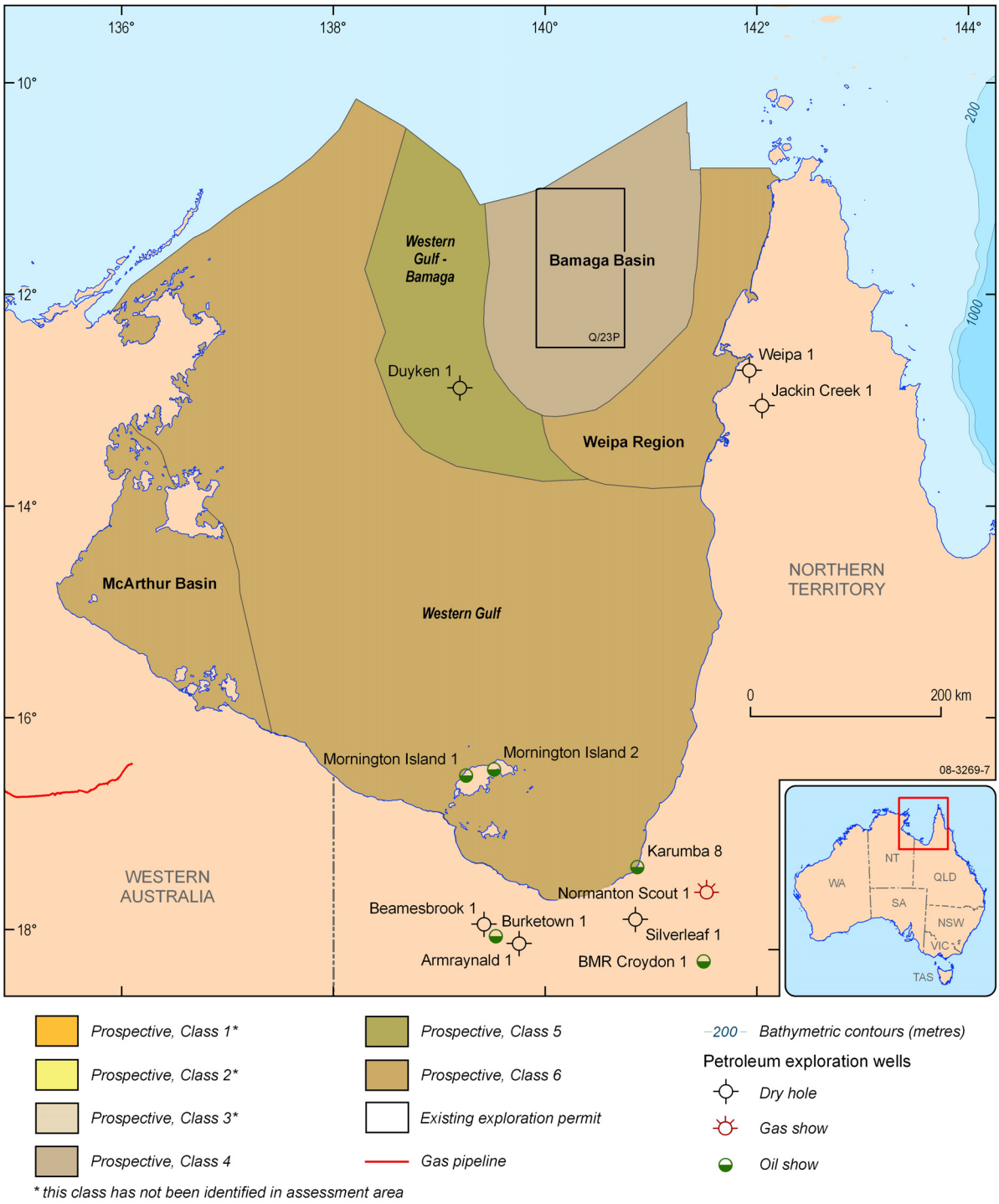

Figure 12: *Petroleum prospectivity map for the Gulf of Carpentaria assessment region. Note: Relevant onshore petroleum wells, stratigraphic holes and water bores are included as many contain evidence of petroleum prospectivity.*

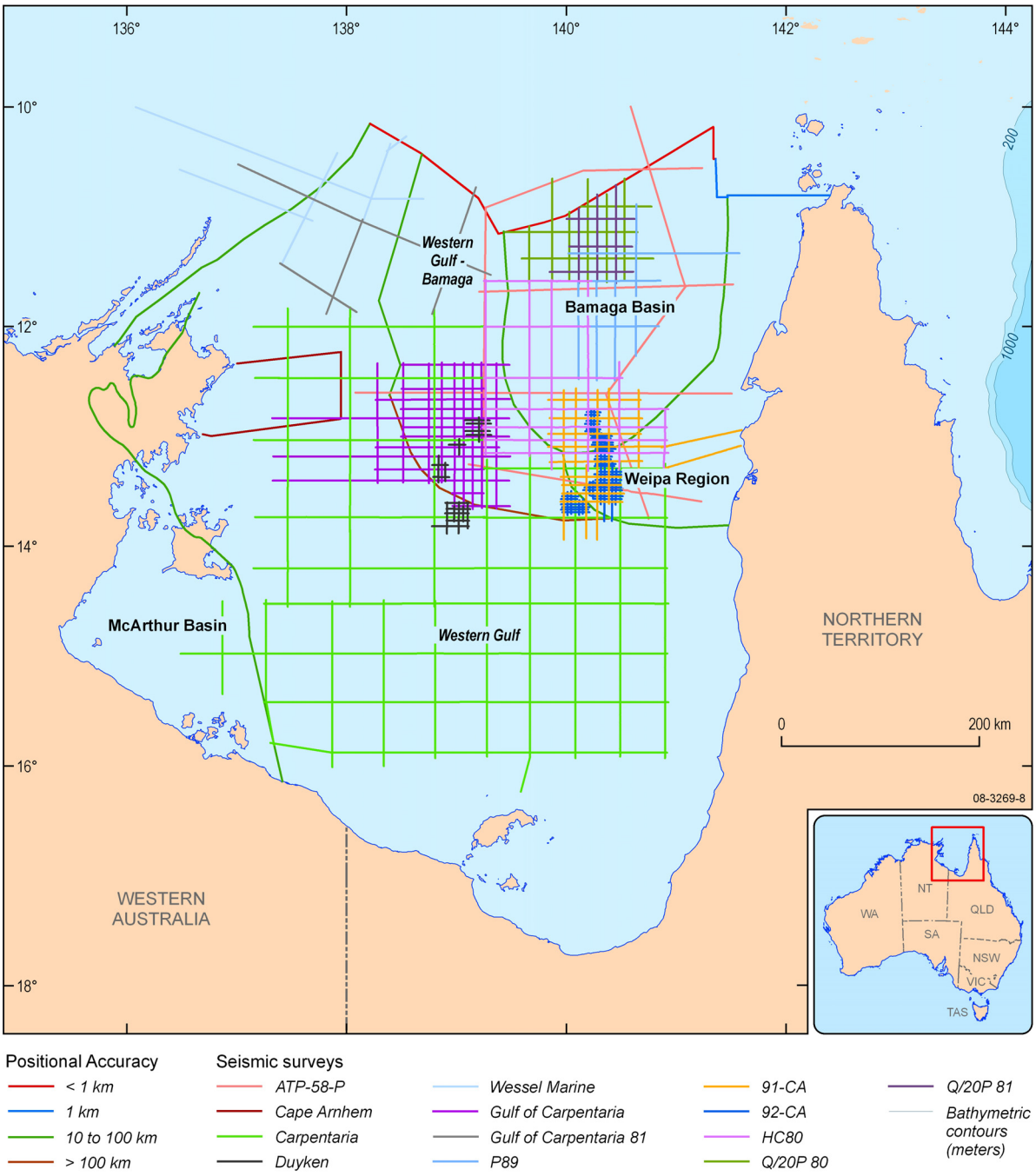

Figure 13: *Positional accuracy of boundaries for prospectivity areas in the Gulf of Carpentaria assessment region. Known seismic coverage is also shown.*

Table 12. Prospectivity classifications for the Gulf of Carpentaria assessment area.

Assessment Area	Name *	Classification **	Overall Likelihood of Hydrocarbon Occurrence#	Confidence
Gulf of Carpentaria	Bamaga Basin	Prospective – 4	0.036	Mod
	Western Gulf –Bamaga	Prospective – 5	0.024	Mod
	McArthur Basin	Prospective – 6	0.0025	Low
	Weipa Region	Prospective – 6	0.024	Mod
	Western Gulf	Prospective – 6	0.006	Mod

Bamaga Basin – Prospective-4

The 'Bamaga Basin' region comprises the northern part of the Karumba and Carpentaria Basins. The Bamaga Basin contains up to about 5.4 km of Proterozoic to ?Palaeozoic sediments and is overlain by up to 2 km of Mesozoic to Cainozoic sediments.

The assessment area encompasses the main Carpentaria Basin depocentre, which contains high quality Jurassic source rocks. It is unlikely that hydrocarbons have been generated from this section due to the thinness of the sedimentary overburden and would require a high geothermal gradient. There is some evidence of this in onshore wells (Burgess, 1984) but offshore data is lacking. The assessment region could also contain hydrocarbons sourced from the underlying Bamaga Basin. Evidence that hydrocarbon generation has occurred was identified by Passmore et al. (1993) with possible hydrocarbon indicators (bright amplitudes) present in seismic data. Some of these anomalies terminate at faults that extend into the Carpentaria Basin. This suggests possible hydrocarbon migration up faults from the Bamaga Basin into the Carpentaria Basin.

Known good quality regional Jurassic-Cretaceous sandstone reservoirs and Cretaceous seal units from neighbouring well control (Duyken-1 and onshore wells) have been mapped across the area using seismic data. The oldest Jurassic reservoirs are confined to erosional hollows and depressions but the younger Jurassic–Cretacous reservoirs are laterally extensive and are a more promising exploration target. Seismic coverage is good in the central-western part of the region (**Figure 13**), with a number of mapped prospects in both the Carpentaria and the Bamaga sediments. Targets include stratigraphic onlap and drape and fault related structures (Passmore et al., 1993; McConachie et al., 1994).

There is currently one exploration permit in the region, Q/23P, held by Gulf Energy P/L which expires on the 20th of May 2009 (**Figure 12**).

Western Gulf - Bamaga – Prospective-5

The 'Western Gulf-Bamaga' region comprises the Karumba Basin overlying several structural elements of the Carpentaria Basin including the Western Gulf Sub-basin and the northern tip of the Staaten Sub-basin (**Figure 11**). Mesozoic and Cainozoic sediments reach a maximum of approximately 2 km thickness. The underlying stratigraphy is unknown.

The assessment area likely relies on migration from the only known mapped potential source pod, the Bamaga Basin, which is located within 120 km of this region. The source quality and thus timing and volume of potential hydrocarbon generation from this area are unknown. Underlying sediments could also form potential hydrocarbon sources but their extent, composition and age is currently unknown.

Seismic coverage is good in the southern part of the region (**Figure 13**) and from Duyken-1 and onshore wells known good quality regional Cretaceous seal units have been mapped across the area. The main potential reservoirs in the Jurassic–Cretaceous sandstones are minimal to absent across the Western Gulf sub-basin. The Staaten Sub-basin also contains thin, variable basal Mesozoic potential reservoir rocks (McConachie, 1990). The western margin of the assessment area is partially defined by a pinch-out of these reservoirs (as mapped by Burgess, 1984). Structural and stratigraphic plays are likely with some fault induced structuring throughout the area. A large closed structure has been identified on seismic in the eastern region of the assessment area (McConachie et al., 1994).

There is one well within the assessment region, Duyken-1 (**Table 13)**. This is the only offshore well in the Gulf of Carpentaria assessment region. The well targeted a basement high and is a dry hole. Final assessment concluded that the well was not a valid test, as the lower reservoir section of Jurassic to Cretaceous age was absent, likely pinching out on the edges of the high.

Table 13: Well in the 'Western Gulf – Bamaga' assessment area.

Well	Company	Year	Result
Duyken-1	Canada Northwest Oil	1984	Dry

McArthur Basin – Prospective-6

The 'McArthur Basin' region is underlain by up to 5.5 km (Thomas et al., 1991) of Proterozoic McArthur Basin sediments, located both onshore and offshore.

The offshore region of the basin is largely unknown but inferences can be made from the more explored onshore region. Structurally the Batten Trough is likely to extend into the near shore environment. The trough succession and general basin succession has identified petroleum potential, with two major source rocks of lacustrine and marine origin and live oil intersected within the latter (BMR Urapunga 4, **Figure 12**). These organic-rich units range from immature to overmature (Crick et al., 1988). Potential reservoirs and seals in the region have also been identified onshore, but their offshore distribution and composition are unknown. The reservoirs are considered of fair to good quality, composed of vuggy carbonates and sandstones (Jackson et al., 1988). Faulting is common in the onshore region, providing potential trapping structures but is currently unmapped offshore. The general north-northwest and north-northeast trends of identified structures suggest they would continue offshore. Seismic coverage is poor in the assessment area, with only parts of two lines extending into the region (**Figure 13**).

Weipa Region – Prospective-6

The 'Weipa' region comprises the Weipa Sub-basin of the Carpentaria Basin which is overlain by the Karumba Basin. Overall, sediment thickness reaches a maximum of 2 km.

Due to a thin sedimentary overburden hydrocarbon generation from known high quality Jurassic and Cretaceous sources is unlikely. The assessment area likely relies on migration from the only known mapped potential source pod, the Bamaga Basin, which is located within 120 km of this region. The source quality and thus timing and volume of potential hydrocarbon generation from this area are unknown. A thin Permian succession has been interpreted under the Weipa Depression (Smart and Rasidi, 1979) which may have some source potential. Thus, there is a possibility of sourcing from underlying older sediments, but this section is currently undrilled.

Seismic coverage is good in the south western part of the region (**Figure 13**), and known good quality regional Jurassic–Cretaceous sandstone reservoirs and Cretaceous seal units identified by on and offshore drilling results have been mapped across the area. The oldest Jurassic reservoirs are confined to topographic lows but the younger Jurassic-Cretacous reservoirs are laterally extensive and are a more promising exploration target. A number of large closed structures have been identified in the south western region. (McConachie et al., 1994).

Western Gulf – Prospective-6

The 'Western Gulf' region encompasses part of the Western Gulf and Staaten Sub-basins of the Carpentaria Basin, overlain by the Karumba Basin. Sediment thickness reaches a maximum of approximately 2 km of Cainozoic to Mesozoic sediments in the NW, where the main basin depocentre is located. Sediments pinch out towards the west, where they onlap onto McArthur Basin sediments and basement.

In-situ hydrocarbon generation within the known good quality Jurassic-Cretaceous source rocks is unlikely due to a thin overburden. The area relies on long range hydrocarbon migration from potential source pods, such as the Bamaga Basin, which is over 120 km from the assessment unit. Undefined sediments under the assessment region have unknown source potential. Towards the west, the area is likely underlain by the McArthur Basin, which has some identified source potential. Hydrocarbons generated recently could migrate into the overlying Carpentaria Basin succession.

Known good quality regional Jurassic sandstone reservoirs and Cretaceous seal units identified by on and offshore drilling results have been mapped across the area, but thin and pinch out towards the western boundary. The main reservoirs in the Jurassic–Cretaceous are minimal to absent across the Western Gulf Sub-basin. The Staaten Sub-basin also contains thin, variable basal Mesozoic reservoirs (McConachie, 1990). Seismic coverage is poor over the assessment unit (**Figure 13**).

4. CONCLUSIONS

The northern marine assessment region encompasses three geographic provinces; the Timor Sea, the Arafura Sea and the Gulf of Carpentaria. These areas have differing degrees of hydrocarbon prospectivity associated with different sedimentary fill, structural architecture, development histories and varying amounts of data coverage.

The Timor Sea is underlain by the Bonaparte Basin which is a mature exploration region, with established oil and gas fields. There is a high level of knowledge and data availability for this area. This is reflected in many of the assessment areas being classified as Prospective-1 (hydrocarbon accumulations identified) with a high level of confidence. This includes the Troubadour Terrace, Calder Graben and the Petrel Sub-basin assessment units.

Areas assessed as Prospective-2 do not currently contain discovered fields, but are likely to, based on geological evidence. This includes the Sahul Platform and Malita Graben. The Darwin Shelf area was assessed as the least prospective (Prospective-4) in the Timor Sea area due to a lack of data and perceived low prospectivity. There is no seismic in the southern region and only one well has intersected the shelf sediments. There is also no potential for in-situ hydrocarbon generation due to a thin sediment cover. The area instead relies on migration from neighbouring source kitchens, such as the Malita Graben and the Petrel Sub-basin. The extent of the prospectivity of the Timor Sea region assessment units is largely associated with geological changes, such as the limits of basin structural elements, rather than changes in data coverage.

The Arafura Sea and Gulf of Carpentaria are located in a frontier setting with no field discoveries, low levels of knowledge and limited data availability. In the Arafura Sea, the most prospective areas are the Northern Arafura and Northern Money Shoal regions (Prospective-2). Both areas are likely to contain hydrocarbon accumulations due to the presence of key petroleum system elements, including sediment thicknesses capable of generating hydrocarbons. The Goulburn Graben region was categorised as Prospective-3, as this was the only region with well control and there was evidence for hydrocarbons in these wells. There are three areas classified as Prospective-6 – Southern Money Shoal, Southern Ramp and Eastern Arafura. These areas are characterised by thinning sediments, no well control and poor data coverage.

The most prospective area in the Gulf of Carpentaria is defined by the limits of the Bamaga Basin. This basin may contain potential source rocks and has been categorised as Prospective-4. The Western Gulf-Bamaga area has been classified as Prospective-5, relying on migration from the Bamaga Basin, which is within 120 km. The area contains the only well control for the region, Duyken-1. Three areas have been classified as Prospective-6 – Weipa, Western Gulf and McArthur Basin. These areas have no well control and seismic coverage is variable. Weipa relies on migration from the Bamaga Basin, which is within 120 km of the area. The Western Gulf and McArthur Basin regions both rely on long range migration or sourcing from possible underlying unknown sediments.

No non-prospective areas were found within the northern marine planning assessment area.

5. ACKNOWLEDGMENTS

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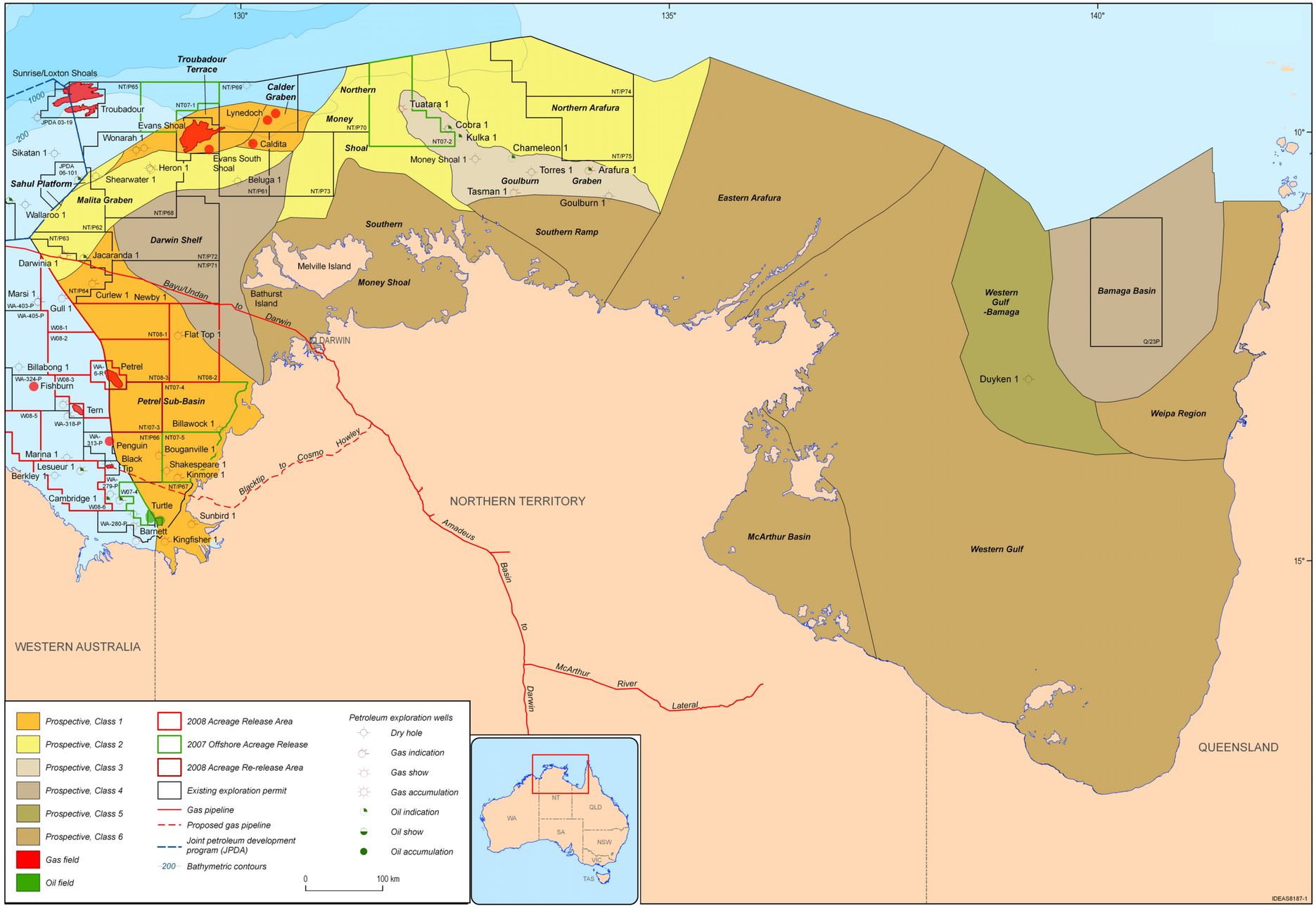
ENCLOSURE 1
Prospectivity of the Northern Marine Assessment region.



APPENDIX

A1: Results of risk ratings and comments on the petroleum prospectivity assessment in the Timor Sea.

Assessment area	Name	Comments	HC_risk	Description	Seal_risk	S_comment	Trap_risk	T_comment	Final_risk	Confidence	Class	Rating
Timor Sea	Calder Graben	Known gas with minimal condensate accumulations, no production	1.0000	Known hydrocarbon accumulations, potential for future development	1.0000	Known regionally extensive reservoirs and seals. Moderate to poor quality reservoirs.	1.0000	Known trapped accumulations	1.0000	high	Prospective	1
	Petrel Sub-basin	Basin element with known hydrocarbon fields	1.0000	Known hydrocarbon fields, development in progress at Blacktip (in same structural province in offshore WA)	1.0000	Known regionally extensive seals and reservoirs.	1.0000	Known trapped accumulations	1.0000	high	Prospective	1
	Troubadour Terrace	Known gas/condensate accumulations, no production, giant gas fields	1.0000	Known hydrocarbon accumulations, likely to be developed	1.0000	Known regionallly extensive seals and reservoirs. Moderate quality quality reservoirs	1.0000	Known trapped accumulations	1.0000	high	Prospective	1
	Malita Graben	Known source klitchen with inferred accumulation	0.8000	Inferred hydrocarbon accumulation	0.7000	Good regional seal but reservoir quality reduced due to depth of burial. Fracture porosity untested	0.8000	Known mapped prospects	0.4480	mod-high	Prospective	2
	Sahul Platform	Known gas/condensate accumulations, no production	0.9000	Known hydrocarbon accumulations in geological province outside of assessment area	0.8000	Good quality regional seals and reservoirs, reduced quality reservoir in Shearwater-1	0.8000	Valid structure tested by Shearwater-1, dead oil indications	0.5760	high	Prospective	2
	Darwin Shelf	Platform structure which relies on unproven long range migration from neighbouring source kitchens	0.4000	Relies on long range migration from Petrel/Malita, no known hydrocarbons	0.5000	Seal becoming sandy, reservoir untested, quality is inferred from neighbouring wells	0.4000	Potential strat traps (pinch-outs, basement drape), mild structuring	0.0800	mod	Prospective	4

A2: Results of risk ratings and comments on the petroleum prospectivity assessment in the Arafura Sea.

Assessment Area	Name	Description	HC Risk	HC Comment	Seal Risk	Seal Comment	Trap Risk	Trap Comment	Final Risk	Confidence	Class	Rating
Arafura Sea	Northern Arafura	Main Arafura Basin depocentre containing up to 15 km of Neoproterozoic to Late Palaeozoic sediments. Overlain by Money Shoal Basin.	0.7000	Indirect evidence for hydrocarbons from SAR and DHI's. Potential source rock (Jigaimara Formation) can be mapped on seismic.	0.6000	Potential good quality Mesozoic reservoirs and seals in western region. Palaeozoic reservoir quality inferred to be improved compared to GG due to less burial and diagenesis.	0.6000	Potential traps identified on seismic regional grid (inversion anticlines, fault block traps, stratigraphic traps).	0.2520	Moderate	Prospective	2
	Northern Money Shoal	Area of up to 4.5 kms of Jurassic to Cenozoic fluvial to marine sediments in westward thickening wedge.	0.7500	Plover Formation intersected in Tuatara 1 showing good source potential. Present throughout the area and mature in the western part. Oil indication in Tuatara 1.	0.6000	Probable regionally extensive reservoir-seal pairs based on seismic and nearby wells.	0.6000	Range of stratigraphic traps identified on good seismic coverage.	0.2700	Moderate-High	Prospective	2
	Goulburn Graben	Obliquely inverted half-graben.	1.0000	Hydrocarbon shows in Arafura 1 and Goulburn 1. Numerous hydrocarbon indications in other wells.	0.5000	Good quality Mesozoic reservoirs and seals (especially in western region), variable quality in the Palaeozoic section.	0.3000	Timing of structuring unfavourable in some areas, remaining potential exists for favourable timing.	0.1500	High	Prospective	3
	Eastern Arafura	Eastward thining wedge of Neoproterozoic to Palaeozoic (Arafura Basin) overlying the McArthur Basin.	0.2000	Cambrian Jigaimara Formation can be mapped on poor quality sparse seismic data.	0.2000	Based on poor quality seismic data; interpretation based on better quality data to the west of the area.	0.2000	Some indications of mild structuring on sparse poor quality seismic.	0.0080	Low	Prospective	5
	Southern Money Shoal	Thin Jurassic to Cenozoic sediments (1.5-2 secs TWT) over Proterozoic Pine Creek Inlier basement. No seismic coverage.	0.1000	Unlikely access to source pods in Bonaparte and Goulburn Graben. Too thin for in-situ generation (<2 secs TWT)	0.2000	Seal and reservoir properties inferred from adjacent areas (well control).	0.2000	No seismic coverage. Probable stratigraphic traps inferred from neighbouring areas	0.0040	Low	Prospective	5
	Southern Ramp	North dipping ramp of Neoproterozoic to Devonian Arafura Basin sediments.	0.5000	Cambrian Jigaimara Formation source rock can be mapped on seismic.	0.2500	Potential Palaeozoic seal and reservoir pairs.	0.2000	North dipping ramp but limited seismic evidence of minor structuring.	0.0250	Low	Prospective	5

A3: Results of risk ratings and comments on the petroleum prospectivity assessment in the Gulf of Carpentaria.

Assessment Area	Name	Description	HC Risk	HC Comment	Seal Risk	Seal Comment	Trap Risk	Trap Comment	Final Risk	Confidence	Class	Rating
Gulf of Carpentaria	Bamaga Basin	Area of known thick Sub-Carpentaria pre-Mesozoic sediments. Source potential and hydrocarbon generation timing unknown. 1 current exploration permit.	0.3000	Thick sedimentary fill, indirect hydrocarbon indicators, main source pod inferred	0.3000	Regionally extensive reservoirs and seals in the Carpentaria Basin succession	0.4000	No timing constraints	0.0360	moderate	Prospective	4
	Western Gulf - Bamaga	Encompasses part of the Western Gulf Sub-basin. Within 120 km of potential Bamaga Sub-basin source pod. Presence of potential reservoir (Gilbert River Formation). Intersected by only offshore well in region, Duyken-1.	0.2000	Relies on long distance migration from Bamaga Basin source	0.3000	Regionally extensive reservoirs and seals in the Carpentaria Basin succession	0.4000	No timing constraints	0.0240	moderate	Prospective	5
	McArthur Basin	Proterozoic sediments. Live oil intersected onshore in 1 well within the Roper Group. Heavily indurated old sediments that are unlikely to have petroleum potential.	0.1000	Unknown thickness and composition of sediments	0.1000	Unknown thickness and composition of sediments	0.2500	Structuring unknown but likely	0.0025	low	Prospective	6
	Weipa Region	Encompasses Weipa Sub-basin sag feature. Eastern part is poorly known. If hydrocarbons present likely charged from potential Bamaga Basin source pod.	0.2000	Relies on long distance migration from Bamaga Basin source	0.3000	Regionally extensive reservoirs and seals in the Carpentaria Basin succession	0.4000	No timing constraints	0.0240	moderate	Prospective	6
	Western Gulf	Encompasses part of the Western Gulf and Staaten Sub-basins. Further than 120 km from known potential Bamaga Basin source pod. Presence of other sub-unconformity sediments (source pods) unknown.	0.1000	Relies on long-range migration (>120 km) from Bamaga Basin or sourcing from unknown underlying source pod	0.3000	Regionally extensive reservoirs and seals in the Carpentaria Basin succession	0.2000	Sparse seismic coverage, limited structuring	0.0060	moderate	Prospective	6