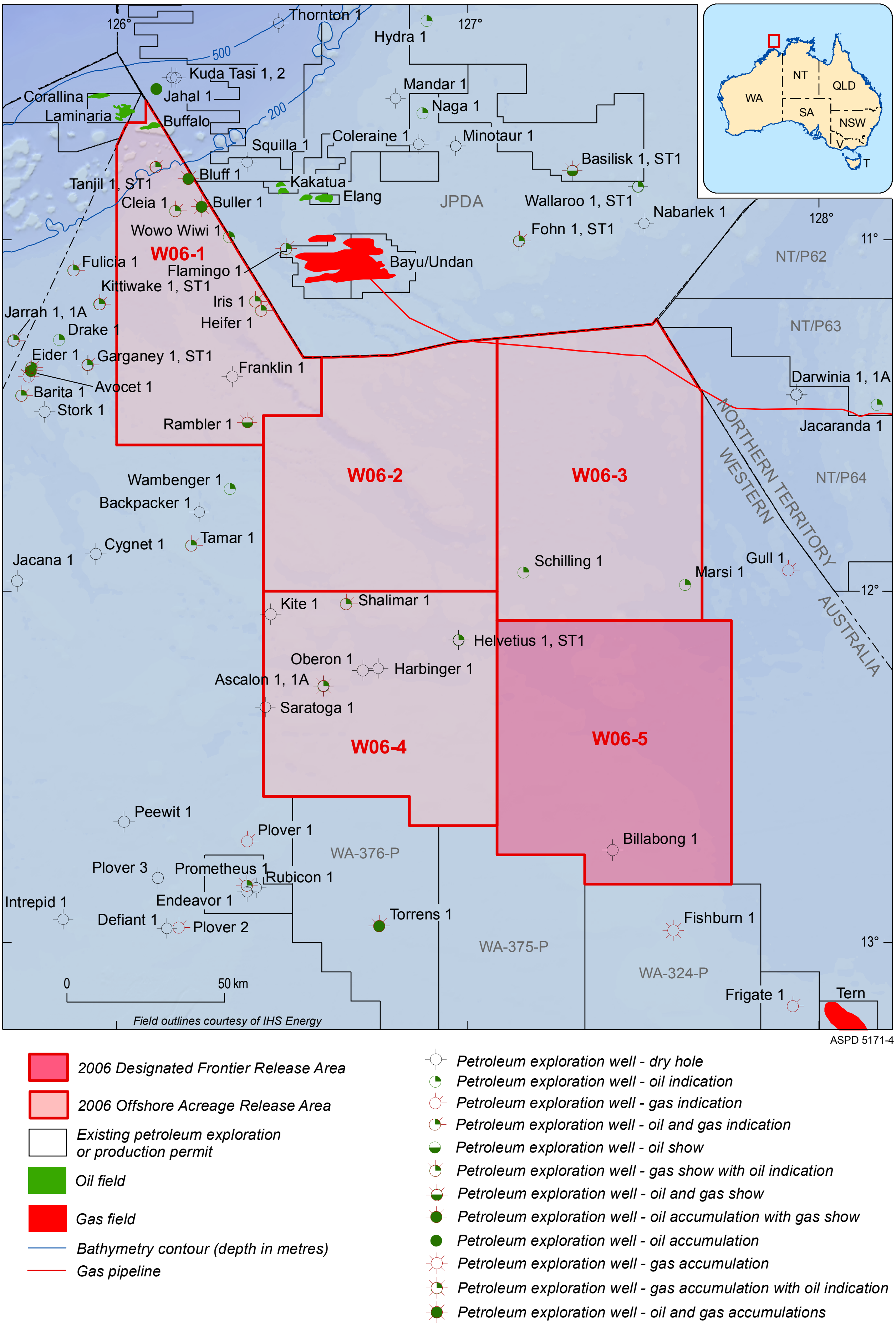
RELEASE OF OFFSHORE PETROLEUM EXPLORATION AREAS AUSTRALIA 2006

AREAS W06-1, W06-2, W06-3, W06-4 AND W06-5 NORTHERN BONAPARTE BASIN, WESTERN AUSTRALIA

BIDS CLOSE 10TH MAY 2007

- **Designated Frontier Tax Concession applies to W06-5.**
- Major hydrocarbon province near newly completed gas pipeline to onshore LNG facility.
- Evidence of oil and gas generation, migration and accumulation.
- Thick Permian–Lower Cretaceous mature source rocks.
- Tilted Permo-Triassic to Jurassic fault blocks with multiple reservoir facies.
- Permian to Cretaceous regional and intra-formational seals.
- Water depths range from 300 m to less than 50 m.
- Special Notices apply, refer to Guidance Notes.



126°
127°
128°
11°
12°
13°
500
200
Thornton 1
Hydra 1
Kuda Tasi 1, 2
Jahal 1
Corallina
Laminaria
Buffalo
Mandar 1
Naga 1
Squilla 1
Coleraine 1
Minotaur 1
Basilisk 1, ST1
Bluff 1
Kakatua
Elang
Tanjil 1, ST1
Cleia 1
Buller 1
JPDA
Wallaroo 1, ST1
Nabarlek 1
Wowo Wiwi 1
Fohn 1, ST1
W06-1
Fulicia 1
Flamingo 1
Bayu/Undan
NT/P62
Kittiwake 1, ST1
Iris 1
Jarrah 1, 1A
Heifer 1
Drake 1
NT/P63
Eider 1
Garganey 1, ST1
Franklin 1
Darwinia 1, 1A
Barita 1
Avocet 1
Stork 1
Rambler 1
Jacaranda 1
NORTHERN TERRITORY
WESTERN AUSTRALIA
Wambenger 1
W06-2
W06-3
NT/P64
Backpacker 1
Tamar 1
Cygnet 1
Jacana 1
Schilling 1
Gull 1
Marsi 1
Kite 1
Shalimar 1
Helvetius 1, ST1
Oberon 1
Harbinger 1
Ascalon 1, 1A
Saratoga 1
W06-4
W06-5
Peewit 1
Plover 1
WA-376-P
Billabong 1
Plover 3
Prometheus 1
Rubicon 1
Intrepid 1
Endeavor 1
Torrens 1
Fishburn 1
Defiant 1
Plover 2
WA-375-P
WA-324-P
0
50 km
Frigate 1
Tern
Field outlines courtesy of IHS Energy
NT
QLD
WA
SA
NSW
V
T
ASPD 5171-4
2006 Designated Frontier Release Area
2006 Offshore Acreage Release Area
Existing petroleum exploration or production permit
Oil field
Gas field
Bathymetry contour (depth in metres)
Gas pipeline
Petroleum exploration well - dry hole
Petroleum exploration well - oil indication
Petroleum exploration well - gas indication
Petroleum exploration well - oil and gas indication
Petroleum exploration well - oil show
Petroleum exploration well - gas show with oil indication
Petroleum exploration well - oil and gas show
Petroleum exploration well - oil accumulation with gas show
Petroleum exploration well - oil accumulation
Petroleum exploration well - gas accumulation
Petroleum exploration well - gas accumulation with oil indication
Petroleum exploration well - oil and gas accumulations

AREAS W06-1, W06-2, W06-3, W06-4 AND W06-5
NORTHERN BONAPARTE BASIN,
WESTERN AUSTRALIA

BIDS CLOSE 10TH MAY 2007

LOCATION

Areas W06-1, W06-2, W06-3, W06-4 and W06-5 are located in the Bonaparte Basin, 350–550 km west of Darwin off the northwest coast of Western Australia (**Figure 1**). The areas lie adjacent to current offshore petroleum exploration and development permits including the Joint Petroleum Development Authority (JPDA), and near significant petroleum developments including Buffalo, Bayu/Undan, Elang/Kakatua and Laminaria/Corallina.

Area W06-1 contains 58 graticular blocks or parts thereof (approximately 4220 km^2). Area W06-2 contains 66 graticular blocks or parts thereof (approximately 5150 km^2). Area W06-3 contains 72 graticular blocks or parts thereof (approximately 5685 km^2). Area W06-4 contains 59 graticular blocks (approximately 4930 km^2). Area W06-5 contains 69 blocks (approximately 5760 km^2). Water depths range from 300 m to less than 50 m.

REGIONAL GEOLOGY

Basin summary

The Bonaparte Basin is a large sedimentary basin, located predominantly offshore. It covers an area of approximately 270,000 km^2 of Australia's northwest continental margin. The basin contains up to 15 km of Phanerozoic, marine and fluvial siliciclastics, as well as marine carbonates. The regional geology and petroleum potential have been described by Laws and Kraus (1974), Gunn (1988), Lee and Gunn (1988), MacDaniel (1988), Mory (1988, 1991) and Botten and Wulff (1990), and summarised by Cadman and Temple (2004). Recent papers on the petroleum geology of the region are presented in the Proceedings of the Timor Sea Symposium, Darwin, June 2003 (Ellis et al, 2004).

The Bonaparte Basin is bounded to the northwest by the Timor Trough, where water depths exceed 3000 m. In the northeast, beyond the limits of the Darwin Shelf, the basin adjoins the Arafura and Money Shoal basins. To the southwest, the basin is contiguous with the Browse Basin.

Structurally, the Bonaparte Basin is complex and comprises a number of Palaeozoic and Mesozoic sub-basins and platform areas (**Figure 2**). The basin developed during two phases of Palaeozoic extension, followed by Late Triassic compression, and then further extension in the Mesozoic that culminated in the break up of Gondwana in the Middle Jurassic (O'Brien et al, 1993). Convergence of the Australia-India and Eurasia plates in the Miocene to Pliocene resulted in flexural downwarp of the Timor Trough and widespread fault reactivation across the western Bonaparte Basin.

The Petrel Sub-basin is a northwest-trending Palaeozoic rift that occurs in the eastern portion of the Bonaparte Basin and extends onshore. The sub-basin contains a thick section of mostly Palaeozoic and thinner Mesozoic sediments, and is underlain by Proterozoic crystalline basement (dolerite in well sections) and sediments of the Proterozoic Kimberley Basin (Colwell and Kennard, 1996). The eastern and southwestern margins of the sub-basin are flanked by platforms of relatively shallow basement and thin sediment cover. Sedimentation in the sub-basin commenced in the Cambrian, and northeast-southwest rifting was initiated in the Late Devonian to Early Carboniferous. Offshore, the Petrel Sub-basin is orthogonally overprinted by a northeast-trending structural grain that resulted from Late Palaeozoic and Mesozoic rifting.

The Malita and Calder graben form a major, northeast-trending, rift system that lies between the Petrel Sub-basin and the Sahul Platform. The graben contain a significant thickness of Upper Palaeozoic, Triassic, Jurassic and Lower Cretaceous sediments.

The Sahul Platform, which underlies most of the Joint Petroleum Development Area (JPDA), is an area of relatively shallow basement. The Permo–Triassic succession in this area was uplifted to form a structural high during Jurassic extension of the adjacent Malita and Calder graben.

The Vulcan Sub-basin is a major northeast-trending, Upper Jurassic rift depocentre in the western part of the Bonaparte Basin. It is flanked to the southeast and northwest by Permo-Triassic platforms: the Londonderry High and the Ashmore Platform, respectively.

The Sahul and Flamingo synclines are northwest-trending depocentres that link and offset the northeast-trending Malita and Calder graben and Vulcan Sub-basin rift systems. These synclines are separated by the Laminaria and Flamingo highs.

Basin evolution and tectonostratigraphy

The Bonaparte Basin has undergone a complex structural history. The Phanerozoic evolution of the region has been described by Gunn (1988), Veevers (1988), Pattillo and Nicholls (1990), O'Brien et al (1993), AGSO NW Shelf Study Group (1994), Baillie et al (1994), Whittam et al (1996) and Kennard et al (2002).

Neogene tectonism (and its implications for petroleum exploration in the Bonaparte Basin) is described by McCaffrey (1988), Shuster et al (1998), Keep et al (1998, 2002) and Longley et al (2002). Key events in the evolution of the Bonaparte Basin include:

- Widespread vulcanism and subsidence initiated deposition in the onshore portion of the Petrel Sub-basin in the Cambrian.
- Late Devonian to Early Carboniferous extension that formed the northwest-trending Petrel Sub-basin.
- Extension in the Late Carboniferous to Early Permian overprinted the older trend with a northeast oriented structural grain. The proto-Vulcan Sub-basin and Malita Graben developed at this time.
- A compressional event in the Late Triassic caused uplift and erosion on the Londonderry High, the Ashmore and Sahul platforms and the southern margins of the Petrel Sub-basin.
- In response to Mesozoic extension, the Vulcan Sub-basin, Sahul Syncline, Malita Graben and Calder Graben became major Jurassic depocentres. This structuring coincided with the commencement of sea-floor spreading in the Argo Abyssal Plain to the west of the Browse Basin.
- With the onset of thermal subsidence in the Early Cretaceous (Valanginian), a thick wedge of fine-grained, clastic and subsequently carbonate sediments prograded across the offshore Bonaparte Basin throughout the Cretaceous and Tertiary.
- Regional compression associated with the collision of the Australia-Indian Plate with the Southeast Asian Microplates in the Miocene formed the Timor Trough and the strongly faulted northern margin of the adjacent Sahul Platform.

The stratigraphy varies widely across the basin – Palaeozoic sediments are largely restricted to the onshore and inboard portions of the Petrel Sub-basin, while Mesozoic and Cenozoic sequences are largely confined to the outboard portion of the Bonaparte Basin. The stratigraphy of the basin is summarised in **Figure 3**.

Volcanic and clastic sedimentation commenced in the onshore Petrel Sub-basin in the Cambrian. This pre-rift sequence contains extensive evaporite deposits, but the precise age (Ordovician, Silurian or Devonian), lateral continuity and extent of these salt bodies is poorly known.

Subsequent salt tectonics (flow, diapirism and withdrawal) has controlled the development of numerous structural and stratigraphic traps within the sub-basin (Edgerley and Crist, 1974; Gunn, 1988; Durrant et al, 1990; Lemon and Barnes, 1997).

Northeast–southwest rifting was initiated in the Late Devonian, and clastic and carbonate sediments were deposited in shallow marine and non-marine environments within the Petrel Sub-basin. During the Carboniferous, a thick succession of marine and fluvio–deltaic (Bonaparte Formation to Point Spring Sandstone) and, finally, glacial sediments (Kuriyippi Formation and Treachery Shale) were deposited in response to post-rift subsidence and salt withdrawal.

The Late Devonian–Carboniferous rift-sag system was orthogonally overprinted in the Late Carboniferous to Early Permian by northeast-trending rifts to form the proto-Malita Graben and probably a proto-depocentre in the Vulcan Sub-basin (O'Brien, 1993; Baxter, 1996). A succession of northwest-thickening, shallow marine to fluvio–deltaic, Permian and Triassic sediments was then deposited across the Bonaparte Basin (Keyling to Cape Londonderry formations). These form the reservoir facies for the Tern, Petrel and Fishburn discoveries in the Petrel Sub-basin and the Prometheus, Rubicon and Ascalon gas discoveries on the Londonderry High (Robinson and McInerney, 2004).

Compression in the Late Triassic resulted in reactivation and inversion of the previous Palaeozoic fault systems (O'Brien et al, 1993) and caused widespread uplift and erosion on the Ashmore Platform, Londonderry High and in the southern portion of the Petrel Sub-basin. Late Triassic – Early Jurassic fluvial sedimentation (Malita Formation) was followed by a thick widespread succession of Lower–Middle Jurassic fluvial and coastal plain deposits (Plover Formation) throughout most areas of the Bonaparte Basin except for the Ashmore Platform and crest of the Londonderry High. The Plover Formation forms a major source and reservoir unit over much of the northern Bonaparte Basin.

The onset of rifting in the mid-Callovian resulted in a widespread marine transgression and the deposition of retrogradational deltaic sands (Elang, Laminaria and Montara formations), which form reservoir units in many of the commercial petroleum accumulations in the northern Bonaparte Basin. Continued rifting and rapid subsidence resulted in the deposition of a thick succession of marine mudstone (Vulcan Formation and Frigate Shale) within the Vulcan Sub-basin, Sahul Syncline, Malita Graben and Calder Graben. These marine sediments contain good quality oil-prone source rocks, but source quality decreases within the Malita and Calder graben.

Mesozoic extension ceased with the onset of sea-floor spreading in the Valanginian and was followed by widespread thermal subsidence and flooding of the western Australian continental margin. Fine grained clastics and carbonates of the Bathurst Island Group were deposited across the Bonaparte Basin during this phase. At the base of the Bathurst Island Group, claystones of the Echuca Shoals Formation provide a regional seal for the hydrocarbon accumulations in the Vulcan Sub-basin. This unit thins onto the platform areas in the west (Ashmore and Sahul platforms) and in the Petrel Sub-basin to the east. The Late Cretaceous and Cenozoic sections typically comprise thick, prograding platform carbonates. Lowstand sands developed in the Maastrichtian (Puffin Formation) and Eocene (Grebe Formation).

Regional compression associated with the collision of the Australia-India Plate with the Southeast Asian Microplates reactivated Mesozoic faulting and breached many fault-dependent structures in the Vulcan Sub-basin and adjacent areas. This regional tectonism resulted in the loss of hydrocarbons from previous accumulations (O'Brien and Woods, 1995; O'Brien et al, 1999; Longley et al, 2002) and leakage to the sea floor that appears to have controlled the development and distribution of present-day biohermal mounds in the region (Bishop and O'Brien, 1998; O'Brien et al, 2002).

Northern Bonaparte Basin

The Northern Bonaparte Basin, as redefined by Whittam et al (1996), encompasses the area to the northwest of the Petrel Sub-basin that contains a thick Mesozoic and Cenozoic succession. Two major depocentres of Late Jurassic to Early Cretaceous age are recognised in the northern Bonaparte Basin (**Figure 2**); the northeast-trending Malita and Calder graben, and the northwest-trending Sahul Syncline (including its western extension, the Nancar Trough). These depocentres are flanked to the north by the Sahul Platform and to the south by the Londonderry High.

The stratigraphy and geologic history of the northern Bonaparte Basin has been described by Mory (1988), Gunn (1988), MacDaniel (1988), Veevers (1988), Pattillo and Nicholls (1990), O'Brien et al (1993), Whittam et al (1996), Shuster et al (1998) and Labutis et al (1998), and is summarised by Cadman and Temple (2004).

The present day configuration of the northern Bonaparte Basin results from the intersection and superimposition of three cycles of rifting: an initial northwest–trending Late Devonian rift extending outboard from the Petrel Sub-basin, and northeast-trending Late Carboniferous–Permian and Jurassic rifts in the Malita and Calder graben and Vulcan Sub-basin. The pre-existing Palaeozoic structural grain had considerable influence on the distribution and thickness of the Mesozoic and Cenozoic succession on the western part of the Sahul Platform (particularly during the Triassic), and is expressed in the southeast-trend of both the Sahul and Flamingo synclines (Whittam et al, 1996).

This structural grain is cross-cut by a series of Jurassic faults, the strike of which varies from northeast–southwest in the area adjacent to the Londonderry High, through north-northeast–south-southwest at the western-end of the Malita Graben, to east–west in the area of the Flamingo and Laminaria highs. Woods (1992) attribute this latter east–west-trend to Tithonian tectonism.

Whittam et al (1996) concluded that the geological history in the northern Bonaparte Basin and Vulcan Sub-basin are broadly similar, but there are significant differences recognised in the northern Bonaparte Basin:

- The strong influence of the Permo-Carboniferous rifting event in the distribution and thickness of the Triassic succession.
- The tectonic event at the Jurassic/Triassic boundary, which marks the onset of extension during the Mesozoic.
- The relative unimportance of the Callovian phase of tectonism that initiated subsidence in the Vulcan Sub-basin.
- The Tithonian extensional event resulted in the development of east–west-trending horsts and graben that characterise the structure of the Sahul Syncline and Flamingo Syncline region, which have proven to be the most prospective structural traps in the area.
- The identification of the base-Aptian disconformity as a regional seismic marker that is the principal structural mapping horizon in the region, and the most reliable indicator of regional structure at the top of the Callovian reservoir section.

These differences have important implications for petroleum exploration in the area. Variations in the subsidence history and timing of tectonic events between the two regions influenced the distribution and preservation of potential reservoir and source rocks (Whittam et al, 1996). For example, it is considered unlikely that deposition of the Elang/Laminaria Formation reservoir sands would be widespread on the Laminaria and Flamingo highs and Sahul Platform if the major Callovian extension that occurred in the Vulcan Sub-basin had occurred on the western part of the Sahul Platform. Similarly, differences in subsidence history and in the thickness of the mid-Cretaceous to Cenozoic succession had a major impact on the timing of hydrocarbon generation, and on the extent to which later episodes of faulting affected the integrity of Jurassic traps.

Sahul Syncline

The Sahul Syncline (and its western extension, the Nancar Trough) is a prominent Palaeozoic to Mesozoic northwest-trending trough located between the Londonderry and Flamingo highs in the northern Bonaparte Basin (**Figure 2**). It is the primary source kitchen for petroleum accumulations discovered on the adjacent Laminaria and Flamingo highs.

Botten and Wulff (1990) considered the Sahul Syncline formed in the Late Triassic to Middle Jurassic, whereas Durrant et al (1990) believe it formed as part of the Late Devonian rift system in the Petrel Sub-basin. O'Brien et al (1993) and Robinson et al (1994) described the Sahul Syncline as a 'sag' feature, and considered that Late Carboniferous to Early Permian extension reactivated pre-existing, northwest-trending fault zones (such as the Sahul Syncline) as transfer faults.

Subsidence in the Permian and Triassic led to the deposition of a thick sedimentary succession in the region between the Londonderry High and Sahul Platform (including the present day Sahul Syncline, Flamingo High and Flamingo

Syncline). Tectonic compression in the Late Triassic resulted in uplift and erosion of the Flamingo High, but deposition continued within the Sahul Syncline where a thick section of the Plover Formation was deposited.

Further subsidence resulting from minor Callovian and then more pronounced Tithonian extension controlled the deposition of Upper Jurassic to Lower Cretaceous clastic sequences (Elang/Laminaria Formation and Flamingo Group). In axial areas of the syncline, the Plover and Elang/Laminaria sands lie too deep to constitute valid exploration objectives, but these units form good quality reservoirs on the Laminaria and Flamingo highs. Following continental break up in the Valanginian, a thick Cretaceous–Cenozoic thermal sag section was deposited across the Sahul Syncline.

Figure 4 shows part of Geoscience Australia's regional seismic line 116-09, which transects Area W06-1 and shows typical structural style and stratigraphic relationship across the Sahul Platform, Flamingo High, Sahul Syncline and up onto the Londonderry High.

Malita and Calder graben

The Malita and Calder graben form a major, northeast-trending, rift system, which contains a significant thickness of Late Palaeozoic, Triassic, Jurassic and Early Cretaceous sediments. The graben are bounded by large displacement, northeast to east-northeast-trending faults. While no exploration well has penetrated the entire Mesozoic section in the central part of the graben, Mesozoic and Cainozoic sediments are probably up to 10 km thick, and are underlain by a considerable section of Upper Carboniferous–Permian sediments. Key features of the stratigraphic succession deposited in these graben are:

- Early–Middle Jurassic Plover Formation sediments thicken markedly into the graben, and may include good quality source rocks.
- Thick, organic-rich mudstones of the Late Jurassic Flamingo Group may also have source potential in the area.
- Tithonian turbidite sands (which were intersected in Heron-1) may provide valid exploration targets in the graben.
- The Early Cretaceous Echuca Shoals Formation may provide additional source potential in the graben.
- The Cretaceous–Tertiary section exceeds a thickness of 4000 m in the central Malita Graben.

Figure 5 shows Geoscience Australia's regional seismic line 116-07, which transects areas W06-2, W06-3 and W06-4, and shows typical structural style and stratigraphic relationship across the Malita Graben, Sahul Syncline and up onto the Londonderry High.

Londonderry High

The Londonderry High is characterised by a highly faulted sequence of Palaeozoic and Triassic rocks which acted as a major source of sediment for adjacent depocentres during Late Jurassic rifting (Whibley and Jacobsen, 1990; de Ruig et al, 2000), overlain unconformably by a relatively unfaulted, Upper Jurassic and younger succession. Although most faulting terminates at the top of the Triassic sequence, some faults show evidence of Miocene reactivation. On higher parts of the Londonderry High the Triassic section is deeply eroded. Uplift and erosion are less pronounced on the eastern and northern flanks where the unconformity is underlain by progressively younger sediments.

Petrel Sub-basin

The Petrel Sub-basin is an asymmetric, northwest–southeast-trending Palaeozoic rift that contains a succession of thick Palaeozoic and thinner Mesozoic sediments. The eastern and western faulted margins of the sub-basin converge onshore to form a southern termination. To the south and east of the Petrel Sub-basin, extensions of the Halls Creek–Fitzmaurice Mobile Zone separate this sub-basin from the Precambrian Victoria River Basin and Pine Creek Geosyncline. Extensive basement shelves overlain by a thin cover of Phanerozoic sediments lie on the eastern, western and southern margins of the Petrel Sub-basin. To the east, the Kulshill Terrace and Moyle Platform extend to the north-northeast into the Darwin Shelf. In the southwest, the Berkley Platform has been sub-divided into several, smaller southeast-trending horst (Lacrosse Terrace and Turtle–Barnett High) and graben (Cambridge Trough) structures.

Strata within the Petrel Sub-basin dip regionally to the northwest about a northwest-plunging synclinal axis, resulting in exposure of lower Palaeozoic sediments in the southern onshore area, and in the progressive subcropping of Upper Palaeozoic, Mesozoic and Cenozoic sediments offshore. The Upper Palaeozoic–Mesozoic section exceeds 15 km in thickness in the central and northern Petrel Sub-basin.

The generalised stratigraphy of the Petrel Sub-basin is shown in **Figure 3**. The stratigraphic and tectonic development of the sub-basin was discussed in detail by Mory (1988, 1991), Lee and Gunn (1988), Gunn and Ly (1989), McConachie et al (1996) and Colwell and Kennard (1996), and is most recently summarised by Kennard et al (2002) and Cadman and Temple (2004). Hydrocarbon expulsion models for the Petrel Sub-basin are presented by Kennard et al (2002). **Figure 6** shows Geoscience Australia's regional seismic line 100-07, which transects Area W06-5, and shows typical structural style and stratigraphic relationships across the Petrel Sub-basin and up onto the Londonderry High.

EXPLORATION HISTORY

Previous exploration

Offshore exploration of the Bonaparte Basin commenced in 1965 when regional aeromagnetic data were acquired. This was supplemented by regional seismic coverage acquired between 1965 and 1974. The first offshore exploration wells, Ashmore Reef 1 and Sahul Shoals 1 located on the Ashmore Platform, were drilled as stratigraphic tests. Although these wells failed to encounter hydrocarbons, they indicated that the Jurassic section is either thin or absent and that Triassic sandstones form potential petroleum reservoirs over much of the Ashmore Platform.

Between 1969 and 1971, seven wells were drilled in the offshore Petrel Sub-basin. This drilling campaign resulted in the discovery of the Petrel and Tern gas accumulations reservoired within the Upper Permian Hyland Bay Formation, which constitutes a primary exploration target in the Petrel Sub-basin.

In the early 1970s, exploration expanded beyond the limits of the Petrel Basin, into the Vulcan Sub-basin and onto the Londonderry High and Sahul Platform. Between 1971 and 1975, 24 wells were drilled—a further nine in the Petrel Sub-basin, four on the Sahul Platform, six in the Vulcan Sub-basin, two on the Londonderry High and two on the Ashmore Platform. Several significant petroleum discoveries were made during this period including Puffin, Troubadour and Sunrise.

Between 1975 and 1982 relatively low levels of exploration drilling were recorded in the offshore Bonaparte Basin (a total of eight wells) due to disputation between Indonesia and Australia over sovereignty of the sea-bed boundary.

The discovery in 1983 of economic oil and gas in Jabiru 1A, which tested a Jurassic horst block in the Vulcan Sub-basin, stimulated further exploration in the offshore part of the Bonaparte Basin, and 21 exploration wells were drilled in the next three years (1984 to 1986). Of these wells, 12 were located in the Vulcan Sub-basin and on the western flank of the Londonderry High.

This phase of exploration resulted in the discovery of a further three commercial oil accumulations in the Vulcan Sub-basin (Cassini, Challis and Skua), and two non-commercial discoveries in stacked reservoirs within the Lower Carboniferous Milligans Formation and Upper Carboniferous to Lower Permian Kuriyippi Formation at Turtle and Barnett in the offshore Petrel Sub-basin.

After a brief downturn in 1987, levels of offshore exploration drilling in the Bonaparte Basin accelerated. Between 1988 and 1990, 31 exploration wells were drilled in the Vulcan Sub-basin. Drilling results from these wells proved disappointing, although several other oil and gas discoveries were made. Further to the north on the Troubadour Terrace, Evans Shoal 1 (1988) identified a significant gas accumulation within the Jurassic Plover Formation. An appraisal well (Evans Shoal 2) was drilled in 1998 and development options are under consideration.

Resolution of the territorial dispute between Indonesia and Australia in 1991 established of the Zone of Cooperation (ZOC) and allowed exploration on the Sahul Platform to resume. Between 1992 and 1998, the focus of exploration in the offshore Bonaparte Basin shifted to this area. Of the 73 exploration wells drilled in the offshore Bonaparte Basin during this period, 43 were located either on or adjacent to the Sahul Platform, Laminaria High and Flamingo High. The first commercial petroleum success in the area resulting from this phase of exploration occurred in 1994, with the discovery of oil at Elang 1 and the identification of a new oil play on the Flamingo and Laminaria highs.

In 1999, Timor-Leste was granted independence by Indonesia. This created a climate of uncertainty with regard to petroleum exploration in the Zone of Cooperation. In that year, only one exploration well (Jura 1) was drilled in the former ZOC Area A. Since that time, Coleraine 1 (2000) and Kuda Tasi 1 (2001) have been drilled within ZOC Area A (now the Joint Petroleum Development Area). These were followed by Kuda Tasi 2 in 2003, which recovered oil.

Exploration drilling on the Londonderry High identified numerous gas accumulations within the Hyland Bay Formation at Prometheus/Rubicon (2000) Ascalon (2000) and Saratoga (2000).

During 2001, two wells (Sandbar 1 and Blacktip 1), were drilled in the inshore portion of the Petrel Sub-basin. No hydrocarbons were encountered in Sandbar 1 but Blacktip 1 was completed as a gas discovery. This well encountered a 20 m gross gas column within the Triassic Mount Goodwin Formation, and a 339 m gross gas column from several high quality, stacked reservoir zones within the Lower Permian Keyling Formation.

Relevant wells and hydrocarbon accumulations

Areas W06-1 and W06-2, Sahul Syncline

Areas W06-1 and W06-2 lie largely within the Sahul Syncline, although the southwestern corner of Area W06-2 also extends up onto the Londonderry High. Many of the major accumulations in the northern Bonaparte Basin lie adjacent to Area W06-1.

At least twenty oil, gas, and oil and gas discoveries have been made in the northern Bonaparte Basin, and commercial production has occurred from six of these (Elang, Kakatua/Kakatua North, Laminaria, Corallina, Buffalo and Bayu/Undan). The now depleted Buffalo accumulation lies within Area W06-1, and the others all lie adjacent to the northeastern and northern flanks of Area W06-1.

The Elang structure is on the crestal culmination of the ‘Elang Trend’, an east–west oriented structural high, located on the northwest flank of the Flamingo High. Oil at Elang is trapped in late Callovian to early Oxfordian sandstones beneath the Frigate Shale. In December 1994, Kakatua 1 and Kakatua North 1 were drilled to the west of the Elang oil discovery. Both wells recovered oil on test from the Elang/Laminaria Formation, and commercial oil production from a joint Elang/Kakatua/Kakatua North development commenced in 1998.

Further commercial success in the area quickly followed. In late 1994, immediately to the west of the ZOC, Laminaria 1 was drilled on the Laminaria High. The well tested a faulted horst complex on this high and intersected a 102 m gross oil column. As at Elang, the Laminaria oil accumulation is trapped in transgressive, estuarine dominated delta sands of Callovian to early Oxfordian age.

In late 1995, Corallina 1 was drilled on a separate horst complex immediately to the north of the Laminaria 1 discovery. Oil and gas were recovered from the same reservoir sequence intersected by Laminaria 1. In 1999, commercial oil production commenced from a combined Laminaria/Corallina development.

In early 1995, Bayu 1 was drilled to test a crestal culmination on the Flamingo High. The well intersected a 155 m gross gas/condensate column in sandstones of late Oxfordian to early Callovian age. In mid-1995, a successful gas discovery well (Undan 1) was drilled on a separate culmination on an extension of the same feature in an adjacent exploration permit. Post-drill analysis and subsequent appraisal drilling indicate the Bayu 1 and Undan 1 gas/condensate discoveries comprise a single, large gas/condensate accumulation with an areal extent of approximately 160 km^2 (Brooks et al, 1996). Commercial production from Bayu/Undan commenced in 2004.

The first well drilled in Area W06-1 was Cleia 1 drilled in 1992. The primary objective was to test Middle to Upper Jurassic sandstones of a horst block within the Sahul Syncline. Minor hydrocarbon indications were encountered. In 1993, Rambler 1 was drilled to test the Upper Plover and Flamingo Group sands within a tilted fault block on the flank of the Londonderry High and Sahul Syncline. An 85 m gross gas column in the Plover Formation was inferred from wireline logs, and two repeat formation tests (RFTs) recovered oil from the Flamingo Group. The primary objective of Iris 1, also drilled in 1993, was to evaluate Middle to Upper Jurassic sandstones within the Sahul Syncline. The Upper Jurassic Flamingo Group sandstones had a good show over 2 m, with reservoir quality indicated by porosities of around 13%.

In 1996, Buffalo 1 was drilled to test the Callovian–Oxfordian section within a horst block on the Laminaria High. Buffalo 2 was drilled in 1997 as an appraisal well, followed by Buffalo 3 to 9 as development wells between 1999 and 2002. Oil production commenced in December 1999 and the accumulation is now depleted. Since the discovery at Buffalo, a number of other petroleum discoveries and strong hydrocarbon indications have been made both within Area W06-1, and on the adjacent Sahul Platform. Buller 1, also drilled in 1996, tested Upper Jurassic sediments in a tilted fault block. The well encountered a 8.6 m net oil pay, and recovered oil and gas on test from the Upper Jurassic Elang Formation. Capung 1,1A was drilled in 1998 to test Middle Jurassic sandstones in a tilted fault block. Two other wells, Bluff 1 and Tanjil 1,1A drilled in 1998, reported good hydrocarbon indications from the Upper Jurassic Elang Formation, with oil being recovered on test from Bluff 1. Other wells drilled in Area W06-1 include Bogong 1 (1997), Wowo Wiwi 1 (1998), Franklin 1 and Heifer 1 (both 1999), all of which reported minor hydrocarbon indications.

A number of wells have also been drilled immediately adjacent to Area W06-1, on the Flamingo, Laminaria and Londonderry highs, and in the Sahul Syncline, and these include, Fulica 1, Garganey 1,ST1 and Jahal 1, DW1. Fulica 1 (1989) was drilled on a horst block on the flank of the Londonderry High, with the Lower Cretaceous Flamingo Group being the main reservoir target. Hydrocarbon shows were recorded in both the Bathurst Island and Flamingo groups over a 10 m section, but log analysis indicated that there were no moveable hydrocarbons. Garganey 1,ST1, also 1989, was drilled on a cross-faulted, northeast-trending horst block on the Londonderry High. Hydrocarbon shows were recorded in the Bathurst Island Group over a 42 m section, and minor oil shows were detected in Flamingo Group sandstones. Jahal 1,DW1 (1996) was drilled to test sandstones of the Upper Jurassic Elang Formation in a tilted fault block on the flank of the Laminaria High. The well recorded a net pay hydrocarbon column of 13.7 m, and a drill stem test flowed oil at 1422 BOPD, together with 2548 m^3/day of gas from the Elang Formation.

In 1997, Krill 1 was drilled to test the hydrocarbon potential of the Elang Formation within a tilted fault block in the Sahul Syncline. Oil and gas were recovered on test from a depth of 3485 m within the Elang Formation. Kittiwake 1,ST1 (1998) was drilled on the flanks of the Londonderry High, with the Middle Jurassic Plover Formation the primary objective, and Upper Jurassic Flamingo Group the secondary objective. Hydrocarbon shows were encountered in the Upper Jurassic Elang Formation and Flamingo Group, but no testing was carried out. Lameroo 1, drilled on the flanks of the Laminaria High in 1998, reported some oil indications.

No wells are located within Area W06-2, but a number of wells are located on the Londonderry High to the west and south, and within the Sahul Syncline to the east. Four wells have been drilled on the flanks of the Londonderry High to the west of Area W06-2. Tamar 1, drilled in 1979, was designed to test Middle to

Upper Jurassic sandstones in an anticlinal structure. While there were some hydrocarbon indications, no significant hydrocarbons were encountered. Rambler 1 was drilled in 1993, and has been mentioned previously. Wambenger 1 (2000) encountered minor hydrocarbon shows and Backpacker 1 (2001) encountered no hydrocarbons, both were plugged and abandoned as dry holes.

Area W06-3, Sahul Syncline/Malita Graben
Two wells, Schilling 1 and Marsi 1,ST1, have been drilled within Area W06-3 which is located at the junction of the Sahul Syncline and the Malita Graben, immediately to the east of Area W06-2. Some minor hydrocarbon indications were observed in the Schilling 1 (1997) well. Marsi 1,ST1 was drilled in 1998 on the southern platform area adjacent to the Sahul Syncline and Malita Graben. Some fluorescence shows were observed through the Lower Cretaceous Sandpiper Sandstone, the primary target for the well, but no significant hydrocarbons were encountered. The well failed to penetrate the secondary targets.

Area W06-4, Londonderry High
A number of wells are located within Area W06-4 on the Londonderry High to the south of Area W06-2, many with significant hydrocarbon indications. The first well, Kite 1, was drilled to test the Flamingo Group sandstones in a drape over a Triassic–Jurassic horst. No hydrocarbons were encountered in the primary objective, although some gas indications and excellent visual porosity were observed. In 1991, Harbinger 1,ST1 was drilled on a fault-dependent structural closure, mapped seismically at both the top Flamingo Group (primary reservoir target), and top Plover Formation. Hydrocarbon indications were encountered in the Sandpiper Sandstone and Plover Formation, and log analyses confirmed that all potential reservoirs were water saturated. Shalimar 1, also drilled in 1991, was similarly located on an east–west-trending, fault-dependent structural closure at both the top Flamingo Group and near top Plover Formation. While no hydrocarbons were encountered, oil and gas indications were observed in the Flamingo Group sandstones.

Oberon 1, drilled in 1992, also tested the Flamingo Group on a fault-dependent closure. No significant hydrocarbon shows were encountered, although, gas indications were observed. Helvetius 1,1ST1,ST2 was drilled in 1994 to test the hydrocarbon potential of the Upper Cretaceous Sandpiper Sandstone, and Plover Formation. The structure is a fault-bounded horst block, with fault-independent closure, located on a migration pathway out of the Malita Graben and Sahul Syncline source depocentre. Gas indications were encountered in the Sandpiper Sandstone and Plover Formation, but log analyses confirm that all potential reservoirs are water saturated.

Ascalon 1,1A was drilled in 2000 to evaluate the Permian section on the Londonderry High. The well encountered oil shows in the Lower Cretaceous

Sandpiper Sandstone, and a 6.1 m net gas pay in the Permian Hyland Bay Formation. A drill stem test (DST) over the depth ranges 4557–4559 m and 4573–4617 m within the Hyland Bay Formation flowed gas at 29,490 m^3/day, with a maximum flow of 70,800 m^3/day. Saratoga 1, also drilled in 2000, tested an anticline with independent fault closure at the Elang and Plover Formation level. The well encountered a 4.3 m net gas pay within the Upper Jurassic Flamingo Group.

Several wells have been drilled on the Londonderry High to the southwest of Area W06-4. Plover 1 (1972) was drilled as a stratigraphic test of the Lower Cretaceous to Triassic sequences. No oil indications were detected, but numerous gas shows were noted in the Upper Cretaceous Bathurst Island Group shales. Plover 2 (1974) was a stratigraphic test of the Upper Petrel (Sandpiper?) Sandstone where it pinches out against the Kimberly Block. Minor gas shows were recorded while drilling the Triassic and Permian sections, and the Upper Jurassic section had good reservoir quality sandstones, with Cretaceous and Triassic shale sections providing top and bottom seals. Two wells, Prometheus 1 and Rubicon 1, were drilled in 2000 targeting Permian Hyland Bay Formation sandstones in a fault dependent structure. Prometheus 1 encountered a 72 m gross gas column within the Hyland Bay Formation. Rubicon 1, located 3 km east of Prometheus 1, intersected a 30 m gross gas column in the Hyland Bay Formation. The gas-water contact in Rubicon 1 occurs at the same depth as that in Prometheus 1, and is interpreted to be an extension of the Prometheus discovery, and confirms that the structure is filled to the mapped spill point (King, 2001).

Torrens 1 (1993), was drilled to the south of Area W06-4. It targeted fluvio-deltaic sands of the Lower Permian Keyling Formation within a fault dependent closure. Residual oil in sandstones of the Permian Fossil Head Formation and possible minor moveable oil and gas in the Tern Member of the Hyland Bay Formation and the Kuriyippi Formation were recorded. Analysis of oil-bearing fluid inclusions (Lisk and Brincat, 1998; Edwards et al, 2000) indicated a 42 m palaeo-oil column within the Fossil Head Formation. Kufpec (1994) attributed the lack of significant hydrocarbons to a lack of structural closure.

Area W06-5, Petrel Sub-basin

Area W06-5 contains one well, Billabong 1 (1992) which tested the Jurassic Plover Formation in a tilted fault block, but showed only minor hydrocarbon indications. Fishburn 1 to the south of Area W06-5 was also drilled in 1992. It tested a tilted fault block with a three-way dip closure, with Lower to Middle Jurassic sandstones of the Plover Formation as the prime objective. The underlying Upper Permian Hyland Bay Formation sandstones provided a secondary objective. The well intersected a 51 m gross gas column in the Hyland Bay Formation, but the primary objective was dry.

PETROLEUM POTENTIAL

Hydrocarbon families and source rocks

Several hydrocarbon families and/or petroleum systems of various ages have been documented within the Bonaparte Basin (Bradshaw et al, 1997; Edwards et al, 1997, 2000, 2004; Colwell and Kennard, 1996; Kennard et al, 2000, 2002; McConachie et al, 1996; Barrett et al, 2004; Edwards and Zumberge, 2005), and are summarized in Earl (2004):

- A Late Devonian-sourced petroleum system (Larapintine 3);
- An Early Carboniferous-sourced petroleum system (Larapintine 4 or Larapintine/Gondwanan Transition);
- A Permian-sourced petroleum system (Gondwanan 1);
- An Early–Middle Jurassic-sourced petroleum system (Westralian 1);
- A Late Jurassic-sourced petroleum system (Westralian 2); and
- An Early Cretaceous-sourced petroleum system (Westralian 3).

Most of the commercial oil and gas accumulations are reservoired in the Middle and Upper Jurassic Plover and Montara/Elang formations. Commercial accumulations also occur in Upper Triassic and Upper Cretaceous sands in the Vulcan Sub-basin. In the Petrel Sub-basin, gas and gas/condensate accumulations (including Fishburn 1) occur in the Upper Permian Hyland Bay Formation, and gas discoveries on the Londonderry High (Prometheus 1, Rubicon 1 and Ascalon 1A) also occur within the Hyland Bay Formation.

Oils interpreted to be derived from the Lower Carboniferous Milligans Formation in the Petrel Sub-basin (Barnett and Turtle wells) have biomarker signatures which indicate generation from marine, anoxic, clay-rich source rocks (Edwards et al, 2000). Oil stains obtained from the Upper Carboniferous Kuriyippi Formation reservoir in the Torrens 1 well have been correlated with the oils in the Barnett and Turtle wells (Ruble et al, 2000).

In contrast, the biomarker signature of condensates from the Petrel and Tern Fields in the Petrel Sub-basin are consistent with derivation from land plant material. The most likely source of these hydrocarbons are the Permian Keyling and Hyland Bay formations which are rich in land-plant remains and were deposited in coastal plain and deltaic environments respectively (Edwards et al, 2000).

The gas discoveries at Fishburn 1 in the Petrel Sub-basin, and Ascalon 1A, Prometheus 1 and Rubicon 1 on the Londonderry High, are all reservoired in the Upper Permian Hyland Bay Formation, and are attributed to this Permian source (Edwards et al, 1997, 2000). Oil shows in the Lower Cretaceous Sandpiper Sandstone in Ascalon 1A and gas recovered from the Jurassic Flamingo Sandstone in Saratoga 1 have most probably been sourced from the younger Jurassic system.

Analysis of oil-bearing fluid inclusions and stains from the Torrens 1 well indicates a 42 m gross palaeo-oil column within the Permian Fossil Head Formation (Lisk and Brincat, 1998). Isotopic and biomarker profiles of a residual oil from this palaeo column are comparable to the condensates from the Petrel and Tern wells that are attributed to a Permian source (Edwards et al, 2000; Ruble et al, 2000).

Petroleum Systems

At least two petroleum systems are relevant to areas W06-1, W06-2, W06-3, W06-4 and W06-5;

- the Gondwanan 1 petroleum system, and
- the Westralian 2 petroleum system.

Gondwanan 1 Petroleum System

In the Petrel Sub-basin, the Permian Gondwanan 1 Petroleum System is based on the presently non-commercial gas accumulations at Fishburn 1, Penguin 1, Petrel and Tern (Colwell and Kennard, 1996; Edwards et al, 1997, 2000; Kennard et al, 2002). These accumulations are thought to have been sourced from either prodelta marine mudstones of the Hyland Bay Formation, or marine–deltaic shales and coaly shales of the Keyling Formation, and are reservoired within deltaic and shoreface sandstones of the Hyland Bay Formation. This petroleum system has accordingly been designated the 'Hyland Bay/Keyling-Hyland Bay (.) Petroleum System' (Kennard et al, 2002; Barrett et al, 2004). A map showing the extent of this petroleum system is shown in **Figure 7**.

Regional seal is provided by transgressive marine shales of the Mount Goodwin Formation. The main trap types within this petroleum system are faulted anticlines, large-scale inversion anticlines, stratigraphic traps and pinchouts, and drape/pinchout associated with diapiric salt.

Gas accumulations attributed to probable Permian source rocks also occur on the Londonderry High (Prometheus 1 and Rubicon 1) in the southwest of the Bonaparte Basin. These accumulations are also reservoired in the Hyland Bay Formation and form extensions or outliers of the Permian Gondwanan 1 Petroleum System in the Petrel Sub-basin.

Oil shows in Torrens 1 also provide encouragement for Permian-sourced oil on the Londonderry High (Edwards et al, 2000, Kennard et al, 2000; Ruble et al, 2000c). This outlying Permian petroleum system has been designated the 'Permian-Hyland Bay (?)' Petroleum System by Barrett et al (2004). A map showing the extent of this petroleum system is shown in **Figure 8**.

Westralian 2 Petroleum System

In the central northern Bonaparte Basin (Laminaria and Flamingo highs), oils reservoired within the Middle–Upper Jurassic Plover and Elang formations, which includes all the commercial accumulations, have been divided into two end-member families (Preston and Edwards, 2000). The first family includes the relatively land-plant-influenced oils in the northwestern part of the area (e.g., Buffalo, Corallina, Jahal and Laminaria accumulations), and the second family includes the relatively marine-influenced oils/condensates to the southeast (e.g., Bayu/Undan accumulation. Oils of intermediate composition occur between these accumulations (e.g., Bluff, Elang, Kakatua and Krill).

While none of the oils can be uniquely correlated with a single source unit, Preston and Edwards (2000) conclude that all of the accumulations in this area are sourced predominantly from the Middle Jurassic Plover Formation and Upper Elang Formation, with additional contributions from the overlying sealing units: the land-plant rich, Upper Jurassic Frigate Formation in the northwest and the marine-dominated, Upper Jurassic–Lower Cretaceous Flamingo Group in the southeast. These central northern Bonaparte accumulations thus represent a hybrid Westralian 1/Westralian 2 petroleum system. Barrett et al (2004) referred to this petroleum system as the 'Elang-Elang (!) petroleum system'. A map showing the extent of this petroleum system is shown in **Figure 9**.

DATA AVAILABILITY

Open-file reports, data and down-hole samples (wells, geophysical surveys and other petroleum exploration and production data submitted by the petroleum industry) relevant to these areas are available from both the Western Australia Department of Industry and Resources (DoIR), Perth, and Geoscience Australia (GA), Canberra.

Digital wireline logs from wells drilled within the release areas and in adjacent acreage are available from Crocker Data Processing, Perth, and Wiltshire Geological Services, Adelaide.

Table 1. Relevant Wells

Well	Operator	Year	Total Depth (m)	Hydrocarbons
Ascalon 1	Mobil Exploration and Prod.	1995	694	
Ascalon 1A	Mobil Oil Aust Ltd	1995	4688	Proven gas zone, oil indications
Backpacker 1	Newfield Australia (Cartier) Pty Ltd	2001	2276	Oil & gas indications
Billabong 1	BHP Petroleum	1992	2028	No shows
Bluff 1	BHP Petroleum Pty Ltd	1998	3535	Proven oil zone, gas shows
Bogong 1 (BHP)	BHP Petroleum Pty Ltd	1997	3675	Oil indication
Buffalo 1	BHP Petroleum Pty Ltd	1996	3473	Proven oil & gas zones
Buffalo 2 DW	BHP Petroleum Pty Ltd	1997	3926	Potential oil zone, gas indication
Buffalo 3	BHP Petroleum Pty Ltd	1999	3750	Proven oil zone, gas indication
Buffalo 4	BHP Petroleum Pty Ltd	1999	3845	
Buffalo 5	BHP Petroleum Pty Ltd	1999	3477	Proven oil zone, gas indication
Buffalo 7	Nexen Petroleum Australia Pty Ltd	2002	3452	Proven oil zone, gas indication
Buffalo 8	Nexen Petroleum Australia Pty Ltd	2002	3793	Gas indications
Buffalo 9	Nexen Petroleum Australia Pty Ltd	2002	3749	Proven oil zone, gas indication
Buller 1	BHP Petroleum Pty Ltd	1996	3609	Proven oil & gas zones

Capung 1	BHP Petroleum (NW Shelf) P/L	1997	400	
Capung 1A	BHP Petroleum	1998	3545	Oil indication
Cleia 1	Phillips Aust Oil Co	1992	3789	Oil & gas indications
Fishburn 1	BHP Petroleum	1992	2870	Proven gas zone
Franklin 1	BHP Petroleum	1999	1650	No shows
Fulica 1	Bond Corp Holdings Ltd	1989	2674	Oil & gas indications
Garganey 1 ST1	Bond Corp Holdings Ltd	1989	2481	Oil & gas indications
Harbinger 1	Kufpec Aust	1991	2765	
Harbinger 1 ST1	Kufpec Aust	1991	2765	No shows
Heifer 1	BHP Petroleum Pty Ltd	1999	3840	Oil & gas indications
Helvetius 1	MIM Petroleum Explor Ltd	1994	723	
Helvetius 1 ST1	MIM Petroleum Explor Ltd	1994	655	
Helvetius 1 ST2	MIM Petroleum Explor Ltd	1994	2787	Oil indication
Iris 1	Phillips Aust Oil Co	1993	3900	Oil & gas indications
Jahal 1 DW 1	BHP Petroleum	1996	3445	Proven oil zone
Kite 1	Western Mining Corp Ltd	1990	2310.5	No shows
Kittiwake 1 ST1	Boral Energy Resources Ltd	1998	2800	Oil & gas indications
Krill 1	BHP Petroleum	1997	3640	Oil indication
Lameroo 1	Woodside Petroleum (Timor Sea 19) Pty Ltd	1998	3958	Oil indication
Marsi 1	MIM Petroleum Explor Ltd	1996	3062	Oil indication
Marsi 1 ST1	MIM Petroleum Explor Ltd	1996	3062	
Oberon 1	Kufpec Aust	1992	2008	No shows
Plover 1	Arco Australia Ltd	1972	2438	Strong gas indications
Plover 2	Arco Australia Ltd	1974	1524	Gas indications
Prometheus 1	Kerr McGee NW Shelf Energy Australia Pty Ltd	2000	2360	Gas flowed on test, oil indication

Rambler 1	SAGASCO Resources	1993	3709	Gas flowed on test, oil shows
Rubicon 1	Kerr McGee NW Shelf Energy Australia Pty Ltd	2000	1766	Oil & gas indications
Saratoga 1	Kerr McGee NW Shelf Energy Australia Pty Ltd	2000	2139	Gas indications
Schilling 1	Petroz NL	1997	3300	Oil indication
Shalimar 1	Kufpec Aust	1992	2750	Oil & gas indications
Tamar 1	Getty Oil Dev Co Ltd	1979	2863	Oil & gas indications
Tanjil 1	BHP Petroleum (NW Shelf) P/L	1998	4199	Gas indications
Tanjil 1 ST1	BHP Petroleum (NW Shelf) P/L	1998	4263	Oil & gas indications
Torrens 1	Kufpec Aust	1993	2497	Potential oil zone, gas shows
Wambenger 1	Newfield Australia (Cartier) Pty Ltd	2000	2653	Oil indication
Wowo Wiwi 1	BHP Petroleum (NW Shelf) P/L	1998	3518	Oil indication

Geoscience Australia's geological databases provide detailed biostratigraphic (STRATDAT), geochemical (ORGCHEM) and less-detailed reservoir, hydrocarbon shows and interpreted depositional environment information (RESFACS) from open file exploration wells (attached **Northern Bonaparte Data File**).

These data can also be obtained via the Geoscience Australia Petroleum Well Database interface, www.ga.gov.au/oracle/apcrc

Table 2. Relevant Wells – Cores and Cuttings Availability

Well	Type	Top (m)	Bottom (m)	Remark
Ascalon 1A	Core	4396	4414.25	
Ascalon 1A	Cuttings	720	4688	
Backpacker 1	Cuttings	1044	2276	
Billabong 1	Cuttings	143	2028	
Bluff 1	Cuttings	650	3534	
Bogong 1 (BHP)	Cuttings	1012	3675	
Buffalo 1	Cuttings	1120	3473	2710m–2905 m poorly labelled unable to identify depths

Buffalo 2 DW	Core	3759	3800.79	
Buffalo 2 DW	Cuttings	1360	3926	
Buffalo 3	Cuttings	810	3750	
Buffalo 4	Cuttings	810	3845	
Buffalo 5	Cuttings	810	3477	
Buffalo 7	Cuttings	610	3450	
Buffalo 8	Cuttings	730	3793	
Buffalo 9	Cuttings	800	3749	
Buller 1	Cuttings	2280	3609	3490–3609 m section is unable to be identified correctly.
Capung 1A	Cuttings	1089	3545	
Cleia 1	Cuttings	670	3789	
Fishburn 1	Cuttings	140	2870	
Franklin 1	Cuttings	310	1650	
Fulica 1	Cuttings	430	2675	
Harbinger 1	Cuttings	350	855	no sample at some depths
Harbinger 1	Cuttings	390	2764	sidetrack 1
Heifer 1	Cuttings	650	3840	
Iris 1	Cuttings	630	3900	
Jahal 1 DW 1	Core	3303	3383	
Kite 1	Cuttings	365	2310	
Krill 1	Core	3487.7	3541.74	
Lameroo 1	Cuttings	910	3957	
Marsi 1	Cuttings	1240	3460	including sidetrack 1
Oberon 1	Cuttings	380	2008	
Plover 1	Cuttings	236.52	2438.4	
Plover 2	Cuttings	227.38	1524	
Prometheus 1	Cuttings	505	2360	samples taken at random intervals.
Rambler 1	Cuttings	461	3705	
Rambler 1	Cuttings	461	3710	
Rubicon 1	Cuttings	460	1766	
Saratoga 1	Cuttings	755	2139	
Shalimar 1	Core	2177	2195.06	
Shalimar 1	Cuttings	370	2749	
Tamar 1	Cuttings	410	2860	
Tanjil 1	Cuttings	1205	4198	
Tanjil 1	Cuttings	3170	4202	sidetrack 1
Torrens 1	Core	1002	2433.43	
Torrens 1	Cuttings	486	2489	
Wambenger 1	Cuttings	1150	2653	some sample intervals missed
Wowo Wiwi 1	Cuttings	2015	3518	

Contact Geoscience Australia's Repository for more information or to arrange access to core and cuttings, phone 61 (0)2 6249 9222, e-mail ausgeodata@ga.gov.au.

Table 3. Relevant Wells – Available Analysis Reports

Well	Report No	Report Title	Company	Year
Ascalon 1A	DAR1178	Apatite fission track and vitrinite reflectance analysis.	Geotrack	1998
Bogong 1 (BHP)	DAR1087	Vitrinite reflectance and apatite fission track analysis.	Monash University	1994
Fishburn 1	DAR1195	Geochemical study of samples in the Londonderry High area.	Japan National Oil Corp	1998
Iris 1	DAR1213	Geochemical extraction of hydrocarbons from Iris 1.	BHP	1999
Kite 1	DAR1178	Apatite fission track & vitrinite reflectance analysis.	Geotrack	1998
Plover 1	DAR0529	The Permian sediments of the NW Shelf of Australia.	University of London	1985
Plover 1	DAR0639	Petroleum geochemistry of the Australian NW Shelf. Preliminary Report 1564.	Robertson Research (Aust) Pty	1985
Plover 1	DAR0650	Petroleum geology & geochemistry - NW shelf WA - Phase 2 Vol 3 Part 6c.	Robertson Research (Aust) Pty	1986
Plover 1	DAR0785	Bulk fluid inclusion mass spectrometry on samples from Plover 1 well.	Amoco Aust Pet Co	1991
Plover 1	DAR0828	New palynology on cuttings for Plover 1.	BMR	1991
Plover 1	DAR0861	New palynology from Plover 1 well.	BP Australia Ltd	1991
Plover 1	DAR1027	Palynology report, Plover 1 and 2, Bonaparte Basin.	Kufpec Aust	1993
Plover 1	DAR1178	Apatite fission track & vitrinite reflectance analysis.	Geotrack	1998
Plover 1	DAR1195	Geochemical study of samples in the Londonderry High area.	Japan National Oil Corp	1998
Plover 2	DAR0529	The Permian sediments of the NW Shelf of Australia.	University of London	1985
Plover 2	DAR0730	Studies in Australian Mesozoic palynology.	Assoc of Aust Palynology	1987

Plover 2	DAR1027	Palynology report, Plover 1 and 2, Bonaparte Basin.	Kufpec Aust	1993
Plover 2	DAR1195	Geochemical study of samples in the Londonderry High area.	Japan National Oil Corp	1998
Rambler 1	DAR1178	Apatite fission track & vitrinite reflectance analysis.	Geotrack	1998
Tamar 1	DAR0650	Petroleum geology & geochemistry - NW Shelf WA - Phase 2 Vol 3 Part 6c.	Robertson Research (Aust) Pty	1986
Tamar 1	DAR0790	Bulk fluid inclusion mass spectrometry on samples from Tamar 1 well.	Amoco Aust Pet Co	1991
Tamar 1	DAR0864	New palynology from Tamar 1 well.	BP Australia Ltd	1991
Tamar 1	DAR0951	New palynology of six Frigate Shale cuttings, Tamar 1, Bonaparte Basin.	Enterprise Oil Ltd	1992
Tamar 1	DAR1178	Apatite fission track & vitrinite reflectance analysis.	Geotrack	1998
Torrens 1	DAR1178	Apatite fission track & vitrinite reflectance analysis.	Geotrack	1998
Torrens 1	DAR1195	Geochemical study of samples in the Londonderry High area.	Japan National Oil Corp	1998

Contact Geoscience Australia’s Repository for more information regarding access to analysis reports, phone 61 (0)2 6249 9222, e-mail ausgeodata@ga.gov.au.

Table 4. Relevant Seismic Surveys

Survey Name	UNO	2D/3D	Year	Processed	Field	Navigation
1990 Bonaparte Gulf	S0900003	2D	1990	YES	YES	YES
1991 Bonaparte Gulf	S0910001	2D	1991	YES	YES	YES
92-SA-14-ZA	S9920006	2D	1992	YES	YES	YES
Alligator	S6950005	2D	1995	YES	YES	YES
B-1/85	S6950001	2D	1995	YES	YES	NO
Baldwin Bank	S0720001	2D	1972	NO	YES	YES
Bonaparte Gulf 1981	S6810021	2D	1981	YES	YES	NO
Browse-Bonaparte Tie	S6960034	2D	1996	YES	YES	YES
Cape Bernier (1-10)/ Petrel (11-12)	S6790023	2D	1979	YES	YES	NO
Cape Talbot	S0740001	2D	1974	YES	YES	YES
Cartier	S0730003	2D	1973	YES	YES	YES
Caulerpa	S8920004	2D	1992	YES	YES	YES
Central Bonaparte 1989	S6880051	2D	1988	YES	YES	YES
Dillon Shoals	S0730004	2D	1973	NO	YES	YES
Emperor	S6800015	2D	1980	YES	YES	YES
Endeavour	S6940028	2D	1994	YES	YES	YES
Fourcroy	S6930057	2D	1993	YES	YES	YES
Gale Bank	S0710004	2D	1971	YES	YES	YES
HCB90A	S6900006	2D	1990	YES	YES	YES
HCB91A	S6910010	2D	1991	YES	YES	YES
Helvetius	S6920025	2D	1992	YES	YES	YES
Holothuria	S0700003	2D	1970	NO	YES	YES
HZ96A 2D	S0960002	2D	1996	NO	NO	NO
HZI92	S9920002	2D	1992	YES	YES	YES
HZI96	S6960006	2D	1996	NO	YES	YES
Kaye	S6890031	2D	1989	YES	YES	YES
Kuhuma 1991	S6910004	2D	1991	YES	YES	YES
Kuhuma	S6900005	2D	1990	YES	YES	NO
Kununga 1995	S6950002	2D	1995	YES	NO	YES
Laminaria	S8930009	2D/3D	1993	YES	YES	YES
Londonderry Rise	S6670009	2D	1967	NO	YES	NO
Malita	S6910027	2D	1991	YES	NO	YES
Myrmidon	S6910030	2D	1991	YES	YES	YES
NT/P33	S8840010	2D	1984	YES	YES	YES
Pago	S0720002	2D	1972	YES	YES	YES
Pelsart 2	S6800018	2D	1980	NO	NO	NO
PW91	S6910009	2D	1991	YES	YES	YES
Rambler	S6930002	2D	1993	YES	YES	YES
Sahul Rise	S0670082	2D	1967	NO	NO	YES
Sahul Shelf	S0660096	2D	1966	NO	YES	YES
Shona	S6880045	2D	1988	YES	YES	YES

Stuart PW92	S6920031	2D	1992	YES	YES	YES
Tamar Spec 1989	S6880051	2D	1988	YES	YES	YES
Timor Sea	S8720003	2D	1972	NO	YES	NO
Trimouille-Dillon	S0700120	2D	1970	YES	YES	NO
Troughton	S6790015	2D	1979	YES	YES	NO
Van Cloon Shoal	S6770008	2D	1977	NO	YES	YES
Vulcan Teritary Tie 165	S6950038	2D	1995	YES	YES	YES
Walet	S9920008	2D	1992	YES	YES	NO
Zara	S9920001	2D	1992	YES	YES	YES

Contact Geoscience Australia's Repository for more information regarding access to seismic data, phone 61 (0)2 6249 9222, e-mail ausgeodata@ga.gov.au.

Table 5. Initial Reserves

Field	Liquids MMbbls	Gas TCF	Gas MMBOE	Date	Source
Buffalo	20.5	0.0	5.3	Dec-04	DoIR
Corallina	99.0	0.0	0.0	Nov-05	DPIFM
Laminaria	110.2	0.0	0.0	Nov-05	DPIFM
Prometheus/Rubicon	0.6	0.3	43.6	Dec-04	DoIR
Tern	5.7	0.5	79.6	Dec-04	DoIR

* All reserves are P_{50}
* Conversion factor for gas (BCF to MMBOE) is 0.17

* All developed field resources from DoIR have been compiled using the remaining reserves plus the cumulative production as of December 2004. All other fields are reserves as of 31st December 2004.
DoIR - Department of Industry and Resources, Western Australia.
DPIFM - Department of Primary Industry, Fisheries and Mines, Northern Territory.

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FIGURES

Figure 1. Location map of areas W06-1, W06-2, W06-3, W06-4 and W06-5, showing existing petroleum title areas and known petroleum fields and discoveries.

Figure 2. Structural elements map of Bonaparte Basin showing location of the 2006 release areas, wells, and seismic cross-sections shown in Figures 4, 5 and 6 (Edwards and Zumberge, 2005).

Figure 3. Stratigraphic summary of the Bonaparte Basin (after Cadman and Temple, 2004).

Figure 4. Part of Geoscience Australia's regional seismic line 116-09 across Area W06-1, showing typical structural style and stratigraphic relationships. Location of line is shown in Figure 2.

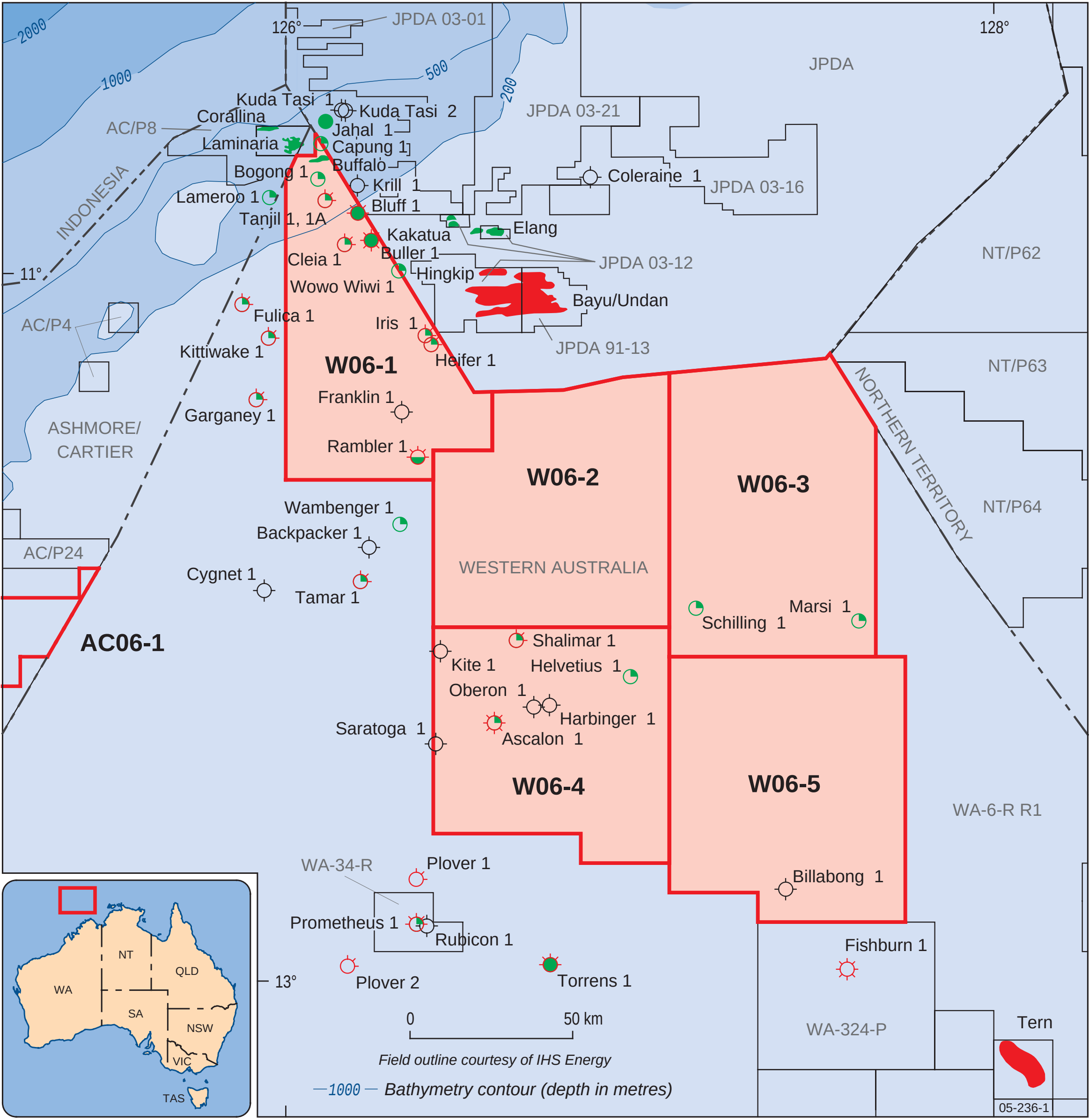
Figure 5. Geoscience Australia's regional seismic line 116-07 across areas W06-2, W06-3 and W06-4, showing typical structural style and stratigraphic relationships. Location of line is shown in Figure 2.

Figure 6. Geoscience Australia's regional seismic line 100-07 across area W06-5, showing typical structural style and stratigraphic relationships. Location of line is shown in Figure 2.

Figure 7. The Permian Hyland Bay/Keyling-Hyland Bay (.) petroleum system in the Petrel Sub-basin (Barrett et al, 2004). Source pod modelled by Kennard et al (2000).

Figure 8. The Permian Hyland Bay (?) petroleum system on the Londonderry High (Barrett et al, 2004).

Figure 9. The Jurassic Elang-Elang (!) petroleum system in the Sahul and Flamingo synclines, and Laminaria and Flamingo highs (Barrett et al, 2004). Limit of source mapping by Preston and Edwards (2000) shown by box.



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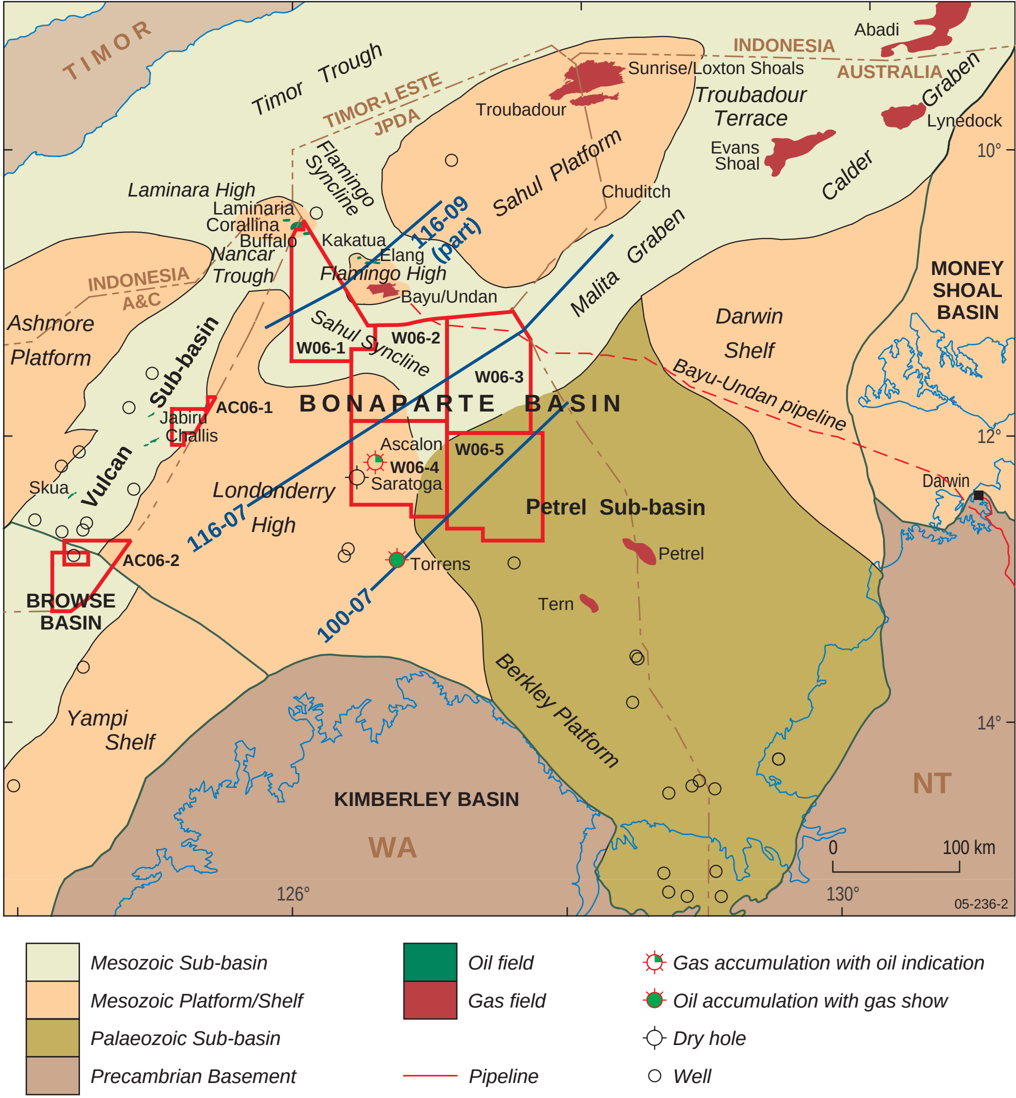

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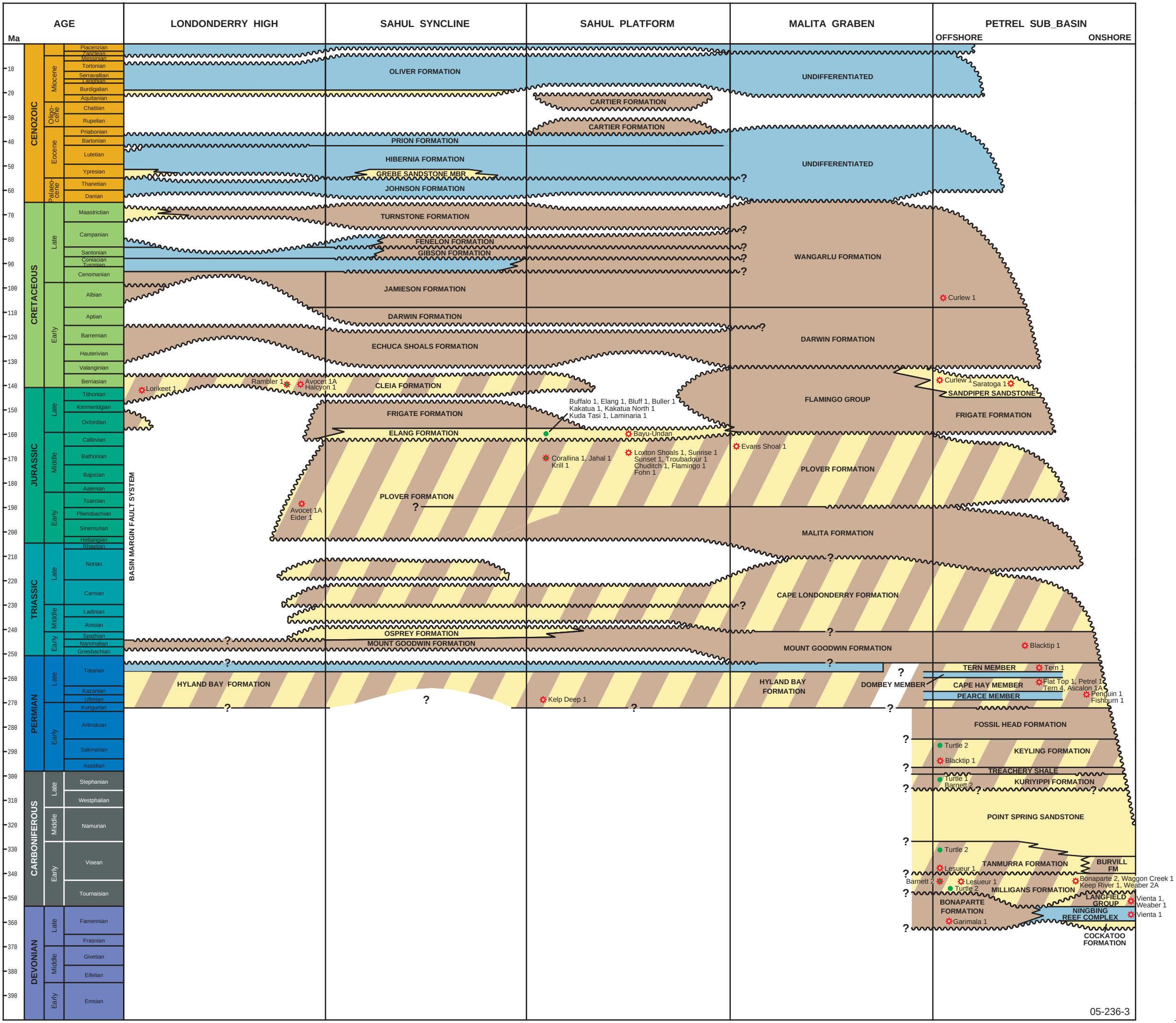

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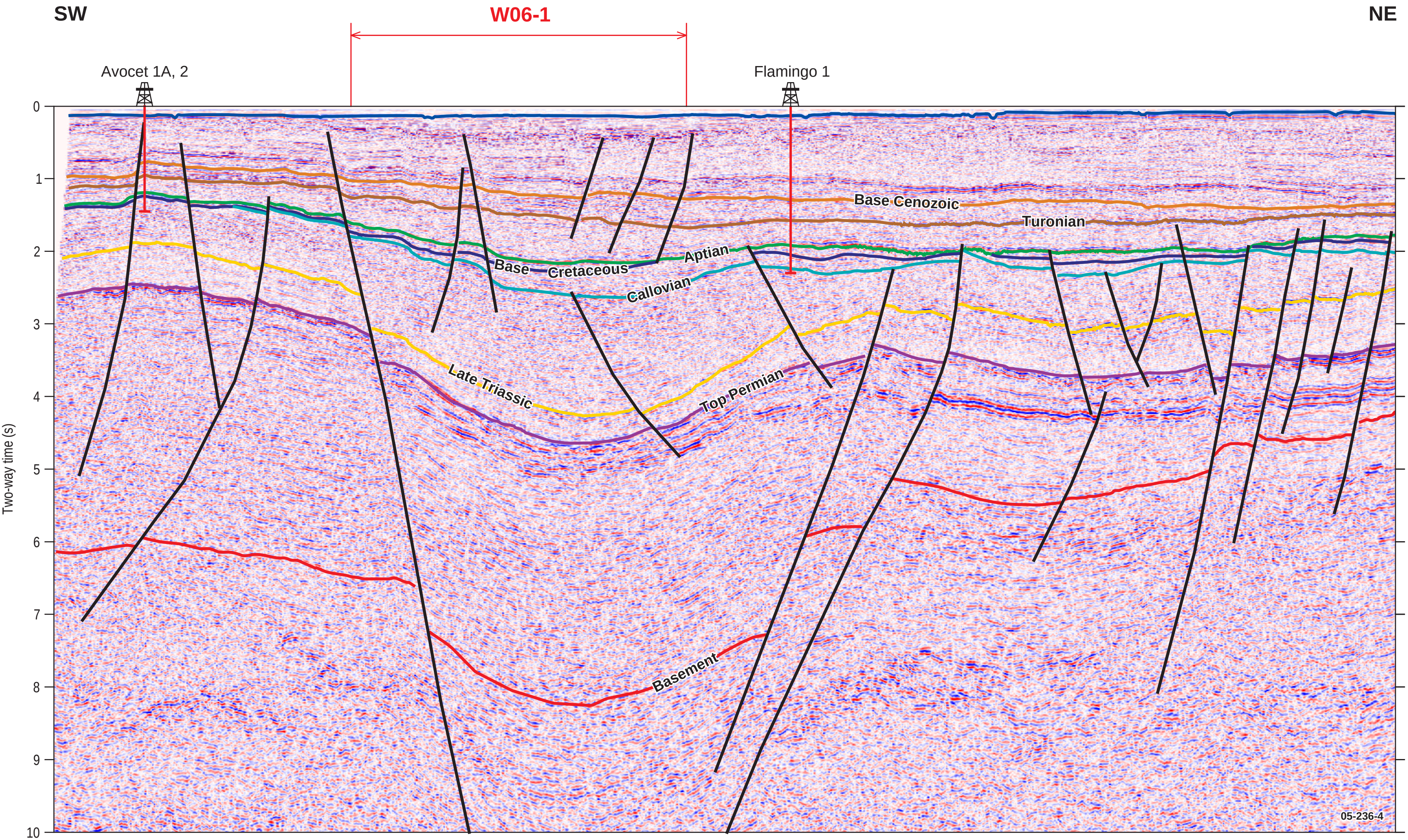

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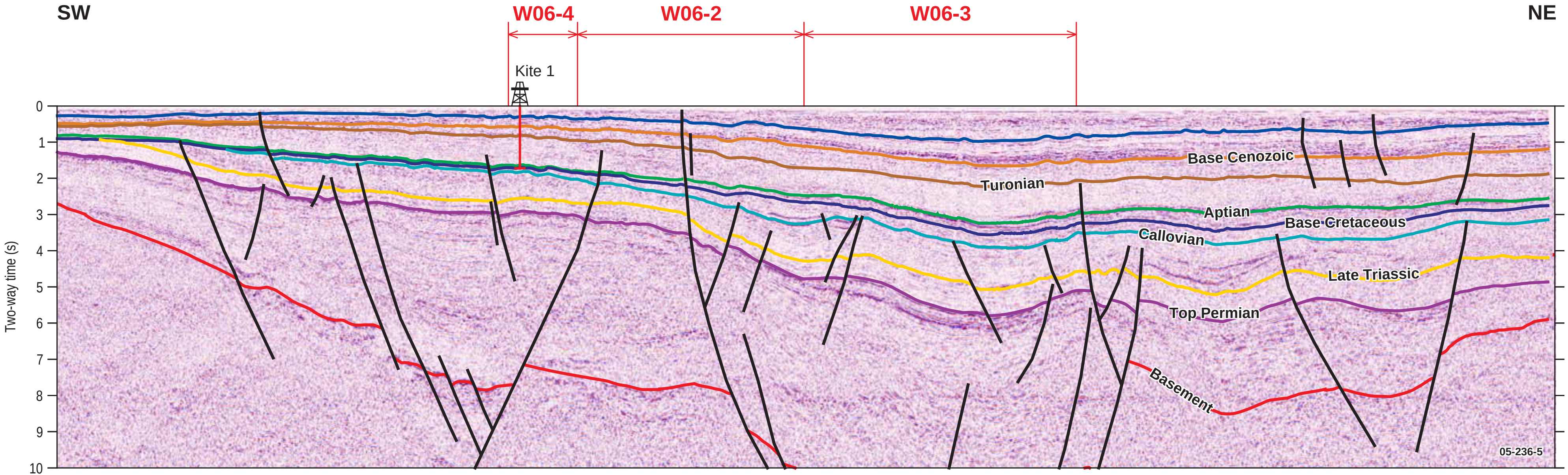

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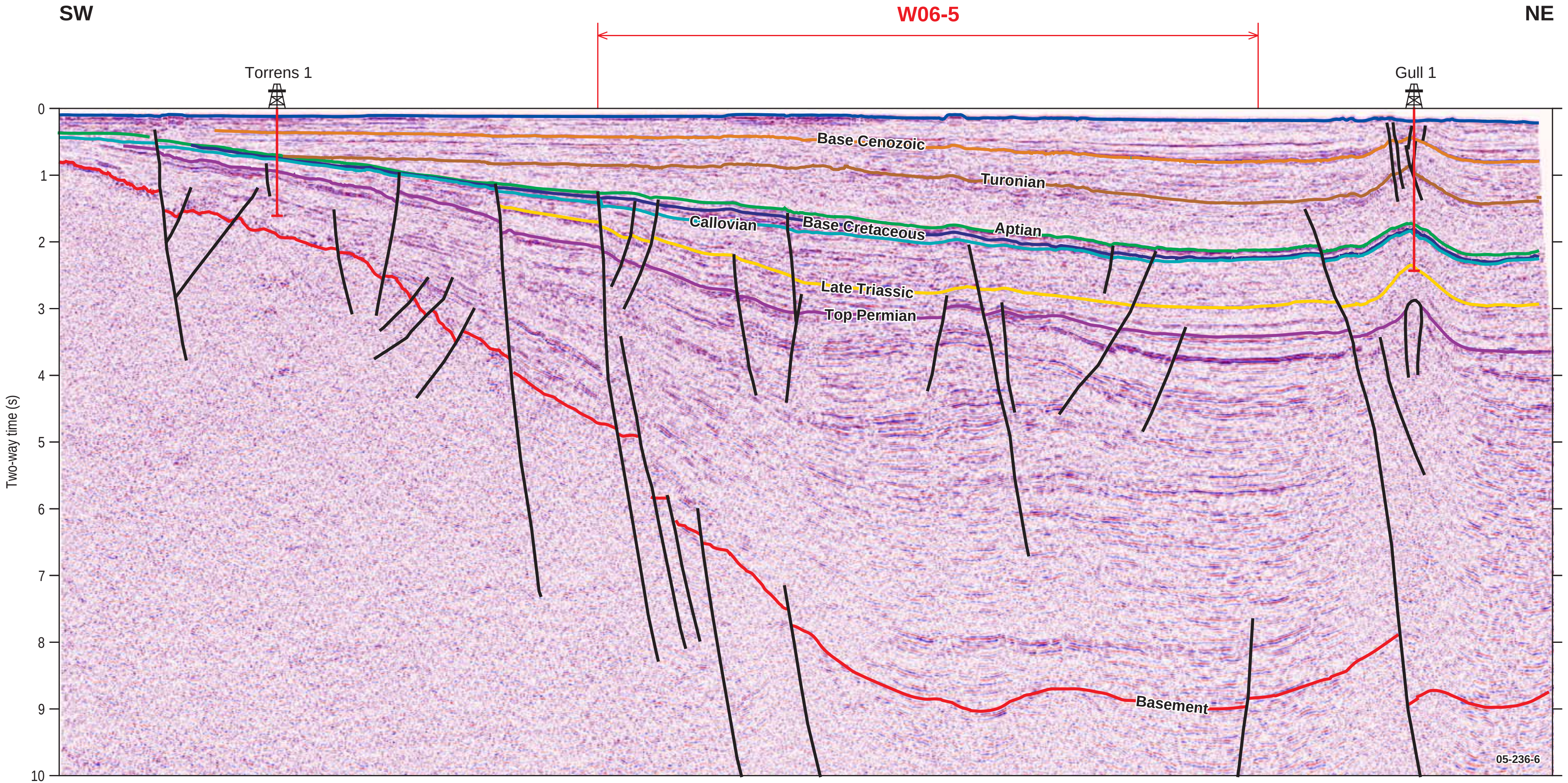

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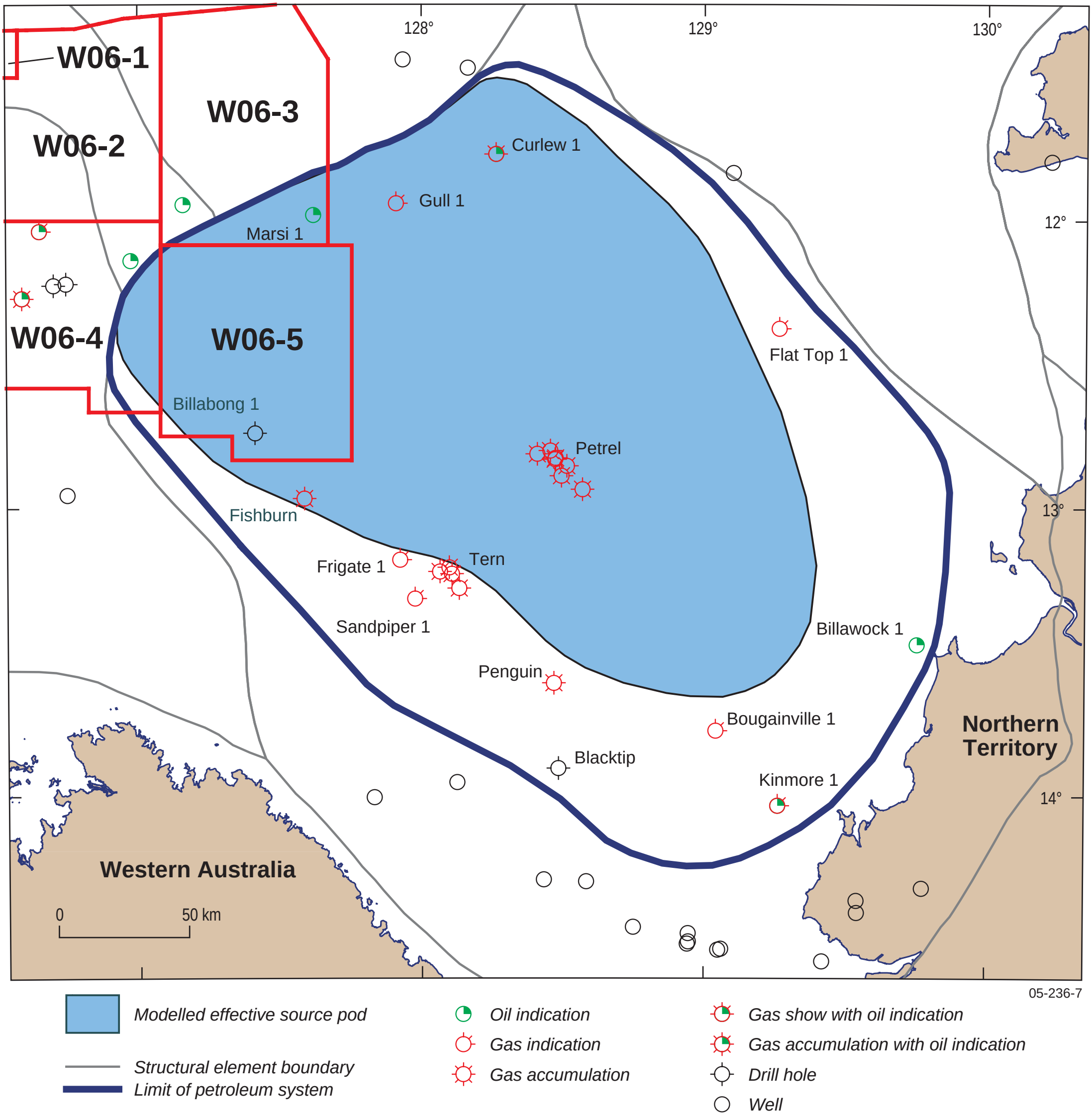

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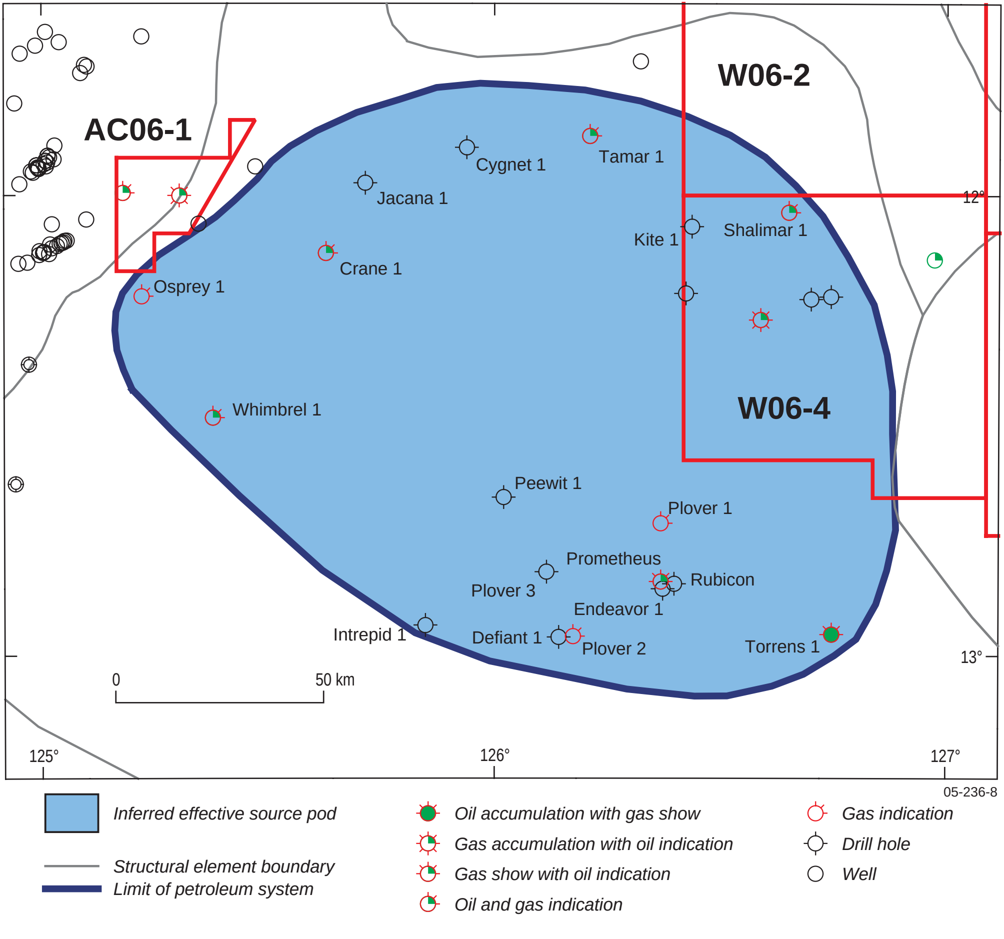

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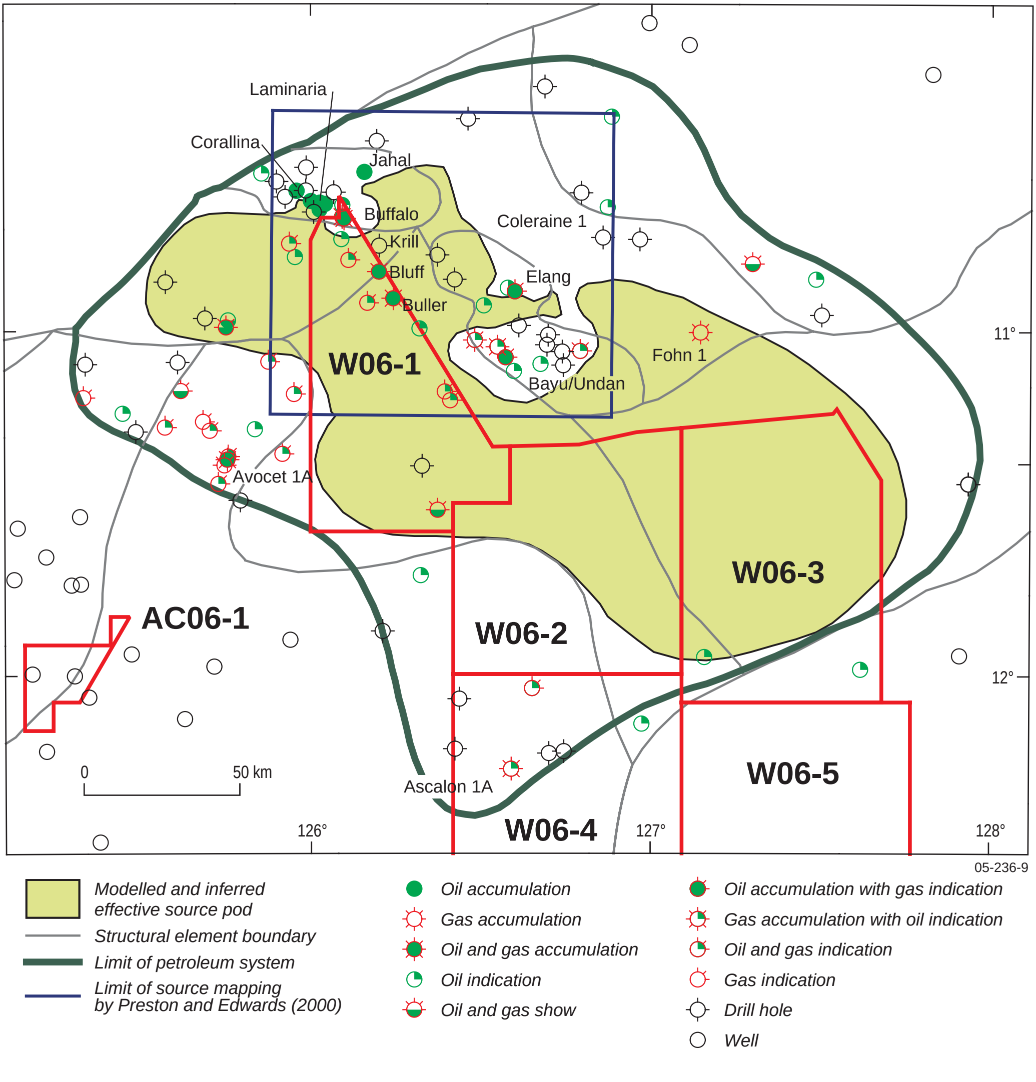

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GRATICULAR BLOCK LISTING

W06-1
Northern Bonaparte Basin, Western Australia

Map Sheet SC 52 (Melville Island)

2234 part	2305 part	2306 part	2307 part	2377	2378
2379 part	2449	2450	2451 part	2452 part	2521
2522	2523	2524 part	2593	2594	2595
2596 part	2597 part	2665	2666	2667	2668
2669 part	2670 part	2737	2738	2739	2740
2741	2742 part	2809	2810	2811	2812
2813	2814 part	2815 part	2881	2882	2883
2884	2885	2886	2887 part	2953	2954
2955	2956	2957	2958	2959	3025
3026	3027	3028	3029		

Assessed to contain 58 blocks (includes 42 full blocks and 16 part blocks).

W06-2
Northern Bonaparte Basin, Western Australia

Map Sheet SC 52 (Melville Island)

2816 part	2817 part	2818 part	2819 part	2820 part	2821 part
2888 part	2889	2890	2891	2892	2893
2960	2961	2962	2963	2964	2965
3030	3031	3032	3033	3034	3035
3036	3037	3102	3103	3104	3105
3106	3107	3108	3109	3174	3175
3176	3177	3178	3179	3180	3181
3246	3247	3248	3249	3250	3251
3252	3253	3318	3319	3320	3321
3322	3323	3324	3325	3390	3391
3392	3393	3394	3395	3396	3397

Assessed to contain 66 blocks (includes 59 full blocks and 7 part blocks).

W06-3
Northern Bonaparte Basin, Western Australia

Map Sheet SC 52 (Melville Island)

2754 part	2755 part	2822 part	2823 part	2824 part	2825 part
2826 part	2827 part	2828 part	2894	2895	2896
2897	2898	2899	2900 part	2966	2967
2968	2969	2970	2971	2972 part	3038
3039	3040	3041	3042	3043	3044
3110	3111	3112	3113	3114	3115
3116	3182	3183	3184	3185	3186
3187	3188	3254	3255	3256	3257
3258	3259	3260	3326	3327	3328
3329	3330	3331	3332	3398	3399
3400	3401	3402	3403	3404	

Map Sheet SD 52 (Darwin)

14	15	16	17	18	19
20					

Assessed to contain 72 blocks (includes 61 full blocks and11 part blocks).

W06-4
Northern Bonaparte Basin, Western Australia

Map Sheet SD 52 (Darwin)

6	7	8	9	10	11
12	13	78	79	80	81
82	83	84	85	150	151
152	153	154	155	156	157
222	223	224	225	226	227
228	229	294	295	296	297
298	299	300	301	366	367
368	369	370	371	372	373
438	439	440	441	442	443
444	445	515	516	517	

Assessed to contain 59 full blocks.

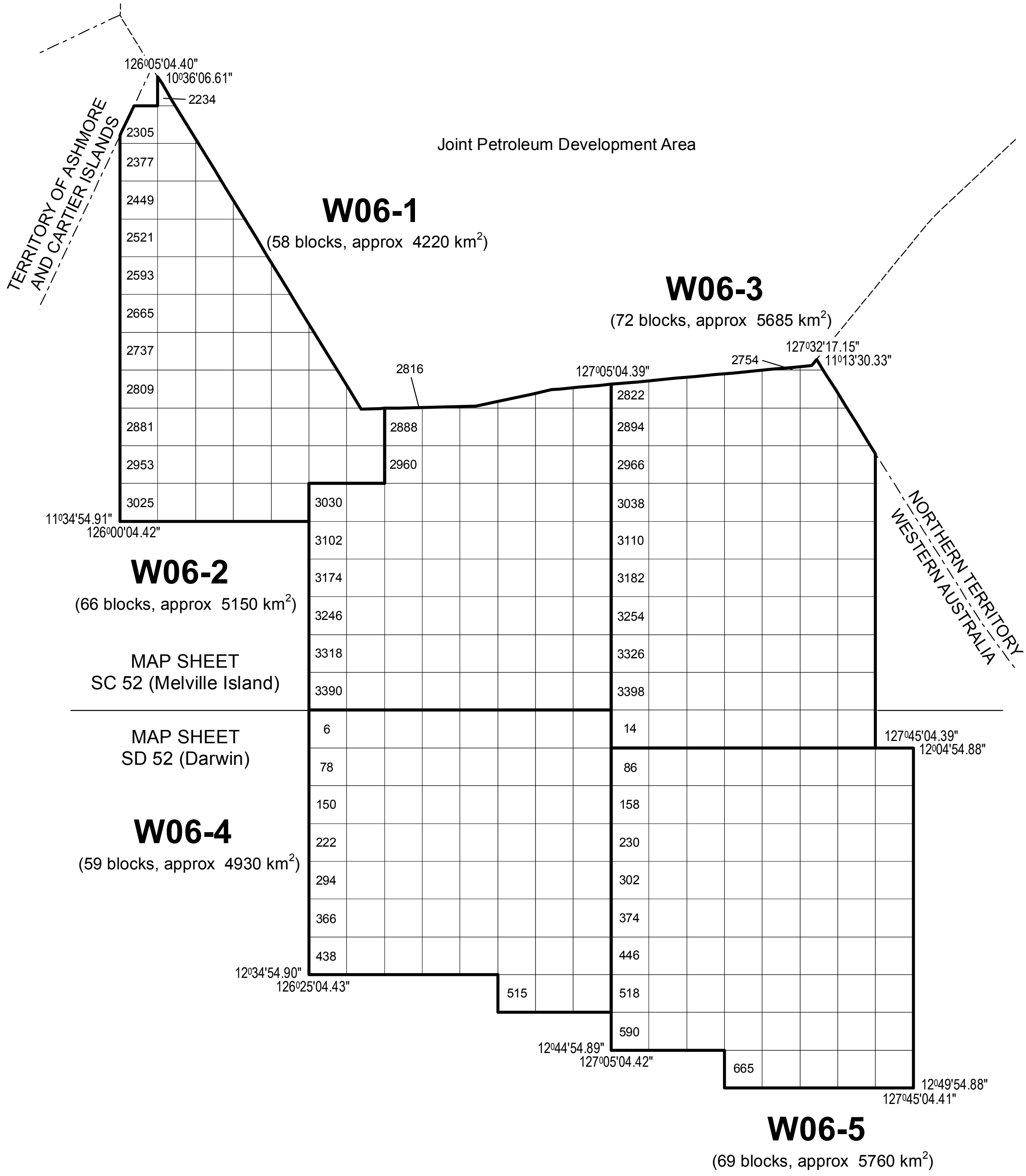
W06-5
Northern Bonaparte Basin, Western Australia

Map Sheet SD 52 (Darwin)

86	87	88	89	90	91
92	93	158	159	160	161
162	163	164	165	230	231
232	233	234	235	236	237
302	303	304	305	306	307
308	309	374	375	376	377
378	379	380	381	446	447
448	449	450	451	452	453
518	519	520	521	522	523
524	525	590	591	592	593
594	595	596	597	665	666
667	668	669			

Assessed to contain 69 full blocks.

2006 Release Area
Northern Bonaparte Basin, Western Australia



Grid coordinates on this map are presented with reference to the Geocentric Datum of Australia (GDA94). Permit areas are based on the same grid, Australian Geodetic Datum (AGD66), that has defined areas since the Petroleum (Submerged Lands) Act was proclaimed in 1967. However, with the adoption of GDA94, the gridlines are no longer referred to in whole multiples of 5 minutes as they were under AGD66.

ASPD 5170-3