Release Areas W09-9, W09-10 and W09-11, Rankin Platform, Carnarvon Basin, Western Australia

Location

Release Areas W09-9, W09-10 and W09-11 are three separate graticular blocks located along the Rankin Platform, where giant gas fields are in production for export LNG and others are scheduled for development. Release Areas W09-9, W09-10 and W09-11 are all approximately 80 km^2 in area. No wells have been drilled in the three Release Areas though they are near to discovered fields and exploration wells.

Release Area W09-9 is the most northerly of the Release Areas and is located between the Echo/Yodel and Sculptor fields (southern end of the producing Rankin Trend) and Chevron's Wheatstone field which is under consideration for development. Release Area W09-9 is in shallow water depths of less than 200 m, around 150 km from the coastline and about 30 km from the pipeline network (**Figure 1**) that supplies gas to the North West Shelf Venture export LNG trains onshore near Karratha. In total the five LNG production unit trains have an annual capacity of 16.3 million tonnes.

Release Area W09-10 is located on the western flank of the Rankin Platform and extends onto the Exmouth Plateau. The Release Area lies between the Orthrus, West Tryal Rocks and newly discovered Julimar Complex gas fields. Release Area W09-10 is located along the shelf break and slope in water depths of between 200 m and 1000 m. The giant Pluto gas field lies to the north along the same shelf break that strikes across the Release Area (**Figure 1**). The Pluto development is well under way with first gas for LNG export expected in 2010 (Woodside, 2008). Release Area W09-10 is about 140 km from the coastline and about 40 km from the gas pipeline that links the John Brookes field to supply the local Western Australian market (**Figure 1**).

Release Area W09-11 is the most southerly of the Release Areas and is located on the western flank of the Rankin Platform where it joins the Exmouth Plateau and the Exmouth Sub-basin. The giant Gorgon gas field is 10 km to the north of Release Area W09-11 and the producing Woollybutt and Griffin oil fields are approximately 30 km to the southwest and 40 km to the south, respectively. It is planned to produce the 40 Tcf of gas in the "greater Gorgon" area, including the supergiant Jansz field, for export LNG, by piping the gas to Barrow Island for processing (Gorgon Project, 2008). Barrow Island, to the east of the Release Area, has produced over 300 MMbbl of oil since the mid-1960s. Release Area W09-11 is in deep water on the continental slope in depths between 500 m and 800 m. It is about 125 km from the coastline and approximately 35 km from the gas pipeline that joins the East Spar field to the domestic gas network (**Figure 1**).

Release Area Geology

Local Tectonic Setting

Release Areas W09-9 and W09-10 are located along the central section of the Rankin Platform. The Rankin Platform is the uplifted eastern edge of the Exmouth Plateau where it bounds the Barrow and Dampier sub-basins along a buried fault escarpment that was modified by erosion and further fault movements in the Middle and Late Jurassic. Release Area W09-9 is the most northerly of the Release Areas and lies on the Rankin Platform where it broadens to about 30 km in width before it steps down into the Dampier Sub-basin to the east (**Figure 2**). The structural grain of the Rankin Platform here is dominated by the northeast-southwest Westralian trend (Bradshaw et al, 1988).

The fault geometries on the Rankin Platform reflect both this deep-seated northeast-southwest trend that is related to the separation of Australia and Greater India; and a north-south structural grain controlled by reactivation of Paleozoic faults (Korn et al, 2003). Triangular shaped horsts (in map view) that host the West Tryal Rocks, Orthrus and Dionysus gas fields that surround Release Area W09-10, have developed at the intersection of these two fault trends (**Figure 1** and **Figure 4**). A similar host structure extends into Release Area W09-10 (WAPET, 1983, 1997).

Release Area W09-11 is located off the western margin of the southern extremity of the Rankin Platform. Here the platform narrows as it swings to a more north-south orientation and joins with the Alpha Arch, an intra-basin high that separates the Exmouth and Barrow sub-basins (**Figure 2**).

Structural and stratigraphic evolution

The Early Triassic of the Carnarvon Basin is marked by a regional marine transgression that represents the sag phase of a previous Paleozoic rift cycle. The marine Locker Shale unconformably overlies the Permian and grades upwards into the fluvio-deltaic Mungaroo Formation. The Mungaroo Formation was deposited in a broad, low relief, rapidly subsiding coastal plain that extended across the Release Areas and throughout the Exmouth Plateau.

The Exmouth, Barrow, Dampier and Beagle sub-basins formed as a series of northeast-trending en-echelon structural depressions during Pliensbachian to Oxfordian times (Tindale et al, 1998). Reactivation of Early Jurassic faults developed the Alpha Arch as an uplifted area separating the Exmouth Sub-basin from the Barrow Sub-basin. These sub-basins are Jurassic depocentres representing a failed rift system that developed during the early syn-rift phase of break-up in the Carnarvon Basin. They contain thick successions of Jurassic oil-prone sediments and are bounded to the west by the subsided continental platform of the Exmouth Plateau which is dominated by a thick, faulted Triassic sedimentary sequence.

Rifting between Australia and Greater India at the end of the Jurassic produced uplift

along the Cape Range Fracture Zone to the south of the Exmouth Sub-basin and provided the sediment source for the Barrow Delta. During the latest Tithonian to mid-Valanginian, the delta prograded from the southwest across the Exmouth Sub-basin and southern Exmouth Plateau; and ultimately into the Barrow Sub-basin, once the barrier of the Alpha Arch was transgressed. Continental break-up in the Valanginian, terminated sediment supply to the Barrow Delta and resulted in reworking and re-deposition of the older delta deposits before a regional marine transgression and post-rift subsidence occurred.

The Late Cretaceous basin inversion event is most pronounced in the Exmouth Sub-basin and on the Exmouth Plateau, where it formed the Novara Arch (**Figure 2**), the Exmouth Plateau Arch and the Resolution Arch. However, there is also some evidence of local structural inversion at this time closer to the Release Areas with a very thin Cretaceous/thick Cenozoic section over the Geryon and Io fields and a thicker Cretaceous/thinner Cenozoic section over the Orthrus and Maenad fields (Korn et al, 2003).

Mid-Miocene uplift, fault re-activation and inversion related to the collision of the Australia-India and Eurasia plates produced anticlinal warping. Structures were formed or enhanced at Woollybutt, Spar, East Spar, John Brookes and Barrow Island (Hearty et al, 2002).

Stratigraphy

The Rankin Platform is underlain by a thick sequence (15 km or more) of Late Paleozoic to Cenozoic sediments. The Early Triassic Locker Shale (**Figure 3**) is expected to underlie the Release Areas, but no units older than the Middle to Late Triassic Mungaroo Formation have been intersected in this part of the Carnarvon Basin.

The fluvio-deltaic Mungaroo Formation is composed of interbedded fine- to coarse-grained fluvial sandstones with grey to black siltstones and claystones and coaly shales that were deposited in an upper delta plain environment. Seismic interpretations indicate that the formation may reach thicknesses of up to 8000 m (Korn et al, 2003) and over 3000 m of Mungaroo Formation were intersected in the Jupiter 1 well on the Exmouth Plateau. This well terminated in interbedded grey-brown siltstones, claystones and white to grey sandstones, with minor coals and dolomites that are of Anisian to Carnian age based on palynomorphs from the *S. quadrifidus* spore/pollen zone (Nicoll, 2002). On the Rankin Platform, intersections of the Mungaroo Formation yielded younger ages including the *M. crenulatus* and underlying *S. speciosus* spore/pollen zones which are considered Carnian to Norian in age (Backhouse et al, 2002; Nicoll, 2002; Seggie et al, 2007). Well log character and amplitude time slices from the seismic data suggest that the Late Triassic sequence in Bluebell 1, located immediately to the south of Release Area W09-10, is not older than the *M. crenulatus* zone (WAPET, 1983) and was deposited as part of a major channel system (Korn et al, 2003).

The uppermost 300 to 400 m of the Mungaroo Formation (the AA sands in WAPET terminology or the E reservoir unit in the Woodside scheme, see Sibley et al, 1999;

Seggie et al, 2007) can include coastal sandstone and claystone indicating a more marine influence towards the top of the formation. Gas bearing, high quality, blocky AA sands occur at the top of the Mungaroo Formation in the Gorgon field located a few kilometres to the north of Release Area W09-11.

In the latest Triassic, a marine transgression flooded the Carnarvon Basin, leading to the deposition of Rhaetian to Early Jurassic marls on the Exmouth Plateau and the marginal marine interbedded sandstones, shales, claystones and siltstones of the Brigadier Formation (*A. reducta* biozone). The Brigadier Formation has been eroded from much of the Rankin Platform but is preserved at Bluebell 1 in the low area between the Gorgon and West Tryal Rocks horsts and may well be present in Release Area W09-10. The Brigadier Formation is absent on the high blocks drilled at Iago 1 (ChevronTexaco, 2003) and Malmsey 1 (Woodside, 1998), but present at Malus 1 and may be preserved across part of Release Area W09-9.

During the Middle to Late Jurassic several kilometres of restricted marine mudstones (Dingo Claystone) were deposited in the subsiding Barrow, Dampier and Exmouth sub-basins. The deep-water central depocentres were progressively filled with fine-grained sediments which overlapped onto the flanks of the Rankin Platform. Thin Late Jurassic sections have been penetrated in Malus 1 (10 m), Dionysus 1 (53 m), Chrysaor 1 (44 m), and North Gorgon 2, 3 and 4 (WAPET,1997) and may extend into the Release Areas W09-9 and W09-10. On the Exmouth Plateau at Zeepaard 1, over 50 m of Late Jurassic dark grey siltstones and very fine sandstones were intersected and may also occur within Release Area W09-11.

In the earliest Cretaceous, the Barrow Delta prograded from the south over the Exmouth Sub-basin and the southern and central Exmouth Plateau. It had blanketed the Alpha Arch by the mid-Berriasian (Smith et al, 2003) and extended into the Barrow Sub-basin as far as the southern end of the Gorgon field. The Barrow Group thins across the Alpha Arch and Release Area W09-11 where it is approximately 1500 m thick, while it is in excess of 2000 m thick in the Exmouth Sub-basin depocentre to the south and the Woollybutt area in the Barrow Sub-basin to the east of W09-11 (Hearty et al, 2002, figure 4). Deepwater, fine-grained prodelta sediments (Forestier Claystone) were deposited further north, beyond the delta front, in Release Areas W09-10 and W09-9. At Bluebell 1 the complete Barrow Group section is represented by 102 m of prodeltaic siltstones and claystones and at Malmsey 1 it has thinned to a condensed claystone section of only nine metres.

Final separation of Australia and Greater India in the early Valanginian along the southern edge of the Exmouth Plateau cut off the sediment supply for the Barrow Delta. The delta sediments were then eroded and reworked, and re-deposited as the Zeepaard and Birdrong Formations (Arditto, 1993). The Zeepaard Formation (*S. areolata* biozone) is separated from the underlying Barrow Group sediments by the major sequence boundary of the Valanginian unconformity (KV seismic horizon in Woodside terminology, Longley et al, 2002). The deltaic Zeepaard Formation is the dominant reservoir sequence for the Griffin and Chinook/Scindian oil and gas fields to the south of Release Area W09-11 (**Figure 4**). The shelfal Birdrong Formation was deposited as a back-stepping progradational sequence on top of, but displaced eastwards of the Zeepaard delta as the

transgression proceeded.

The thin, glauconitic Mardie Greensand which overlies the Barrow Group represents the reworked top of the delta sequence in shallow marine, sediment starved environments. After break-up, as the basin margin subsided, the marine shales and siltstones of the Muderong Shale and Gearle Siltstone, respectively, were deposited across the Barrow Sub-basin and Rankin Platform (**Figure 3**). The Late Cretaceous to Cenozoic sedimentary section in the region of the Release Areas is dominated by fine-grained carbonates. Across the Dampier and Barrow sub-basins, a major carbonate platform developed from the Late Oligocene onwards. The shallow shelf has advanced westward, built by successive wedges of bioclastic carbonates such that the shelf edge lies now seaward of Release Area W09-9 and is at the eastern edge of Release Area W09-10 (**Figure 1** and **Figure 5**).

Exploration History

The offshore Carnarvon Basin was established as a major hydrocarbon province in the 1960s and early 1970s, with WAPET's island and shallow water drilling program (Mitchelmore and Smith, 1994). Giant discoveries were made, including (in 1964) a billion barrels of oil-in-place at Barrow Island in the Barrow Sub-basin. Tryal Rocks 1, drilled in 1970, was one of the first tests of an offshore prospect. Early Cretaceous Barrow Group sandstones were intersected in the well but no significant hydrocarbon shows were recognised (Auld et al, 2002). The giant gas fields on the Rankin Platform were found in 1971 with the North Rankin 1 and Goodwyn 1 exploration wells. There was no immediate market for the gas and the main focus of exploration in the offshore Carnarvon Basin was the inboard oil trend in the Dampier and Barrow Sub-basins.

In the late 1970s and early 1980s exploration in the Carnarvon Basin again shifted westwards to the deepwater Exmouth Plateau. During this phase, the giant Gorgon gas field was discovered on the southern Rankin Platform. In 1984 the North West Shelf Project commenced domestic gas production from the North Rankin field and in 1989 the first LNG cargo was shipped to Japan .

Demand for LNG in Asia and rising energy prices have seen increased exploration along the Rankin Platform and on the Exmouth Plateau in recent years. One of the largest discoveries yet made in Australia is Jansz, a super-giant gas field in a new play type drilled in 2000 on the Exmouth Plateau in the Carnarvon Basin (Jenkins et al, 2003). Other recent large gas finds have been made along the Rankin Platform at Wheatstone, Pluto, Xena, Clio and Julimar.

Triassic horst blocks were the initial play type successfully pursued along the Rankin Platform with success from North Rankin (1971) in the north to Gorgon (1980) in the south; and more recent discoveries such as Wheatstone (2004). In the mid-1990s discoveries at Perseus (1995) and Keast (1997) demonstrated that downside-fault block traps were also viable gas targets on the Rankin Platform and the recent discoveries within the Julimar Complex have proven the success of stratigraphic traps identified with geophysical techniques (Apache Corporation, 2008).

Well Control

More than 100 exploration and appraisal wells have been drilled along the Rankin Platform resulting in the discovery of many giant gas fields. No wells have been drilled in Release Areas W09-9, W09-10 and W09-11. The key wells in the areas surrounding the Release Areas are described below and are grouped geographically. The wells located on the central Rankin Platform, and relevant to Release Areas W09-9 and W09-10, are discussed first, then follow those located on the southern Rankin Platform, Alpha Arch and Exmouth Plateau that are relevant to Release Area W09-11.

North Tryal Rocks 1 (1972)

North Tryal Rocks 1 drilled to test the Mungaroo Formation within a Triassic horst recovered a small quantity of gas by wireline formation test.

West Tryal Rocks 1 (1973)

West Tryal Rocks 1, located to the immediate southeast of Release Area W09-10, was drilled in 1972 by WAPET. Gas was recorded in sandstones of the Mungaroo Formation in a Triassic horst block, extending the proven trend from the south where the North Rankin and North Tryal Rocks discoveries were made earlier that year.

Malus 1 (1972)

Malus 1, drilled to a total depth of 3658 mRT, tested the hydrocarbon potential of a large, uplifted and tilted fault block to the southwest of the Rankin Trend. This feature extends into Release Area W09-9. This well penetrated sediments of Late Jurassic age (*O .montgomeryi* to *W. spectabilis* biozones) for the first time on the Rankin Platform. The Jurassic section was composed of Tithonian marls and claystones (Dingo Claystone) and Oxfordian sands (Jansz Sandstone equivalent?) which unconformably overlie interbedded claystones, sandstones and minor coals of the Brigadier and Mungaroo formations (Figure 3). No significant hydrocarbons were encountered and wireline log evaluation and test results showed that all intervals penetrated were water-bearing.

Sultan 1 (1979)

This well was drilled to test the Mungaroo Formation on a horst on the Rankin Platform (**Figure 5**), and is located mid-way between Release Areas W09-9 and W09-10. The Mungaroo Formation sandstones were found to be water-bearing. A core cut in one of the sandstones, exhibited porosities ranging from 14 to 23% and permeabilities ranging from 2 to 128 mD. A core plug (with the lowest porosity and permeability) had a residual oil saturation of 0.8%.

Bluebell 1 (1983)

Bluebell 1 was drilled by WAPET to test the Mungaroo Formation on a tilted horst on the Rankin Platform to the south of Release Area W09-10. The structure is surrounded by the gas-bearing Chrysaor, Gorgon and West Tryal Rocks horsts. The top of the Mungaroo Formation was penetrated 549 m deeper than predicted. Two cores were cut in the Brigadier Formation, and two in the Mungaroo Formation. Reservoir properties determined by core analysis are poor. Sandstones of the Mungaroo Formation are water-bearing. The well may not have been drilled at an optimal location on the structure, and gas-bearing pools may exist further updip to the southwest in the structure.

Echo 1 (1988), Yodel 1 (1990)

The Echo/Yodel field at the southern end of the Rankin Trend was discovered in 1988 with the drilling of Echo 1. This well tested a Triassic fault block trap. The well intersected a 19 m gross gas column in upper E Unit Mungaroo Formation sands sealed by the Early Cretaceous Forestier Claystone (Bal et al, 2002). Yodel 1 was drilled in 1990 to test lower E Unit Mungaroo sands updip from Echo 1, where these excellent reservoir quality sands were water wet. In Yodel 1 a 40 m gross gas column was intersected in the Lower E Unit sands with an intervening claystone. The Triassic lower E unit sands were found to be hydrocarbon-bearing and with a different gas-water-contact (GWC) than that seen in the Echo 1 well. The condensate yield from Yodel 1 was also different to that from Echo 1. The Yodel 1 well successfully demonstrated the sealing nature of the Mungaroo Formation E unit claystones. (Bal et al, 2002).

Venture 1, 1ST1 (1990), Venture 2 (1995)

Venture 1 was drilled to test the Mungaroo Formation close to the boundary between the Rankin Platform and the Barrow Sub-basin (**Figure 5**). After a gas kick whilst drilling claystones and siltstones of the Muderong Shale, the pipe became stuck and the original hole was sidetracked. 3L of liquid hydrocarbon with an API gravity of 36° were recovered from the mud pit after a gas kick with an accompanying 16 barrel pit gain at 2949 mRT. This liquid hydrocarbon is likely to be a condensate separated from the gas. After the mud weight had been increased to 1.88 g/cc to cope with increasing mud gas, the well was plugged and abandoned within the Muderong Shale (WAPET, 1991).

After the 1993 Venture-Carey 3D seismic data sets had been interpreted, **Venture 2** (1995) was drilled to test Upper Jurassic and Lower Cretaceous fan sandstones on a rollover structure adjacent to the Triassic Venture horst structure some 4 km northeast of the Venture 1 well. Below the Muderong Shale, the well intersected the Barrow Group and reached total depth in the Dingo Claystone. This well was not programmed to drill into the Triassic Venture horst. Although high-density mud (up to 2.05 g/cc) was used, strong wet gas shows were encountered in the Muderong Shale, Barrow Group and Dingo Claystone. However, only thin sandstones were intersected in these sequences. No testing was attempted in the well.

Chrysaor 1 (1994), Dionysus 1 (1996)

The Chrysaor and Dionysus gas fields are located on the Rankin Platform immediately to the west of Release Area W09-10. In the mid 1990s, the established Triassic fault block play was targeted by WAPET and its successor Chevron Australia Pty Ltd, in deeper water along the eastern margin of the Exmouth Plateau. Chrysaor 1 (1994) and Dionysus 1 (1996) were drilled by WAPET to test potential DHIs north of the giant Gorgon gas field and led to the discovery of further giant gas fields with significant quantities of associated condensate (Longley et al, 2001; Walker, 2007). From 1999 to 2001, gas discoveries were also made at Geryon/Callirhoe, Orthrus, Maenad and Urania, all of which have strong AVO-signatures (Korn et al, 2003). Most of the discovery wells tested Triassic horsts where good quality reservoir facies were intersected in Late Triassic sediments, and, to a lesser extent, in the Early Jurassic (Brigadier Formation) sediments. Overlying

seals in the Late Triassic and Early Jurassic were preserved on some fault blocks, and where this section has been removed due to Late Jurassic erosion, traps can occur beneath the regional Cretaceous seal.

Sculptor 1 (1995)

Sculptor 1 was drilled in 1995 to test the hydrocarbon potential of one of the east-west orientated fault blocks to the south of the Echo/Yodel field. High quality lower E Unit Mungaroo Formation sandstones were intersected and a gross 18 m gas column was encountered, with the GWC masked by shale. Pressure and gas composition data support Sculptor 1 being isolated from Echo/Yodel field according to Bal, et al (2002).

Keast 1 (1997)

Keast 1 was the first well to be drilled within the Keast Graben to the east of Echo/Yodel field (Woodside, 1997). In the graben the Early Jurassic Brigadier Formation (*A. reducta* biozone) is preserved and directly underlies the Early Cretaceous Forestier Claystone (*E. torynum* biozone). Keast 1 tested a structural/stratigraphic trap and reached a total depth of 3763 mRT in sandstones of Norian age representing the G Unit of the Mungaroo Formation. Five different hydrocarbon bearing zones were encountered in the Brigadier and Mungaroo formations (D and E units).

Malmsey 1 (1998)

Malmsey 1, located to the immediate south of Release Area W09-9 was drilled by Woodside Energy Ltd on the same large triangular horst block drilled by Malus 1. At this near crestal location the Early Cretaceous Muderong Shale directly overlies the Mungaroo Formation, while in Malus 1 both the Late Jurassic Dingo Claystone and Early Jurassic Brigadier Formation were intersected. Malmsey 1 encountered well developed reservoir sandstones within the Triassic Mungaroo Formation, 138 m higher than predicted and water wet. Malmsey 1 encountered the objective, the Triassic Mungaroo Formation sandstones belonging to the F, G, H and I Units (Woodside, 1998; Seggie et al, 2007). No significant hydrocarbon shows were encountered and petrophysical evaluation indicates that all potential reservoir sands are water wet. The well encountered 337 m of potential net'reservoir' sand. Average log porosity ranged from 20% in the F and G Unit sandstones, higher than prognosis, to 14.6% in the H Unit sandstones. The well completion report (Woodside, 1998) suggests that sealing bounding faults on the Malmsey-Malus horst have prevented migration of hydrocarbons into the structure.

Jansz 1 (2000), Io 1 (2001)

The supergiant Jansz/Io gas accumulation introduced a new play type to the basin. Hydrocarbons are stratigraphically trapped in an Oxfordian shallow marine sandstone (**Figure 4**) on the western limb of the Kangaroo Syncline (Jenkins et al, 2003). The field

covers an area of approximately 2000 km^2 and the discovery wells Jansz 1, drilled by Mobil Exploration & Producing Australia Pty Ltd, and Io 1, drilled by Chevron Australia Pty Ltd, are located 18 km apart. The Oxfordian (*W. spectabilis* biozone) gas reservoir at Jansz 1 and Io 1 is in pressure communication with Tithonian and Triassic to Early Jurassic Brigadier Formation gas-bearing sandstones at Geryon 1 and Callirhoe 1 (Jenkins et al, 2003), a further 30 km away. Appraisal wells Jansz 2 (2002) and Jansz 3 (2003), plus a prominent AVO-response indicate that this discovery has a large areal extent and its mapped shape demonstrates the stratigraphic nature of the trap (**Figure 4**).

Iago 1 (2000)

Iago 1 is located on the Rankin Platform about 8 km to the south of Release Area W09-9. It was drilled by ChevronTexaco on an offset structure to the North Tryal Rocks gas accumulation, which was discovered in 1972. The well encountered a total net gas pay of 20 m in high-quality sandstones at the top of the Mungaroo Formation (AA Sand, see ChevronTexaco, 2003 and Sibley et al, 1999). About 30 m of Early Cretaceous Forestier Claystone (the deepwater facies equivalent of the Barrow Group) seals the Mungaroo Formation sandstones.

Wheatstone 1 (2004)

Wheatstone is a giant gas accumulation on the Rankin Platform located to the immediate west of Release Area W09-9. Over 53 m of net gas sands were intersected in the Tithonian overlying the main reservoir interval of 126 m in the Triassic Mungaroo AA sands (Chevron, 2004). A seven well appraisal program has been completed and the planned development is for both export LNG and domestic gas (Chevron, 2008).

Pluto 1 (2005)

Pluto 1 is a giant gas discovery made by Woodside Energy Ltd in April 2005 on the Rankin Platform between Release Areas W09-9 and W09-10. As with Release Area W09-10, the accumulation straddles the shelf break. The Triassic sandstone is the reservoir in the Pluto accumulation (Walker, 2007). The fast-track Pluto gas development is currently under construction. The Pluto project is a production platform-based development with a trunk pipeline to the mainland. A Pluto production platform will provide nearby undeveloped or yet to be discovered gas accumulations with aggregation possibilities and could become a regional hub. The operator intends to commence gas production from the Pluto accumulation in 2010.

Julimar 1 (2007)

The Julimar Complex is located on the central Rankin Platform to the immediate east of Release Area W09-10. During 2007 and 2008 Apache Corporation made six gas discoveries within the Julimar Complex - Julimar 1, Julimar East 1, Julimar Southeast 1,

Julimar Northwest 1, Brunello 1 and Brulimar 1. These wells intersected stacked gas pay in a number of Mungaroo Formation sandstones and the size of the gas accumulation is thought to be in the range of 2 to 4 Tcf According to the operator (Apache Corporation, 2008). In the Julimar Complex, geophysical techniques have been successfully used to target gas sands in stratigraphic traps.

Spar 1 (1976)

Spar 1 was drilled as a 3000 m test of a domal closure in the top of the Barrow Group and was ultimately drilled to a total depth of 3721 mRT as a result of encouraging hydrocarbon shows in the objective section. Two discrete gas accumulations were discovered in the Barrow Group, separated vertically by shales and water wet sands. Log evaluation indicates 86.6 m of net and effective and 7.5 m of probable gas pay. Spar 1 discovered the first substantial hydrocarbon accumulation yet found in the Flacourt Formation of the Barrow Group. The well terminated in the basal Cretaceous (*P. iehiense* biozone) because of rapidly increasing formation pressure and resultant high mud weights.

Zeepaard 1 (1980)

Zeepaard 1 was drilled by Esso Australia Ltd in 740 m of water to a total depth of 4215 mKB within the Mungaroo Formation. Zeepaard 1 is a gas discovery located on the Exmouth Plateau less than 20 km west of Release Area W09-11. The primary objective was sandstones of the Mungaroo Formation within a horst, and the secondary objective was turbidite sandstones of the Barrow Group on a stratigraphic pinch-out trap on the down-thrown side of a fault. Both sandstones were found porous and permeable. Minor gas shows were recorded in the Barrow Group. Gas was recovered by a wireline formation test at 4014.5 mKB from a thin sandstone in the Mungaroo Formation. The Dingo Claystone is thin (55 m) in this well, but this formation, as well as the underlying Mungaroo Formation, is over-pressured. The lower part of the Barrow Group and the Dingo Claystone have good oil sourcing potential with high quantities of extractable hydrocarbons and a high proportion of sapropel. These units are early mature with mean vitrinite reflectance values of up to 0.64%. Claystones within the Mungaroo Formation have good TOC contents with mixed oil and gas-prone kerogen types (Esso Australia Limited, 1981).

Gorgon 1 (1980)

Gorgon 1 was drilled by WAPET and reached a total depth of 4401 mRT. It is the discovery well on a giant gas/condensate field located about 10 km to the north of Release Area W09-11. The well was drilled towards the southern end of a large fault-bounded uplifted Triassic horst draped by younger sediments. Sandstones in both the Early Cretaceous Barrow Group and Late Triassic Mungaroo Formation were the well objectives. The main accumulation is within Triassic sandstones of the Mungaroo Formation. The gas composition is relatively high in carbon dioxide and the plans for the

development of the field include geological storage of the CO_2 in reservoirs below Barrow Island (Gorgon Project, 2008).

Griffin 1 (1990)

The Griffin and Chinook/Scindian oil fields are located on the Alpha Arch some 40 km south of Release Area W09-11. The Griffin/Ramillies oil field was originally discovered by the Hilda 1A well, which was drilled in 1974, to primarily test the Triassic Mungaroo Formation within a horst on the Alpha Arch. The primary target was water-bearing, and an oil discovery in the Mardie Greensand was not considered as an economically viable accumulation at that time, and the petroleum exploration permit was relinquished. BHP Petroleum Pty Ltd (BHP) drilled Griffin 1 in 1990 and discovered a commercial oil accumulation. In the previous year, BHP drilled the Chinook 1 oil discovery well in an adjoining petroleum exploration permit. Petroleum is reservoired in the Zeepard Formation of the Barrow Group and the overlying Mardie Greensand in these oil fields. Reservoir quality is far better in the Zeepard Formation than in the Mardie Greensand. Top seal is provided by the Muderong Shale. To date, Griffin/Ramillies is the largest offshore oil field in the Barrow Sub-basin, with initial oil reserves of 149.6 MMbbls (Department of Mines and Petroleum, Western Australia, 2008).

Minden 1 (1991)

Minden 1 is located on the Alpha Arch, approximately 10 km south of Release Area W09-11. It was drilled by BHP as a test of the Triassic Mungaroo Formation with a secondary target in the overlying Barrow Group. Due to overpressured gas sands in the Barrow Group, the primary target was not reached and the well terminated in the Early Cretaceous (*D. lobispinosum* biozone)

York 1 (1993)

York 1 is located on the Alpha Arch some 20 km south of Release Area W09-11. It was drilled to test the Birdrong Sandstone on a four-way dip closure with 15 m vertical relief. Good reservoir sandstones with high net-to-gross ratios were intersected in the Birdrong Sandstone and underlying Zeepaard Formation. The Birdrong Sandstone has core plug porosities of 15 to 20% and permeabilities of up to 3000 mD. The well intersected the entire Zeepaard Formation and reached a total depth of 3372 mRT in the Barrow Group (*E. torynum* biozone), without encountering any significant hydrocarbons. The mapped closure may not be valid on the York structure. This well was not drilled into a deeper target of possible slope fan sandstones that may form stratigraphic traps in the intra-Barrow Group on the York structure.

East Spar 1 (1993)

The East Spar field was discovered by the East Spar 1 well drilled by Western Mining

Corporation in 1993. The field is a Barrow Group gas accumulation in a four way dip closure. Careful depth conversion was required to reveal the East Spar structure which is not apparent in time. The gas-bearing sandstone at the top of the Barrow Group was deposited as an incised-valley fill at a progradational edge of the Barrow Delta lobe. The sandstone is overlain by the shallow marine, glauconitic Mardie Greensand, which acts as a thief zone. Top-seal is provided by the Muderong Shale. Production commenced in 1996, and gas and condensate are piped to processing facilities on Varanus Island, which is located 60 km east of the field (Craig et al, 1997).

Woollybutt 1 (1997)

The producing Woollybutt oil field is located off the Alpha Arch in the western Barrow Sub-basin, some 30 km southeast of the Release Area W09-11. The West Barrow 1A (1982) and 2 (1985) wells were the first to test the Woollybutt structure. Because of overpressure-related drilling problems, the Mardie Greensand or top Barrow Group sandstone was not tested in either well. More than ten years later the Woollybutt 1 well discovered an oil pool in these sandstones. The top Barrow Group sandstone, the prime reservoir in the Woollybutt field, was deposited as an incised-valley fill within the top-set sequence of the Barrow Delta. The lateral continuity of the sandstone is poor on the Woollybutt structure (Hearty et al, 2002). The Woollybutt field was commissioned in 2003.

Euryale 1 (1999)

Euryale 1 is located close to the northern boundary of Release Area W09-11 in about 700 m of water. It was drilled by WAPET targeting Barrow Group sands in a faulted anticlinal closure formed by drape over a rotated Triassic fault block at depth. Euryale 1 was a valid structural test and good sands were intersected in the Barrow Group but were water wet. The well reached a total depth of 3298 mRT in the Barrow Group/Zeepaard Formation (*S. areolate* biozone). Potential reservoirs deeper in the Barrow Group or in the Triassic remain untested on the structure. Poor reservoir quality sandstones in the Mardie Greensand, directly overlying the Barrow sands, were also water wet and may have acted as a thief zone for any hydrocarbons at this top porosity level beneath the Muderong Shale regional seal.

Antiope 1 ST1 (2000)

Antiope 1 ST1, drilled by BHP on the Alpha Arch, is a gas discovery in the Early Cretaceous Zeepaard Formation . The well targeted an anticline in the hanging wall of the Minden Fault based based on interpretation of 2D seismic data. Antiope 1 was sidetracked due to mechanical problems and Antiope ST1 intersected a total of 20.5 m of gas-bearing sandstone, composed of two discrete gas-on-water sands.

Xanthe 1 (2001)

Xanthe 1 was drilled by BHP to test a drape anticline on the Alpha Arch, located about 15 km to the south of Release Area W09-11. The primary targets were the Early Cretaceous sandstones of the Birdrong Sandstone and Zeepaard Formation. Good quality sands were intersected in both units but were found to be water wet. The well completion report (BHP Petroleum, 2001) states that lack of structural closure is the most likely reason for the failure of Xanthe 1, given that it is a low relief structure that is very sensitive to lateral velocity changes.

Lauda 1 and 2, and Maier 1 (2005)

These three wells were drilled in early 2005 by OMV in petroleum exploration permit WA-280-P, which adjoins Release Area W09-11. They were sited using the non-exclusive Minden Multi Client 3D seismic survey. Lauda 1 intersected a 6 m gross oil column at the top of the Barrow Group. Lauda 2, which was a sidetrack of Lauda 1, did not intersect the oil column, and Lauda 1 was plugged and abandoned. Maier 1 was a dry well.

Table 1: Key wells listing

Well	Operator	Year	Total Depth	Hydrocarbons
Altair 1	West Australian Petroleum Pty Ltd	1995	3793 mRT	No shows
Antiope 1	BHP Petroleum Pty Ltd	2000	3084 mRT	no tests
Antiope 1 ST1	BHP Petroleum Pty Ltd.	2000	3468 mRT	Gas
Bluebell 1	West Australian Petroleum Pty Ltd	1983	4605 mRT	minor gas
Bowers 1	West Australian Petroleum Pty Ltd	1982	4300 mKB	Gas
Brunello 1	Apache Northwest Pty Ltd	2007	3274 mRT	no public data
Brunello 1 ST1	Apache Northwest Pty Ltd	2007	3771 mRT	Gas

Carey 1	Apache Northwest Pty Ltd	2006	4408 mRT	no public data
Chrysaor 1	West Australian Petroleum Pty Ltd	1995	3597 mRT	Gas
Clio 1	Chevron Australia Pty Ltd	2006	4953 mRT	Gas
Dionysus 1	West Australian Petroleum Pty Ltd	1996	4417 mRT	Gas
East Spar 1	Western Mining Corporation Ltd.	1993	2622 mRT	Oil and Gas
Euryale 1	West Australian Petroleum Pty Ltd	1999	3297.6 mRT	No tests
Gorgon 1	West Australian Petroleum Pty Ltd	1981	4401 mRT	Gas
Gorgon 3	West Australian Petroleum Pty Ltd	1998	4510 mRT	Gas
Guilford 1	Woodside Energy Ltd	2003	4272 mRT	Gas
Iago 1	Chevron Australia Pty Ltd	2001	3383 mRT	Gas
Ixion 1	Woodside Energy Ltd	2008	3145 mRT	no public data
Julimar 1	Apache Energy Limited	2007	3777 mRT	Gas
Julimar East 1	Apache Energy Limited	2007	5202 mRT	Gas
Julimar North West 1	Apache Energy Limited	2008	3816 mRT	Gas

Julimar South East 1	Apache Energy Limited	2008	3976 mRT	Gas
Lady Nora 1	Woodside Energy Ltd	2007	3558 mRT	minor gas
Lady Nora 2	Woodside Petroleum Ltd	2008	3425 mRT	minor gas
Lauda 1	OMV Barrow Pty Ltd	2005	3288 mRT	Oil
Lauda 2	OMV Barrow Pty Ltd	2005	3613 mRT	no public data
Maenad 1	Chevron Australia Pty Ltd	2000	1734 mRT	no tests
Maenad 1A	Chevron Australia Pty Ltd	2000	3680 mRT	Gas
Maier 1	OMV Barrow Pty Ltd	2005	3240 mRT	no public data
Malmsey 1	Woodside Offshore Petroleum Pty. Ltd.	1997	4249 mRT	no tests
Malus 1	B.O.C. of Australia Limited	1972	3658 mRT	no tests
Minden 1	BHP Petroleum Pty. Ltd.	1991	3790 mKB	no tests
Minden 1 ST1	BHP Petroleum Pty. Ltd.	1991	4022 mKB	minor gas
North Gorgon 1	West Australian Petroleum Pty. Limited	1983	4500 mRT	Gas
North Tryal Rocks 1	West Australian Petroleum Pty Ltd	1972	1920 mRT	no tests
North Tryal Rocks 1 ST1	WAPET	1972	3658.5 mKB	Gas

Pemberton 1	Woodside Energy Ltd	2006	3326 mRT	Gas
Pluto 1	Woodside Energy Ltd	2005	3300 mRT	Gas
Robot 1	BP Petroleum Development Ltd.	1988	969 mKB	no tests
Robot 1A	BP Petroleum Development Ltd.	1988	3454 mKB	minor oil
Saturn 1	Phillips Australian Oil Company	1981	4000 mRT	Gas
Sultan 1	West Australian Petroleum Pty Ltd	1979	3620 mRT	Minor gas
Venture 1	West Australian Petroleum Pty Ltd	1990	2949 mRT	Oil and minor gas
Venture 1 ST1	West Australian Petroleum Pty Ltd	1990	3324 mRT	no tests
Webley 1	Woodside Energy Ltd	1999	1725 mRT	no tests
Webley 1A	Woodside Energy Ltd	1999	3108 mRT	minor gas
West Tryal Rocks 1	West Australian Petroleum Pty Ltd	1973	3866 mKB	Gas
West Tryal Rocks 2	West Australian Petroleum Pty Ltd	1974	3825 mRT	Gas

West Tryal Rocks 3	West Australian Petroleum Pty Ltd	1982	4035 mRT	minor oil and minor gas
Wheatstone 1	ChevronTexaco Australia Pty Ltd	2004	3410 mRT	Gas
Wilcox 1	Woodside Offshore Petroleum Pty Ltd.	1983	4024 mDF	Gas
Woollybutt 1	Ampolex Ltd	1997	2642 mRT	Oil
Woollybutt 3A	British Borneo Australia Ltd	1999	2952 mRT	Oil and Gas
Xanthe 1	BHP Petroleum (Australia) Pty Ltd	2001	3220 mRT	no tests
Xena 1	Woodside Energy Ltd	2006	1834 mRT	no public data
Xena 1ST1	Woodside Energy Ltd	2006	3490 mRT	Gas
York 1 (BHP)	BHP Petroleum	1993	3372 mRT	no tests
Zeepaard 1	Esso Australia Ltd	1980	3843.8 mKB	no tests
Zeepaard 1 ST1	Esso Explor and Prod Aust Ltd	1980	4215 mKB	Gas and minor oil

Rig Release Year shown. Shaded areas highlight those wells for which complete data sets are not yet available. Data accurate as at 31 March 2009

Seismic Coverage

Although there are no wells drilled within the Release Areas, there is a dense grid of 2D seismic of various vintages as well as recent 3D seismic coverage, some of which is open file. A full listing of the seismic is available in the _____

Hydrocarbon Potential

The surrounding gas and oil fields indicate that Release Areas W09-9, W09-10 and W09-11 are highly prospective for petroleum. Locally there are proven plays at the Triassic, Early Jurassic and Early Cretaceous levels.

Petroleum Systems

Two proven petroleum systems are recognised in the Release Areas. Release Areas W09-9 and W09-10 are located within the heart of the Rankin Platform, where giant gas fields in Triassic and Early Jurassic sands, are charged from deltaic Triassic to Middle Jurassic source rocks and sealed by Early Cretaceous shales. Release Area W09-11 is located at the southern end of the Rankin Platform and in addition to the Triassic-dominated system, also has access to the Late Jurassic oil-prone system as seen in the Barrow and Exmouth sub-basins. Early Cretaceous Barrow Group sands as well as the Late Triassic Mungaroo Formation and the Early Jurassic Brigadier Formation are viable reservoirs.

Hydrocarbon Families

Geochemical studies (Boreham et al, 2001; Edwards and Zumberge, 2005; Edwards et al, 2007) indicate that the giant gas accumulations of the Rankin Platform were sourced from deltaic Triassic to Middle Jurassic source rocks. Release Areas W09-9 and W09-10 are surrounded by these gas fields.

The oil fields of the Barrow Sub-basin are sourced from the marine Jurassic Dingo Claystone, particularly the organic rich Oxfordian interval (van Aarssen et al, 1996). The Dingo Claystone is also the source of the oil fields in the Exmouth Sub-basin (Tindale et al, 1998). In Euryale 1, located immediately adjacent to Release Area W09-11, fluid inclusion analyses undertaken by CSIRO (WAPET, 1999) indicate that a palaeo-oil column was present and was sourced from a moderately mature marine source rock. This observation is consistent with a local Jurassic oil source being present as well as the pervasive Triassic gas source.

Source Rocks

The underlying thick sequence of Mungaroo Formation deltaic sediments is considered a major source of the hydrocarbons on the Rankin Platform. Gas charge from deeply buried Mungaroo Formation coals and carbonaceous claystones may be supplemented by possible organic-rich units in the Early Triassic (marine Locker Shale equivalents). Where mature, there also may be contributions from the marginal marine Early Jurassic Brigadier Formation, which can have enhanced organic richness (up to 10.78% in Keast 1, Woodside, 1997). The variation in gas/condensate ratios along the Rankin Platform may in part reflect different source facies within the Triassic and Early Jurassic.

The Late Jurassic Dingo Claystone is the principal oil source rock for the Carnarvon Basin. It was deposited in deep-water, low energy, anoxic environments in the Exmouth, Barrow and Dampier sub-basins and is generally absent from the Rankin Platform. However the Griffin oil field and the fluid inclusions in Euryale 1 are consistent with the Alpha Arch receiving an oil charge from the Dingo Claystone in the Exmouth and the Barrow sub-basins.

Expulsion and Migration

On the Exmouth Plateau, peak gas generation from Triassic source rocks is interpreted to occur now at depths greater than 5 km below sea floor (Bussell et al, 2001). The Rankin Platform is assumed to have access to this active gas source, as well as to late gas generation from the Jurassic in the adjacent Barrow depocentre. Oil generation from the Dingo Claystone commenced in the Exmouth Sub-basin and southern parts of the Barrow Sub-basin in the Early Cretaceous with the loading of the Barrow Delta (Tindale et al, 1998; Smith et al, 2003). Further north into the Barrow Sub-basin, beyond the main delta front, significant oil expulsion may have occurred as early as the Late Cretaceous. This was followed by Cenozoic gas generation in response to the progradation of the carbonate shelf. The John Brookes and East Spar fields provide evidence of an earlier palaeo-oil charge (Mobil Exploration & Producing Australia, 1999). The oil accumulation at Woollybutt was shielded from flushing by this late gas charge by the presence of a major northwesterly plunging fold through the Spar and East Spar gas fields (Hearty et al, 2002).

Reservoirs

The proven hydrocarbon-bearing reservoirs in the region surrounding the Release Areas include sandstones in the Late Triassic Mungaroo Formation, Early Jurassic Brigadier Formation and the Early Cretaceous Barrow Group and Birdrong Sandstone. Potentially, Late Jurassic sandstones, analogous to the Jansz Sandstone may occur on the flanks of the Rankin Platform.

The major concentrations of stacked channel sands are recognised within the Mungaroo Formation in the E, G and I Units of Norian age (Seggie et al, 2007). The good quality upper Mungaroo Formation E reservoir unit in the Woodside scheme is equivalent to the AA sands in WAPET terminology (Sibley et al, 1999; Seggie et al, 2007). In Iago 1, located close to Release Area W09-9, the AA sands have an average porosity of 19.5% and in West Tryal Rocks 1, located close to Release Area W09-10, the upper Mungaroo Formation sandstone has maximum porosities of 28% and permeabilities of up to 323 mD at 3440 mKB. Good quality reservoirs also occur within the Early Jurassic Brigadier Formation and there is the potential to find amalgamated coastal sand bodies in this marginal marine unit. On the northern Rankin Platform, younger Jurassic sands (North Rankin, Athol and Legendre formations) subcrop the main unconformity and are important gas reservoir units (Seggie et al, 2007; Taylor et al, 1998).

Oxfordian shallow-marine sandstones (Jansz Sandstone) represent the major reservoir

interval for the supergiant Jansz/Io gas accumulation (Jenkins et al, 2003). Malus 1, located about 3 km to the west of Release Area W09-9, intersected around 30 m of coarse grained sandstone and silty claystone of Oxfordian age that may have reservoir potential within the Release Area.

Thin Tithonian gas-bearing sandstones were encountered in Geryon 1 and Callirhoe 1 to the west of Release Area W09-10 and over 53 m of net gas sands were intersected in the Tithonian in Wheatstone 1 (Chevron, 2004) to west of Release Area W09-9 (**Figure 3**, **Figure 4** and **Figure 5**).

On the southern Rankin Platform and Alpha Arch, the deltaic Barrow Group sandstones are productive gas reservoirs at Gorgon, Spar and East Spar; and are reservoir targets within Release Area W09-11. The upper Barrow Group delta front and the delta front of the younger back-stepping Zeepaard Formation both prograded over the region of Release Area W09-11 (Smith et al, 2003). In Euryale 1, a total of 198 m of net sand was intersected in the Barrow Group, with porosities around 16% in the Zeepaard Formation sandstone (*S. aerolata* biozone) which is the dominant reservoir sequence for the Griffin and Chinook/Scindian oil and gas fields to the south. There is also some reservoir potential in the overlying Birdrong Sandstone and Mardie Greensand.

Seals

The regional seal for the Rankin Platform is the Early Cretaceous Muderong Shale. On the southern Rankin Platfrom, across the Aphla Arch and in the Barrow and Exmouth sub-basins, the Muderong Shale overlies the Barrow Group sands; and the Birdrong Sandstone and Mardie Greensand where these units are developed (**Figure 3**). Across the central and northern Rankin Platform, the Muderong Shale grades into the Forestier Claystone, the age equivalent of the Barrow Delta. Here the main unconformity surface is sealed by the Forestier Claystone which variously seals the different reservoir units of the Mungaroo and Brigadier formations depending on the trap geometry and the stratigraphic levels within the fault block. There are also proven intra-formational seals within the Mungaroo and Brigadier formations which are important in the development of downside trap configurations as at Keast 1 (Bal et al, 2002).

Play Types

The proven traditional Triassic fault block play, which hosts most of the hydrocarbon reserves in the Carnarvon Basin, has the potential to extend into the Release Areas. Reservoirs in the Mungaroo and Brigadier formations in fault block traps sealed by Muderong Shale or older marine claystones, occur along the Rankin Platform and its flanks The recent discoveries in the Julimar Complex, located immediately east of Release Area W09-10, underline the remaining potential in the Triassic in the central Rankin Platform and the role of amplitude analyses of 3D seismic data as a valuable tool for pursuing stratigraphic plays (Apache Corporation, 2008). Keast 1 and the Perseus field, on the northern Rankin Platform (Taylor et al, 1998) demonstrate the viability of downside fault block traps. Late Jurassic sands, as intersected at Malus 1, in drape

anticlines overlying Triassic fault blocks or in stratigraphic traps fringing the high blocks, provide another potential play type that may be developed in Release Area W09-9. Favourable geometries may provide access to migration pathways that are thought to have bypassed some of the high standing horsts.

In the area around Release Area W09-11, only Zeepaard 1 and the wells in the Gorgon field have penetrated the Triassic and in both cases the Mungaroo Formation sandstones were found to be gas bearing. The fault block underlying the Euryale structure which extends into Release Area W09-11 remains untested at this level. Barrow Group sandstones, sealed by Muderong Shale or inter-bedded claystones in stratigraphic and structural traps, are an additional target to the Triassic in Release Area W09-11. Here, a complex geometry of prograding and back-stepping deltas over a substrate of Triassic horst and graben, may have produced a variety of trap configurations.

Gas charge in Triassic, Early Cretaceous and Paleocene reservoirs has a seismic expression which has been successfully used to guide exploration and development in the region surrounding the Release Areas (Sit et al, 1994; Craig et al, 1997; Auld et al, 2002; Korn et al, 2003 and Apache Corporation, 2008).

Critical Risks

Gas charge appears to be pervasive throughout the region of the Release Areas and there is evidence of an oil charge through the Alpha Arch. Trap geometry, reservoir occurrence and quality, and favourable location with respect to migration pathways are some of the main risks. In the region around Release Area W09-11 over-pressure is a drilling hazard.

Figures

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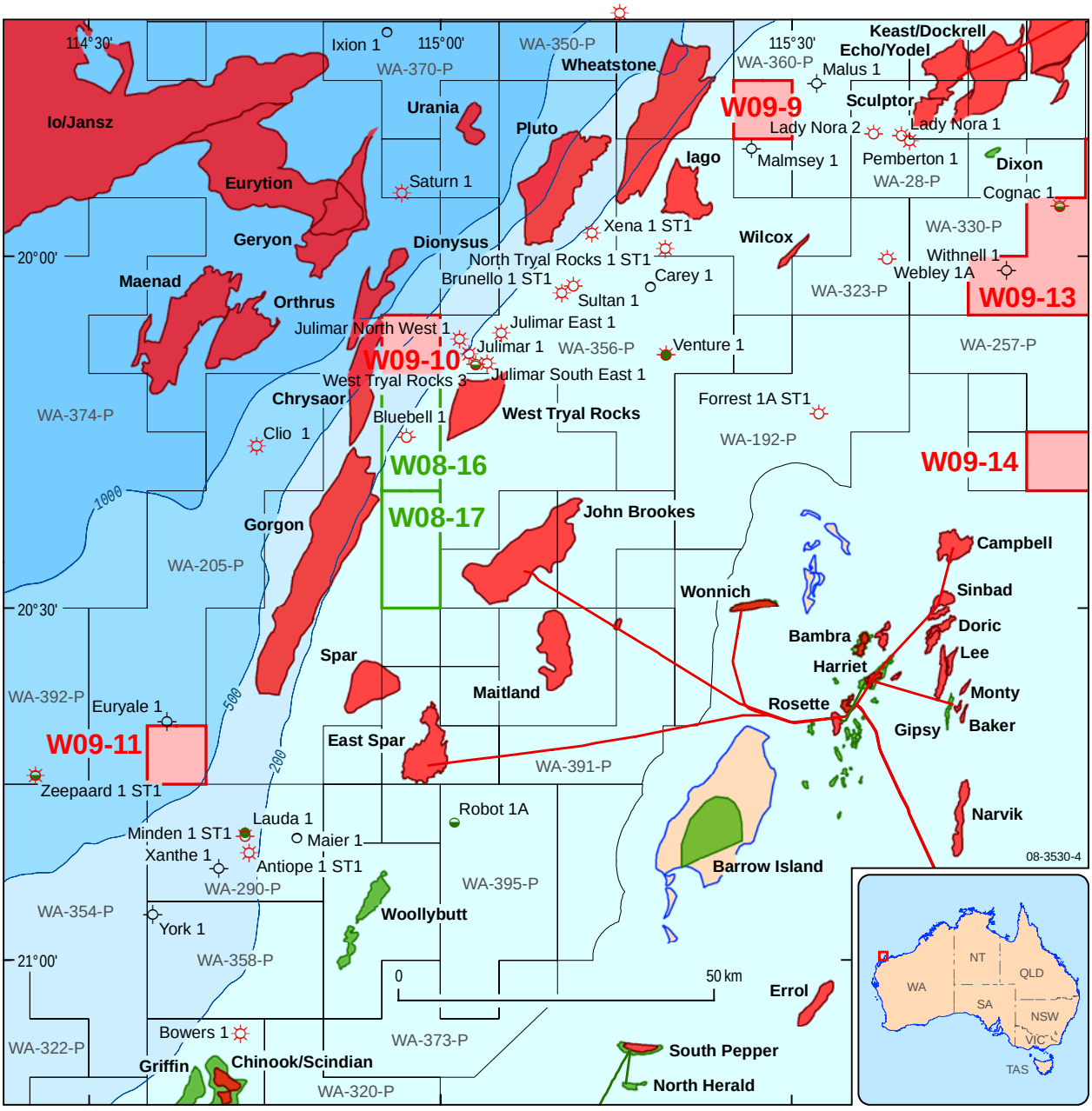


Where well symbol information is sourced from publicly available "open file" data, it has been provided by Geoscience Australia from Well Completion Reports. These symbols were generated from open file data as at 31 March 2009. Where well symbol information is not publicly available from titleholders' data, the information has been extracted from other public sources. Field outlines are provided by GPinfo, an Encom Petroleum Information Pty Ltd product. Field outlines in GPinfo are sourced, where possible, from the operators of the fields only. Outlines are updated at irregular intervals but with at least one major update per year.

- *2009 Offshore Petroleum Acreage Release Area*
- *2008 Offshore Petroleum Acreage Release Area*
- *Existing petroleum title*
- *Gas field*
- *Oil field*
- *Gas pipeline*
- *Oil pipeline*
- *200 Bathymetry contour (depth in metres)*
- *Petroleum exploration well - Not classified*
- *Petroleum exploration well - Dry hole*
- *Petroleum exploration well - Gas show*
- *Petroleum exploration well - Gas discovery*
- *Petroleum exploration well - Oil show*
- *Petroleum exploration well - Oil discovery*
- *Petroleum exploration well - Oil and Gas show*
- *Petroleum exploration well - Oil discovery and Gas show*
- *Petroleum exploration well - Gas discovery and Oil show*

Figure 1. Location map of Release Areas W09-9, W09-10 and W09-11, showing existing petroleum permits, oil and gas accumulations and discoveries, and gas pipelines.

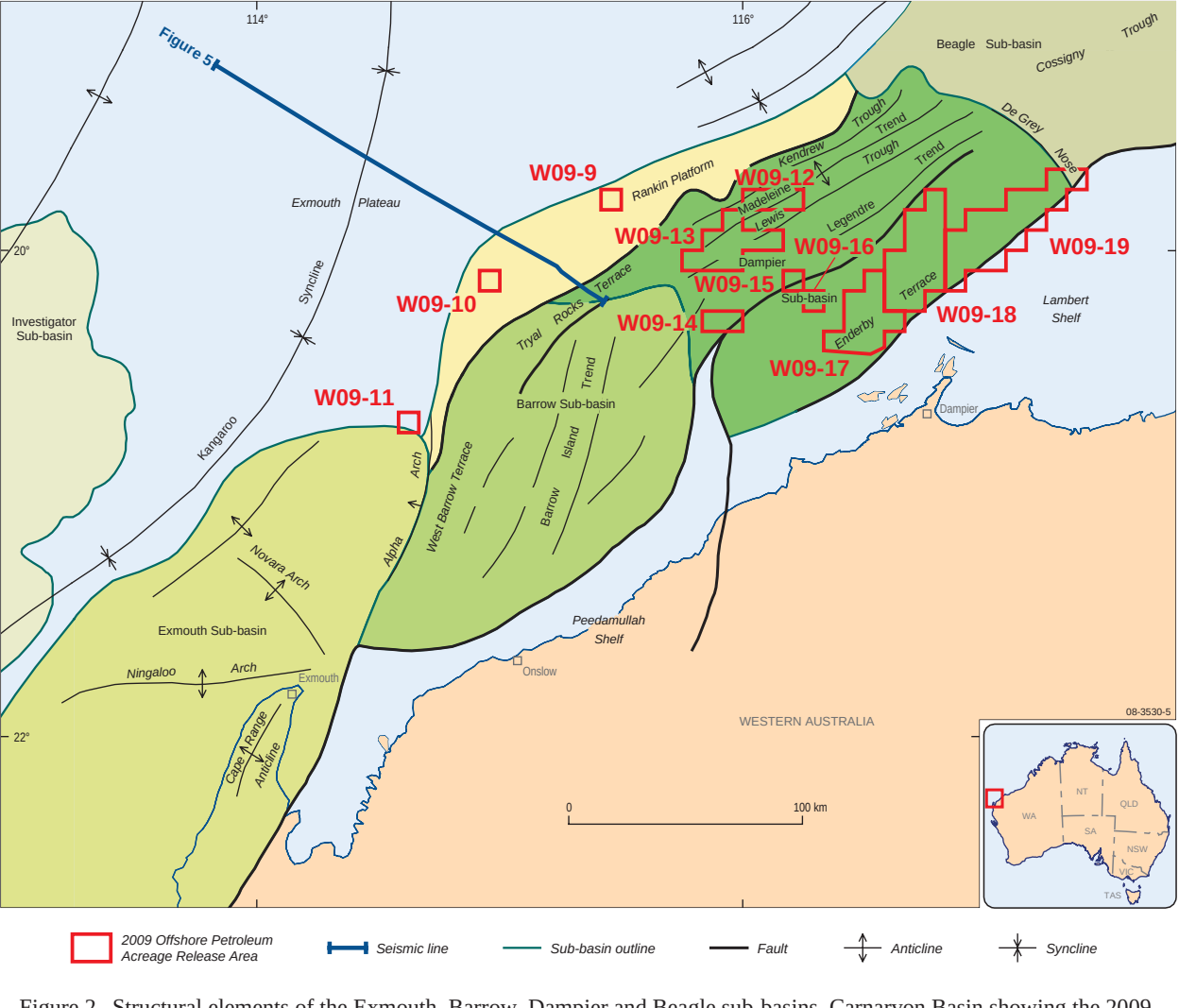
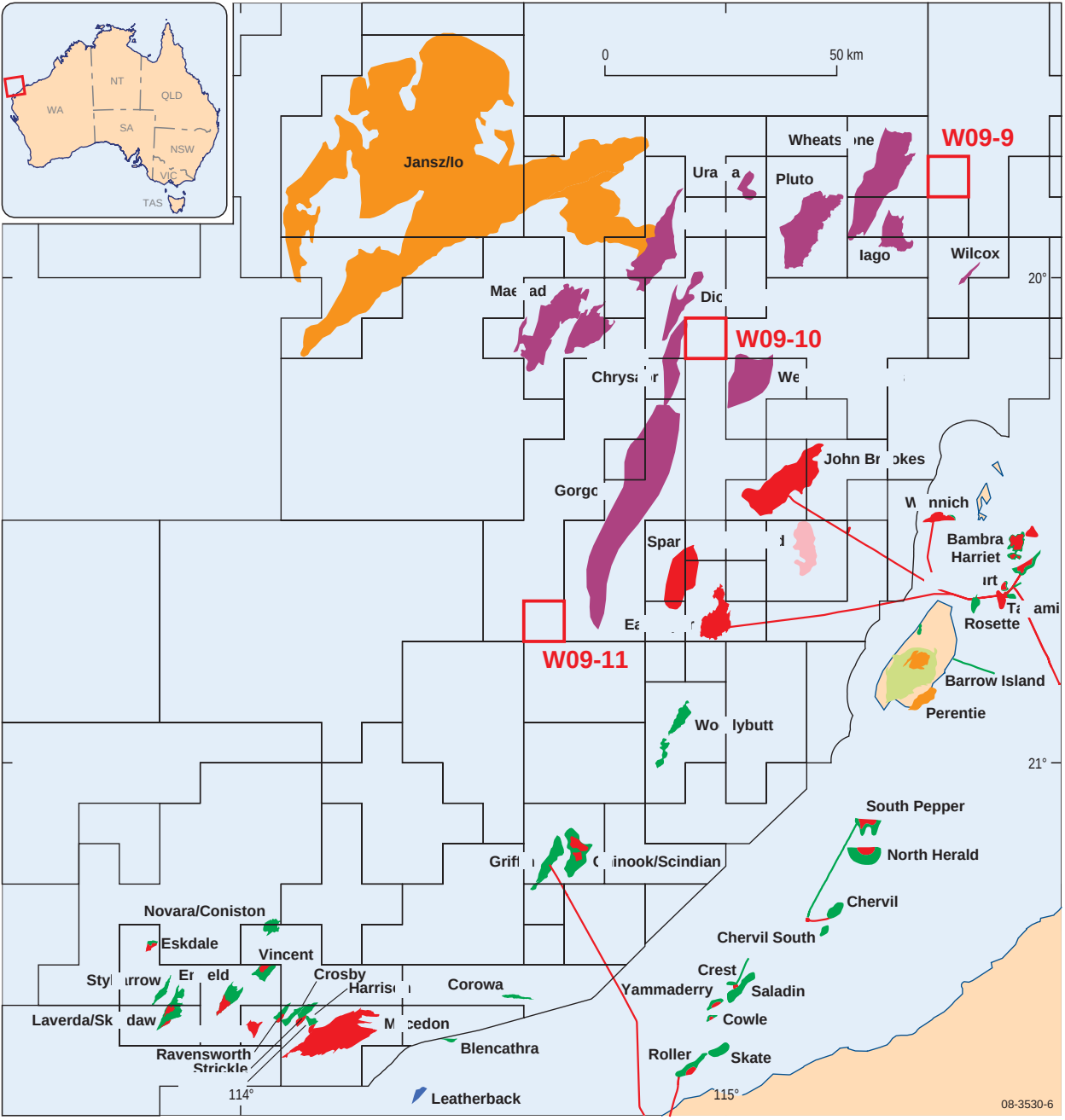


Figure 2. Structural elements of the Exmouth, Barrow, Dampier and Beagle sub-basins, Carnarvon Basin showing the 2009 Release Areas.



Where well symbol information is sourced from publicly available "open file" data, it has been provided by Geoscience Australia from Well Completion Reports. These symbols were generated from open file data as at 31 March 2009. Where well symbol information is not publicly available from titleholder's data, the information has been extracted from other public sources. Field outlines are provided by GPinfo, an Encom Petroleum Information Pty Ltd product. Field outlines in GPinfo are sourced, where possible, from the operators of the fields only. Outlines are updated at irregular intervals but with at least one major update per year.

2009 Offshore Petroleum Acreage Release Area

Existing petroleum title

Gas pipeline

Oil pipeline

Period (Formation)	Oil accumulation	Gas accumulation
Paleocene		
Barremian (Windalia Sandstone)		
Valanginian & Berriasian (Barrow Group) & Birdrong Sst		
Tithonian, Oxfordian and Middle Jurassic		
Upper Triassic (Brigadier and Mungaroo Formations)		

Figure 4. Major oil and gas accumulations of the western Barrow Sub-basin, offshore Exmouth Sub-basin and southern Exmouth Plateau.

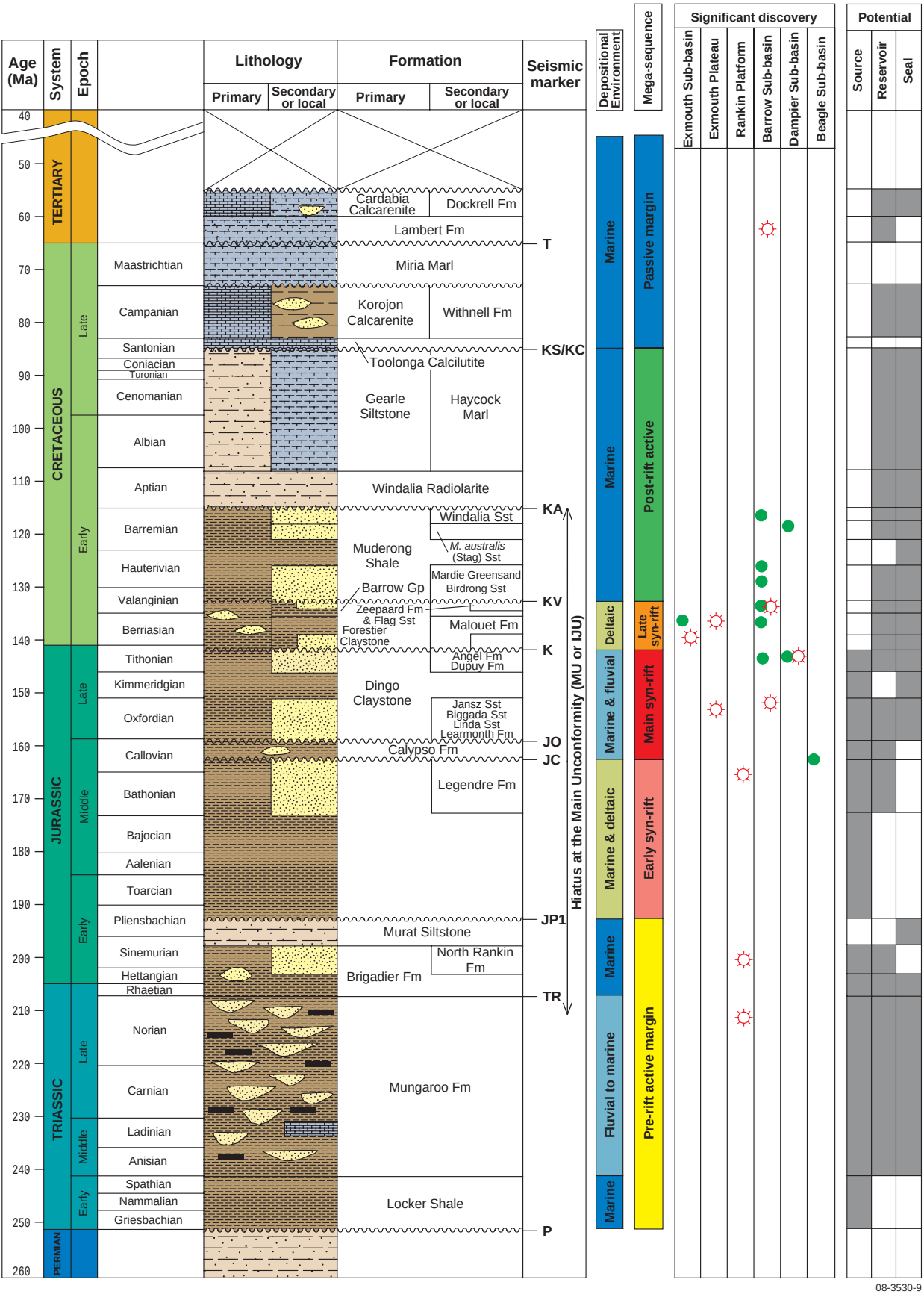


Figure 3. Regional stratigraphy of the Northern Carnarvon Basin, AGSO 1996 Time Scale (Young and Laurie, 1996).

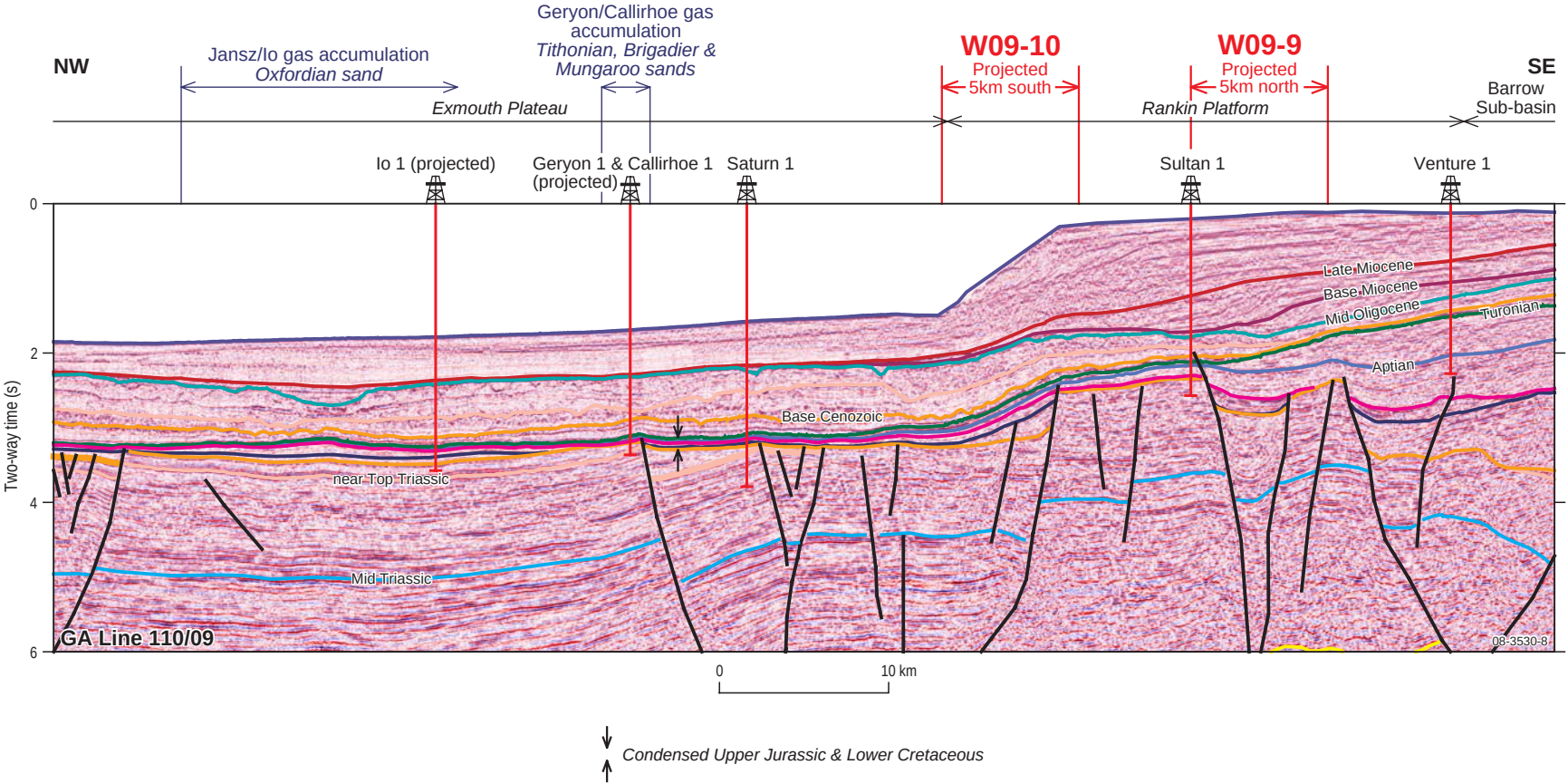


Figure 5. Geoscience Australia seismic line 110/09 across the Exmouth Plateau, Rankin Platform and Barrow Sub-basin.