



Regional Geology of the Bass Basin

The Cretaceous–Cenozoic Bass Basin is a northwest-trending, intracratonic rift basin that underlies the Bass Strait between northern Tasmania and southern Victoria. The Bass Basin is separated from the Otway and Sorell basins to the west by the King Island High, and from the Gippsland Basin to the northeast by Flinders Island and the Bassian Rise (**Figure 1**). The Bass Basin is divided into the Cape Wickham Sub-basin in the west and the Durroon Sub-basin in the east (Blevin et al, 2005; **Figure 1**). The Cape Wickham Sub-basin is a proven hydrocarbon province, hosting several gas discoveries and a producing gas and condensate field (Yolla). In comparison, the Durroon Sub-basin is underexplored, and no discoveries have been made in this portion of the Bass Basin. A comprehensive report on the petroleum geology of the Bass Basin is presented by Blevin (2003a).

Tectonic development

Intracontinental extension between Australia and Antarctica during the Jurassic and Early Cretaceous resulted in the formation of a series of rift basins along the southern margin of Australia—the Southern Rift System (SRS; Stagg et al, 1990). The Bass Basin, which forms the easternmost element of the SRS, was initiated in the Early Cretaceous (**Figure 2**). Extension in the Bass Basin preceded eventual breakup between Australia and Antarctica (Blevin, 2003b), which commenced in the Bight Basin to the west in the latest Santonian–earliest Campanian (83 Ma; Sayers et al, 2001). To the east, commencement of breakup in the Tasman Basin in the Campanian was approximately coeval with breakup along the southern margin (Symonds et al, 1996; Blevin, 2003b). Blevin (2003b) argued that the location of the Bass Basin at the junction between two Cretaceous rift systems (the Southern Rift System and Tasman Basin) had a strong control on the evolution of the basin and resulted in the area experiencing multiple periods of deformation. Although extension progressed to breakup and seafloor spreading in the adjacent Southern Ocean and Tasman basins, the Bass Basin remained a ‘failed rift’ basin where breakup did not occur (Blevin, 2003b).

The Bass Basin is characterised by generally northwest to north-northwest trending half graben (Etheridge et al, 1985; Williamson et al, 1985; Smith, 1986; Blevin, 2003b; Cummings et al, 2004; Blevin et al, 2005). Half graben are bounded by large displacement normal faults that generally dip to the southwest to west-southwest in the Cape Wickham Sub-basin and northeast to east-northeast in the Durroon Sub-basin. The Cape Wickham and Durroon sub-basins are separated by the north-northeast-striking Chat Accommodation Zone (**Figure 1**). Blevin (2003b) suggested that the location of this feature and the structural architecture of the two sub-basins are likely to have been controlled by the underlying basement fabric, with the Durroon Sub-basin overlying the deformed sediments and granites of the Lachlan Fold Belt, and the Cape Wickham Sub-basin overlying an older fold belt terrane.

Cape Wickham Sub-basin

The Cape Wickham Sub-basin consists of a series of large northwest- to north-northwest-trending Cretaceous–Cenozoic half graben informally named the Cormorant, White Ibis, Yolla, Dondu and Pelican troughs (Lennon et al, 1999; Blevin et al, 2003, 2005; Cummings et al, 2004; **Figure 1**). Rift bounding faults generally dip to the southwest to west-southwest. The Cormorant Trough has a more of full graben architecture, with faults on both sides of the rift (**Figure 3**). The fault on the southern side of the trough partly defines a distinctive northwest-trending intra-basin horst block that is a key feature of the sub-basin. This horst is offset along-strike across a north-northeast striking feature, the Yolla Accommodation Zone, the location of which may reflect the underlying basement fabric (Blevin et al, 2003; Cummings et al, 2004; Blevin and Cathro, 2008). Fault throws in the sub-basin are in the order of 3–5 km, with the total sedimentary succession (syn-rift and post-rift) reaching a thickness of 8–10 km in the main depocentres. The sub-basin has been

variably affected by compressional episodes in the Cenozoic that resulted in partial inversion of structures such as the Cormorant Trough (**Figure 3**).

The southwestern margin of the Cape Wickham Sub-basin is characterised by a structural ramp that dips basinward, while the northwestern margin is generally bounded by a steep fault that has been focus of reactivation during mid-Miocene compression. The northwestern margin of the sub-basin is heavily affected by volcanic intrusions and extrusions.

Durroon Sub-basin

The structural style of the Durroon Sub-basin differs significantly from that of the Cape Wickham Sub-basin. The Durroon Sub-basin (Baillie and Pickering, 1991; Das and Lemon, 2000) is characterised by a series of northwest- to north-northwest-trending half graben, bounded by northeast- or east-northeast-dipping faults, which are generally narrower and more intensely faulted than those in the western part of the basin (Blevin, 2003b; **Figure 4**). Some inversion structures are observed on the northern and eastern margins of the sub-basin. Blevin and Cathro (2008) proposed that these structures developed as a result of compressional deformation in the Cenomanian and mid-Eocene, prior to the deposition of the Flinders Sequence. The sub-basin contains a Cretaceous–Cenozoic rift and post-rift succession up to 7000 m thick (Baillie and Pickering, 1991).

Basin evolution

The evolution of the Bass Basin was dominated by a series of distinct rift phases. The two earliest phases affected the entire basin, while the final period of crustal extension was concentrated in the Cape Wickham Sub-basin. The first phase of extensional deformation, the Otway rift phase, is generally interpreted to have occurred in the Early Cretaceous (Barremian–earliest Cenomanian; **Figure 2**), coeval with extension in the adjacent Otway Basin (e.g. Blevin, 2003b; Blevin et al, 2005). Cummings et al (2004) presented an alternative interpretation of basin evolution, suggesting that the initial rift phase in the Cape Wickham Sub-basin was older (Berriasian–mid-Barremian), equivalent to the syn-rift Crayfish Group of the Otway Basin.

The subsequent Turonian–Campanian Durroon rift phase (**Figure 2**) has been attributed to extensional stresses that preceded Tasman Basin break-up to the east (Cummings et al, 2002; Blevin and Cathro, 2008). During this period of extension, half graben initiated in the Otway rift phase continued to develop and expand, forming a system of linked depocentres (Blevin et al, 2005). The syn-tectonic successions deposited during the first two rift phases (Otway and Durroon sequences) are well imaged within the deeper half graben on seismic data (**Figure 3**, **Figure 4**), but have rarely been penetrated by drilling due to the depth of burial. Durroon 1 and Chat 1, in the Durroon Sub-basin, were the only wells to recover Lower and mid-Cretaceous sediments (Baillie and Pickering, 1991; Blevin, 2001; Partridge, 2003). Extension in the Durroon Sub-basin largely ceased in the mid-Campanian with sediments of Late Cretaceous to Miocene age deposited under dominantly sag (thermal subsidence) conditions (Blevin, 2003b; **Figure 2**).

A final phase of extension (Bass rift phase) occurred in the Campanian–early Eocene (Smit, 1988; Blevin, 2003b; Blevin and Cathro, 2008; **Figure 2**). This phase of extension focused particularly on structures within the Pelican, Yolla and Cormorant troughs (**Figure 3**), and resulted in episodic reactivation of existing Lower Cretaceous half-graben structures from the Campanian until the early Eocene. In the Cape Wickham Sub-basin, the oldest sediments penetrated by drilling are Campanian in age (Bass Rift Phase).

Until the late Eocene, deposition of non-marine sediments in the Bass Basin was controlled by internal drainage systems that migrated from the uplifted flanks of the basin into the developing half-graben structures. Following the cessation of rift-related activity in the latest early Eocene, accommodation was controlled by normal post-rift subsidence and eustatic fluctuations. Widespread marine flooding of the basin occurred from west to east in the late middle Eocene, although indications of periodic marine incursions are recorded as early as the Paleocene. Multiple periods of post-rift tectonic reactivation, including several episodes of Cenozoic inversion, have been recognised in the Bass Basin (Hill et al, 1995; Holford et al, 2011). The contractional events formed large scale anticlines within the syn- and post-rift successions, with several of these structures targeted by exploration drilling (e.g., Cormorant 1; **Figure 3**). Polygonal faulting is widespread throughout the basin (Das, 2001), but is generally limited to fine-grained late Oligocene to early Miocene successions (Blevin, 2003b; Blevin et al, 2005).

The Bass Basin and adjacent areas of mainland Tasmania and southern Victoria have been affected by multiple periods of volcanic activity during the syn- and post-rift phases of basin evolution. Offshore, these events are marked by the widespread emplacement of intrusive (sills and dykes) and extrusive rocks (hydrothermal vents, volcanic mounds and flows), particularly in the southern and western parts of the basin (Blevin and Cathro, 2008; Holford et al, 2012; **Figure 3** and **Figure 5**). Volcanic activity appears to have been focused along large-scale faults and accommodation zones in the basin (Etheridge et al, 1985; Cummings et al, 2002, 2004; Blevin and Cathro, 2008).

Stratigraphy

The Bass Basin contains sediments ranging in age from Early Cretaceous to Quaternary (**Figure 2**). Several stratigraphic nomenclature schemes have been proposed for the basin (Smith, 1986; Maung et al, 1993, Lennon et al, 1999; Cummings et al, 2002). These schemes vary mainly in their recognition of subdivisions within the Cretaceous to middle Eocene succession (e.g. Eastern View Group/Coal Measures/Formation).

In the early 2000s, a study aimed at integrating biostratigraphy, sequence stratigraphy and seismic stratigraphy to identify accommodation cycles and related environments, resulted in a revised sub-division of the stratigraphic succession (Boreham et al, 2003; Blevin et al, 2003, 2005). Six depositional sequences—mainly megasequences and supersequences—were recognised by this study and correlated to phases of tectonic activity and eustatic fluctuations. The following summary of the tectonostratigraphic development of the basin is based largely on the results of those studies. A recent analysis of the palaeogeographic evolution of the basin (Briguglio et al, 2013) provides additional detail about depositional systems in the area.

The key sequences of potential economic interest in the Bass Basin are the Bass, Aroo and Flinders sequences, which correspond approximately with the middle and upper sections of the Eastern View Formation (EVF). Thin successions of the older Durroon (equivalent to the lower portion of the EVF) and Otway sequences onlap the margins of the rift basin and may also be viable drilling targets in these locations, although they are probably of greater economic importance as potential source rocks in the deeper flanking half graben. Stratigraphic targets may also be present in the younger Torquay Sequence.

The mid-Campanian to lower Eocene Bass Megasequence was deposited during the final extensional phase in the western Bass Basin. This megasequence, formerly known as the Middle Eastern View Coal Measures (Lennon et al, 1999), is largely terrestrial in origin with intermittent brackish/marine influences evident during the early Paleocene and early Eocene. Sedimentation continued within an internal drainage basin setting, with fluvial systems feeding into the slowly subsiding depocentres from the uplifted basin flanks. The Bass Megasequence consists of the following component sequences: the mid-Campanian to Maastrichtian Furneaux Sequence, the late Maastrichtian to late Paleocene Tilana Sequence, and the late Paleocene to early Eocene Narimba Sequence. Each sequence was deposited during episodic periods of rift activity that were focused in the central and western Bass Basin (Cape Wickham Sub-basin). Within the depocentres, these sequences consist of expanded sections of aggradational fluvio-deltaic sandstones and siltstones, and finer-grained lacustrine sediments. On the rift flanks, sediments accumulated as thinner, stacked successions of fluvial-deltaic sandstones and interbedded over-bank shales, mudstones and thin coal beds. The systems of lakes that formed during the late Maastrichtian to early Eocene (**Figure 6a**) and their importance as source rocks in the Bass Basin are discussed in Boreham et al (2003) and Blevin et al (2005).

In the latest early Eocene to middle Eocene, tectonic activity in the Bass Basin began to wane. This marked a period of transition from rift to post-rift subsidence conditions, and resulted in a rapid decrease in the rate of accommodation and a distinct change in depositional style. At this time, the basin had relatively low relief and sediments were deposited in low-energy, meandering fluvial environments flanked by floodplains and ephemeral lakes. From the latest early Eocene until the early middle Eocene (Upper M. diversus and P. asperopolus spore/pollen zones), coal beds up to 25 m thick accumulated in peat mires that fringed the margins of the former rift depocentres. Lakes were formed in areas of maximum subsidence overlying the half graben, particularly in the northern and western parts of the basin. This coal-rich section is the Aroo Sequence (formerly the upper Eastern View Coal Measures; Lennon et al, 1999).

By the middle Eocene, faulting related to rift activity and sediment loading had largely ceased. Fluvial environments continued to dominate in the Durroon sub-basin, while thin coals and fine-grained sediments accumulated in lower delta plain and paralic environments further to the west (Flinders Sequence). Lakes and restricted lagoons filled the central and western parts of the basin, as marine water began to encroach from the west (**Figure 6b**). Third and fourth-order fluctuations in sea level (base level) resulted in rapid shifts of sediment facies along the basin margins, although sedimentation within the deeper parts of the basin was

probably continuous. In the late middle Eocene (Middle N. asperus spore/pollen zone), a short regression led to incision across much of the basin and the deposition of a widespread sand facies. Locally, the sandy facies associated with the regression is known as the 'Boonah Sands'. This sequence represents the 'top of reservoir' across most of the basin. A rapid flooding of the basin occurred in the late Eocene resulting in the deposition of the thick regional sealing shales of the Demons Bluff Formation. Shallow bay siltstones and shales were deposited until the latest early Oligocene. The predominantly terrestrial nature of sedimentation in the Bass Basin until the middle Eocene has meant that most reservoir and seal facies occur as interfingering and interbedded units.

The upper Oligocene to Quaternary Torquay Sequence consists of a lower argillaceous (mud and marl) succession up to 650 m thick, overlain by a calcarenite-dominated succession up to 860 m thick and ranging in age from late Miocene to Quaternary (Williamson et al, 1985).

There has been extensive and widespread magmatic activity in the Bass Basin, particularly in the southeast and western regions. Volcanic and intrusive rocks are intersected in many wells and imaged in seismic data (**Figure 3** and **Figure 5**).

Regional petroleum systems

The hydrocarbons discovered to date on the southern margin of Australia have been assigned to the Austral Petroleum Supersystem based on the age of their source rocks and common tectonic history (Edwards et al, 1999). Bass Basin oils are derived from Upper Cretaceous–Cenozoic source rocks and are therefore assigned to the Austral 3 system (Edwards et al, 1999). In the Cape Wickham Sub-basin of the Bass Basin, exploration drilling has confirmed accumulations at Yolla, Pelican, White Ibis, Cormorant, Trefoil and Rockhopper, reservoirs in sands of Paleocene to Eocene age (*L. balmei* to *M. diversus*; **Figure 2**). At present, only the accumulation at Yolla has been developed (Beach Energy-operated BassGas Project). Exploration in the Durroon Sub-basin has not yet been successful. The hydrocarbon accumulations discovered in the Cape Wickham Sub-basin are assigned to the Austral 3 subsystem.

The Bass Basin oils and gases have a terrestrial source affinity and are geochemically similar to the Gippsland Basin oils (Summons, 1996); some geochemical differences are attributed to differences in source rock palaeoenvironment, palaeogeography and biota between the two basins (Summons et al, 2002). The Yolla 1 oil is a medium-gravity (46°API) crude with a correspondingly high wax content, whereas the Cormorant 1 oil is a heavy crude (21°API) as a result of biodegradation (Edwards et al, 1999). Geochemical analyses of the hydrocarbons indicate an input of predominantly land-plant material to the source kerogens, and there is no evidence of marine organic matter (Edwards et al, 1999).

Cape Wickham Sub-basin petroleum systems elements

Sources	<ul style="list-style-type: none">Lower Paleogene (particularly Paleocene to lower Eocene) coals and interbedded shales of the Bass Megasequence and Aroo Sequence (middle and upper Eastern View Formation [EVF])Lower Cretaceous coals and shales of the Otway Megasequence (Otway Basin Eumeralla Formation equivalent)
Reservoirs	<ul style="list-style-type: none">Campanian–Maastrichtian, Paleocene and lower Eocene fluvio-deltaic to marginal marine sandstones of the Bass Megasequence and Aroo Sequence (middle and upper EVF)
Seals	<ul style="list-style-type: none">Lacustrine and interdistributary–floodplain shales within the Upper Cretaceous–Eocene Bass Megasequence and Aroo Sequence (intraformational seal)Siltstones and calcilutites of the marginal to shallow marine Flinders Sequence (Demons Bluff Formation; regional seal)
Traps	<ul style="list-style-type: none">Rotated fault blocks and overlying drape closure located up-dip from deep half grabenReactivation structures such as Eocene, Miocene and younger inversion anticlinesCrestal collapse fault blocksAnticlinal closures associated with the intrusion of volcanic rocks

Durroon Sub-basin petroleum systems elements

Sources	<ul style="list-style-type: none">Barremian–Albian coaly facies of the Otway Megasequence (Otway Basin Eumeralla Formation equivalent)Maastrichtian–lower Paleocene coals and shales (generally immature)
Reservoirs	<ul style="list-style-type: none">Sandstone units in the upper Otway MegasequenceSandstone units in the Campanian–Eocene Bass Megasequence and Flinders Sequence
Seals	<ul style="list-style-type: none">Deep-water lacustrine shales in the Upper Cretaceous Durroon MegasequenceOverbank shales in the Lower Cretaceous Otway MegasequenceShales within the Eocene–Oligocene Flinders Sequence and the overlying Torquay Sequence
Traps	<ul style="list-style-type: none">Rotated fault blocks with structural closure extending in to onlapping and overlying strataStratigraphic traps in sandy facies along eastern basin margin and lacustrine and deltaic facies associated with the Durroon Lake near the base of the Durroon Megasequence.

Source rocks and maturation

Potential source rocks in the Bass Basin are non-marine and include Maastrichtian to middle Eocene coals and carbonaceous claystones (Boreham, 2003; Boreham et al, 2003; **Figure 2**). These successions were deposited in low-energy fluvial, deltaic and lacustrine environments (Blevin et al, 2003; Lang et al, 2003). The coals are between 5 m and 25 m thick, and are rich in extractable organic matter with significant petroleum generation potential. Coals within the upper Bass and Aroo sequences (upper Eastern View Formation) generally have high hydrocarbon indices and contain abundant exinite and vitrinite (Miyazaki, 1995). Differences in the organic character and relative abundance of coals have been recognised, and are attributed to fluctuations in regional water tables and sea level during deposition (Baillie, 1992). In general, coals are thicker and occur more frequently within the younger Aroo Sequence (upper *M. diversus* and *P. asperopolus* spore/pollen zones). In addition, the younger coals are richer in exinite and poorer in inertinite than coals within the underlying stratigraphic succession (Smith, 1986).

3D petroleum systems modelling by Arian et al (2010) indicates that maturity values are highest in the Cape Wickham Sub-basin and the Bark Trough of the Durroon Sub-basin; the rest of the Durroon Sub-basin is less mature. Paleocene and older source rocks are mature for hydrocarbon generation and expulsion across much of the basin, particularly the deeper central areas in Cape Wickham Sub-basin. Deeper undrilled source rocks may be present in the Durroon and Otway sequences. Arian et al (2010) suggested that there was early expulsion of hydrocarbons from Lower Cretaceous source rocks in the Otway Megasequence; these hydrocarbons are modelled to have migrated upwards via permeable faults prior to the deposition of a regional seal.

Some early studies (Nicholas et al, 1981; Miyazaki, 1995) proposed that liquid hydrocarbons were generated from disseminated organic matter within carbonaceous claystones, while gases were sourced mainly from coaly facies. However, oil-to-source correlations undertaken at Geoscience Australia (Boreham et al, 2003) have shown that the oils were sourced by lower Paleogene coals, particularly those concentrated within the Paleocene to lower Eocene succession (Boreham et al, 2003). Oils in the basin are a single oil population (Yolla and Pelican accumulations), while in-reservoir biodegradation of the Cormorant oil has resulted in its statistical classification as a separate oil family (Boreham et al, 2003). Fluid inclusions studies (Kempton et al, 2002) have identified palaeo-oil zones at Yolla 1 and Cormorant 1, along with suspected zones at King 1 and Pelican 5. In addition, several potential palaeo-hydrocarbon zones were identified at Yurongi 1, Chat 1, Seal 1, Tilana 1 and Squid 1. These zones are characterised by aqueous inclusions containing small amounts of oil (Kempton et al, 2002).

Gaseous hydrocarbons have a similar source to the oil, but have been generated over a wider maturity range. Boreham (2003) reported that Yolla gases are associated with Yolla oils and both were generated from the same source and at similar maturities; White Ibis gases were generated at a higher maturity than the Yolla gases.

While Paleogene coals are abundant in the Cape Wickham Sub-basin, in the Durroon Sub-basin, the equivalent section is either missing or the facies are sand-prone (DITR, 2004). Therefore, in this part of the basin potential source rocks are likely to be older, occurring within the Barremian–Maastrichtian section.

Geochemical analysis and maturity modelling (Boreham, 2003; Boreham et al, 2003; Cummings and Tingate, 2003; Radlinski et al, 2003) suggests that the basin-wide onset of oil generation and expulsion in the Bass Basin occurs at a depth of 2450–3000 m. Blevin et al (2005) reported that the key events in the process of petroleum generation and migration from source rocks were:

- Onset of oil generation occurred at a VR of 0.65% (2450 m in Pelican 5)
- Onset of expulsion (primary migration) occurred at a VR of 0.75% (2700–3200 m across the basin; 2850 m in Pelican 5)
- Main oil window occurred between VR of 0.75% and 0.95% (28500–3300 m in Pelican 5)
- Main gas window occurred at VR>1.2% (>3650 m in Pelican 5)

A zone of overpressure below about 2800 m (Miyazaki, 1995) and a permeability barrier at depths greater than 2900 m are probably related to a decrease in pore space as a result of oil moving from smaller to larger pore space (Radlinski et al, 2003). This depth correlates to a VR of about 0.75%, the onset of primary oil migration.

Geohistory and maturation modelling indicates that key potential source rocks (Paleocene–lower Eocene coals) entered the oil generation window just prior to and following deposition of the Demons Bluff regional

seal (Flinders sequence), and after the major structural trap forming events in the Late Cretaceous and early Eocene (Cummings and Tingate, 2003; Williamson and Pigram, 1986). Paleocene to early Eocene units continued to pass into the oil expulsion window during and after Miocene structural events. A petroleum systems modelling study by Arian et al (2010), suggested that expulsion from these oil-prone source rocks (Paleocene–early Eocene Narimba Sequence) in the deeper parts of the Yolla Trough only commenced in the last 5 million years. Migration from mature source rocks into available traps may have occurred via local fault-related conduits and intra-stratal fairways. The overlying upper Eocene and younger marine succession (Flinders and Torquay sequences) is immature across the basin. Overall, the pattern of hydrocarbon distribution in the basin shows that hydrocarbon generation has occurred in the Cormorant, Yolla and Pelican troughs with migration into structures within the depocentres and on the adjacent flanks.

Reservoirs and seals

Proven petroleum-bearing reservoirs in the Bass Basin occur within the Paleocene and lower Eocene succession (Bass and Aroo sequences; **Figure 2**). These reservoirs are predominantly fluvio-deltaic sandstones with a net thickness of 20–50 m. Facies analysis and correlation of cores with wireline logs suggests that reservoir sandstones were deposited in a range of terrestrial, paralic and shallow marine environments (Baillie et al, 1991; Brooks et al, 2006). The lateral continuity of these facies is expected to vary widely. Porosity analyses on cores and sidewall cores at Cormorant 1 and Yolla 1 recorded average values of 15–25%. In general, porosity declines moderately with increasing depth (approximately 5.7 porosity units per 1000 m; Meszoly et al, 1986), while permeabilities range from 16 mD to 308 mD.

A study of the nature and distribution of porosity by Meszoly et al (1986) suggests that present-day reservoir quality is highest between 1900 m and 2700 m subsea over the extent of the basin. Two depth-related diagenetic zones have been recognised within the quartz-rich siliciclastics of the Bass and Aroo sequences—an upper zone characterised by carbonate authigenesis from 1950 m to the top Aroo Sequence; and a lower zone lying below 2000 m, characterised by dissolution, compaction, quartz overgrowth cementation, and authigenic illite and kaolinite (Meszoly et al, 1986).

Hydrocarbon accumulations at the Yolla and White Ibis fields and in the Pelican wells are reservoirised in fault blocks and associated anticlinal structures within the Bass and Aroo sequences. These traps are sealed by intraformational shales that were deposited in lacustrine and interdistributary to floodplain environments. The upper Eocene Flinders Sequence (Demons Bluff Formation) contains a marginal marine to shallow marine shale that blankets much of the Bass Basin. The shale forms a thick regional seal over the underlying terrestrial reservoir successions. Seal analyses of recent wells such as Barramundi 1, have highlighted the negative implications of late stage reactivation events on trap integrity that has often resulted in localised fracturing and faulting of the regional seal. Details of the sealing capacity of mudstone and siltstone units from Bass Basin wells is presented by Daniel et al (2003).

Play types

Play types for the basin include rotated fault blocks and overlying drape closure, as well as extensive reactivation structures such as inversion anticlines, crestal collapse fault blocks and deformation associated with the intrusion of igneous rocks (e.g., Trefoil 1). In the western Cape Wickham Sub-basin, the Cormorant and White Ibis troughs are known to have generated hydrocarbons, as shown by gas and condensate accumulations at the White Ibis, Bass, Trefoil and Rockhopper fields, and at Cormorant 1 (Lennon et al, 1999; Blevin et al, 2003; Boreham et al, 2003). To the east, accumulations at Yolla and Pelican attest to the presence of a petroleum system in the Yolla and Pelican troughs.

Wells in the western Bass Basin have tested a range of plays, including:

1. onlap onto or structural closure (drape) over the crest of intra-basin fault blocks located updip from deep flanking half-graben (Yolla 1, White Ibis 1, Aroo 1, Rockhopper 1 and Tilana 1);
2. Miocene and younger inversion structures and fault blocks associated with crestal collapse (Cormorant 1, Toolka 1A, Spikey Beach 1);
3. Eocene anticlines within the hanging wall of half graben and associated crestal collapse fault blocks (Pelican wells, Peejay 1);

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4. low-relief fault blocks within the basin associated with late-stage growth faults (Poonboon 1, Tarook 1);
 5. footwall fault blocks along the basin margin with stratigraphic onlap (Tasmanian Devil 1, Flinders 1).

Many of these plays have experienced late stage enhancement of structural closure (Eocene, Oligocene and Miocene) that may have partially breached in-place accumulations (White Ibis 1, Cormorant 1). The most successful plays have been those located updip or along the flanks of Cretaceous half graben where growth faulting continued until the early Eocene.

In the Durroon Sub-basin, play types include rotated fault blocks with structural closure extending upward into onlapping and overlying strata, with charge provided by mature source rocks in the deepest and thickest successions in the half graben. Stratigraphic traps are also possible in sandy facies along the basin margin (alluvial fans), and lacustrine deltaic and turbidite facies associated with the “Durroon Lake” near the base of the Durroon Megasequence. Mature source rocks are likely to occur in Eumeralla Formation-equivalent coals in the Otway Megasequence. Potential long-range migration from the western Bass Basin is also possible given the westward-thickening, wedge-like geometry of Upper Cretaceous and younger strata across the basin (DITR, 2004).

A range of plays based on 3D petroleum systems modelling is presented by Arian et al (2010).

Exploration history

The Bass Basin is a moderately explored basin with 45 wells drilled since 1965 (**Figure 1**). Similar to other basins along the Australia's southern margin, exploration has occurred in phases, although development of the discovered reserves and production from the Yolla Field has only commenced in recent years.

Hydrocarbon exploration in the Bass Basin began in the early 1960s with permits awarded to Hematite Petroleum Pty Ltd (BHP) and Esso Exploration and Production Australia Ltd (Esso) (Robinson, 1974; Smith, 1986). Bass 1, the first well in the basin, was drilled by Esso in 1965. Esso's subsequent exploration program included 15 wells drilled from 1966 to 1974; Hematite drilled four wells between 1974 and 1982. During this exploration phase, gas and condensate accumulations were discovered at Pelican 1 and Pelican 2, while numerous gas shows were recorded at several wells (including Bass 3, Cormorant 1, Pelican 4 and Aroo 1). Only one well was drilled in the eastern Bass basin during this period, Durroon 1. The well was unsuccessful, failure being attributed to minimal structural closure, poor reservoir quality, poor regional sealing facies and a lack of hydrocarbon charge (Trigg et al, 2003).

In 1985 Amoco Australia Petroleum Company made a significant gas discovery at Yolla 1, a crestal test of the Eastern View Formation (EVF) within a four-way dip and fault-closed structure. The well encountered five separate gas columns in the middle Eastern View Formation, as well as a separate hydrocarbon column (wet gas over an oil leg) in the upper EVF (Brooks et al, 2006). The stacked hydrocarbon accumulations within the EVF at Yolla are sealed by relatively thick and laterally continuous intraformational lacustrine shales (Lennon et al, 1999).

The following year, Amoco Australia drilled Pelican 5 in the southern part of the basin to test the production potential of the lower Eocene sands (M. diversus spore/pollen zone) of the middle EVF, which had good shows of gas and condensate at Pelican 1, 2 and 4, but had not been tested for production. Numerous hydrocarbon shows were noted while drilling through the EVF. Gas was produced during two tests, and wireline log evaluation indicated the presence of moveable hydrocarbons at various levels (Amoco, 1987). Hydrocarbons were found in limited quantities, with the low permeability of EVF reservoirs preventing the accumulation of economic quantities of hydrocarbons. In the Durroon Sub-basin, Chat 1 was drilled by Bridge Oil to test a large fault block with overlying anticlinal closure located near the western boundary of the sub-basin; however, no significant hydrocarbon shows were encountered during drilling, nor were any indicated from log analysis.

In 1998, Boral Energy Resources Ltd and partners drilled two wells in the central Bass Basin—Yolla 2 and White Ibis 1. Both wells encountered gas columns in the Paleocene to lower Eocene succession, with liquids-rich gas recovered from reservoirs in wireline tests (Lennon et al, 1999). Yolla 2 was an appraisal well that confirmed a resource of 450–600 Bcf (12.74–17.0 Bcm) of liquids-rich gas and 70 MMbbls (11.1 MMcm) of oil in-place (OIP). The White Ibis 1 well was a crestal test over a large basement high up-dip of Bass 3. Formation pressure data suggests the presence of a thin oil rim, with the well encountering a gas accumulation with an estimated 85 Bcf (2.4 Bcm) of gas in-place. The well was suspended for possible future production (Premier Oil, 1998).

In mid-2004, a consortium of Origin Energy Resources Limited (Permit Operator and 32.5% participant), Origin Energy Northwest Limited (5%) and joint venture partners, AWE Petroleum Pty Ltd (30%), CalEnergy Gas (Australia) Limited (20%) and Wandoo Petroleum Pty Ltd (12.5%) commenced a three-well drilling campaign in the western part of the basin. The first two wells were the Yolla 3 and Yolla 4 development wells in production licence T/L1 (**Figure 7**). These wells successfully encountered and tested several gas zones, and an oil and gas saturated sand in the upper EVF.

The final well in the three well drilling campaign was Trefoil 1, located in the White Ibis Trough, 37 km west of the Yolla production platform. The well intersected approximately 50 m of net gas pay over eight zones in good quality sandstone reservoirs within the EVF and was confirmed as a wildcat gas-condensate discovery; the well was cased and suspended for possible future production (Brooks et al, 2005). Early estimates for in-place resources for the field ranged from 200–300 Bcf (5.6–8.5 Bcm) of gas and 14–21 MMbbls (2.2–3.4 MMcm) of associated liquids (AWE, 2004).

The most recent phase of exploration (2005–12) saw the acquisition of several 3D and 2D seismic data sets in both the Cape Wickham and Durroon sub-basins, and the drilling of 6 exploration wells and one side-tracked well. Spikey Beach 1 and Peejay 1 were drilled by Beach Energy in the Pelican Trough, to test anticlinal closures in the upper EVF for predicted oil accumulations; however, both were dry. Origin drilled Trefoil 2 to appraise the accumulation encountered in Trefoil 1, with the well providing additional control on reservoir and hydrocarbon distribution (Hall, 2012a). This was followed by the successful drilling of Rockhopper 1. The well

(and its side-tracked appraisal well Rockhopper 1 ST1) intersected up to 28 separate hydrocarbon (gas condensate and oil) bearing intervals within Paleocene and Cretaceous sandstones of the EVF, with a total net hydrocarbon pay of 28.9 m. The accumulations at Rockhopper 1 were interpreted to have been sourced from mature source rocks in the Yolla Trough to the east, and the Cormorant Trough to the north (Hall, 2012b).

The most recent exploration wells drilled in the basin—Silvereye 1 drilled by Origin in the southwestern part of the Cape Wickham Sub-basin, and Craigow 1 drilled by TAP on the northeastern edge of the Cormorant Trough—were both unsuccessful. In 2014-15, a further two production wells were drilled and brought online at Yolla—Yolla 5 and Yolla 6. In 2021 Beach Energy conducted the Prion 3D Marine Seismic Survey to further assess the Trefoil, White Ibis and Bass gas fields in retention licenses T/RL2, T/RL4 and T/RL5.

While most recent exploration activity, including all drilling, has been focused on the Cape Wickham Sub-basin, 3D Oil and Bass Strait Oil also carried out exploration programs in the Durroon Sub-basin. New 2D and 3D seismic data sets were acquired and prospects identified; however, no wells were drilled and the three permits in the sub-basin were relinquished in 2012. Seismic data coverage across the Bass Basin is shown in **Figure 8**.

Currently, one production licence and three retention leases are held in the Bass Basin, all are operated by Beach Energy (**Figure 7**).

Production status

Gas, condensate and LPG are currently produced by the BassGas project from the Yolla Field. The BassGas project (a joint venture between Origin Energy and AWE Petroleum, and later partners) was formed to develop the Yolla field, and is the first production of hydrocarbons from the Bass Basin. The production platform was installed in 2004, a pipeline to Victoria was constructed, and first gas was produced in June 2006 (Offshore-Technology.com, 2017).

Beach Energy is the operating partner of the BassGas joint venture, which also includes Prize Petroleum International Pte Ltd. Total production from BassGas in 2022-2023 was 0.9 MMboe, comprising 3.9 PJ natural gas, 135 kbbls (21.5 Mm³) condensate and 8 kt LPG (Beach Energy, 2023a). This represents a decline in production of 21% on the previous year, attributed to downtime for maintenance (both planned and unplanned) and the natural decline of the field. In June 2023, Beach Energy reported net 2P reserves for the Yolla field of 4.2 MMboe, down from 4.8 MMboe in 2022 (Beach Energy, 2023a).

Potential future developments are being assessed for the White Ibis, Bass and Trefoil gas discoveries and review of the Yolla West infield opportunity (Beach Energy, 2023b).

Well control

Cormorant 1 (1970)

Cormorant 1 was drilled by Esso Exploration and Production in 1970 to test Eocene sandstones of the upper Eastern View Formation (EVF) in a large NW–SE trending anticlinal closure that formed in the Miocene. The well intersected the primary target, reaching a TD of 3001 mRT in Eocene strata. Significant oil, gas and condensate shows were encountered. The first oil show from the Bass Basin was recovered from a thin sand at 1499–1501 m, and four sandstones located deeper in the Eocene section of the EVF were interpreted to contain gas and condensate. Porosity values within reservoir sands were good (averaging 20%), however permeability data for the well is limited. The lack of an economic accumulation at Cormorant 1 was attributed to ineffective seal (Esso, 1973) and late development of the trapping structure.

Durroon 1 (1972)

Durroon 1, drilled in 1972 by Esso Exploration and Production Australia Ltd, was the first well to test the sedimentary succession and petroleum potential of the eastern Bass Basin. The well targeted a rotated fault block with onlapping and draping strata with anticlinal closure. Previous drilling in the western Bass Basin, along with regional correlations and onshore geology, suggested that the age of the deeper basin succession would range from Permian to Early Cretaceous. However, drilling confirmed the section to be much younger than predicted, with the oldest sediment penetrated being Aptian in age (Esso, 1973); the well reached a total depth of 3024 mKB. The overlying Cenozoic succession was encountered essentially as predicted, although it consisted of largely coarse- to medium-grained siliciclastic sediments. The “Eocene Shale” (or “Demons Bluff Shale”), considered a regional seal in the western Bass Basin, was largely absent at the Durroon 1 well. No significant hydrocarbons were encountered in Durroon 1 or interpreted from well logs, although numerous small indications of gas (maximum reading of $C_1 = 0.7\%$) were recorded from 1000 mKB to TD (Trigg, 2003). Well failure was attributed to minimal structural closure, poor regional sealing facies and a lack of hydrocarbon charge. The well was plugged and abandoned.

Yolla gas and condensate field (1985-present)

Yolla 1 was drilled in 1985 by Amoco Australia Petroleum Company as a crestal test of the EVF within a four-way dip and fault-closed structure. The well terminated at a TD of 3347 mRT in igneous rocks within the Paleocene middle (“Intra”) EVF section. Yolla 1 successfully encountered commercial hydrocarbon accumulations with approximately 30 m of net gas pay over a 278 m interval (2718–2996 mRT) in the middle EVF (Lennon et al, 1999). Gas pay was interpreted in 5 separate zones within this section (Brooks et al, 2006). In addition, the well penetrated a gross hydrocarbon column of 31 m (wet gas cap of 20.4 m overlying a 10.6 m oil leg) in the upper EVF. A drill-stem test from middle EVF sands over the interval 2809.1–2824.6 mRT flowed gas and condensate at rates of up to 425 Mcm/day and 92 kL/day respectively (15.1 MMscfd and 580 bcpd) (Brooks et al, 2006). The well was suspended for possible future re-entry.

The stacked hydrocarbon accumulations within the EVF at Yolla 1 are sealed by relatively thick and laterally continuous intraformational shales deposited in a lacustrine environment (Lennon et al, 1999). The success of Yolla 1 was attributed to the structure being well placed with respect to hydrocarbon charge, with the structure draining an extensive Paleocene source kitchen that extends into both the Cormorant and Yolla troughs (Lennon et al, 1999).

Work on commercialising the Yolla field has continued since its discovery (Brooks et al, 2006), with the drilling of a further five wells by Premier Oil (Yolla 2 appraisal well) and Origin Energy Resources (Yolla 3, 4, 5 and 6 production wells). The BassGas project (a joint venture between Origin Energy and AWE Petroleum, and later partners) was formed to develop the Yolla field. The production platform was installed in 2004, a pipeline to Victoria was constructed, and first gas was produced in 2006. In 2016–2017 the production facility underwent a Mid-Life Enhancement project to fully develop the field and support future production; tie-in and commissioning of compression and condensate modules on the Yolla platform was also completed (Origin Energy, 2016; AWE, 2017). Beach Energy is the current operating partner of the BassGas joint venture, which also includes Prize Petroleum International Pte Ltd. Production has recently declined, partly due to the natural decline of the field. Further development at Yolla West is currently being assessed (Beach Energy, 2023b).

Pelican 5 (1985)

Pelican 5 (**Figure 9**) was drilled in 1985–1986 by Amoco Australia to test the production potential of the lower Eocene sands (*M. diversus* spore/pollen zone) of the middle EVF, which had good shows of gas and condensate at Pelican 1, 2 and 4, but had not been tested for production. The secondary objective was to investigate Upper Cretaceous to Paleocene sands that were thought to be in a structurally favourable position. Pelican 5 is located on the same large anticlinal structure that was found to be valid at Pelican 1, 2 and 4. Pelican 5 achieved its drilling objectives, reaching a total depth of 4267 m in Campanian–Maastrichtian rocks. Numerous hydrocarbon shows were noted while drilling through the EVF. Gas was produced during two tests, and wireline log evaluation indicated the presence of moveable hydrocarbons at various levels within the interval 2750–4050 m (Amoco, 1987). Hydrocarbons were found in limited quantities, with the low permeability of EVF reservoirs preventing the accumulation of economic quantities of hydrocarbons. Potential source rocks for both oil and gas were found in mature Paleocene and Eocene coals, to over-mature exinite-rich Cretaceous shales (Trigg et al, 2003).

Chat 1 (1986)

Chat 1 was drilled by Bridge Oil Ltd in early 1986. The well targeted a large fault block with overlying anticlinal closure located near the western boundary of the Durroon Sub-basin. The primary objective of the well was to test the hydrocarbon potential of the Upper Cretaceous to Oligocene succession, in particular the Paleocene section. The well reached a total depth of 3104 m in volcanic rocks underlying Maastrichtian–Campanian strata. No significant hydrocarbon shows were encountered at Chat 1 during drilling, nor were any indicated from log analysis. Some traces of gas and oil were observed at 2450 m depth (Bridge Oil, 1986).

Post-drill analysis suggests the well was a valid structural test. The well intersected good quality reservoir, sealing and potential source facies. Well failure was attributed to the lack of mature source rocks, access to hydrocarbon charge or possible trap breach. A fluid inclusion study by Kempton et al. (2002) identified a potential palaeo-hydrocarbon zone, characterised by aqueous inclusions containing small amounts of oil, within Eocene sands at Chat 1. These sands occur near the top of structural closure at the well, within an interval affected by late stage reactivation faulting.

White Ibis 1 (1998)

White Ibis 1 was drilled in 1998 by Premier Oil Australasia and partners on a prominent fault-bounded basement high on the southwestern margin of the Yolla Trough. The well was drilled to evaluate the Upper Cretaceous–Paleocene section of the EVF in a structurally optimal location up-dip of the gas discovery at Bass 3 (Lennon et al, 1999). The well intersected the full EVF section and reached a total depth of 2220 mRT in Paleozoic basement rocks. The structure was found to be valid, with fault-dependent closure at the middle EVF level and four-way dip closure at the top EVF. The well encountered three short hydrocarbon columns, sealed by intraformational shales within the objective section of the EVF; the thickest gas column covered a gross interval of 23 m (Lennon et al, 1999). Lennon et al (1999) suggested that the occurrence of a series of stacked reservoirs was the result of inadequate fault seal. Lennon et al (1999) proposed that formation pressure and sample data from the upper reservoir (2001.5–2023 m) could indicate the presence of an oil leg underlying a liquids-rich gas column; the lower two reservoirs (2044–2053 m and 2128–2140 m) are considered to contain dry gas only. The well was not tested and was suspended as a sub-commercial gas discovery (Premier Oil, 1998). Probabilistic calculations suggest a mean resource of 85 Bcf (2.4 Bcm) gas-in-place (Lennon et al, 1999).

Trefoil 1 (2004)

Trefoil 1 was drilled by Origin Energy Resources Limited and joint venture partners in 2004 to test the Cretaceous–Paleocene and Eocene EVF sandstone reservoirs that are hydrocarbon-bearing at the nearby Yolla Field and White Ibis 1 discovery (Brooks et al, 2005). The well penetrated the target EVF section and reached TD at 3545 mRT in igneous rocks within Campanian–Maastrichtian strata. The well intersected approximately 50 m of net gas pay over several zones in good quality sandstone reservoirs within the EVF. Multiple gas and condensate columns were discovered in the lower Paleocene and Cretaceous sands. MDT pressures showed that the middle EVF in the well consists of several different over-pressured and isolated layers. Production tests were carried out over two separate zones in the Cretaceous–lower Paleocene

section, from 3040–3047 m and 3141–3150 m, flowing gas at 9.5 MMscf/d (268.4 Mcm/d) and 14.4 MMscf/d (406.8 Mcm/d) respectively (Brooks et al, 2005). Preliminary estimates for in-place resources for the field are 200–300 Bcf of gas (5.6–8.5 MMcm) and 14–21 MMbbls (2.2–3.4 MMcm) of associated liquids (AWE, 2004). The well was confirmed as a wildcat gas-condensate discovery.

Rockhopper 1 (2009)

Rockhopper 1 was drilled by Origin Energy Resources in 2009–2010 to test the crest of a fault-dependant three-way dip closure anticline within the middle EVF (Hall, 2012). The well was expected to intersect 50–100 m of gross gas pay, based on the results of Trefoil 1 and re-interpretation of the results of Aroo 1, which is located on the same structure. The well reached a total depth of 3522 mRT in Cretaceous volcanics.

Rockhopper 1 (and its side-tracked appraisal well Rockhopper 1 ST1, which was drilled to determine fluid contacts and reservoir quality extent) intersected up to 28 separate hydrocarbon bearing intervals within Paleocene and Cretaceous sandstones of the EVF, with a total net hydrocarbon pay of 28.9 m. Hydrocarbons were sampled from seven sandstone units using the MDT tool; gas condensate was sampled from five and oil from two. Petrological analyses showed considerable variations in reservoir quality; although sandstones at the top of the reservoir section have been only mildly affected by diagenesis, deeper sandstones have been severely affected (Hall, 2012). The accumulations at Rockhopper 1 were interpreted to have been sourced from mature source rocks in the Yolla Trough to the east, and the Cormorant Trough to the north (Hall, 2012).

Geoscience Australia products and data

Regional geology

- Petroleum geology inventory of Australia's offshore frontier basins. [Geoscience Australia Record 2014/009 by Totterdell et al, 2014](#)
- Petroleum Geology of the Bass Basin – Interpretation Report. [Geoscience Australia, Record 2003/19 compiled by Blevin, 2003.](#)
- Australian southern margin synthesis, Project GA707. [A report to Geoscience Australia by Blevin and Cathro, 2008](#)
- An audit of petroleum exploration wells in the Bass Basin: 1965–1999. [Geoscience Australia Record 2003/011 by Trigg et al, 2003](#)
- Bass Basin basic data compilation. [Geoscience Australia record 2003/017 by Blevin et al, 2003](#)
- Regional potential field interpretation report, Bass Basin. [Geoscience Australia Record 2003/004 by Teasdale et al, 2003](#)

Stratigraphy

- Review and compilation of open file micropalaeontology and palynology data from offshore Tasmania. [Geoscience Australia Record 2003/007 by Partridge et al, 2003](#)
- [Geoscience Australia's Basin Biozonation and Stratigraphy Chart Series](#): Bass Basin Biozonation and Biostratigraphy Chart 17, 1998. [Chart by Shafik et al, 1998](#)

Petroleum systems and accumulations

- The Oils of Eastern Australia. [Geoscience Australia Report by Summons et al, 2002](#)
- South-eastern Australia Surface Geochemistry II: Light Hydrocarbon Geochemistry in Bottom-waters of the Gippsland Basin, Eastern Otway Basin, Torquay Sub-basin and the Durroon Sub-basin. Vols 1 and 2. [Australian Geological Survey Organisation Record 1992/054 by Bishop et al, 1992](#)
- Australian Petroleum Accumulations Report 2: Bass Basin, Tasmania and Victoria. [Bureau of Mineral Resources Report by Ozimic et al, 1987](#)
- Petroleum potential of the Bass Basin. [AGSO Journal of Australian Geology & Geophysics article by Nicholas et al, 1981](#)

Data discovery tools

- The [National Offshore Petroleum Information Management System \(NOPIMS\)](#) provides access to wells and survey data acquired primarily in Commonwealth waters and submitted under legislation, currently the Offshore Petroleum and Greenhouse Gas Storage Act 2006. This data can be downloaded or packaged on request. NOPIMS has been upgraded to provide access to over 50 years of data submission of well and survey information. It represents more than 1 million records and includes an [interactive mapping tool](#) for data discovery.
- [Geoscience Australia's Data Discovery Portal](#) provides full access to Geoscience Australia data and other publically available data sources as well as a suite of analytical and multi-criteria assessment tools. This includes an [Energy persona](#) that allows access to a wide range of geological and geospatial data. Themes include source rock geochemistry, petroleum wells, stratigraphic information, province and basin geology, geophysical survey data coverage and other fundamental geospatial and administrative datasets.

Marine and environmental information

The following section contains information about the existing marine parks, their special habitat zones and physiographic features within the Bight Basin (**Figure 10**). The information is provided in support of business decisions with respect to planned exploration and development activities.

Climate of the region

The region is characterised by a cool temperate climate, with precipitation throughout the year and few temperature extremes. Mean minimum and maximum annual temperatures are 8.3°C and 17.0°C for the period 1991–2017 (<http://www.bom.gov.au>). Mean annual rainfall recorded over 52 years at Devonport Airport is 773 mm (<http://www.bom.gov.au>).

Based on a 20-year average, sea surface temperatures (SST) in this region are comparatively cool for Australian waters (around 15°C), although there are high levels of interannual variations in SSTs often linked to warm eastern incursions from the East Australian Current (R. Przeslawski, Geoscience Australia, pers. comm., March 2017). SSTs are predicted to increase by 0.5°C per decade in the immediate future (Foster et al, 2014).

Oceanic regime

Bass Strait is a 250 km wide, shallow microtidal seaway between mainland Australia and Tasmania. The granitic King Island High to the west and the Bassian Rise to the east isolated the basin (the offshore Bass Basin) at the 60 m isobath during times of glacial low sea level (Blom, 1988; Blom and Alsop, 1988). Li et al (2007) defined the complexity and seasonality of the most significant geostrophic currents that interact to affect Bass Strait: the Flinders, Zeehan, East Australia, and Antarctic Circumpolar currents. Persistent and strong westerly winds also result in uniform velocity profiles through the strait and drive the eastward flowing Westwind Drift throughout the year (Blom and Alsop, 1988). In general, salinity and temperature are consistent throughout the water column, indicating high levels of vertical mixing (Huang and Przeslawski, 2016).

Maximum significant wave heights (MSWH) approaching the western coast of Tasmania are some of the largest in Australia (<9 m), however, Bass Strait is partly protected from these larger swells and MSWH over the western (5–6 m) sill reduces to 4–6 m across the central to eastern Bass Basin and Strait (Li et al, 2007). Maximum tidal speeds are exerted over these flanking sills (0.3 m/s to >0.6 m/s), and tidal currents in the central Basin are much reduced (<0.3 m/s) (Li et al, 2007).

Passlow et al (2004) presented modelled wave to tidal ratios throughout Bass Strait and determined that, while tidal mobilisation dominates a portion of the central western Bass Basin, the remainder of the basin is dominated by waves only. This pattern is reflected in the rates of sediment accumulation whereby the central basin is accumulating at twice the rate (<12 cm/1000 yr) of the basin margins (<6 cm/1000 yr) (Blom and Alsop, 1988), and generally high energy conditions transport fine-grained sediments away from the basin rim and deposit them in either the lower-energy central basin or on the shelf (Fandry, 1981; Harris, 1994; Harris and Coleman, 1998).

The river catchment sediment yield rate in the southeastern Australian region is in the order of 10–30 t/sqkm per annum (Harris, 1995). Li et al (2007) identified the 18 most influential rivers discharging into the Bass Strait region, and of these the Tamar River (Tasmania: low sediment load; flow discharge 6600 GL/a), Snowy River (Victoria: medium sediment load; flow discharge 4000 GL/a), Latrobe River (medium sediment load; flow discharge 2250 GL/a) and Arthur River (Tasmania: medium sediment load; flow discharge 2100 GL/a), are the largest. By global standards, Australian rivers discharge only modest sediment loads into the sea (Blom and Alsop, 1988; Bax and Williams, 2001; Bax et al, 2001; Roy et al, 2001) and, even by Australian standards, the Bass Strait rivers have a low sediment yield (Harris et al, 2002).

Seabed environments: regional overview

The central portion of Bass Strait forms a basin with a maximum depth near its centre of 83 m. Shelf encircles the basin and is, in turn, bounded to the east and west by shallow (55 m) sills and plateaus (Heap and Harris, 2008). Tidal sand waves and sand banks have accumulated atop these shallower features (Malikides et al,

1988, 1989), which coincide with the enhanced tidal velocities generated by ocean current constriction between the land masses (Malikides et al, 1988, 1989; Morrow and Jones, 1988; Black and Hatton, 1992). Amongst these sand waves and banks, seabed erosion has been modelled (Li et al, 2007). Evidence for erosion is provided by the presence of gravel lags (Passlow et al, 2004) and current-parallel depressions (Harris et al, 2003).

Li et al (2007) modelled likely seabed change as a result of climate change scenarios. Their work suggests that, while small changes in climate will result in large (-54% to +24%) changes in total sediment delivery to the Bass Strait region, the absolute contribution of the fluvial sediment to the seabed will remain small and it will be largely overwhelmed by stronger marine forces (waves and currents). Indeed, they assert that climate change may exacerbate sea bed erosion already occurring on the topographic highs in the Bass Strait as a result of potentially strengthened waves and currents. They also identified potential turbidite activity in the central-southern Bass Basin under present and predicted future climate scenarios.

Passlow et al (2004) have summarised Bass Strait seabed sedimentology (see also Jones and Davies, 1983; Blom and Alsop, 1988). In general, the seabed is characterised by cool-water carbonates with a low terrigenous content. Fine-grained sediments (muds and silty sands) are restricted to the deeper waters of the Bass Basin. Gravels and sands cover the remainder of the shelf (Passlow et al, 2004; James et al, 2008). Fine shelly sands occur along the inner shelf of the south-eastern Victorian coast and north of Flinders Island. Moderately well and well sorted sediments are restricted to nearshore environments and to areas between Flinders Island and Mornington Peninsula. Sediments over the remainder of Bass Strait are poorly to very poorly sorted and include quartzose sands, and bryozoan sands and gravels. Carbonate content within the Bass Basin generally exceeds 80% of seafloor sediments. With the exception of restricted occurrences of limestone and beach rock, the carbonate fraction in coarse sediments consists of recognisable skeletal debris derived from bryozoans, molluscs and foraminifera (Passlow et al, 2004; James et al, 2008). Sediments in the Bass Basin also contain a high proportion of carbonate mud derived from the breakdown of carbonate material and containing the remains of coccoliths, benthic foraminifera and tunicate spicules. The sand fraction of these sediments contains benthic foraminifera, bryozoans and molluscs, with minor amounts of echinoids, brachiopods, ostracods and worm tubes, while the gravel fraction is dominated by bryozoans. The non-carbonate fraction generally consists of quartz, with minor amounts of lithic fragments, feldspar and ferromagnesian minerals. Silica, in the form of sponge spicules, is present in small quantities throughout. Quartz and clay are present also in the mud fraction of basin sediments. Distinction of modern and relict material, both in the biogenic and siliciclastic fractions, is difficult in many sediment types. Relict material, characterised by poor sorting and multi-modal grain size distribution, may comprise up to 50% of some sediments.

Ecology

The Bass Basin is part of the Southeast Marine Bioregion which extends from the far south coast of New South Wales to Kangaroo Island. This region hosts high levels of biodiversity and endemism, particularly of macroalgae (Womersley 1990), and possibly represents one of the most diverse marine floral assemblages in the world (Commonwealth of Australia, 2005). At a regional scale, habitats include kelp forests, temperate seagrass meadows, and rocky reefs, as well as extensive soft sediment ecosystems. These marine habitats support a diverse range of temperate marine plants, invertebrates, fishes, and larger marine animals such as whales, dolphins and seals. Humpback Whales, seabirds and other threatened or migratory animals can migrate through this region on their way to breeding grounds, and other species such as Blue Whales may use this region as a feeding ground (Gill et al, 2011). At the smaller scale of provincial bioregions (Commonwealth of Australia, 2006), the Bass Basin is included in the Bass Strait IMCRA Province, which is an area of fauna, flora and ocean conditions distinct from adjacent areas (Commonwealth of Australia, 2005).

Recent geological history

The Bass Basin formed during the Late Cretaceous and Cenozoic during the break-up of Australia and Antarctica (Veevers, 1984). Paleozoic granitic basement ridges form the eastern and western highs that partly enclose the basin (Blom and Alsop, 1988). Quaternary sea level fluctuations have repeatedly exposed the eastern Bassian Rise, which lies at the modern 55 m isobath, forming a large marine embayment with an opening to the northwest. When sea level dropped still further to the modern 67 m isobath, the King Island High to the west was also exposed and the basin formed a shallow saline lake (Blom and Alsop, 1988). Facies changes in cores have been dated and linked directly to these changes in sea level. A succession of highly

calcareous, poorly sorted muddy bryozoan sands towards the base of several cores described by Blom (1988) likely relate to deposition during the latter stages of Marine Isotope Stage 3 when sea level was at least 60 m below present levels (Murray-Wallace, 2014). The later Pleistocene–Holocene stratigraphy of the Bass Basin is broadly described as lacustrine facies overlain by brackish-water (embayment) facies (approximately 10–12 ka BP), overlain by fully marine Holocene facies (approximately 9 ka BP), demonstrating the flooding of the basin by rising post-glacial sea level (Blom, 1988; Blom and Alsop, 1988; Murray-Wallace, 2014).

Commonwealth Marine Reserves

Boags Commonwealth Marine Reserve

<https://www.environment.gov.au/topics/marine/marine-reserves/south-east/boags>

Major conservation values

- Ecosystems, habitats and communities associated with the Bass Strait Shelf Province, and associated with plateau and tidal sandwave/sandbank sea-floor features
- Important foraging area for Shy Albatross, Australasian Gannet, Short-tailed Shearwater, Fairy Prion, Black-faced Cormorant, Common Diving Petrel and Little Penguin

The reserve is zoned Multiple Use Zone IUCN Category VI (**Figure 7**). Management plans for the South-east Marine Reserves Network are in place. Mining operations, including exploration are allowed.

Beagle Commonwealth Marine Reserve

<https://www.environment.gov.au/topics/marine/marine-reserves/south-east/beagle>

Major conservation values

- Ecosystems, habitats and communities associated with the Southeast Shelf Transition, and associated with basin, plateau, shelf and sill sea-floor features
- Important migration and resting on migration area for Southern Right Whale
- Important foraging area for Australian Fur Seal, Killer Whale, White Shark, Shy Albatross, Australasian Gannet, Short-tailed Shearwater, Pacific and Silver gulls, Crested Tern, Common Diving Petrel, Fairy Prion, Black-faced Cormorant and Little Penguin

The reserve is zoned Multiple Use Zone IUCN Category VI (**Figure 7**). Management plans for the South-east Marine Reserves Network are in place. Mining operations, including exploration are allowed.

Fisheries

The following fisheries occur in the Bass Basin area:

- Scallop Fishery. The Tasmanian zone is between the high tide mark, excluding bays and inlets, out 20 nm. The fishery was closed in 2016 (<http://dpipwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/scallop-fishery>). The Commonwealth zone is between the Tasmanian and Victorian fisheries that lie within 20 nm of their respective coasts (<http://www.afma.gov.au/fisheries/bass-strait-central-zone-scallop-fishery>). The fishing season runs 1 April–31 December.
- Eastern Tuna and Billfish Commonwealth Fishery operates in the Australian Fishing Zone and adjacent high seas. The season runs for 12 months starting 1 March (<http://www.afma.gov.au/fisheries/eastern-tuna-and-billfish-fishery-page>).
- Small Pelagic Commonwealth Fishery, western sub-area. The season runs for 12 months starting 1 May (<http://www.afma.gov.au/fisheries/small-pelagic-fishery>).
- Southern and Eastern Scalefish and Shark Fishery, Commonwealth Southeast Trawl Sector and Commonwealth Scalefish Hook Sector. The season runs for 12 months starting 1 May (<http://www.afma.gov.au/fisheries/southern-eastern-scalefish-shark-fishery>).

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- Southern Bluefin Tuna Commonwealth Fishery. The season runs for 12 months beginning 1 December. (<http://www.afma.gov.au/fisheries/southern-bluefin-tuna-fishery>).
 - Rock Lobster Fishery extends to 20 nm from the coastline (<http://dpiwwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/rock-lobster-fishery>).
 - Commercial Scalefish Fishery is a diverse multi-species, multi-gear fishery. The licensing year runs from 1 March. (<http://dpiwwe.tas.gov.au/sea-fishing-aquaculture/commercial-fishing/scalefish-fishery/commercial-scalefish>)

National seabed mapping data and information

Geoscience Australia provides acoustic datasets including bathymetry, backscatter, sidescan sonar and sub-bottom profiles to assist in understanding the shape and composition of the sea floor. Geoscience Australia also maintains the Marine Sediment database ([MARS](#)), comprising information (e.g. percentage mud/sand/gravel, mean grain size, and sediment texture) from seabed sediment samples collected during marine surveys between 1905 and 2017.

These data are discoverable and accessible through the AusSeabed [Marine Data Discovery Portal](#). [AusSeabed](#) is an innovative national seabed mapping initiative designed to coordinate data collection efforts in Australian waters and provide open access to quality-controlled seabed data.

Other online information resources

Please follow these links for more detailed information pertaining to the marine and environmental summaries provided in this section.

- [Bureau of Meteorology: climate statistics](#)
- [National Conservation Values Atlas](#)
- [Boags Commonwealth Marine Reserve](#)
- [Beagle Commonwealth Marine Reserve](#)
- [AusSeabed](#)
- [Commonwealth Fisheries](#)
- [AFMA Commonwealth Fisheries](#)
- [Tasmanian Commercial Fisheries](#)
- [Underwater cultural heritage](#)
- [Protected Matters Search Tool](#)
- [Atlas of Living Australia](#)

References

- AMOCO, 1987—Pelican 5 final well report. Volume 1 – Geology. Amoco Australia Petroleum Company report (unpublished)
- ARIAN, N., TINGATE, P., HILLIS, R.R. AND O'BRIEN, G.W., 2010—Petroleum systems of the Bass Basin: a 3D modelling perspective. *The APPEA Journal*, 50, 511–534.
- AWE, 2004—[web page] AWE's Trefoil-1 gas discovery takes major step towards commercial viability. ASX announcement December 15, 2004. <http://www.asx.com.au/asxpdf/20041215/pdf/3p39c5cn7zrkf.pdf> (last accessed 10 April 2017)
- AWE, 2017—[Web page] BassGas Project. <http://www.awexplore.com/irm/content/bassgas-project.aspx?RID=398> (last accessed 2 February 2017)
- BAILLIE, P.W., 1992—Relationship of coal facies with sea level in the Bass Basin. *Geological Society of Australia, Abstracts*, 32, 116–117.
- BAILLIE, P.W. AND PICKERING, R., 1991—Tectonic evolution of the Durroon Basin, Tasmania. *Exploration Geophysics*, 22, 13–18.
- BAILLIE, P.W., TINGATE P.R. AND STUART W.J., 1991—Reservoir development and diagenesis in the Bass Basin, Tasmania. *The APEA Journal*, 33(1), 85–100.
- BAX, N.J., BURFORD, M., CLEMENTSON, L. AND DAVENPORT, S., 2001—Phytoplankton blooms and production sources on the south-east Australian continental shelf. *Marine and Freshwater Research*, 52, 451–462.
- BAX, N.J. AND WILLIAMS, A., 2001—Seabed habitat on the south-eastern Australian continental shelf: Context, vulnerability and monitoring. *Marine and Freshwater Research*, 52, 491–512.
- BEACH ENERGY, 2023a—[Web page] Annual Report 2023. https://www.beachenergy.com.au/wp-content/uploads/BPT_2023_Beach_Energy_Ltd_Annual_Report.pdf (last accessed August 2023)
- BEACH ENERGY, 2023b—[Web page] Bass Basin. <https://www.beachenergy.com.au/bass-basin/> (last accessed August 2023)
- BLACK, K.P. AND HATTON, D.N., 1992—Hydrodynamic and sediment dynamic measurements in eastern Bass Strait, Volume 4, Two and three dimensional numerical hydrodynamic and dispersion models Technical Report No. 17, Victorian Institute of Marine Science.
- BLEVIN, J.E., 2001—Hydrocarbon prospectivity of Australia's remote frontier areas in offshore east and south-east Australia – examples from the basins of Lord Howe Rise. In: Hill, K.C. and Bernecker, T. (eds), *Eastern Australasian Basins Symposium, A Refocused Energy Perspective for the Future*, Petroleum Exploration Society of Australia, Special Publication, 25–35.
- BLEVIN, J.E. (Compiler), 2003a—Petroleum geology of the Bass Basin—interpretation report: an output of the Western Tasmanian Regional Minerals Program. Geoscience Australia, Record, 2003/19, 263 pp.
- BLEVIN, J.E., 2003b—Tectonic evolution. In: Blevin, J.E. (Compiler), *Petroleum geology of the Bass Basin—interpretation report: an output of the Western Tasmanian Regional Minerals Program*. Geoscience Australia, Record, 2003/19, 17–42.
- BLEVIN, J.E. AND CATHRO, D.L., 2008—Australian Southern Margin Synthesis, Project GA707. Client report to Geoscience Australia by FrOG Tech Pty Ltd. Accessed 2 February 2017. https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=68892
- BLEVIN, J.E., TRIGG, K.R., LANG, S.C. AND PARTRIDGE, A.D., 2003—Accommodation cycles and sequence stratigraphy. In: Blevin, J.E. (Compiler), *Petroleum geology of the Bass Basin—interpretation report: an output of the Western Tasmanian Regional Minerals Program*. Geoscience Australia, Record, 2003/19, 43–83.
- BLEVIN, J.E., TRIGG, K.R., PARTRIDGE, A.D., BOREHAM, C.J. AND LANG, S.C., 2005—Tectonostratigraphy and potential source rocks of the Bass Basin. *The APPEA Journal*, 45, 601–621.
- BLOM, W.D., 1988—Late Quaternary sediments and sea-levels in Bass Basin, southeastern Australia – a preliminary report. *Search*, 19, 94–96.

- BLOM, W.A. AND ALSOP, D.B., 1988—Carbonate mud sedimentation on a temperate shelf: Bass Basin, southeastern Australia. *Sedimentary Geology*, 60, 269–280.
- BOREHAM, C.J., 2003—Petroleum geochemistry of source rocks, oils and gases. In: Blevin, J.E. (Compiler), *Petroleum geology of the Bass Basin—interpretation report: an output of the Western Tasmanian Regional Minerals Program*. Geoscience Australia, Record, 2003/19, 85–124.
- BOREHAM, C.J., BLEVIN, J.E., RADLINSKI, A.P. AND TRIGG, K.R., 2003—Coal as a source of oil and gas: a case study from the Bass Basin, Australia. *The APPEA Journal*, 43(1), 117–148.
- BRIGUGLIO, D., KOWALCZYK, J., STILWELL, J.D., HALL, M. AND COFFA, A., 2013—Detailed palaeogeographic evolution of the Bass Basin: Late Cretaceous to present. *Australian Journal of Earth Sciences*, 60, 719–734.
- BROOKS, D.M., LONERGAN, M. AND PARVAR, J., 2005—Trefoil 1, T/18P offshore Bass Basin, well completion report: interpretive data. Origin Energy report (unpublished).
- BROOKS, D.M., PIDGEON, B.A., HALL, A.D., TAYLOR, R.J. AND PARVAR, J.L., 2006—Appraising the Yolla field in the Bass Basin—how effective data collection, analysis and integration increased estimated hydrocarbon volumes in place. *The APPEA Journal*, 46, 15–34.
- COMMONWEALTH OF AUSTRALIA, 2005—[webpage] National Marine Bioregionalisation of Australia. Department of the Environment and Heritage: Canberra. <http://www.environment.gov.au/node/18076> (last accessed 7 April 2017).
- COMMONWEALTH OF AUSTRALIA, 2006—A Guide to the Integrated Marine and Coastal Regionalisation of Australia Version 4.0. Department of the Environment and Heritage, Canberra, Australia. <https://parksaustralia.gov.au/marine/management/resources/scientific-publications/guide-integrated-marine-and-coastal-regionalisation-australia-version-40-june-2006-imcra> (last accessed 7 April 2017)
- CUMMINGS, A.M., HILLIS, R.R. AND TINGATE, P.R., 2002—Structural evolution and thermal maturation modelling of the Bass Basin. *The APPEA Journal*, 42(2), 175–191.
- CUMMINGS, A.M., HILLIS, R.R. AND TINGATE, P.R., 2004—New perspectives on the structural evolution of the Bass basin: implications for petroleum prospectivity. In: Boulton, P.J., Johns, D.R. and Lang, S.C. (Editors), *Eastern Australasian Basins Symposium II*. Petroleum Exploration Society of Australia, Special Publication, 133–149.
- CUMMINGS, A. AND TINGATE, P., 2003—Geohistory and maturity modelling. In: Blevin, J.E. (Compiler), *Petroleum Geology of the Bass Basin—Interpretation Report: an output of the Western Tasmanian Regional Minerals Program*. Geoscience Australia, Record, 2003/19, 125–165.
- DANIEL, R., KALDI, J. AND ROOT, R., 2003—Hydrocarbon seal evaluation. In: Blevin, J.E. (Compiler), *Petroleum Geology of the Bass Basin—Interpretation Report: an output of the Western Tasmanian Regional Minerals Program*. Geoscience Australia, Record, 2003/19, 167–174.
- DAS, P.K., 2001—Extensional subsidence, inversion and volumetric contraction in the Bass Basin of Australia; a seismic study. PhD. thesis, National Centre for Petroleum Geology and Geophysics, University of Adelaide (unpublished)
- DAS, P.K. AND LEMON, N., 2000—A new model for the tectonic evolution of the southeastern Bass Basin, Australia (Poster Abstract). *The APPEA Journal*, 40(1), 775–776.
- DITR, 2004—Australia: Release of Offshore Petroleum Exploration Areas, 2004. Department of Industry, Tourism and Resources, Australia.
- EDWARDS, D.S., STRUCKMEYER, H.I.M., BRADSHAW, M.T. AND SKINNER, J.E., 1999—Geochemical characterisation of Australia's southern margin petroleum systems. *The APPEA Journal*, 39(1), 297–321.
- ETHERIDGE, M.A., BRANSON, J.C. AND STUART-SMITH, P.G., 1985—Extensional basin-forming structures in Bass Strait and their importance for hydrocarbon exploration. *The APEA Journal*, 25(1), 344–361.
- FANDRY, C.B., 1981—Development of a numerical model of tide and wind driven circulation in Bass Strait. *Australian Journal of Marine and Freshwater Research*, 32, 9–29.
- FOSTER, S.D., GRIFFIN, D.A. AND DUNSTAN P.K., 2014—Twenty years of high-resolution sea surface temperature imagery around Australia: inter-annual and annual variability. *PLOS one*, 9(7), e100762, 13pp.

- GILL, P.C., MORRICE, M.G., PAGE, B., PRIZL, R., LEVINGS, A.H. AND COYNE M., 2011—Blue whale habitat selection and within-season distribution in a regional upwelling system off southern Australia. *Marine Ecology Progress Series*, 421, 243–263.
- HALL, N., 2012a—Trefoil 2, T/18P offshore Bass Basin, well completion report (interpretive data volume). Origin Energy report (unpublished).
- HALL, N., 2012b—Rockhopper 1, T/18P offshore Bass Basin, well completion report (interpretive). Origin Energy report (unpublished).
- HARRIS, P.T., 1994—Comparison of tropical, carbonate and temperate, siliciclastic tidally dominated sedimentary deposits: examples from the Australian continental shelf. *Australian Journal of Earth Sciences*, 41, 241–254.
- HARRIS, P.T., 1995—Marine geology and sedimentology of Australian continental shelf. State of the marine environment report for Australia: The marine environment—Technical Annex 1: Department of the Environment and Heritage, Australian Government.
- HARRIS, P.T. AND COLEMAN, R., 1998—Estimating global shelf sediment mobility due to swell waves. *Marine Geology*, 150, 171–177.
- HARRIS, P.T., HEAP, A., BRYCE, S., SMITH, R., RYAN, D. AND HEGGIE, D., 2002—Classification of Australian clastic coastal depositional environments based upon a quantitative analysis of wave, tidal and fluvial power: *Journal of Sedimentary Research*, 72, 858–870.
- HARRIS, P., HEAP, A., PASSLOW, V., SBAFFI, L. FELLOWS, M., PORTER-SMITH, R., BUCHANAN, C., AND DANIELL, J. 2003—Geomorphic features of the continental margin of Australia. *Geoscience Australia, Record*, 2003/30, 142 pp.
- HEAP, A.D. AND HARRIS, P.T., 2008—Geomorphology of the Australian margin and adjacent seafloor. *Australian Journal of Earth Sciences*, 55(4), 555–585.
- HILL, K.C., HILL, K.A., COOPER, G.T., O'SULLIVAN, A.J., O'SULLIVAN, P.B. AND RICHARDSON, M.J., 1995—Inversion around the Bass Basin, SE Australia. In: Buchanan, J.G. and Buchanan, P.G. (Editors), *Basin Inversion*. Geological Society, London, Special Publications, 88, 525–547.
- HOLFORD, S., HILLIS, R.R., DUDDY, I.R., GREEN, P.F., STOKER, M.S., TUITT, A.K., BACKE, G., TASSONE, D.R. AND MACDONALD, J.D., 2011—Cenozoic post-breakup compressional deformation and exhumation of the southern Australian margin. *The APPEA Journal*, 51, 613–638.
- HOLFORD, S., SCHOFIELD, N., MACDONALD, J.D., DUDDY, I.R. AND GREEN, P., 2012—Seismic analysis of igneous systems in sedimentary basins and their impacts on hydrocarbon prospectivity: examples from the southern Australian margin. *The APPEA Journal*, 52, 229–252.
- HUANG, Z. AND PRZESLAWSKI, R., 2016—Appendix C: Environmental modelling in Bass Strait. In *Marine Seismic Survey Impacts on Fish and Invertebrates*. Geoscience Australia, Record, 2016/35.
- JAMES, N.P., MARTINDALE, R.C., MALCOM, I., BONE, Y. AND MARSHALL, J., 2008—Surficial sediments on the continental shelf of Tasmania, Australia. *Sedimentary Geology*, 211(1), 33–52.
- JONES, H.A. AND DAVIES, P.J., 1983—Superficial sediments of the Tasmanian continental shelf and part of Bass Strait. Bureau of Mineral Resources, Geology and Geophysics, Bulletin 218, 25 pp.
- KEMPTON, R.H., LIU, K., BOREHAM, C.J., BLEVIN, J.E. AND EADINGTON, P.J., 2002—Hydrocarbon migration and accumulation in the Middle to Upper Eastern View Coal Measures of the Bass Basin, Tasmania: evidence from GOITM, QGF and QGF-E. CSIRO, Division of Petroleum Resources, Confidential Report 02-089 (unpublished).
- LANG, S., ROOT, R. AND MCEACHERN, J., 2003—Depositional environments and facies analysis. In: Blevin, J.E. (Compiler), *Petroleum Geology of the Bass Basin—Interpretation Report: an output of the Western Tasmanian Regional Minerals Program*. Geoscience Australia, Record, 2003/19, 209–237.
- LENNON, R.G., SUTTILL, R.J., GUTHRIE, D.A. AND WALDRON, A.R., 1999—The renewed search for oil and gas in the Bass Basin; results of Yolla 2 and White Ibis 1. *The APPEA Journal*, 39(1), 248–261.
- LI, F., DYT, C.P., GRIFFITHS, C.M. AND MCINNES, K.L., 2007—Predicting seabed change as a function of climate change over the next 50 yr in the Australian southeast. *Geological Society of America, Special Papers*, 426, 43–64.

- MALIKIDES, M., HARRIS, P.T., JENKINS, C.J. AND KEENE, J.B., 1988—Carbonate sandwaves in Bass Strait. *Australian Journal of Earth Sciences*, 35(3), 303–311.
- MALIKIDES, M., HARRIS, P.T. AND TATE, P.M., 1989—Sediment transport and flow over sandwaves in a non-rectilinear tidal environment: Bass Strait, Australia. *Continental Shelf Research*, 9(3), 203–221.
- MAUNG, T.U., MIYAZAKI, S., BAILLIE, P.W., LAVERING, I.H., VUCKOVIC, V., STEPHENSON, A.E., WILLIAMSON, P.E., STAUNTON, J., RADKE, S.G., WEST, B.W., GIPPE SPIE, R.G., RESIAK, E. AND TEMPLE, P.R., 1993—Eastern Bass Basin Petroleum Prospectivity Bulletin. Bureau of Resource Sciences, Petroleum Prospectivity Bulletin, 1993/2.
- MESZOLY, G.F.J., BODARD, J.M. AND WALL, V.J., 1986—Diagenesis and porosity in the Eastern View Group, Bass Basin. In: Glenie, R.C. (ed.), *Second South-Eastern Australia Oil Exploration Symposium*, PESA Symposium, Melbourne, 303–315.
- MIYAZAKI, S., 1995—Oil generation from coals and carbonaceous claystones in the Bass Basin. *PESA Journal*, No. 23, 91–100.
- MORROW, R.A. AND JONES, I.S.F., 1988—Sea floor drag coefficients—eastern Bass Strait. Ocean Sciences Institute, University of Sydney, Report 29, 26 pp.
- MURRAY-WALLACE, C.V., 2014—The continental shelves of SE Australia. *Geological Society, London, Memoirs*, 41(1), 273–291.
- NICHOLAS, E., LOCKWOOD, K.L., MARTIN, A.R. AND JACKSON, K.S., 1981—Petroleum potential of the Bass Basin. *BMR Journal of Australian Geology & Geophysics*, 6, 199–212.
- OFFSHORE-TECHNOLOGY.COM, 2017—[web page] BassGas Project, Australia. <http://www.offshore-technology.com/projects/bassgas-project/> (last accessed 10 April 2017)
- OGG, J.G., OGG, G.M. AND GRADSTEIN, F.M., 2016—A Concise Geologic Time Scale 2016. Elsevier, Oxford, 234 pp.
- ORIGIN ENERGY, 2016—Quarterly production report for period ending 30 June 2016. <https://www.originenergy.com.au/wp-content/uploads/160729-June-2016-Quarterly-Production-Report.pdf> (last accessed 2 February 2017)
- PARTRIDGE, A.D., 2003—Appendix C2, Palynological review of Upper Cretaceous units in Durroon 1, Bass Basin. In: Blevin, J.E. (Compiler), *Petroleum Geology of the Bass Basin—Interpretation Report: an output of the Western Tasmanian Regional Minerals Program*. Geoscience Australia, Record, 2003/19, Volume 2, CD-ROM.
- PASSLOW, V., O'HARA, T., DANIELL, J., BEAMAN, R.J. AND TWYFORD, L.M., 2004—Sediments and benthic biota of Bass Strait: an approach to benthic habitat mapping. *Geoscience, Australia, Record*, 2004/23.
- PREMIER OIL, 1998—White Ibis 1 well completion report. Premier Oil report (unpublished).
- RADLINSKI, A., HINDE, A. AND BOREHAM, C., 2003—Appendix H: Small Angle Neutron Scattering (SANS) study on low-ash coals from Cormorant–1 and Pelican–5. In: Blevin, J.E. (compiler), *Petroleum geology of the Bass Basin, interpretation report, an output of the Western Tasmanian Regional Minerals Program*. Geoscience Australia, Record 2003/19, CD-ROM.
- ROBINSON, V.A., 1974—Geologic history of the Bass Basin. *The APPEA Journal*, 14(1), 45–49.
- ROY, P.S., WILLIAMS, R.J., JONES, A.R., YASSINI, I., GIBBS, P.J., COATES, B., WEST, R.J., SCANES, P.R., HUSON, J.P. AND NICHOL, S., 2001—Structure and function of south-east Australian Estuaries: Estuarine, Coastal and Shelf Science, 53, 351–384.
- SAYERS, J., SYMONDS, P.A., DIREEN, N.G. AND BERNARDEL, G., 2001—Nature of the continent–ocean transition on the non-volcanic rifted margin of the central Great Australian Bight. In: Wilson, R.C.L., Whitmarsh, R.B., Taylor, B. and Froitzheim, N. (Editors), *Non-volcanic rifting of continental margins: a comparison of evidence from land and sea*. Geological Society, London, Special Publications, 187, 51–77.
- SMIT, R., 1988—A new tectonic model for the Bass Basin. *ASEG/SEG Conference Papers*, 163–168.
- SMITH, G.C., 1986—Bass Basin geology and petroleum exploration. In: Glenie, R.C. (Editor), *Second South-Eastern Australia Oil Exploration Symposium*. Petroleum Exploration Society of Australia, 257–284.

-
- STAGG, H.M.V. COCKSHELL, C.D., WILLCOX, J.B., HILL, A.J., NEEDHAM, D.V.C., THOMAS, B., O'BRIEN, G.W. AND HOUGH, L.P., 1990—Basins of the Great Australian Bight region, geology and petroleum potential. Bureau of Mineral Resources, Geology and Geophysics, Continental Margins Program Folio, 5.
- SUMMONS, R.E., 1996—Origin of petroleum from the Bass Basin. Professional Opinion with data from Oils of Australia, GeoMark Research Inc. and Australia Geological Survey Organisation (AGSO) (unpublished).
- SUMMONS, R.E., ZUMBERGE, J.E., BOREHAM, C.J., BRADSHAW, M.T., BROWN, S.W., EDWARDS, D.E., HOPE, J.M. AND JOHNS, N., 2002—The oils of eastern Australia: petroleum geochemistry and correlation. Volume 2: Gippsland, Bass, Otway, Stansbury, McArthur, Amadeus, Adavale, Galilee and Drummond basins. Geoscience Australia and GeoMark Research. <https://pid.geoscience.gov.au/dataset/ga/68754>
- SYMONDS, P.A., COLWELL, J.B., STRUCKMEYER, H.I.M., WILLCOX, J.B. AND HILL, P.J., 1996—Mesozoic rift basin development off eastern Australia. In: Mesozoic Geology of the Eastern Australia Plate Conference. Geological Society of Australia, Extended Abstracts, 43, 528–542.
- TRIGG, K.R., BLEVIN, J.E. AND BOREHAM, C.J., 2003—An audit of petroleum exploration wells in the Bass Basin, 1965–1999. Geoscience Australia, Record, 2003/11.
- VEEVERS, J.J., (Editor) 1984—Phanerozoic Earth History of Australia. Oxford Geological Series, 2. Clarendon Press, Oxford, 418 pp.
- WILLIAMSON, P.E. AND PIGRAM, C.J., 1986—Subsidence and maturation history of the Bass Basin from geohistory calculations. In: Glenie, R.C. (ed.), Second South-Eastern Australia Oil Exploration Symposium, PESA Symposium, Melbourne, 285–299.
- WILLIAMSON, P.E., PIGRAM, C.J., COLWELL, J.B., SCHERL, A.S., LOCKWOOD, K.L. AND BRANSON, J.C., 1985—Pre-Eocene stratigraphy, structure, and petroleum potential of the Bass Basin. The APEA Journal, 25(1), 362–381.
- WOMERSLEY, H.B.S., 1990—Biogeography of Australasian marine macroalgae. In: Clayton, M.N. and King, R.J. (Eds), Biology of Marine Plants. Longman Cheshire, Melbourne, 266–295.

Figure captions

- Figure 1** Regional setting of the Bass Basin showing basin boundaries, structural elements, petroleum wells, fields, infrastructure and location of seismic figures shown in Figures 3, 4 and 5. (SRF-121351-1)
- Figure 2** Stratigraphy and hydrocarbon discoveries of the Bass Basin. Geologic Time Scale after Ogg et al (2016). (SRF-121351-2)
- Figure 3** Seismic line 90-27 across the Cape Wickham Sub-basin. Interpretation by Geoscience Australia. Location of the seismic section is shown in Figure 1. (SRF-121351-3)
- Figure 4** Seismic line 82-302 across the Cape Wickham and Durroon sub-basins. Interpretation by Geoscience Australia. Location of the seismic section is shown in Figure 1. (SRF-121351-4)
- Figure 5** Geological cross-section across the central Cape Wickham Sub-basin showing the syn-tectonic nature of the Durroon and Bass megasequences, and the overlying post-rift successions of the Aroo, Flinders and Torquay sequences. Key exploration targets are within the Bass and Aroo sequences; the Flinders sequence is the regional seal. The distribution of volcanic and intrusive igneous rocks is indicated by the v symbols (from Blevin et al, 2003). (SRF-121351-8)
- Figure 6** Generalised palaeogeographic maps showing the extents of a) the Koorkah lake in the Paleocene and b) the Toolka Lake in the early Eocene (after Blevin et al, 2005). (SRF-121351-7)
- Figure 7** Seismic data coverage for the Bass Basin. (SRF-121351-10)
- Figure 8** Petroleum permits and operators in the Bass Basin. (SRF-121351-5)
- Figure 9** Well composite showing basin phases, sequences, well logs (GR and DT) and hydrocarbon shows in Pelican 5, illustrating key oil and gas reservoir horizons in the Pelican Trough (after Blevin et al, 2005). (SRF-121351-9)
- Figure 10** Marine reserves, marine parks, multiple use zones, ecological features in the Bass Basin. (SRF-121351-6)