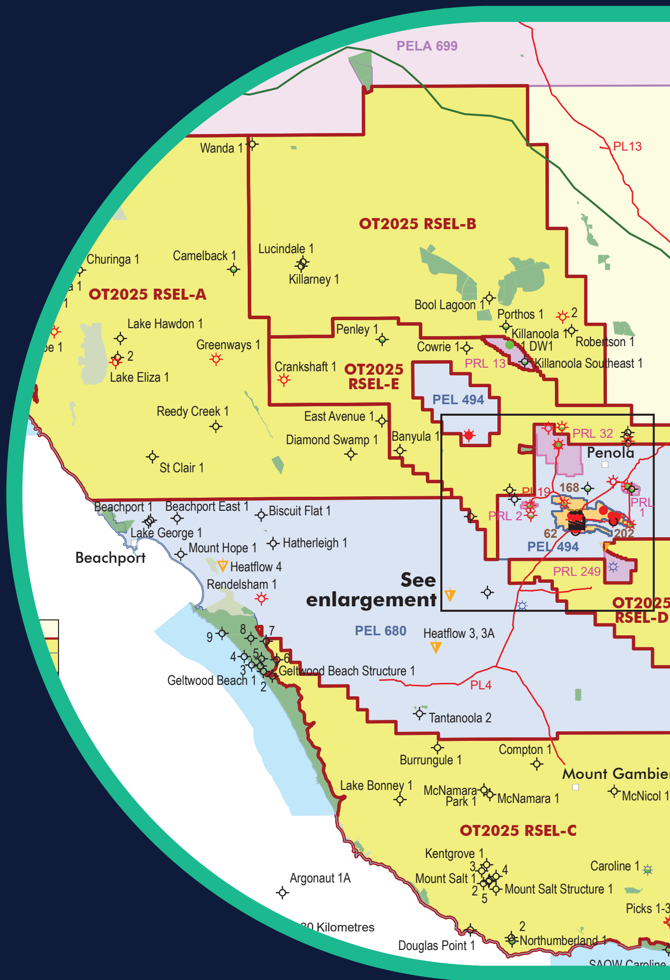
South Australia

OTWAY BASIN

Acreage Release

OT2025 RSEL-A to D, GSEL-A to C and GEL-A



BIDS CLOSE 5.00 pm ACDT
Friday 31 OCTOBER 2025

energymining.sa.gov.au/energyresources

SOUTH AUSTRALIA

Government of South Australia
Department for Energy and Mining

Contents

Otway Basin Acreage Release Blocks
OT2025 RSEL-A to E, GSEL-A to C and GEL-A

BIDS OPEN **27 May 2025**
BIDS CLOSE **5:00 pm Australian Central Daylight Time on Friday 31 October 2025**

THE OFFER

The Otway Basin is a competitive tender region and vacant acreage must be gazetted and offered for work program bidding. Following a recent acreage relinquishment, five new regulated substances exploration licences (RSELs), three gas storage exploration licences (GSELs) and one new geothermal exploration licence (GEL) in the Otway Basin are being offered by the South Australian Government on the basis of work program bidding (Figures 1a, b and c).

A key motivation for the acreage release is the looming shortfall in energy supply in the southeast Australian gas market. The South Australian onshore Otway Basin is in a strategic location for discovering natural gas and for gas storage.

Block	**Area** (km^2)	**Wells**	**2D Seismic** (line km)	**3D Seismic** (km^2)	**Primary target**
OT2025 RSEL-A	2415	12	2332.7	70.9	Early Cretaceous
OT2025 RSEL-B	1708	7	793.8	0	Early Cretaceous
OT2025 RSEL-C	1647	18	1464.7	133.3	Late Cretaceous
OT2025 RSEL-D	269	0	258.8	67.5	Early Cretaceous
OT2025 RSEL-E	749	11	981.2	131.3	Early Cretaceous
OT2025 GSEL-A	2489	15	2595.7	70.9	Early Cretaceous
OT2025 GSEL-B	2070	21	1986.7	63.1	Early Cretaceous
OT2025 GSEL-C	226	1	164.5	46.3	Late Cretaceous
OT2025 GEL-A	1812.35	18	1613.3	134.7	Late Cretaceous

Table 1. Summary of block and available data.

Thirty-seven petroleum wells have been drilled in the OT2025 RSEL acreage release areas (Figure 1a), thirty-seven in the OT2025 GSEL acreage release areas (Figure 1b), and eighteen in OT2025 GEL-A (Figure 1c). Seismic coverage in the basin is shown in Figure 2.

The blocks offer a diversity of play types and the opportunity to build a portfolio of prospects and leads across the Otway Basin.

Applicants should also note:

- in the event that additional Parks or Reserves are proclaimed under the *National Parks and Wildlife Act 1972* prior to the grant of an RSEL, GSEL or GEL and where such Parks or Reserves prohibit the exploration for and production of petroleum, then the area of any such Parks or Reserves shall be excised from the area to be granted as an RSEL, GSEL or GEL. This may also be applicable to potential Native Title areas.
- the *Energy Resources Act 2000* (ER Act) requires licence holders to prepare:
    - an Environmental Impact Report (EIR) in consultation with all potentially affected people, enterprises and organisations as a precedent to co-regulatory consideration of activity approval. EIRs document potential impacts on the social, natural and economic environments (which includes public health and safety), and consider the significance of impacts, after implementation of relevant controls in accordance with the environmental impact assessment criteria; and

- a Statement of Environmental Objectives (SEO), informed by an EIR, that must state the environmental objectives to be achieved in carrying out the specified activities, as well as the assessment and leading performance criteria that must be met to ensure the objectives have been achieved by the licensee

If a proposed activity regulated pursuant to the ER Act cannot demonstrate compliance with the objectives for the protection of social, natural and economic environments, then approval for the activity will not be granted.

The value of contemporaneous, multiple land-use is a key factor in developing all EIRs and SEOs for upstream petroleum operations anywhere in the State, including the southeast of South Australia.

It is business as usual for conventional petroleum operations in the region and the successful applicants will be able to acquire seismic and drill conventional oil and gas wells, subject to the requisite approval process under the ER Act.

To better inform community perceptions in respect to all forms of gas exploration, development and production, the State Government has partnered with CSIRO's Gas Industry Social and Environmental Research Alliance (GISERA) to carry out independent research within the Limestone Coast region. GISERA focussed on impacts to aquifers and potential health, well-being and economic effects on the people and communities living within the vicinity of conventional gas development in the Limestone Coast region. In consultation with government, local industries, community and stakeholders, GISERA set up a Regional Research Advisory Committee (RRAC) to represent their views and provide a conduit for feedback, approving research projects and ensuring that key issues raised by the local community were addressed.

Details on the research projects completed by GISERA can be found online at https://gisera.csiro.au/resources/factsheets/south-australia-factsheets/.

SUMMARY OF THE ONSHORE OTWAY BASIN

Age	Jurassic – Late Cretaceous
Area in South Australia	9650 km^2 (3730 sq. miles)
Onshore commercial success rate	14%
Onshore technical success rate	22.5%
Depth to target zones	1000–5500 m
Sedimentary thickness	>9 km
Hydrocarbon shows	Commercial gas, condensate and oil primarily from the Pretty Hill Sandstone but also the Upper Sawpit Shale, Sawpit Sandstone and Windermere Sandstone
First commercial discovery	1987 gas (Katnook 1), 1967 CO_2 (Caroline 1)
Production history	91.48 PJ (86.3 bcf) sales gas and 444,717 bbl condensate (Katnook, Ladbroke Grove, Redman, Haselgrove, Haselgrove South, Jacaranda Ridge, Limestone Ridge, Hollick, Patrick) to end September 2022 when production ceased. 810,800 tonnes (15.6 BCF at standard conditions) saleable CO_2 (Caroline) to end December 2016.
Infrastructure	Katnook Gas Plant – mothballed Ladbroke Grove Gas-fired Power Station Pipelines – local market serviced by SESA and SEPS pipelines which are connected to the SEA Gas Pipeline
Basin type	Rift
Depositional setting	Fluvial–lacustrine and marginal marine
Conventional reservoir types	Braided and meandering fluvial, deltaic and slope fan sandstones
Regional structure	Early half graben, late shelf collapse
Top and lateral (across-fault) seals	Marine and lacustrine shales
Source rocks	Widely preserved Late Jurassic – Early Cretaceous lacustrine shales north of the Tartwaup Hinge Eumeralla Formation coals are considered as the primary source rock south of the Tartwaup Hinge
Depth to oil/gas window	2800–4000+ m (oil); 2600–4000+ m (gas)
Onshore Otway Basin petroleum wells	108 (comprising 80 exploration, 9 appraisal, 2 development and 17 stratigraphic wells). Plus 10 offshore exploration wells.
Geothermal wells	6
Reflection seismic surveys	Onshore: 10,495 line-km 2D and 945 km^2 3D Offshore: 25,842 line-km 2D and 373 km^2 3D

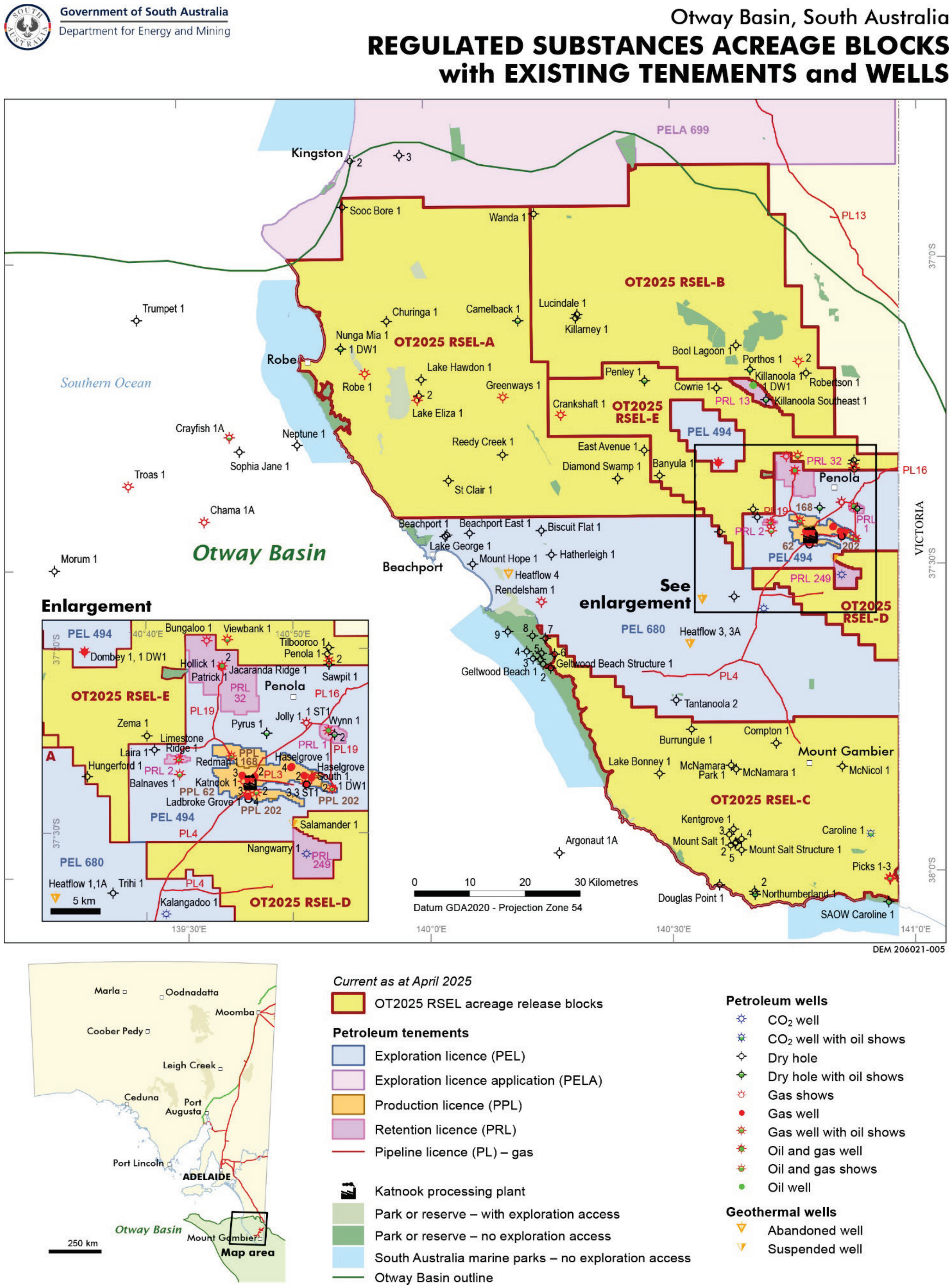


Figure 1a. Otway Basin petroleum licences and OT2025 RSEL acreage release areas.

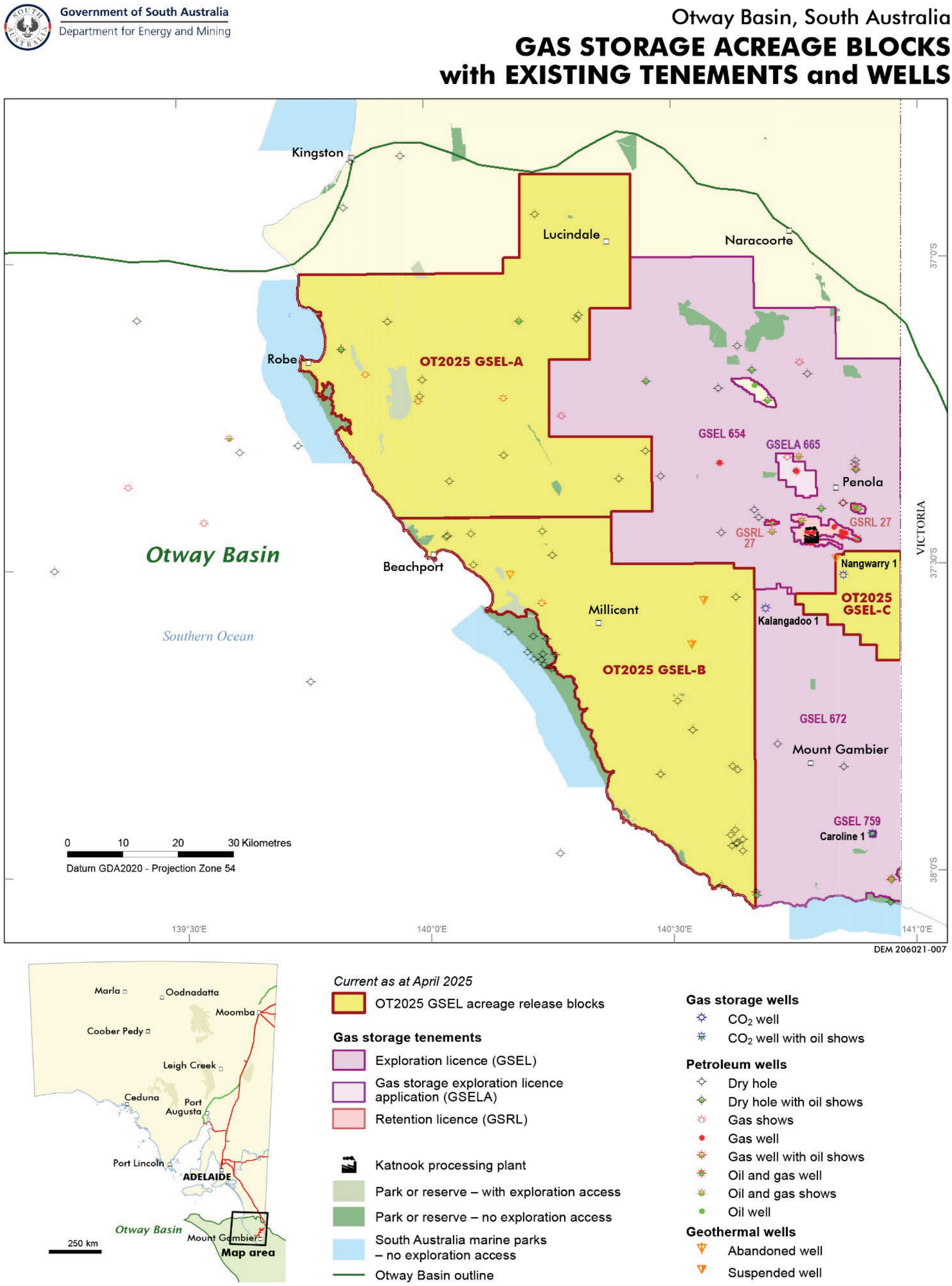


Figure 1b Otway Basin gas storage licences and OT2025 GSEL acreage release areas.

Figure 1c. Otway Basin geothermal licences and OT2025 GEL-A acreage release area.

INTRODUCTION

The Otway Basin is one of the best known and most actively explored of the series of Mesozoic rift basins that span the southern coastline of Australia, and which were formed as a result of rifting between the Antarctic and Australian plates (Figure 3).

In 2022–23 the Geoscience and Exploration Branch (now part of the Geological Survey of South Australia, or GSSA) of the Department for Energy and Mining (DEM) conducted an integrated geological, chemostratigraphic, geochemical and geophysical study to prepare a Petroleum Systems Model (PSM) of most of the onshore Otway Basin in South Australia. The results of the modelling show that significant hydrocarbons have been generated and expelled within the Penola Trough as expected. However, the lightly explored Robe and Tantanoola troughs have also been identified as regions of significant oil and gas expulsion.

The main subsurface technical risk factor is structural integrity. Regional 3D seismic surveys have been used to mitigate below-ground technical risks e.g. explorers are better able to accurately map potentially economic prospects. Additionally, now routine fault leakage analysis of prospects has been used by some operators to rank prospects prior to drilling.

The economic viability of gas discoveries is improved by the proximity to markets with the possibilities of gas discoveries being able to provide both local gas supply and electricity generation. One example of modest gas reserves underpinning profitable peak power generation opportunities was demonstrated by the 80 MW Ladbroke Grove Power Station which was built in 2000 adjacent to the electricity interconnector and the Ladbroke Grove gas discovery.

Local markets were supplied with natural gas from Katnook and adjacent gas fields between 1991 to 2011 via the South East Pipeline System (SEPS), owned and operated by Epic Energy (Figure 1). This system consists of a 46 km long pipeline from the Katnook gas processing plant to the APCEL paper mill operated by Kimberley Clark, with a branch to Mount Gambier and pipelines to the Midfield's Union Dairy Milk Powder Plant.

In 2002–03, the South East Australia (SEA) Gas pipeline was constructed to transport gas to Adelaide from offshore Otway Basin gas fields and the Iona gas storage facility in Victoria. Origin Energy Retail Ltd constructed and commissioned the South East South Australia (SESA) Pipeline in 2005, which was acquired by APA Group in 2007. This 45 km pipeline connects the SEA Gas Pipeline in Victoria to Epic Energy's SEPS and the Ladbroke Grove Power Station.

The Katnook Gas Plant commenced operations in 1991 and has been mothballed since September 2022. Beach Energy Ltd, the plant operator, was awarded a Gas Acceleration Program (GAP) grant by the Federal Government in June 2018 to upgrade the plant following gas discovery at Haselgrove 3. The plant was commissioned in March 2020.

The South Australian Government awarded Plan to Accelerate Exploration (PACE) grants for three exploration wells in the region, which were drilled between 2017 and 2020 — Haselgrove 3 and Dombey 1 (Beach Energy Ltd), and Nangwarry 1 (Lakes Blue Energy NL and Vintage Energy Ltd).

Production of approximately 3.4 bcf of gas and 2000 barrels of condensate from Haselgrove 3 took place between February 2018 and September 2022.

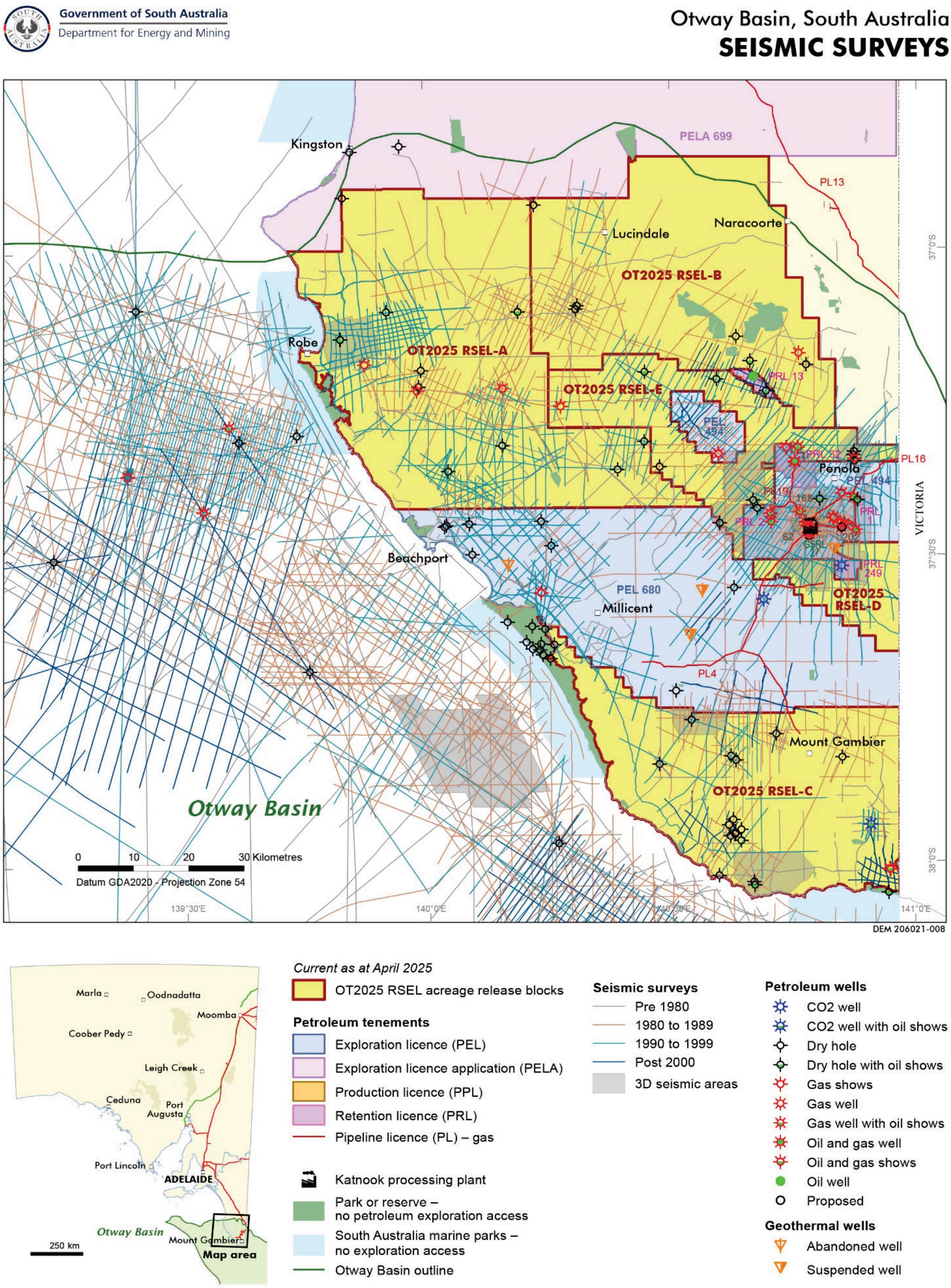


Figure 2. Otway Basin seismic surveys, showing OT2025 RSEL release acreage only.

REGIONAL GEOLOGY

Structural setting

The northern limit of the onshore Otway Basin is defined by outcropping early Palaeozoic Kanmantoo Group metamorphic and igneous rocks (the Padthaway Ridge). Approximately 70% of the basin is offshore and sediments may occur up to 160 km offshore. To the west, the basin passes into the offshore Duntroon Sub-basin of the Bight Basin, and in the east the Otway Basin continues, both onshore and offshore Victoria. Offshore, the Otway Basin is locally bound by a Palaeozoic outer-margin high.

Initiation of the Mesozoic Otway Basin began in the Late Jurassic as part of the breakup of Gondwana and the separation of the Antarctic and Australian plates. Breakup started in Western Australia and propagated eastwards. The locus of propagation was focused by a series of east-west structures which are collectively termed the Southern Australia Fracture Zone. Graben and half-graben are interpreted over much of the Otway Basin and are filled with Jurassic to Early Cretaceous non-marine clastics. These Mesozoic depocentres are interpreted to exist across most of the basin (Figures 3 and 4) but have not yet been penetrated offshore in the Otway Basin. The rate of Cretaceous rifting slowed during the Barremian to Albian (Early Cretaceous) but rapidly increased before the end of the Albian in the southern part of the basin. Over 4 km of late Albian to Late Cretaceous sediments occur within the Morum Sub-basin.

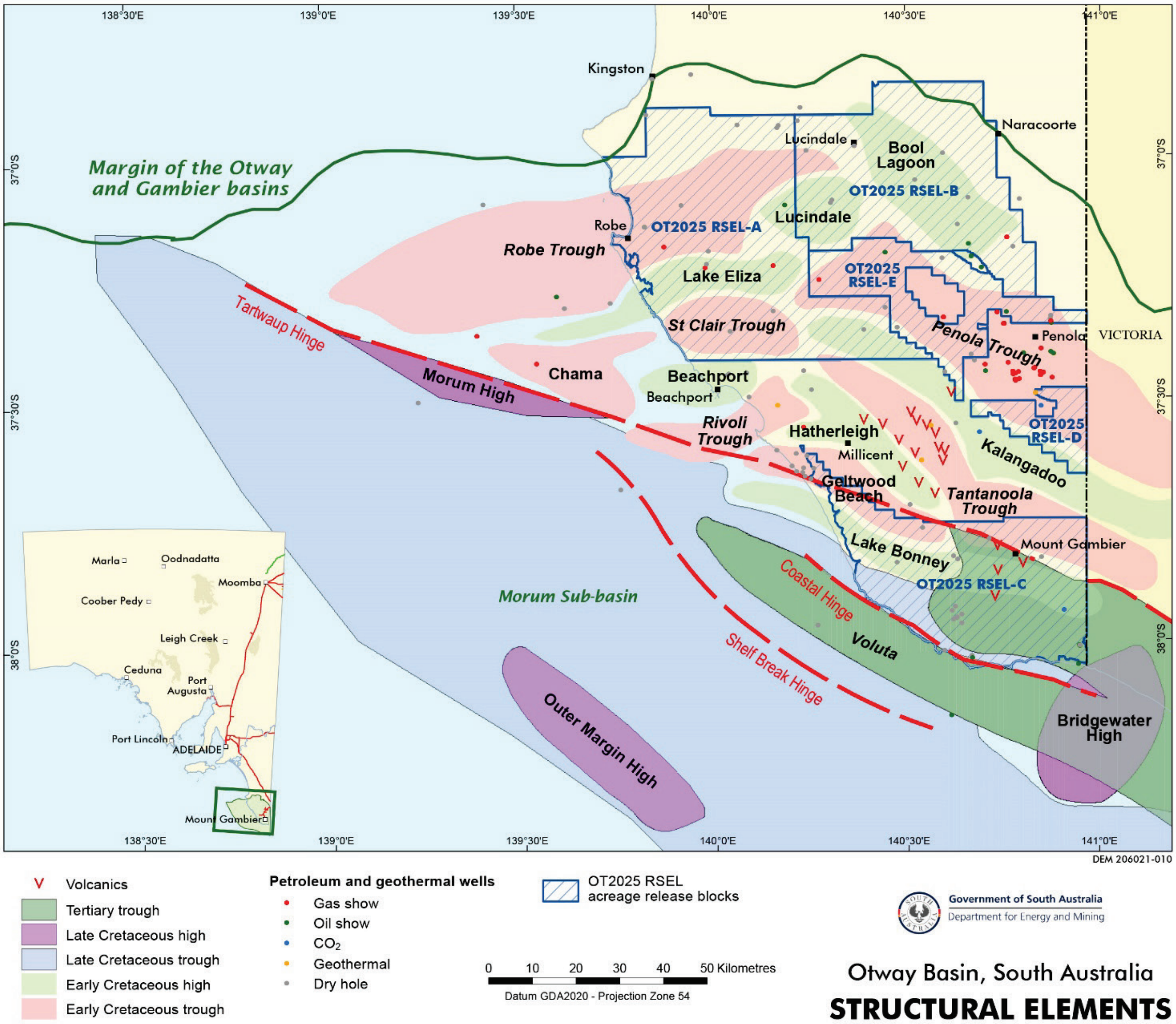


Figure 3. Otway Basin structural elements.

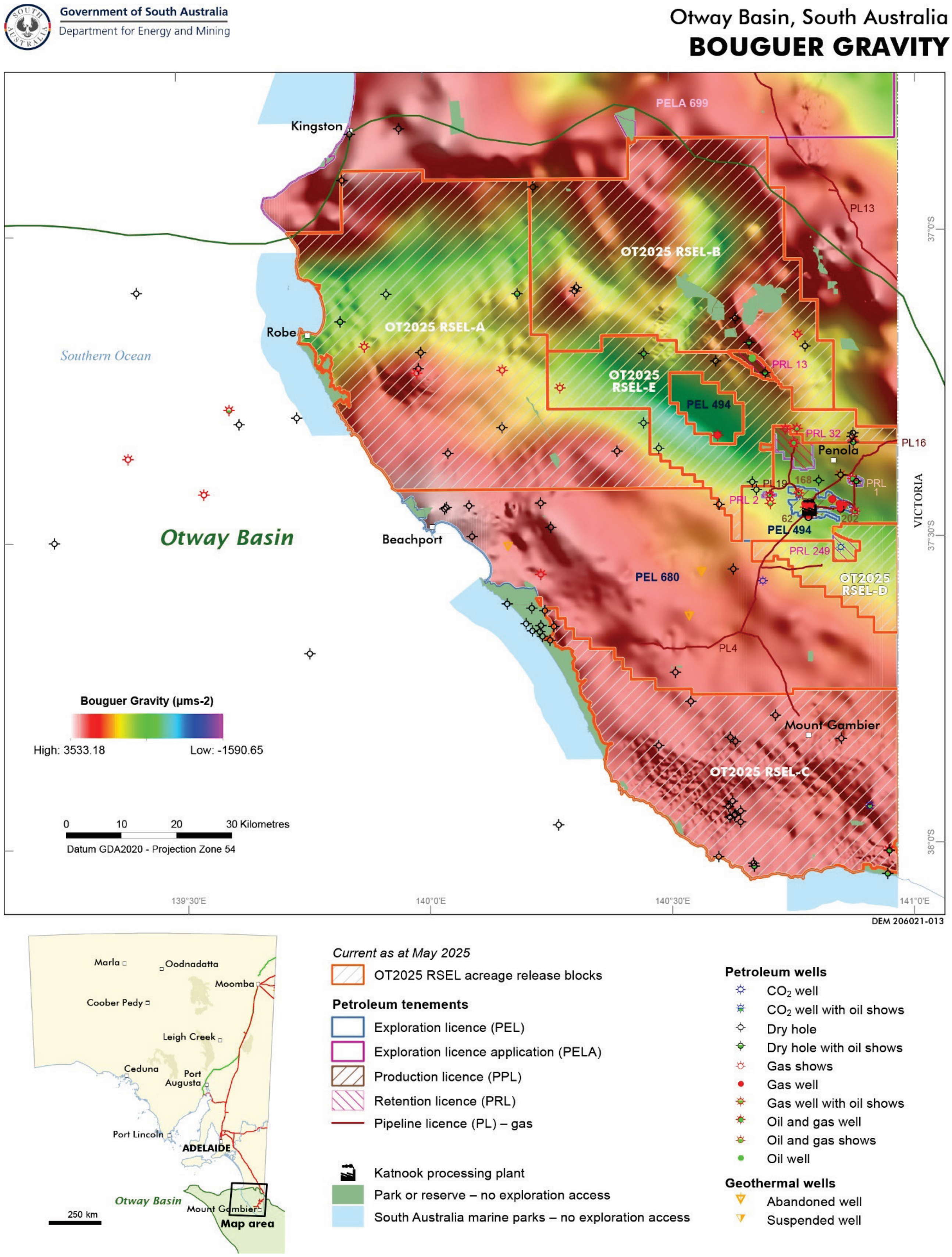


Figure 4. Otway Basin gravity map, showing OT2025 RSEL release acreage only.

Stratigraphy

In 2022–23 the Geoscience and Exploration Branch (now part of the Geological Survey of South Australia, or GSSA) of the Department for Energy and Mining (DEM) conducted an integrated geological, chemostratigraphic, geochemical and geophysical study to prepare a PSM of most of the onshore Otway Basin in South Australia. This was followed in 2024 by a play analysis study of eight potential hydrocarbon reservoir intervals in the same region, to understand the distribution of reservoirs, seals, mature source rocks and potential hydrocarbon migration pathways, to aid hydrocarbon exploration in the region (see the Onshore Otway Basin plays webpage, Strong and Cubitt (2024) and Strong et al. (2025)).

One of the results of these studies was updated stratigraphy for the basin north of the Tartwaup Hinge (Figure 5a). Gross depositional environment maps were made for six key intervals in this area, with varied depositional systems interpreted including anoxic, extensive ice-influenced lacustrine, lacustrine turbidite, extensive fluvial/lacustrine, fluvial/flood plain and growth fault-bound ribbon-like alluvial fan aprons.

The oldest unit is the Casterton Formation deposited as the earliest rift sequence as the Antarctic and Australian plates separated. It consists of a volcanic and lacustrine carbonaceous mudstone unit that occurs in some wells in the Penola Trough in South Australia and to the east in Victoria, including basal units in South Australia interpreted by DEM as reworked Basement deposited in alluvial fans, fluvial channels and turbidite fans, shale and volcanic material with excellent source rock potential. The extrusion of volcanics within this formation occurred via early faults and fractures within Palaeozoic Basement. The Casterton Formation may occur in the undrilled deeper parts of the Robe and Penola Troughs in South Australia (Figures 3 and 5a).

Rapid escalation of rifting activity occurred from the Berriasian with deposition of the Crayfish Subgroup in rift-related half grabens (Figures 3 and 6), primarily north of the Hungerford Fault system. Initially this was dominated by lacustrine mudstones of the Lower Sawpit Shale representing deposition in a cold climate, profundal-lacustrine environment Seismic facies interpretation has identified canyon-like and mound features and interpreted them as slope-feeder channels and turbidite fans respectively, at and away from well control (Tiainen et al. 2024). This rock-based interpretation provides an alternative to the current alluvial channel/crevasse splay/ floodplain lake model for reservoir deposition and as such presents a new exploration play.

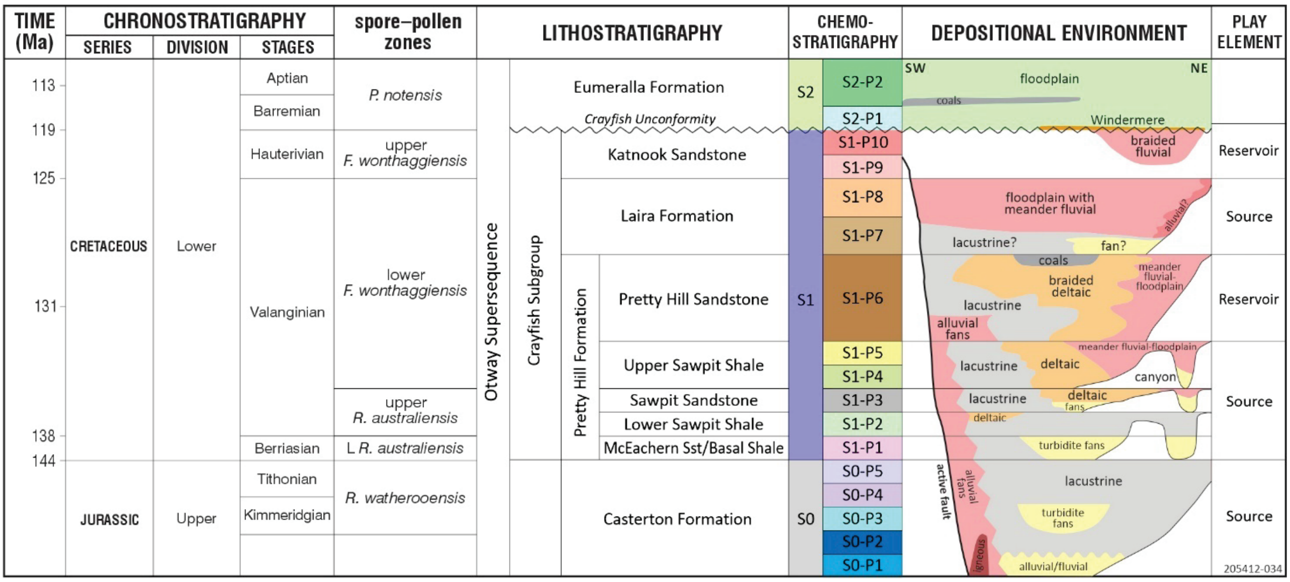


Figure 5a. Upper Jurassic and Lower Cretaceous Otway Basin stratigraphy north of the Tartwaup Hinge (Kirk 2024).

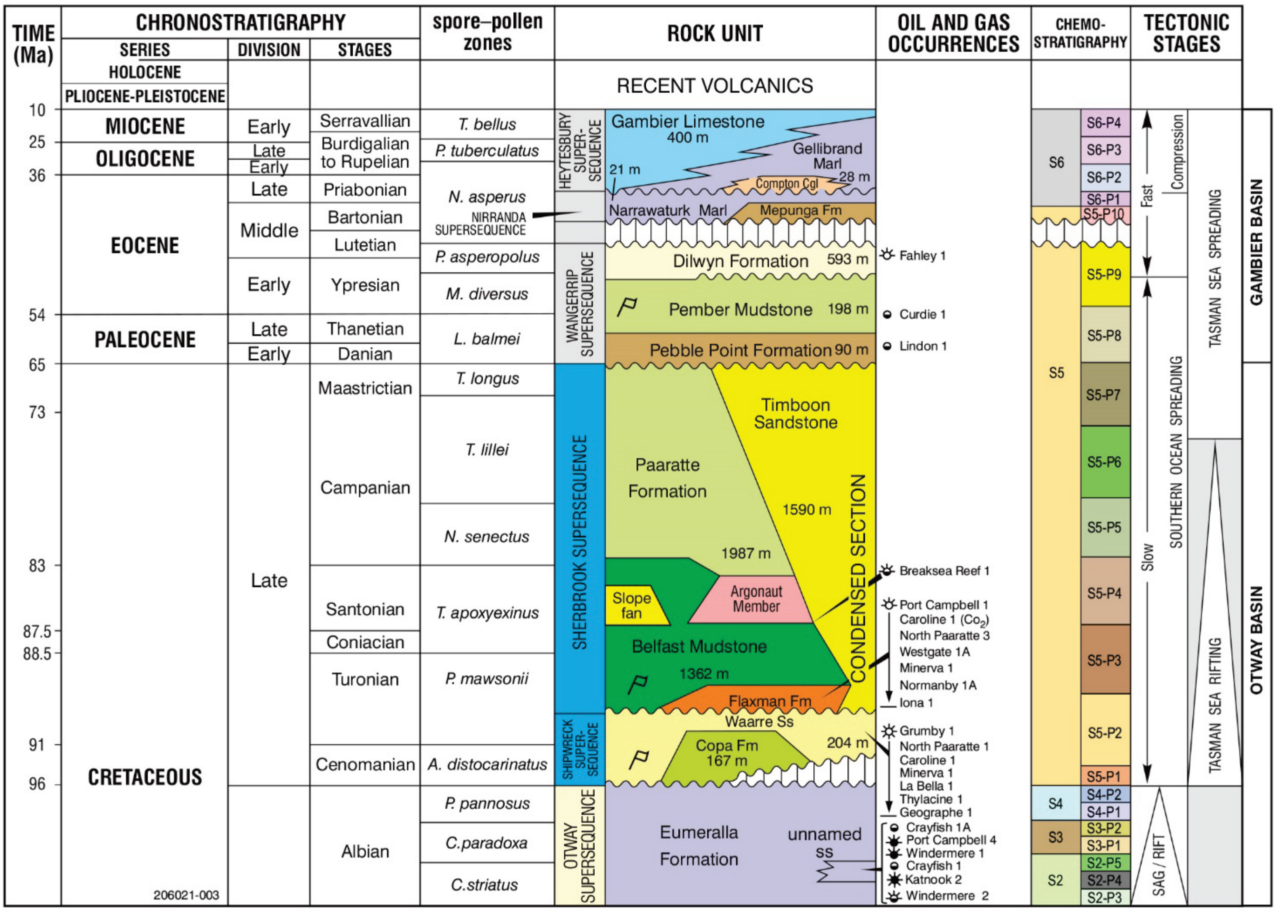


Figure 5b. Otway Basin stratigraphy south of the Tartwaup Hinge (modified from Boult 2002 and Bendall 2021).

Subsequent sedimentation changed with extensive fluvial channels and associated flood plain conditions prevailing during deposition of the Sawpit Sandstone, Upper Sawpit Shale and the Pretty Hill Sandstone (Cubitt et al. 2024). Low sinuosity channels and floodplain development were controlled by local tectonics and basin accommodation space, resulting in maximum sediment thickness adjacent to main faults. The main reservoir for hydrocarbons in the onshore Otway basin is the Pretty Hill Sandstone, a braided fluvial sandstone that occurs in the deepest parts of the troughs north of the Tartwaup Hinge.

The latest Valanginian Laira Formation represents re-establishment of flood plain and fault parallel lacustrine deposition, with zones of high algal content in the upper sequence, suggesting changes from fluvial to shallow lacustrine, although relatively narrow channel belts have been identified (Cubitt et al. 2024).

In the northern Penola Trough region the Laira Formation is overlain by the braided fluvial lithologies of the Hauterivian Katnook Sandstone, although this is generally thin.

The end of this early intensive rift phase occurred in the Barremian. Fault-related tilting, folding and uplift resulted in extensive erosion of the Crayfish Subgroup. An angular unconformity at the top of the Crayfish Subgroup can be clearly seen in the Penola Trough. The Crayfish Subgroup is unconformably overlain by the Eumeralla Formation, forming the last section of the Otway Supersequence (Figures 5a and b). The Eumeralla Formation comprises extensive fluvio-lacustrine and volcanogenic facies with some minor coal and meandering fluvial sandstone units deposited during the sag phase of the basin. The Windermere Sandstone is a basal interval of the Eumeralla Formation and a regionally extensive transgressive sandstone unit which overlays the unconformity above the Crayfish Subgroup primarily in the region of the Penola-St Clair and Robe troughs. The Eumeralla Formation generally thickens to the south and then quite significantly to the south of the Tartwaup Hinge.

The angular Crayfish Unconformity separates the Crayfish Subgroup and the overlying Late Cretaceous Shipwreck Supersequence (approximately 6.5 My duration), with deposition driven by renewed subsidence associated with the onset of Australian–Antarctic plate separation and consisting of post-rift sequences of fluvio-deltaic and paludal sediments (including coals) deposited on a subsiding continental margin. In the northern part of the Otway Basin, the Shipwreck and Sherbrook Supersequences are thin (Figure 7) and comprise a coarse-grained sandstone that is a condensed equivalent of the deltaic wedge of the Copa, Waarre, Flaxman, Belfast, Paaratte and Timboon units that rapidly thicken to the south and account for most of the sediment in the Morum Sub-basin (Figure 10). Offshore, beyond the present-day shelf, thick packages of high amplitude reflectors indicate the possible presence of paralic oil-prone coals or marine oil shale. The Belfast Mudstone to Timboon Sandstone sequence represents a prograding delta with early marine influence and deepwater submarine slope-fans along the outer margin.

Thickening of Cainozoic strata south of the Tartwaup Hinge, in particular Eocene marine mud and carbonate, provide adequate depth of burial to generate hydrocarbons from the Late Cretaceous sequence. Tertiary and Quaternary volcanics introduced magmatic CO_2 into the basin.

Regional correlations across the Otway Basin are shown in Figure 8 (applicable to release blocks OT2025 RSEL-B, D and E and OT2025 GSEL-C), Figure 9 (OT2025 RSEL-A and OT2025 GSEL-A and B) and Figure 10 (OT2025 RSEL-C, D and E, OT GSEL-B and C, and OT2025 GEL-A).

At least four major sedimentary sequences are targets for regulated substances in the onshore Otway Basin in South Australia, whether oil and gas, carbon dioxide or natural hydrogen:

(i) The Late Jurassic Oxfordian (?) to Tithonian Casterton Formation (early rift; Figure 5a) is known in the deeper portions and northern flank of the Penola Trough (Figures 3 and 8) and comprises volcanic and algal-rich lacustrine shale that grades from oil shale to shale oil with depth (and increasing organic thermal maturity) that are yet to be fully tested. This includes basal units in South Australia interpreted by DEM as reworked Basement deposited in the Penola Trough as the lower section of the Casterton Formation;

(ii) The Early Cretaceous Berriasian to Hauterivian Crayfish Subgroup (syn-rift, consisting of the Lower Sawpit Shale, the Sawpit Sandstone, the Upper Sawpit Shale, the Pretty Hill Sandstone and the Laira Formation) is known only from the area north of the Tartwaup Hinge, where east-west and northwest-southeast trending half-grabens (Robe, Penola, St Clair and Tantanoola troughs; Figures 3, 8 and 9) contain fluvial to lacustrine sediments that are proven gas, condensate and oil reservoirs;

(iii) The Early Cretaceous Barremian to Albian sequence (Eumeralla Formation, onshore sag phase) containing lacustrine, back-swamp facies and proven gas reservoirs hosted in meandering fluvial Windermere Sandstone (Figures 8 and 9); 25.4% natural hydrogen was encountered in gas samples from thin sands in the Eumeralla Formation in Robe 1; and

(iv) The Late Cretaceous Cenomanian to Maastrichtian sequence (Shipwreck and Sherbrook Supersequences, Figure 5b) occurs as a deltaic to deep-water wedge south of the Tartwaup Hinge in the Morum Sub-basin (Figures 3, 7 and 10).

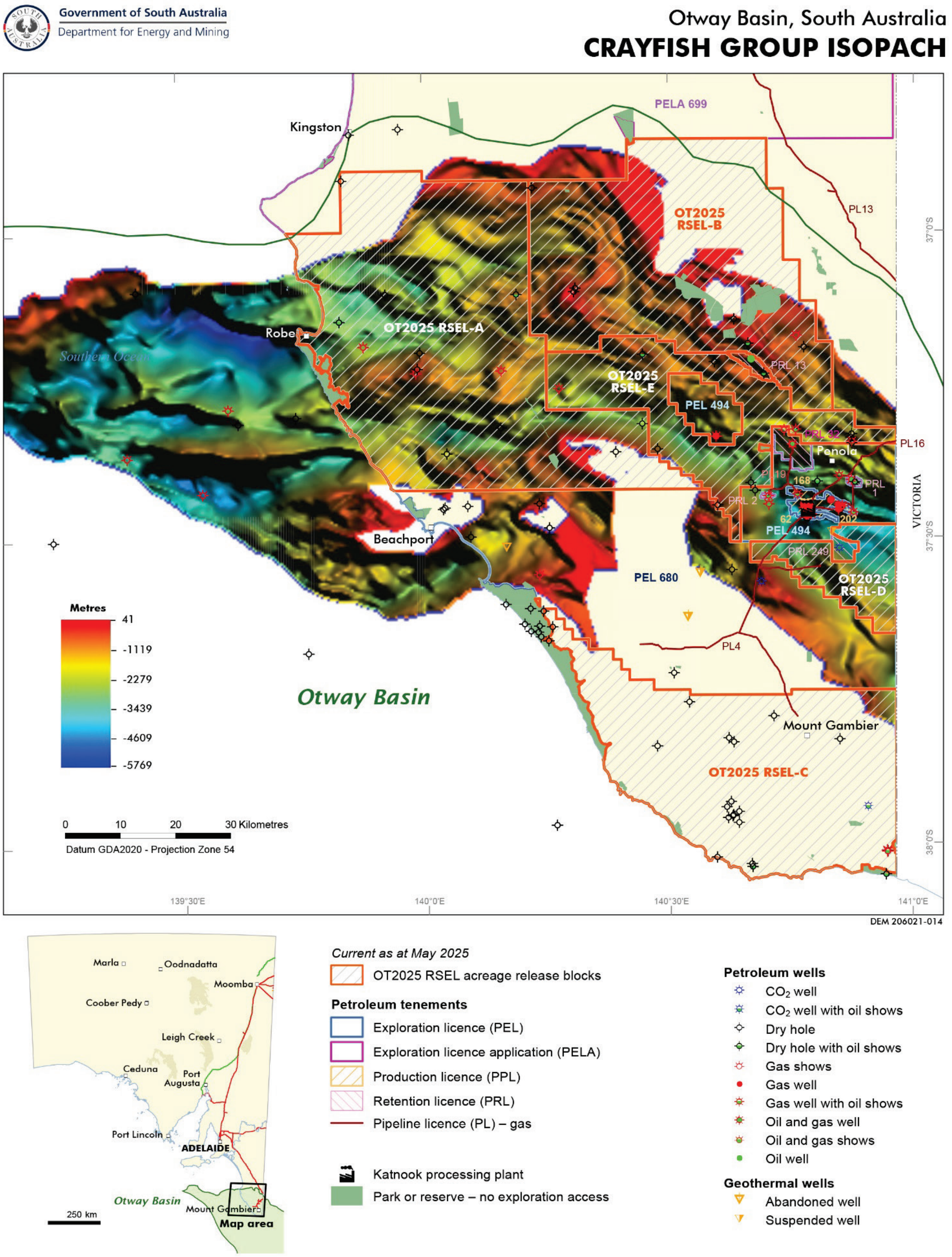


Figure 6. Crayfish Subgroup isopach map, showing OT2025 RSEL release acreage only.

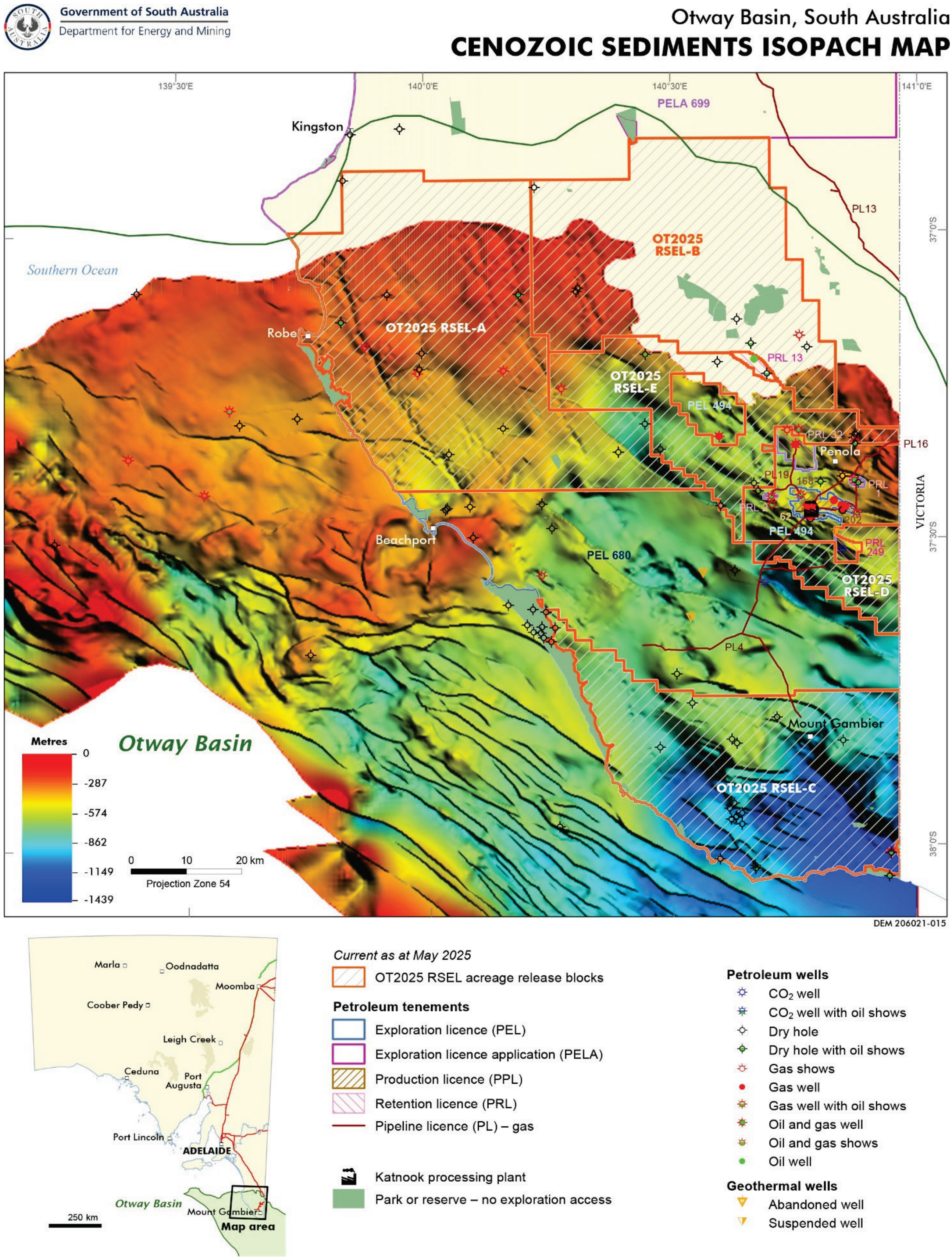


Figure 7. Isopach map of the Shipwreck and Sherbrook Supersequences showing OT2025 RSEL release acreage only.

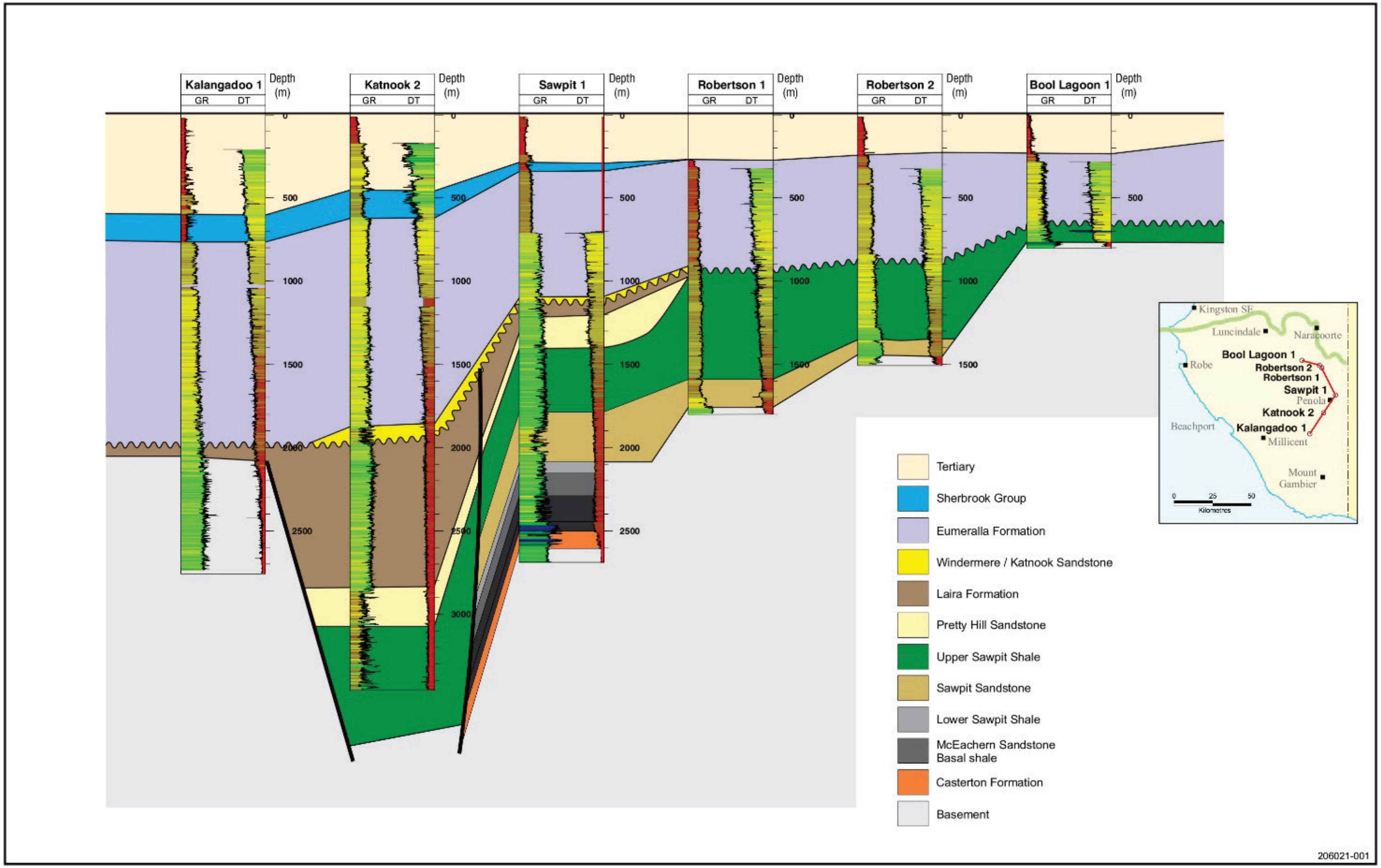


Figure 8. Stratigraphic correlation, Kalangadoo 1 to Bool Lagoon 1.

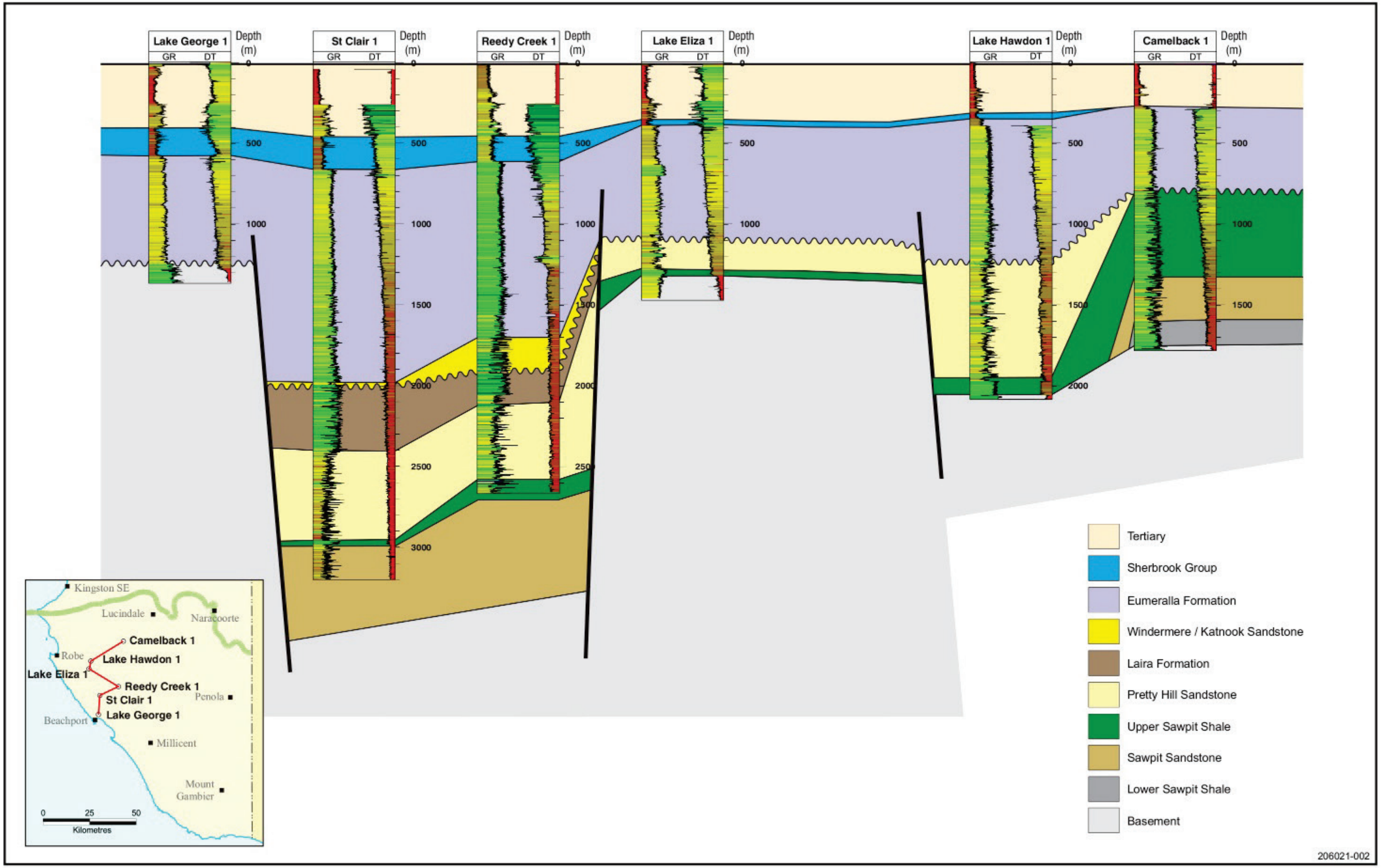


Figure 9. Stratigraphic correlation, Lake George 1 to Camelback 1.

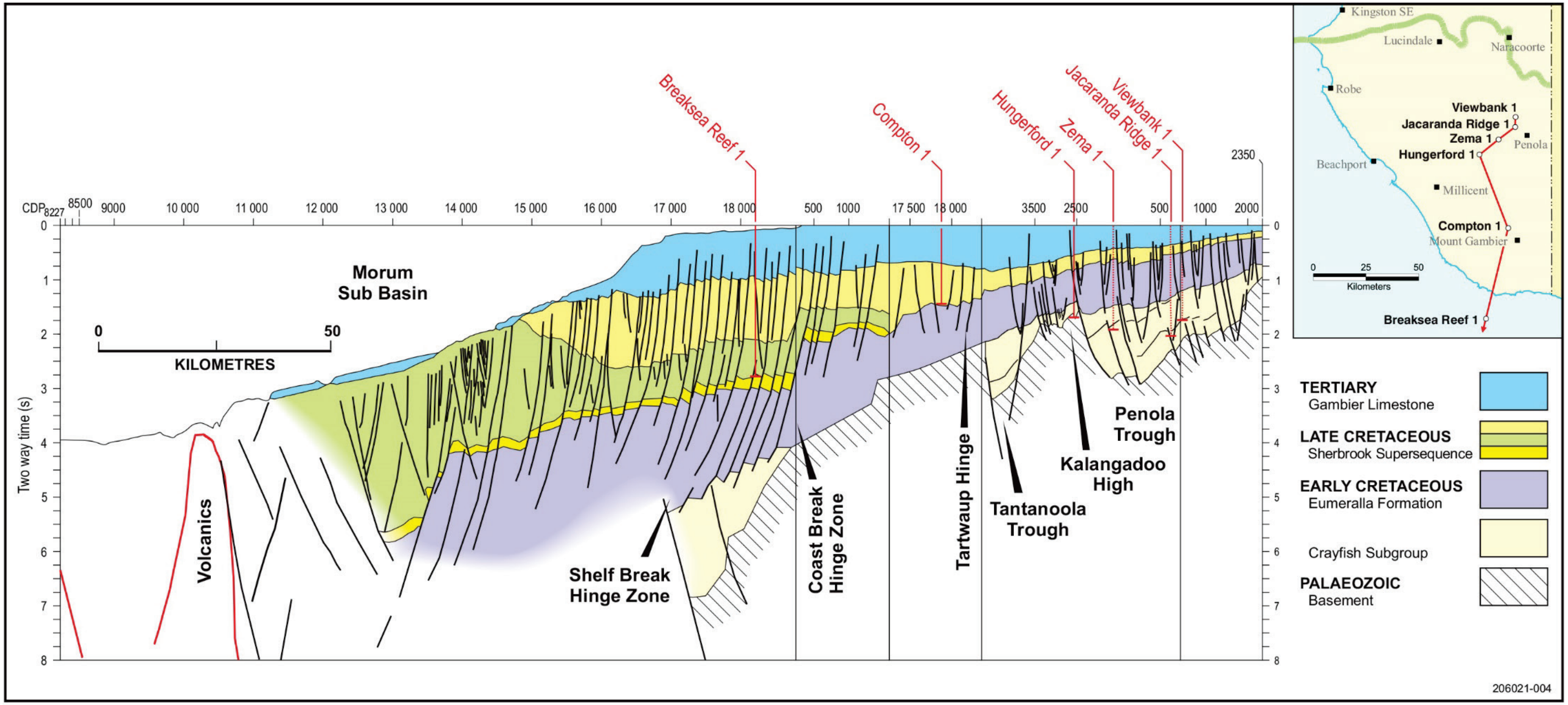


Figure 10. Schematic regional cross-section of the Otway Basin in South Australia (modified from Boult and Freeman 2007).

ENERGY RESOURCES GEOLOGY

Regulatory changes in February 2021 to the Petroleum and Geothermal Energy Act 2000 (PGE Act) allowed for exploration and production of hydrogen as a ‘regulated substance’. This enabled the granting of exploration licences targeting natural hydrogen, and many applications have been made for PELs in the State in order to explore for natural hydrogen. The PGE Act was amended in 2023 to establish the Energy Resources Act 2000 (ER Act).

The exploration philosophy for hydrogen and carbon dioxide (CO_2) is much the same as for hydrocarbons, in that a suitable reservoir container is required, overlain and/or surrounded by a sufficient sealing interval, a source for the regulated substance and a trap in which it can be contained. Therefore, the *Reservoirs and seals* and *Entrapment* sections below are equally applicable to hydrocarbons, hydrogen and CO_2.

Gas and condensate/oil (Table 1) have been produced commercially in the onshore Otway Basin in South Australia as well as CO_2, and hydrogen was encountered during drilling in Robe 1 in 1915/16.

Reservoirs and seals

The Otway Basin in South Australia contains many intervals that may act as suitable reservoirs for the accumulation of regulated substances, whether oil and gas, carbon dioxide or natural hydrogen. These are predominantly fluvial sandstones that generally exhibit good porosity and permeability. Exploration risk associated with reservoir quality and distribution is generally low, but the risk associated with offset lateral seals is more variable. Almost all sandstones above Palaeozoic Basement from Late Jurassic to early Tertiary age are potential conventional reservoirs, and fluvial and lacustrine shales generally provide suitable top seals.

Gross depositional environment (GDE) maps for six key intervals north of the Tartwaup Hinge were made as part of the 2022–23 PSM integrated study, with varied depositional systems interpreted including anoxic, extensive ice-influenced lacustrine, lacustrine turbidite, extensive fluvial/lacustrine, fluvial/flood plain and growth fault-bound ribbon-like alluvial fan aprons (Figure 5a). Some of these maps were subsequently updated as part of the 2024 play analysis study for hydrocarbon exploration in the region. Further details of seismic facies interpretations and core reviews discussed below can be found in Kirk (2024) and Cubitt and Tiainen (2025).

1. Casterton Formation (S0-P1 to S0-P5, Figure 5a)

The oldest potential reservoir interval in the basin is within the Jurassic Casterton Formation, which was the first deposition as the earliest rift sequence as the Antarctic and Australian plates separated to start forming the Otway Basin. The formation comprises interbedded shales, siltstones and sandstones and volcanic lithologies that have only been sparsely intersected in wells.

From core observations the Casterton Formation appears to have been deposited in deep, anoxic standing bodies of water that were seasonally frozen (Cubitt et al. 2024). These freshwater lakes filled the then disconnected Penola and Robe Troughs, with seismic facies also indicating that alluvial fans developed immediately adjacent to active growth faults at the edges of both troughs.

Reservoir quality may be in the low deliverability range in the Casterton, especially in the deeper parts of the troughs, however, 1.5 barrels of oil was recovered from drill stem test (DST) 1 over the interval 2,510–2,607 m MD at Sawpit 1. This hydrocarbon recovery was from a sequence of interbedded metasediments, tuffaceous sediments and organically rich shale originally determined to be Basement, now interpreted by DEM to have been reworked during deposition of the Casterton Formation (S0-P1/ P2). See Strong et al. (2025) for the GDE map of the Casterton Formation.

Figure 5a suggests that the amount of lacustrine shale within the Casterton Formation may greatly exceed reservoir sections, and so are likely to provide good top seal for any potential reservoirs.

Prospectivity in the Sawpit Sandstone is likely to occur in acreage release block OT2025 RSEL-B and E, and may occur in OT2025 RSEL-A and D.

2. McEachern Sandstone of the Lower Sawpit Shale (S0-P1)

The McEachern Sandstone and its equivalent Basal Shale of the Lower Sawpit Shale was deposited in a deep lake primarily north of the Hungerford Fault system as rifting increased. They represent the first Early Cretaceous sediments of the Crayfish Subgroup.

The sedimentological investigation of cores in wells Jolly 1 ST1, Bungaloo 1 and Sawpit 2 in the Penola Trough revealed the presence of a previously unknown deep water lacustrine turbidite play in the Lower Sawpit Shale/ McEachern Sandstone (Tiainen et al. 2024). Subsequent seismic facies interpretation identified mound and canyonlike features representing turbidite fan and slope-feeder channels respectively. See Lower Sawpit Shale | Energy & Mining and Strong et al. (2025) for the GDE map of the Lower Sawpit Shale.

The Well Completion Report (WCR) for Jolly 1 ST1 drilled in 2014 indicates interpreted average porosity of 12% within 182.77 m of net sand in the Lower Sawpit Shale at depths between 3,100 m and 3,698 m TVDSS, so reservoir quality is reasonable even at depth in the Penola Trough.

The lacustrine upper section of the Lower Sawpit Shale acts as a seal for any turbidite and alluvial fan reservoirs below. Oil and gas shows have been recorded Jolly 1 ST1, Bungaloo 1 and Tilbooroo1, suggesting that the immediate lateral association of potential turbidite reservoirs with gas/oil-prone source rocks and seals in the clay-rich lithologies may provide for stratigraphic trapping in addition to the previously targeted fault-controlled structural traps in the basin.

Prospectivity in the Lower Sawpit Shale is likely to occur in acreage release blocks OT2025 RSEL-A, B and E, and may extend into OT2025 RSEL-D.

3. Sawpit Sandstone (S1-P3)

Cubitt et al. (2024) described core from the Sawpit Sandstone in Jacaranda Ridge 1 as comprising light to dark grey claystones as well as rippled, wavy and laminated heterolithics with high clay matrix sandstones also observed. In contrast, well- sorted, fine to medium grained, low clay matrix sandstones were observed in the Patrick 1 and Wynn 1 wells. The heterolithics are interpreted to have been deposited in lower delta plain and delta front lacustrine settings while distributary channel fill is represented by fine grained sandstones and fluvial deposition by medium grained sandstones, sourced by canyon-derived sediment entry points in the north and northeast defined by seismic data. Clearly the location of each of the different depositional environments identified within the interval will affect the quality of potential reservoirs.

The Jolly 1 ST1 WCR indicates interpreted average porosity of 13% within 268.24 m of net sand in the Sawpit Sandstone at depths between 277 m and 3,100 m TVDSS, so reservoir quality is reasonable.

Oil and gas production from the Sawpit Sandstone has occurred in Haselgrove 3, with oil and gas flows recorded in Jacaranda Ridge 1 (408 barrels of oil per day (BOPD) 44.3° API gravity and 0.7 million cubic feet of gas per day (MMCFGD)) and 2 (235 BOPD and 2.4 MMCFGD) and Wynn 1 (up to 107.2 BCPD, 4.1 MMCFGD and 511 BWPD). 11 barrels of gas-cut oil of 34.8° API gravity were recovered in Killanoola 1 DW1, and oil-cut mud was recovered in Killanoola Southeast 1.

The seal to the Sawpit Sandstone interval reservoirs over most of the onshore Otway Basin in South Australia is the floodplain facies of the Upper Sawpit Shale immediately above, with floodplain facies of the Sawpit Sandstone providing lateral seal and potentially acting as a top seal as well.

However, where the Upper Sawpit Shale river systems and alluvial fans are present there may not be a competent seal for Sawpit Sandstone reservoirs as the former may have acted as migration paths for hydrocarbons into reservoirs higher in the section. Therefore, sealing potential of individually prospective areas must be investigated.

Prospectivity in the Sawpit Sandstone is likely to occur in acreage release blocks OT2025 RSEL-A, B and E.

4. Upper Sawpit Shale (S1-P4 to S1-P5)

Seismic horizon, isopach, facies and wireline data provide the majority of the dataset for the Upper Sawpit Shale interval with core only investigated in one well (Robertson 1) in the 2022–23 PSM study (Cubitt et al. 2024). The cores in this well however, proved to be a key control point as they are uniquely composed of mottled brown/green heterolithics. Sedimentary features observed include ripples, bioturbation, coaly rip-up clasts and mottling. The latter suggests the development of paleosols at the Robertson 1 location therefore constraining the extent of flood plain sediments in this region. The remaining parts of this GDE map were interpreted using seismic facies, isopach and log motif data. The sediment transport directions for this interval are constrained by seismic facies and horizon interpretations with the primary sediment input coming through major canyon cuts in the north with the main channel fairways branching to the southeast and southwest diverting due to an isopach-delineated elevated flood plain area.

Morton et al. (2002) reported that pore volume reduction with depth is not considered a major risk for the Pretty Hill Formation[1] due to the suppression of quartz overgrowth formation, and that porosity may be found even in the deepest parts of the Penola Trough. This may well be the case for reservoirs within the Upper Sawpit Shale.

Upper Sawpit Sandstone production in Jacaranda Ridge 2, Patrick 1 and Hollick 1, with average monthly production rates up to 2.8 MMCF (793,000 cubic metres, m^3) of gas per day and 226 BOPD in Jacaranda Ridge 2. 1.5 barrels of waxy oil were recovered in Killanoola Southeast 1.

The seals to the Upper Sawpit Shale sandstone reservoirs are the floodplain facies of the Pretty Hill Sandstone immediately above, with floodplain facies of the Upper Sawpit Shale providing lateral seal and potentially acting as a top seal as well. Over the north-east and parts of the north where the Pretty Hill Sandstone is absent seal is provided by shales of the Eumeralla Formation.

However, where the Pretty Hill Sandstone river systems and alluvial fans are present there may not be a competent seal for Upper Sawpit Shale sandstone reservoirs as the former may have acted as migration paths for hydrocarbons into reservoirs higher in the section.

Prospectivity in the Upper Sawpit Shale is likely to occur in acreage release blocks OT2025 RSEL-A, B, D and E.

5. Pretty Hill Sandstone (S1-P6)

The most important and oldest proven productive conventional reservoir in the onshore South Australian sector of the Otway Basin is the Pretty Hill Sandstone, from which oil, condensate and gas has been produced in the Katnook, Ladbroke Grove, Haselgrove, Haselgrove South, Redman and Limestone Ridge fields (Table 1).

The sandstones of the Pretty Hill Sandstone are typically well-sorted, fine to medium grained with trough, massive, horizontal and planar bedding all observed (Cubitt et al. 2024). Discrete claystone intervals are rare being typically <10 cm in thickness. Together these observations suggest deposition of in an anastomosing fluvial system. Seismic character supports this interpretation with

[1] Note: This definition of the Pretty Hill Formation is from Morton et al. (2002), which consisted of the Pretty Hill Sandstone, the Upper Sawpit Shale, the Sawpit Sandstone and the Lower Sawpit Shale, which have been used in the 2023 DEM Petroleum Systems Study.

truncated channels commonly observed. In contrast, core lithologies and log motifs away from the Hungerford Fault system are more varied with common heterolithics (Lake Eliza 1 and Haselgrove 2). Seismic character also changes from trough-dominated (channels) to more parallel reflectors (Reedy Creek 1) away from the fault system. The resulting GDE map for this interval reflects these discordances with a clear division between a channel fairway trending parallel and close to the Hungerford Fault with flood plains to the north. Alluvial fan aprons are interpreted to fringe all active growth faults in this interval with the Banyula 1 well most likely intersecting such a geo-body. Seismic data provides strong evidence that sediments in this interval were being derived from the north via an extensive canyon system.

In the Katnook Field, the Pretty Hill Sandstone exhibits porosities in excess of 25%, permeabilities in excess of 1000mD, and flowed up to 16.38 MMCF/464,000 m^3 gas per day and 140 BCPD on test (Katnook 2 WCR). Reservoir permeability does not appear to decrease uniformly with depth of burial, plausibly related to dissolution diagenesis.

Nangwarry 1 drilled in 2019/20 encountered a gross gas column of 124.9 m TVD in the Pretty Hill, with the section above the FWL comprising 16.8 m TVD of net reservoir with an average porosity of 14% and average gas saturation of 55.7%. In this instance the gas consists of approximately 90.85% CO_2 and 7.36% methane.

Production data from PEPS indicates that average monthly production rates from the Pretty Hill Sandstone have been as high as 33.1MMCFGD/938,000 m^3 and 165 BOPD, both from Ladbroke Grove 3.

The top seal to the Pretty Hill Sandstone over the southern portion of the area north of the Tartwaup Hinge is the Laira Formation, while in the north where the Laira is absent seal is provided by shales of the Eumeralla Formation. However, in the Robe Trough region the Windermere Sandstone is present at the base of the Eumeralla Formation, so it is there may not be a fully competent seal for the Pretty Hill Sandstone if the Windermere Sandstone directly overlies the Pretty Hill Sandstone reservoir. In this instance the Pretty Hill Sandstone would have acted as a migration path for hydrocarbons into Windermere Sandstone traps, sealed by Eumeralla Formation shales.

Of course, intra-formational seals may occur within the Pretty Hill Sandstone as they may do in any fluvial depositional environment. However, offset lateral seal capacity poses risk for conventional traps, so any individually prospective area must be investigated with this in mind.

Play analysis of the Pretty Hill Sandstone is discussed in further detail in Strong and Cubitt (2024). Prospectivity in the interval is likely to occur in acreage release blocks OT2025 RSEL-A, B, D and E.

6. Laira Formation (S1-P7 to S1-P8)

Laira Formation cores comprise dark grey to black carbonaceous claystones, heterolithics, siltstones and grey planar to rippled sandstones (with coaly rip-up clasts common; Cubitt et al. 2024)). Corresponding log motifs are variable and typically clay-dominated, while seismic facies tend to show extensive parallel reflectors (especially in the upper part). These observations suggest that in the Penola Trough, an extensive lake formed (with possible turbidite deposition) adjacent to the Hungerford Fault that was bordered to the north by floodplain deposition. Similarly, in the Tantanoola Trough, floodplain deposition dominated in the lower part, with both lacustrine and floodplain deposition in the upper section. Several braided and anastomosing river systems have been identified with sediment input primarily from the north-west, although these are much smaller in scale than those in the depositional systems that preceded the Laira Formation.

Any regulated substances that may have migrated into sandstone reservoirs in the Laira Formation are likely to be sealed by intraformational siltstones and shales, unless they are near the top of the formation; in which case Eumeralla Formation shales above would act as suitable seals. However, where the Windermere Sandstone occurs at the base of the Eumeralla Formation top seal is unlikely to occur.

There have been few hydrocarbon shows within the Laira Formation in the onshore Otway Basin and no production. The shows there have been generally weak, both oil and gas, but may indicate migration paths in the area.

Prospectivity in the Laira Formation may occur in acreage release block OT2025 RSEL-A and may extend into OT2025 RESL-E.

7. Eumeralla Formation

Reservoir quality is excellent in the Windermere Sandstone at the base of the Eumeralla Formation, with both primary and secondary porosity. There is in general poor correlation between log and core porosities, with core porosities often higher; and in both Banyula 1 and Katnook 1 (the only two wells with Windermere Sandstone core), core porosities are usually over 20%, and up to 23.4% in Katnook 1 (Morton et al. 2002).

Any hydrocarbons that may have migrated into the Windermere Sandstone would be sealed by Eumeralla Formation shales immediately above. However, the Eumeralla Formation may have poor seal close to major faults. The “strong gas kick associated with the ‘sandy streak’ at 3,689–3,697 (ft)” within the Eumeralla according to the Robe 1 WCR and the “reputed ‘tar sand and thick oil’ near the base of the Tertiary Knight Formation” (now interpretated as the Sherbrook Supersequence) suggest that there may well be opportunity for petroleum discoveries within the Robe Trough provided there is a suitable seal for reservoirs; the tar/thick oil is likely to be biodegraded due to the relatively shallow depth of the interval, suggesting possible poor sealing capacity close to major faults.

Gas was encountered in the Windermere Sandstone in Crankshaft 1, Greenways 1 and Lake Eliza 1 with all flowing gas to surface during DSTs but at rates too small to measure.

Prospective in the Windermere Sandstone is likely to occur in acreage release blocks OT2025 RSEL-A, B, D and E.

8. Shipwreck Supersequence

The Waarre Sandstone is a major reservoir in the Victorian sector of the Otway Basin, with gas having been produced from several fields. Boult et al. (2002b) described the interval in South Australia as comprising pale grey, fine to very coarse-grained sandstone, with subordinate carbonaceous siltstone and mudstone interbeds. The mineralogy is dominated by metamorphic quartz (mostly with undulose extinction), with minor K-feldspar (microcline). The reference section for the South Australian sector of the Otway basin is the intersection from 2,789 to 2,841 m in Caroline 1.

The Waarre Sandstone has been cored in South Australia in offshore well Argonaut 1A over the interval 3,698–3,702 m where it comprises pale grey, medium-grained sandstone with carbonaceous wisps, cemented by kaolinite and illite, concretionary calcite, and dolomite and quartz overgrowths (Boult et al. 2002b). Sedimentary structures include low angle cross-bedding, ripple cross-lamination, horizontal and massive bedding, and some vertical burrows and horizontal trails. Bioturbation and sedimentary structures indicate a possible marginal marine environment (subtidal channel?). Sediment provenance was probably Cambro-Ordovician metamorphics and intrusives to the north.

The Waarre Sandstone – Flaxman Formation/Belfast Mudstone reservoir/seal couplet hosts the Caroline CO_2 field which finished producing in 2016. This proves the viability of this system as a potential trap for this and other regulated substances within the acreage release block OT2025 RSEL-C south of the Tartwaup Hinge.

Hydrocarbon source rock distribution and maturity modelling

Source rocks in the onshore Otway Basin are capable of producing both gas and oil even though the present-day temperature gradient is moderate, averaging approximately 2.7–3.6° C per 100 m depth. There are numerous rocks with significant organic richness throughout the Late Jurassic to Tertiary section of the Otway Basin (Figures 5a and b). For the northern portion of the acreage release area (Blocks OT2025 RSEL-A, B, D and E), based on organic maturity necessary to generate and expel oil and gas, only the nonmarine strata of the Casterton Formation and Crayfish Group are likely to have effective petroleum source potential, with typically III to IV kerogen types derived from land plants and some nonmarine type II algal-rich shales are present, especially in the syn-rift and early rift succession. In the southern block of the acreage release (OT2025 RSEL-C), thin coals of the Eumeralla Formation are considered to be the primary source rock to charge late Cretaceous conventional plays.

Revision of the existing geochemistry database and seismic stratigraphy along with source rock models conducted as part of the PSM built by DEM in 2023 for the onshore Otway Basin north of the Tartwaup Hinge indicates:

- Good quality, liquids-prone lacustrine source rocks are present in the Oxfordian (?) to Tithonian Casterton Formation (S0-P5, Figure 5a) and lacustrine turbidite source rocks from the Berriasian-Valanginian Basal Shale (McEachern Sand equivalent)/Lower Sawpit Shale (S1-P1/S1-P2). Generation from C Organofacies and expulsion of predominantly liquid hydrocarbons were modelled at a maturity equivalent to 0.7–0.72% VR (or 115–118 °C);

- Gas-prone source rocks were modelled in the Valanginian Upper Sawpit Shale (S1-P4/S1-P5), and latest Valanginian Laira Formation (S1-P7 to S1-P8), with generation of predominantly gas taking place from D/E Organofacies at a maturity equivalent of ~1.0% VR (or 145 °C); and

- Floodplain and lacustrine sediments at the mid-Laira Formation level (the approximate boundary between S1-P7 and S1-P8) were also included after being identified on seismic and correlated with cores, logs and geochemistry data; this was modelled with the same inputs as the Lower Sawpit Shale, with the assumption of similar gross depositional environments.

Figure 11 shows RockEval data used in the modelling for the Sherbrook Group, Eumeralla Formation, Crayfish Group and Casterton Formation.

Casterton Formation (S0-P5)

The Casterton Formation represents the richest source rock of the Otway Supersequence that is thought to be the source of most if not all of the produced gas accumulations in the Penola Trough region. It comprises pre-rift to early syn-rift interbedded shales, siltstones and sandstones and volcanic lithologies that have only been sparsely intersected in wells, although exhibiting good quality, liquids prone, coaly shales all the way through the Casterton Formation (S0-P5, Figure 5a). The formation has been mostly intersected on the northern flanks of the Penola Trough where it is marginally organically mature for oil generation and expulsion (as evidenced by oil shows in several wells), but it has been intersected in the deeper portions of the Penola Trough where it reached a thickness of 163.6 m in Bungaloo 1 and 206.9 m TVT in Jolly 1 ST1. It is thought to be over 1,000 m in parts of the Robe Trough based on seismic interpretation.

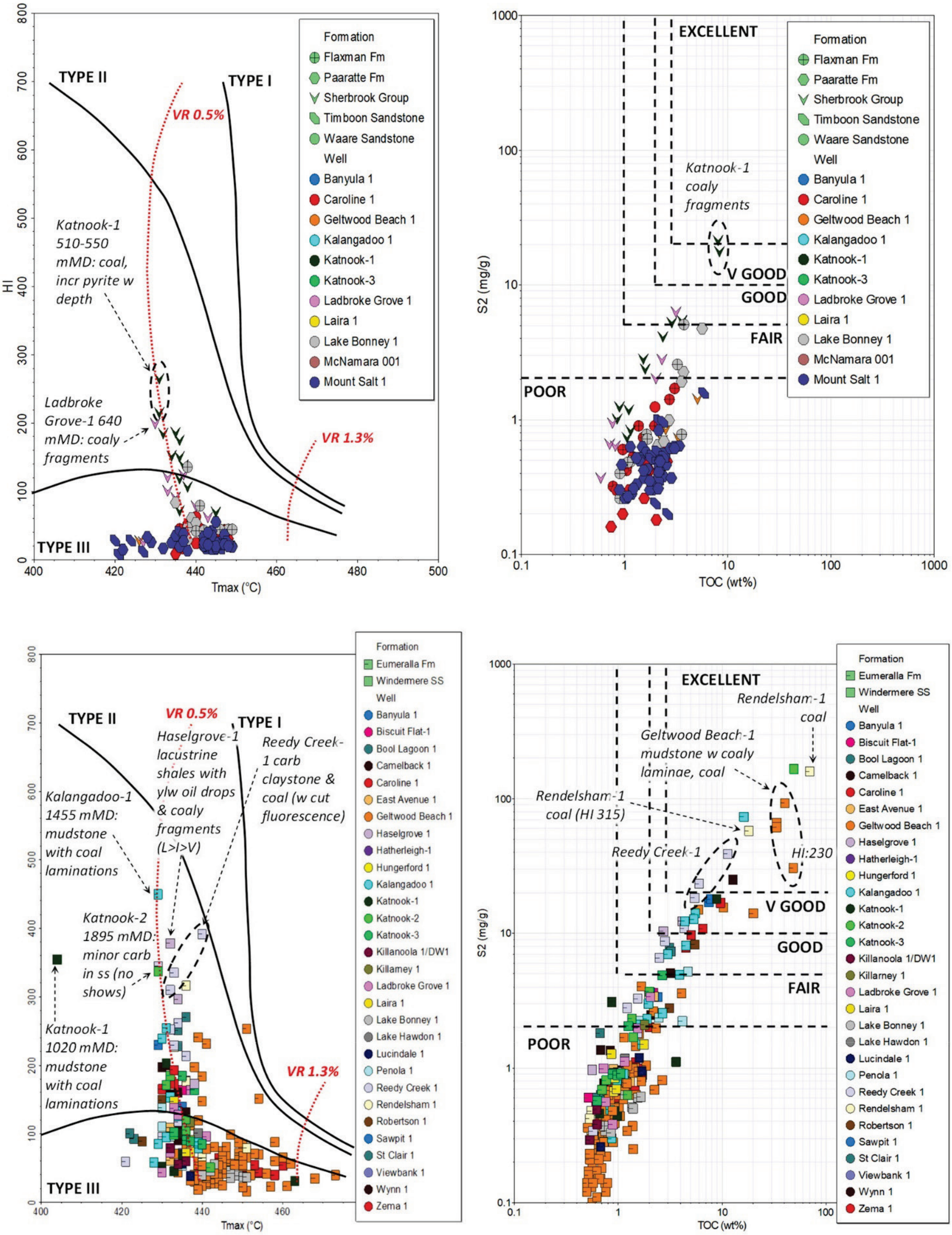


Figure 11a. RockEval data for selected wells north of the Tartwaup Hinge (from Edwards et al. 2024); top – Sherbrook Supersequence; bottom – Eumeralla Formation. Note: the axes refer to the following: Tmax is the maximum temperature of hydrocarbon generation, HI refers to the Hydrogen Index, while S2 is the amount of hydrocarbons generated through thermal cracking, and TOC is a measure of total organic carbon.

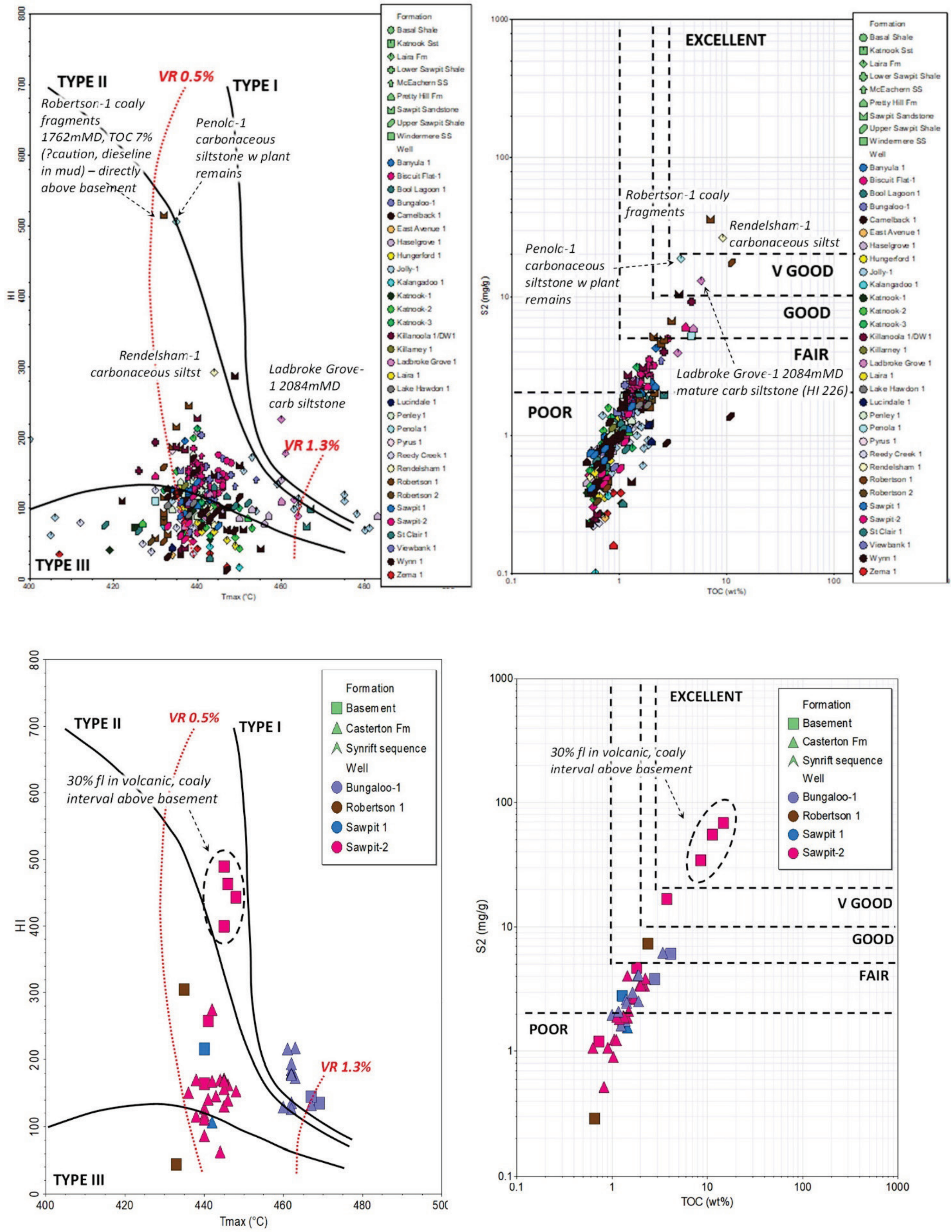


Figure 11b. RockEval data for selected wells north of the Tartwaup Hinge (from Edwards et al. 2024); top – Crayfish Subgroup; bottom – Casterton Formation. Note: the axes refer to the following: Tmax is the maximum temperature of hydrocarbon generation, HI refers to the Hydrogen Index, while S2 is the amount of hydrocarbons generated through thermal cracking, and TOC is a measure of total organic carbon.

A sequence of interbedded metasediments, tuffaceous sediments and organically rich shale was first identified within what appeared to be Basement in Sawpit 1 over the interval 2,510–2,607 m MD, now interpreted by DEM to be reworked Basement during deposition of the Casterton Formation (S0-P1/ P2). The interval contains good quality, liquids prone, coaly shales. A low sulphur (~0.8%) medium gravity API (33–35°) paraffinic oil was recovered from DST 1 over the interval 2,514–2,546 m (1.5 bbl oil, 0.5 bbl mud) with a vitrinite reflectance (VR) of 0.71. The same sequence was intersected in Sawpit 2 over the interval 2,470–2,548 m MD, with oil shows over the interval 2,517–2,547 m recorded 20 to 30% very dull yellow gold fluorescence with instant weak diffuse cut. Subsequent Rock-Eval pyrolysis over the interval 2,517–2,543 m returned average Total Organic Carbon (TOC) values of 8.05% (range: 1.82–14.78%), S2 values averaging 35.89 (range: 4.69–68.43) and HI values averaging 410.6 (range: 258–489) indicating a wet gas to oil rich type 2 (non-marine) algal rich source rock.

The same unit also occurs in Bungaloo 1 (3,428–3,675 m) and Jolly 1 ST1 (3,861–3,976.6 m) where it is likely to be in the wet gas window based on a VR value of 0.94% near the top of the Casterton Formation (Bungaloo 1 Core 4, SWC 3326 m) and remains untested.

Work by Hill et al. (2020) suggests the fluid recovered from the reworked Basement at Sawpit 1, which is geochemically distinct from all other analysed fluids, was derived from a volcanics/weathered Basement dominated lacustrine source with significant organic content and anoxia, representing the initial, cold climate rift sequence deposited directly on Basement.

Good quality, liquids prone, coaly shales from the Casterton Formation (P3 to P5) show total organic content (TOC) values range from 0.6 to over 15% (see Sawpit 2 core log in Cubitt and Tiainen 2025). Pyrolysis Tmax versus Hydrogen Index (HI) cross plot shows that these organic rich shales are primarily type II (algal-rich oil-prone kerogen) to type III (gas-prone) at the threshold of the oil window (Figure 11). However, in the deeper portions of the Penola, Robe and Saint Clair troughs, Casterton Formation source rocks are expected to be gas-prone with liquids potential.

Maturity modelling was run on the top Casterton Formation surface in 2023, using an average of 650 HI and 5% TOC over a 50 m interval, with results suggesting the interval has been mature for generation from C Organofacies with expulsion of predominantly liquid hydrocarbons at a maturity equivalent to 0.7–0.72% VR (or 115–118 °C), with gas expelled from around 1.4% VR (150 °C). Much of the Casterton Formation now lies within the gas generation and expulsion window below depths of 3,500 m in the Penola Trough and Robe Trough, but also in the St Clair and Rivoli Troughs.

The results of the modelling show that significant hydrocarbons have been generated and expelled from the Casterton Formation within the Penola Trough as expected. However, the lightly explored Robe, St Clair and Rivoli Troughs have been identified by the study as regions where significant oil and gas expulsion may have occurred. For further details visit the Petroleum Systems Model webpage and Edwards et al. (2024).

Basal Shale (McEachern Sand equivalent)/Lower Sawpit Shale (S1-P1/S1-P2)

The Lower Sawpit Shale was deposited in a deep lake primarily north of the Hungerford Fault system as rifting increased. The thickest section is interpreted to be in the deepest part of the Penola Trough, with seismic data suggesting it may get up to 3,000 m thick. Jolly 1 ST1 intersected 597.9 m TVT, with 531.6 m in Bungaloo 1.

Most of the section has potential for having generated hydrocarbons, with the Basal Shale containing the best liquids-prone lacustrine source rocks. The Basal Shale and its equivalent the McEachern Sandstone together are 431.2 m in Jolly 1 ST1 and 364.7 m in Bungaloo 1. Core data indicates that the Basal Shale comprises dark grey to black claystones and siltstones while the McEachern Sandstone interval has a markedly different character being defined by interbedded massive sandstones and black massive/varved claystones. Tiainen et al. (2024) contend that the McEachern Sandstone formed via turbidite processes within a deep (anoxic), seasonally frozen lake.

Interestingly TOC as measured from conventional core in Jolly 1 ST1 is higher in the turbidite lithology when compared to the lacustrine mudstone lithology (Cubitt and Tiainen 2025). This is encouraging for the turbidite play in that high TOC, mature source rock (Edwards et al. 2024) is immediately adjacent to potential reservoir. Hydrocarbon fluorescence has also been observed in ultra-violet (UV) core photographs in Bungaloo-1 and Jolly-1ST 1 along with high gas readings over the studied interval, the light blue colour suggestive of a relatively light (API gravity) oil and/or condensate.

Maturity modelling was run on the top Lower Sawpit Shale surface in 2023 using 25% of the overall Lower Sawpit Shale isopach to represent source rock based on sequence stratigraphy, logs, and source rock analysis in the wells. An average of 500 HI and 5% TOC suggests the interval has been mature for generation and expulsion of liquid hydrocarbons around 0.72% VR (118 °C), equivalent to a depth of around 200 m. Commencement of gas generation and expulsion occurred from around 1.1% VR (135 °C), equivalent to a depth of around 2,000 m. The results indicate that oil and gas have been generated from the Lower Sawpit Shale from the Robe Trough to the west and eastwards across much of the northern onshore Otway Basin.

Upper Sawpit Shale (S1-P4/S1-P5)

The Upper Sawpit Shale represent fluvial and lacustrine deposits up to 852 m thick in Wynn 1 and 830 m thick in Jolly 1 ST1, and contains gas-prone source rocks. Floodplain shales are better developed on the northern flank of the Penola Trough, away from the axial drainage in the central part of the trough which is dominated by stacked fluvial channel fill similar to the Pretty Hill Sandstone and the Sawpit Sandstone. Floodplain including lakes dominates the western side of the basin.

Source rock quality for the Upper Sawpit Shale is poorer than that for the Lower Sawpit Shale and the Casterton Formation below, with average HI of 150 and TOC of 2%. 2023 modelling of maturity and expulsion was conducted on both the top and base of the Upper Sawpit Shale surface using 25% of the overall Upper Sawpit Shale isopach in a similar fashion to that for the Lower Sawpit Shale, the results indicating generation and expulsion of gas hydrocarbons around 1.0% VR (145 °C), equivalent to a depth of around 3,000 m. Gas has been generated and expelled from the Upper Sawpit Shale primarily in the deepest parts of the Penola Trough, with much smaller amounts in the Robe, St Clair and Rivoli troughs.

Laira Formation (S1-P7 to S1-P8)

The Laira Formation has not previously been identified as a potential source rock in the onshore Otway Basin. The gross depositional environment map (Cubitt et al 2024) shows that it was deposited primarily in a fluvial-lacustrine environment, with a lake centred over the deeper parts of the Penola Trough, and isolated floodplain lakes elsewhere. Seismic interpretation suggests it may be as thick as 450 m in the Tantanoola Trough. Core data shows that it comprises dark grey to black carbonaceous claystones, heterolithics, siltstones and grey planar to rippled sandstones (with coaly rip-up clasts common; Cubitt et al. 2024). Edwards et al. (2024) identifies isolated good quality, liquid and gas prone carbonaceous claystones and siltstones, as well as high algal content in the upper part of the sequence.

Gas-prone source rocks were modelled on both the top and base of the Laira Formation, using D/E Organofacies (fluvial-floodplain) with an average of 200 HI and 3% TOC. Generation and expulsion of predominantly gas was interpreted to have occurred at a maturity equivalent of approximately 1.0% VR (or 145 °C) for the base of the Laira only; no generation was modelled for the top of the Laira as it is not deep enough.

Floodplain and lacustrine sediments at the Mid-Laira Formation level (approximately the boundary between S1-P7 and S1-P8) were also included after being identified on seismic and correlated with cores, logs and geochemistry data; this was modelled with the same inputs as the Lower Sawpit Shale, with the assumption of similar gross depositional environments. A pseudo-Intra-Laira Formation depth surface was created to test the maturity of the Mid-Laira Formation source rock model, with the sequence showing early to mid-maturity for liquids generation and expulsion in the Tantanoola Trough.

Eumeralla Formation

The Eumeralla Formation comprises extensive fluvio-lacustrine and volcanogenic facies with some minor coal and meandering fluvial sandstone units deposited during the sag phase of the basin. Examination of source rock data from the Eumeralla Formation indicates a better-quality source rock present part way through the sequence. However, maturity modelling shows that the formation is not deep enough north of the Tartwaup Hinge to have generated hydrocarbons.

To the south of the Tartwaup Hinge where thick Sherbrook strata occur, for the OT2025 RSEL-C acreage release area coals and possible deep-water shales within the Eumeralla Formation, Waarre Sandstone and Belfast Mudstone contain potential type II and III source rocks and (Figure 11) and are mature for generating and expelling oil and gas, making these strata a suitable source for overlying and up-dip Waarre Sandstone and Flaxman Formation targets.

Hydrocarbon generation and expulsion

Boult et al. (2004) indicated that an initial minor oil/wet gas charge was displaced by later dry gas in the Penola Trough, with gas wetness and probability of oil occurrence increasing towards the northern flank of the trough.

Maturity modelling conducted by DEM in 2023 suggests the Casterton Formation, Lower Sawpit Shale, Upper Sawpit Shale and the lower Laira Formation have been mature for the generation and expulsion of hydrocarbons in the onshore Otway Basin north of the Tartwaup Hinge. Expulsion modelling indicates liquid hydrocarbons were expelled from the Lower Sawpit Shale between 126 and 70 Ma, with the greatest volume sourced from the Penola and Robe Troughs (Figure 3). Gas and condensate expulsion also took place from the Upper and Lower Sawpit Shale in the Penola and Robe Troughs, with expulsion complete by around 30 Ma. Up to 250 bcf/km^2 of gas is modelled to have been generated and expelled from the Laira Formation in the Tantanoola Trough, between 100 Ma and present day.

Modelling also indicates that late-stage Tertiary and Quaternary volcanism appears to have had little effect on the maturity of petroleum source rocks (Edwards et al 2024).

The results of the modelling show that significant hydrocarbons have been generated and expelled within the Penola Trough as expected. However, the lightly explored Robe and Tantanoola Troughs have also been identified as regions of significant gas expulsion:

- DEM’s modelling reveals significant gas expulsion has occurred from the Casterton, Lower Sawpit Shale and Upper Sawpit Shale in the Robe Trough; and
- The Laira Formation is also generating hydrocarbons from flood plain and lake sediments. Significant generation is observed for the first time in the Tantanoola Trough.

Total modelled expulsion of gas and oil in the onshore Otway Basin north of the Tartwaup Hinge are shown in Figure 12a and b respectively.

The maturity of the top of the Eumeralla Formation south of the Tartwaup Hinge is show in Figure 13. Furthermore, looking offshore at the Morum sub-Basin (in South Australian waters), recent PSM work undertaken by Geoscience Australia and Schlumberger (Schenk et al 2023) detailed aspects of a working petroleum system in this part of the Otway Basin.

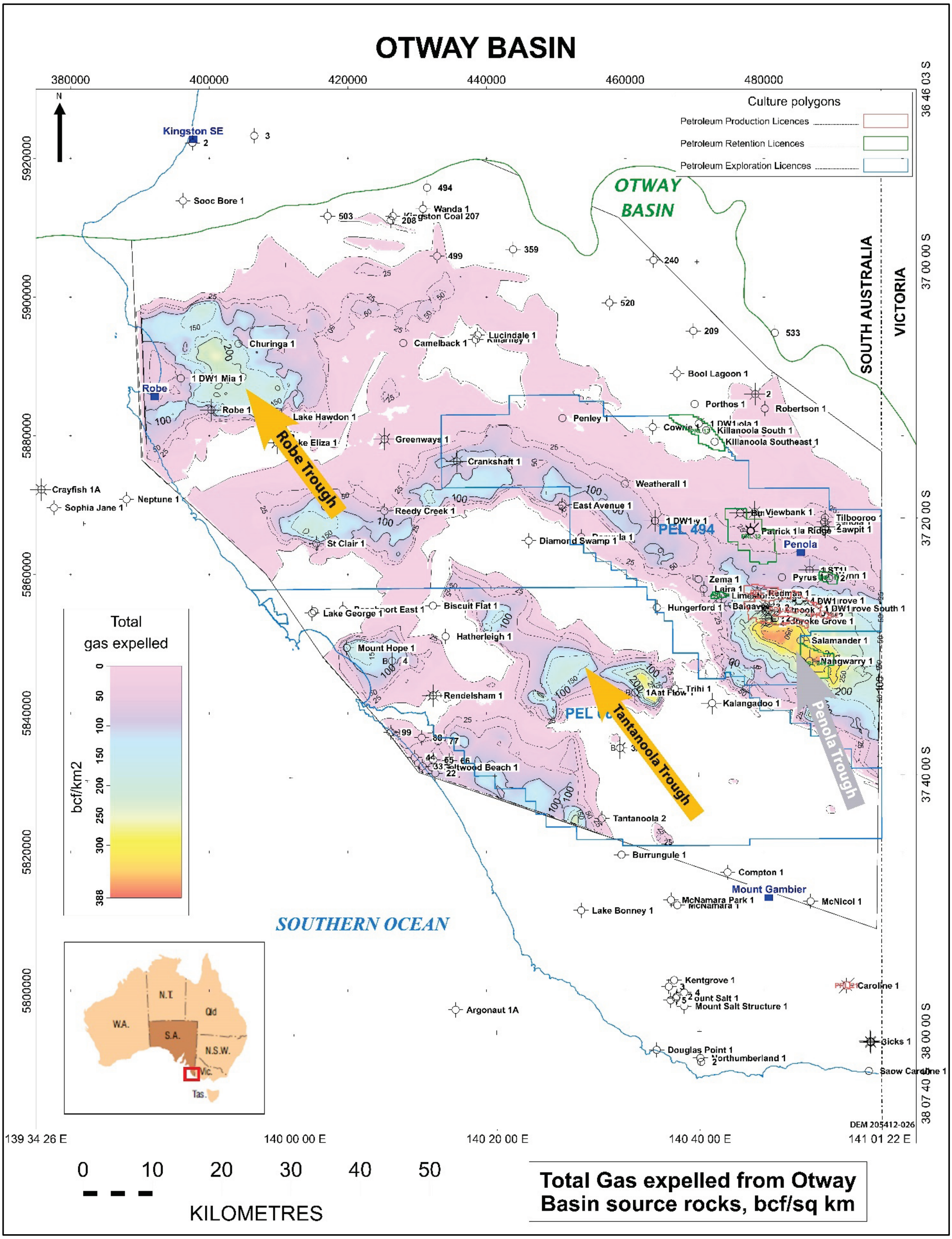


Figure 12a. Modelled gas expulsion map onshore Otway Basin in South Australia.

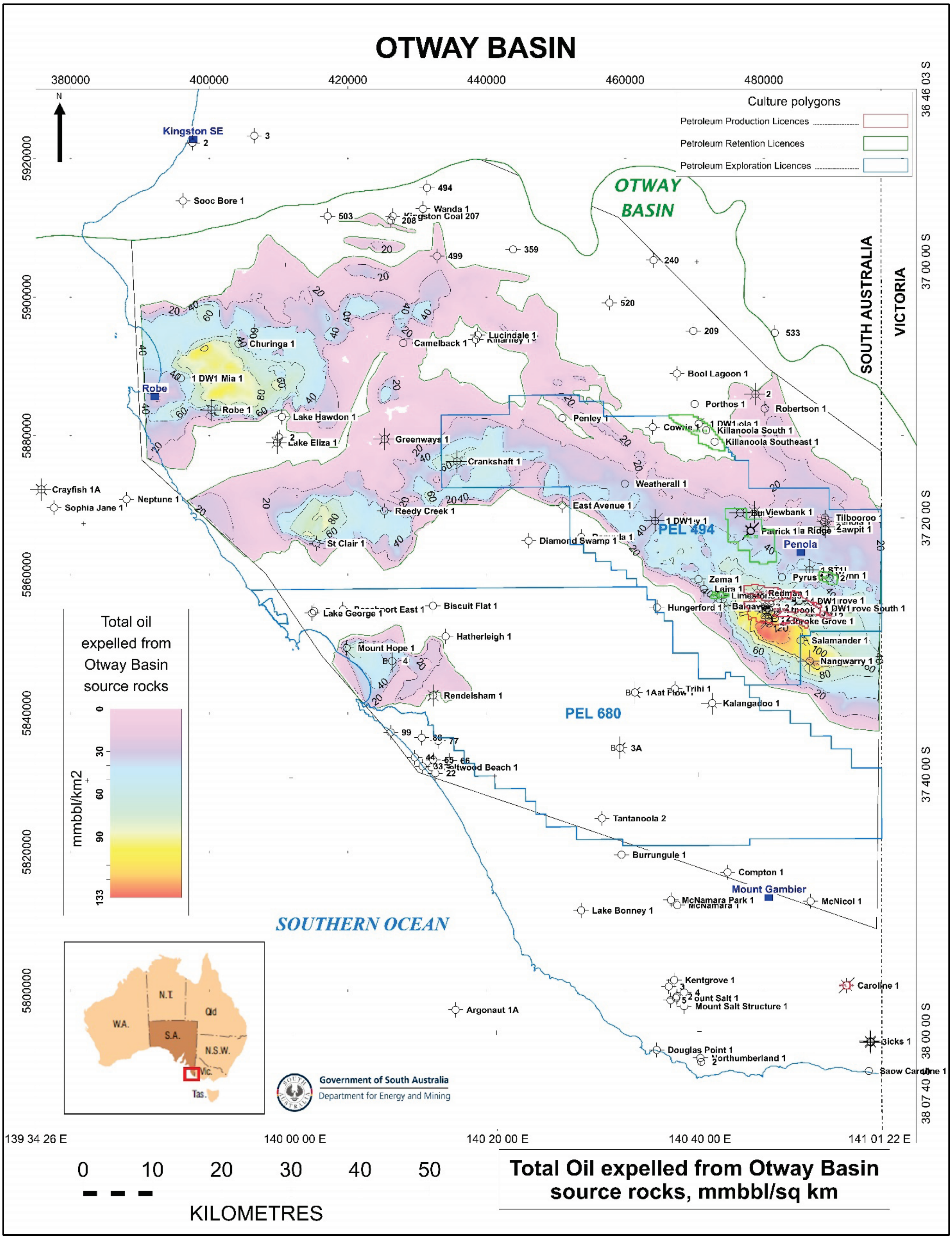


Figure 12b. Modelled oil expulsion map onshore Otway Basin in South Australia.

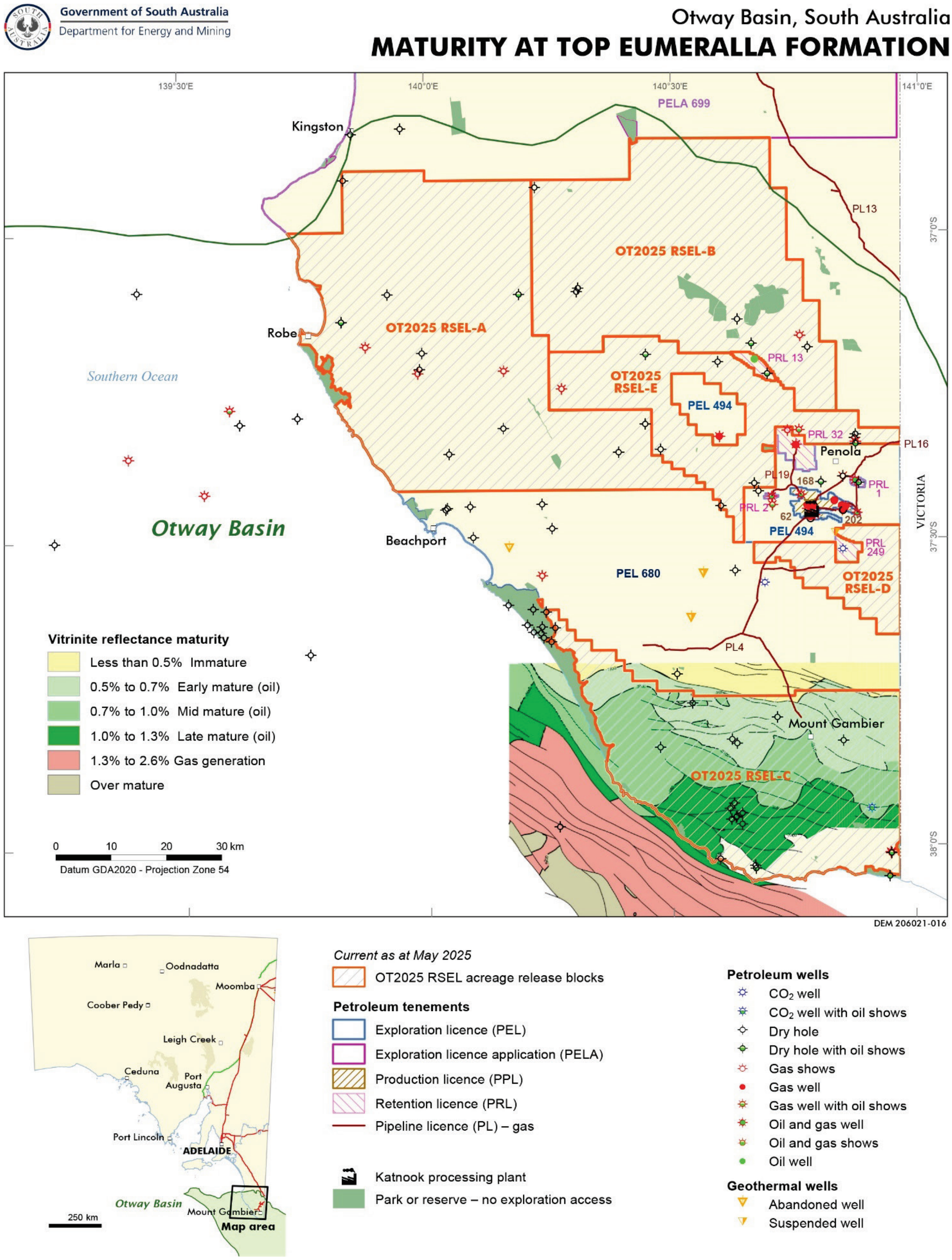


Figure 13. Source rock maturity at top Eumeralla Formation in the southern Otway Basin in South Australia, showing OT2025 RSEL release acreage only.

Carbon dioxide source

Carbon dioxide (CO_2) is a 'regulated substance' in South Australia under the ER Act.

The presence of CO_2 in suitable reservoirs in the South Australian Otway Basin has been known since 1965 with the drilling of Kalangadoo 1 as a petroleum exploration well, with gas flowing on DST at a maximum rate of 1.55 MMCFGD from fractured Basement, consisting of 96% CO_2 and 2.4% methane.

Caroline 1 was drilled 1967/8 with the drilling of as a petroleum exploration well. Gas flowed on DST at a stabilised rate of 2.495 MMCFGD from the Waarre Sandstone, consisting of 98.6% CO_2, 0.93% methane, 0.46% nitrogen, and less than 0.01% each of helium, hydrogen and heavier hydrocarbons. Subsequently 810,800 tonnes (15.6 bcf at standard conditions) of saleable CO_2 was produced from the well between November 1968 and December 2016. Small amounts of oil were also produced.

CO_2 was also discovered in the Pretty Hill Sandstone in Nangwarry 1 in 2019/20, with the well cased and suspended as a potential future CO_2 producer pending further evaluation.

Additionally, there is evidence to the east, in the Victorian extent of the Otway Basin, for natural gas fields with low CO_2 content in proximity to the Boggy Creek CO_2 field e.g. the Naylor, Croft and McIntee gas fields.

Based on isotopic analyses, the CO_2 in the Caroline Field is interpreted to have been sourced from deep volcanics, assumed to be part of the Holocene (in age) Mt Gambier volcanic chain, which trends northwest through the Portland and Tantanoola Troughs. Carbon dioxide from a magmatic source has also been noted in Ladbroke Grove Field and Kalangadoo 1. Indeed, there appears to be a CO_2 gradient, from high concentration at the base (56.6%) to low (29.2%) at the top, in the Ladbroke Grove field indicates that CO_2 migration is very recent, and that CO_2 migration is probably still occurring at present (Boult et al. 2004).

The most recent phase of tectonic activity in the Otway Basin involved extrusion of several episodes of volcanics (Jensen-Schmidt et al. 2002). In Victoria, extensive basaltic and ash volcanics were extruded during the Pliocene–Pleistocene (the Older Volcanics). Two more recent events (the Newer Volcanics) in South Australia and Victoria have been dated as Pleistocene and Holocene.

The presence of CO_2 in the region provides a risk for the presence of other regulated substances in potential reservoirs, which may have been charged with CO_2 at the expense of petroleum or natural hydrogen.

Natural hydrogen source

Natural hydrogen has been detected in wells in the Cooper and Eromanga Basins, Otway Basin and Stansbury Basin in South Australia.

The natural hydrogen industry is in its infancy worldwide. However, South Australia is at the forefront of exploration for natural hydrogen, which became possible in February 2021 via regulatory changes to include hydrogen as a 'regulated substance' under the *Petroleum and Geothermal Energy Act 2000*, which was amended in 2023 to establish the *Energy Resources Act 2000*. This enabled grant of exploration licences targeting natural hydrogen, and many applications have been made for PELs in the State in order to explore for natural hydrogen, with two PELs granted, one over the Yorke Peninsula and Kangaroo Island in the Stansbury Basin, the other over the southern Eyre Peninsula.

Proposed subsurface generation mechanisms for natural hydrogen include, but are not limited to:

- degassing of magmas and deep-seated hydrogen from the Earth's core and mantle
- cataclasis

- oxidation of divalent iron (Fe^{2+}) rich minerals and lithologies through rock-fluid interaction (e.g. serpentinisation); equivalent redox reactions may also occur using other multivalent elements such as sulphur, nitrogen and manganese
- natural radiolysis of water
- biogenic and abiogenic decomposition of organic matter
- a combination of coincident genetic factors

Further details of these methods can be found in Bendall (2022).

Numerous observations worldwide suggest that hydrogen derived from magmatic processes and the degassing of the Earth's upper mantle and, hypothetically, the lower mantle and core is prevalent, and routinely migrates through the crust to the Earth's surface.

In the onshore Otway Basin gas was encountered throughout the Eumeralla Formation in Robe 1 drilled in 1915/16, with samples taken at 3,945 ft (1,110.9 m) towards the base of the formation and analysed by the SA Department of Chemistry, the results indicating 25.4% hydrogen (see Table 1 in Natural hydrogen in South Australia, from Ward 1944).

Gold Hydrogen drilled Ramsay 1 and 2 in October 2023 on the Yorke Peninsula in South Australia as the first dedicated hydrogen exploration wells in Australia, with both hydrogen and helium encountered in significant quantities. The source of the hydrogen is interpreted to be water circulation through iron-rich Basement (hydrolysis) and/or water splitting during the radioactive decay of radiogenic elements (uranium, thorium and potassium) in the Basement (radiolysis). The presence of high helium may be due to the involvement of a radiolytic source of helium or from mantle degassing.

Figure 14 suggests that the pre-Jurassic/Early Cretaceous section in the Penola and Robe Troughs is underlain by granite, as is the Late Cretaceous in the Morum Sub-basin, whereas the rest of the onshore Otway Basin is underlain by metasediments. If the granites are iron-rich they would be a good source for the generation of hydrogen similar to that encountered on the Yorke Peninsula. The presence of serpentinite indicates another possible mechanism for the generation of natural hydrogen in the area.

The derivation of the hydrogen occurrence recorded in Robe 1 is unclear, but it could be due to the proximity of the well to the high displacement basement fault bounding the Robe Trough and Lake Eliza High acting as a conduit for hydrogen migrating up from deep basement sources.

Elsewhere in the Otway Basin, basement faults have acted as migration pathways for mantle-derived $CO_2$and trace gases like helium and nitrogen. Neither the produced CO_2 nor the CO_2occurrences contain anomalous hydrogen contents, so there may not be a link with the hydrogen recorded in Robe 1. Mantle-derived $CO_2$was produced from Late Cretaceous reservoirs in the Caroline Field for decades and the gas contained only trace amounts of hydrogen, nitrogen and helium. CO_2 was produced with natural gas from the Ladbroke Grove Gas Field for some years with no hydrogen reported from multiple gas analyses.

Boreham et al. (2022) suggested that the hydrogen encountered in the Cooper Basin was due to late-stage maturation of hydrocarbon source rocks. This could be a potential source in the Robe Trough due to the high maturity of the hydrocarbon source rocks modelled in the PSM study.

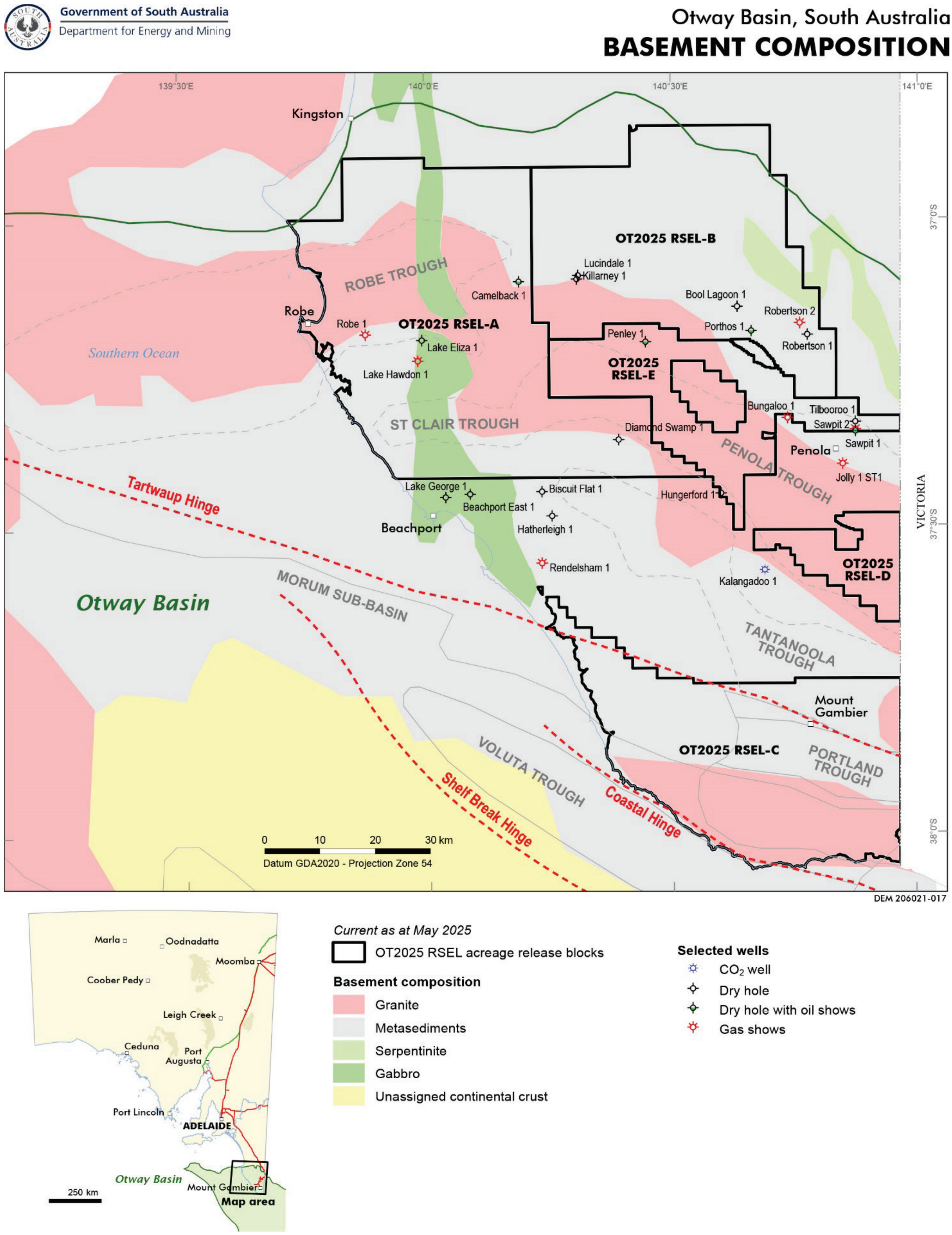


Figure 14. Basement composition in the Otway Basin (modified from Jorand et al. 2010). Note: Wells shown are those that drilled into Basement, except Robe 1.

Entrapment

In the northern part of the basin, where exploration is for Otway Supersequence targets, reservoirs of the fields in the Penola Trough comprise complex, steep sided, east-west tilted fault blocks, with Eumeralla Formation, Laira Formation or floodplain shales of the Pretty Hill Sandstone or Upper Sawpit Shale acting as the seals. Intra-formational seals may also occur. See the results of the 2024 play analysis study for further information on the relationships between reservoirs and seals for each potential target north of the Tartwaup Hinge.

Boult et al. (2004) interpreted closures for the Haselgrove, Haselgrove South, Katnook and Redman fields as being gas-full to structural spill. Several wells exhibit palaeo-columns, of which some structures may have originally been full to spill, with leakage from traps probably being caused by the ineffective offset lateral seals. The location of leakage depends on the interaction between the seal, associated faults, and the regional stress field. The building of 3D structural models may help to reduce seal risk for prospects.

Recognised traps for Windermere Sandstone reservoirs comprise unfaulted low relief domes which are close to the resolution limit of seismic mapping, sealed by the Eumeralla Formation. The base Eumeralla seal is likely to improve towards the south where the Windermere is not present. Considerable potential exists for stratigraphic traps, either as meandering fluvial channels in the Eumeralla Formation (as in Katnook Field), or as pinch-outs of Pretty Hill Sandstone units to the north.

Stratigraphic traps may also occur in the region although have yet to be fully identified. Tiainen et al. (2024), suggested that the immediate lateral association of the potential Lower Sawpit Shale reservoirs with gas/oil-prone source rocks and seals in the clay-rich lithologies may provide for stratigraphic trapping in addition to the previously targeted fault-controlled structural traps.

The Waarre Sandstone and Flaxman Formation have proven to be excellent gas reservoirs in the Victorian portion of the basin, and in South Australia contain the Caroline CO_2 field. Traps are generally northeast tilted fault blocks, bounded by closely spaced rift parallel faults. Offshore, potential exists for overpressured submarine slope-fan traps encased within the Belfast Mudstone (Figure 10). As stated earlier, natural gas fields with low CO_2 content are in proximity to the Boggy Creek CO_2 field, e.g. the Naylor, Croft and McIntee gas fields. In this play area, the acquisition of 3D seismic proved to be a valuable strategy to differentiate between structures bounded by deep-seated master faults (as conduits for CO_2 to migrate from deep igneous sources) and structures only affected by faults that do not extend to potential igneous CO_2 source levels.

The relatively recent tectonic phase represents a potential risk to petroleum exploration by introducing magmatic CO_2 into the sedimentary sequence, to the detriment of hydrocarbon entrapment (Jensen-Schmidt et al. 2002). Three-dimensional (3D) seismic can resolve where traps are bounded by deep-seated versus shallower faults. Experience suggests the chance for encountering higher levels of CO_2 where gas accumulations are nearer to deep-seated faults, onshore in the Otway Basin.

Production

Table 2 shows the hydrocarbon production in the onshore Otway Basin in South Australia.

Field	Co-Formation	Type	Oil (bbl)	Water (bbl)	Gas (mmcf)	First Production Date	Last Production Date
Haselgrove	Pretty Hill Fm	Gas	166,897	67,632	10,864	31 Jul 1994	31 Oct 2011
Haselgrove	Sawpit Sandstone Member	Gas	2,061	20,815	3,415	31 Jul 1994	31 Oct 2011
Hollick	Sawpit Shale Member	Gas	12	43	1	28 Feb 2018	30 Sep 2022
Jacaranda Ridge	Sawpit Shale Member	Gas	12,389	1,318	154	31 May 2011	31 Aug 2011
Katnook	Eumeralla Fm	Gas	640	11,334	215	31 Aug 2007	31 Oct 2011
Katnook	Pretty Hill Fm	Gas	101,150	107,222	16,876	31 Jan 1991	31 May 1992
Ladbroke Grove	Pretty Hill Fm	Gas	46,576	116,952	48,645	31 Jan 1991	31 Oct 2011
Limestone Ridge	Pretty Hill Fm	Gas	3,610	2,276	359	31 Dec 1999	31 Dec 2006
Patrick	Sawpit Shale Member	Gas	382	425	6	30 Apr 2010	31 Jul 2011
Redman	Pretty Hill Fm	Gas	110,999	40,072	4,768	31 Dec 2010	31 May 2011
			444,717	**368,089**	**86,302**		

Table 2. Hydrocarbon production in the South Australian Otway Basin (from PEPS).

In addition, 810,800 tonnes (15.6 bcf at standard conditions) of saleable CO_2 were produced from the Caroline field from November 1968 to end-December 2016.

Undiscovered resources

The Otway Basin in South Australia is only modestly explored, with high potential for further discoveries. Commercial gas and condensate production has been achieved from 8 fields in the South Australian extent of the onshore Otway Basin.

Oil discoveries to date are limited, but there is considerable potential for significant oil discoveries in the future.

The natural hydrogen industry is in its infancy worldwide, although South Australia is at the forefront of exploration. However, no estimate of undiscovered resources for natural hydrogen has been made in the Otway Basin.

EXPLORATION POTENTIAL

The OT2025 RSEL-A to D acreage release is being offered at a time when there is a local market for gas in the southeast of South Australia and potential to access national markets through the SEA Gas pipeline if economically viable.

The acreage contains a diversity of plays for hydrocarbons as discussed above and documented on the Otway Basin webpage. Proven plays in South Australia include the fault bounded 4-way dip closures in the Pretty Hill Sandstone, Upper Sawpit Shale, Sawpit Sandstone and Windermere Sandstone in the Penola Trough (oil and or wet gas), although gas discoveries to date are relatively modest in size. Fault leakage is a key below-ground risk factor for trapping petroleum.

CO_2 has been produced from 1 field in the Otway Basin and has been encountered in several other wells. Natural hydrogen has also been encountered in the basin. The exploration methodology for CO_2 and hydrogen is much the same as for hydrocarbons, and the potential exists for discoveries of both to be made.

Existing infrastructure is a key factor in reducing the uncertainty for the economic prospects of gas plays in the Otway Basin.

Infrastructure and markets

Eight commercial gas fields have been discovered in the Otway Basin in South Australia leading to total production of 91.48 PJ (86.3 bcf) sales gas and 444,717 bbl condensate.

Cumulative production for the Katnook Complex for the period 1991 to end September 2022 is 74.76 PJ sales gas and 70,704 KL (444,730 bbl) condensate.

CO_2 has been produced from Caroline 1 well with total production of 810,800 tonnes (15.6 bcf) of saleable CO_2 since production commenced in 1968. In mid-January 2017, Air Liquide made the decision to cease production and commence decommissioning of the Caroline Plant.

A flowline network exists to allow gas from wells in the Katnook, Haselgrove, Haselgrove South and Redman gas fields to be piped to a gas treatment plant located 300 m southeast of Katnook 1, which was built in 1991. Since 2022 the Katnook Plant and gathering flowline network, now owned by Beach Energy Ltd, have been mothballed (with non-corrosive and non-toxic gas) pending commercialisation of further gas supply.

Sales gas was sold at the outlet from the Katnook Plant and delivered to markets serviced by the SEPS. Condensate was stored onsite at the Katnook Plant before transportation by road tanker to the Shell Refinery in Geelong, Victoria.

Epic Energy owns and operates a 46 km long, 150 mm diameter pipeline, from the Katnook gas processing plant to the Kimberly Clark Pulp Mill (previously APCEL Pulp Mill) at Snuggery, 7 km southeast of Millicent. A second line, also 150 mm diameter and 19 km long, runs from this line to Mt Gambier. A third line, 50 mm diameter, runs from Katnook due east for 4.5 km to the former Safries potato chip factory site (purchased by The Midfield Group in 2014), 9 km south of Penola. The pipelines were constructed in 1990 and have a maximum operating pressure of 10,000 kPa (1450 psi). A fourth line, 11.5 km long and 89 mm diameter, was constructed in the second half of 2000, connecting Kalangadoo to Nangwarry timber mill. None of these pipelines have compression installed.

In 2002–03, the SEA Gas pipeline was constructed to transport offshore Otway gas from the Minerva Gas Processing Plant in Port Campbell, Victoria to Adelaide. Origin Energy Retail Ltd constructed and commissioned the SESA Pipeline in 2005, and was acquired by APA Group in 2007. This 45 km pipeline connects the SEA Gas Pipeline in Victoria to Epic Energy's SEPS and the Ladbroke Grove Power Station.

Opportunities exist for small peaking power stations in a more competitive electricity market. The strategic location of the Ladbroke Grove Field adjacent to the main electricity link between Adelaide and Victoria, led to Origin Energy taking the opportunity to use the high-CO_2 gas to fire a 40 MW power station. As gas production from Ladbroke Grove Field ceased in late 2006, sales gas from the SESA pipeline now feeds both turbines of the Ladbroke Grove Power Station and the SEPS.

In addition to the power station, the main gas customers are the Kimberly Clark paper mill near Millicent, where gas replaced the use of liquefied petroleum gas (LPG) and brown coal briquettes; and domestic and industrial customers in Mt Gambier, which were previously supplied tempered LPG via a reticulation network.

In addition, the southeast of South Australia and western Victoria exhibit a high diversity of local industry — consequently, opportunities exist for gas marketing linked to industry development in the region, given the industry base and service provision in the region. The region is strategically located between the major cities of Adelaide and Melbourne and the eastern Australian market.

A key motivation for the acreage release is the looming shortfall in energy supply in the southeast Australian gas market. The South Australian onshore Otway Basin is in a strategic location for discovering natural gas and for storing net-zero gas.

GAS STORAGE

South Australia has a large endowment of onshore storage reservoirs suitable for carbon capture and storage (CCS), particularly in the depleted oil and gas fields of the Cooper and Otway Basins. The implementation of carbon capture and storage will help to decarbonise existing emissions-intensive industries and increase their global competitiveness in a carbon-constrained future. CCS gives South Australia the opportunity to create a new industrial 'hub' for competitive abatement of emissions – especially in sectors with difficult to abate process emissions such as cement, steel and iron manufacturing; natural gas processing; and biofuel production. Furthermore, CCS can also enable new technologies such as low carbon hydrogen production from natural gas, enhanced oil recovery and direct air carbon capture and storage. Further details can be found on the DEM CCS webpage, including an information factsheet.

All CCS projects in South Australia are regulated under the leading practice framework of the ER Act and in accordance with recognised industry standards. The Moomba CCS project in northeast South Australia completed commissioning in September 2024 and is now injecting all the CO_2 produced at Moomba into depleted gas fields in the Cooper Basin. Each year, the Moomba CCS project will permanently store approximately 1.7 million tonnes of carbon dioxide processed by the Moomba gas plant – representing a cut of more than 7% to South Australia's emissions. These fields have held natural gas and oil for 85 million years and can provide for safe, low-cost and permanent storage of carbon. The same can be said for suitable reservoirs in the onshore Otway Basin.

In addition to CCS, reservoirs in the Otway Basin also have potential for the storage of natural gas and hydrogen. These reservoirs are strategically located near local gas demand and close to connection into the SEA Gas pipeline (subject to necessary augmentation). The Iona Gas Storage Facility in Victoria is an example of a successful underground natural gas storage site that plays an important role in energy security, using depleted gas reservoirs to store and supply gas in peak demand periods.

Gas Storage Exploration Licences are currently in operation over most of the eastern side of the onshore Otway basin in SA. The OT2025 GSEL-A to C acreage release is being offered at a time when there is significant interest in gas storage following the commissioning of the Moomba CCS project.

A key motivation for the release of new GSELs is the opportunity for gas storage to help meet net-zero targets. The SA Otway Basin is in a strategic location for gas storage.

Reservoirs, seals and gas entrapment

Suitable reservoirs for gas storage together with their sealing intervals and trapping mechanisms are described above under the ENERGY RESOURCES GEOLOGY section above.

Suitable reservoirs within OT2025 GSEL-A probably exist within the Windermere Sandstone, the Pretty Hill Sandstone, the Upper Sawpit Shale, the Sawpit Sandstone and the Lower Sawpit Shale. Suitable seals for reservoirs also occur but detailed investigation of seal occurrence and integrity in any given location would be required. See the results of the 2024 play analysis study for further information on the relationships between reservoirs and seals for each potential gas storage target.

The Waarre Sandstone would be the main target for gas storage in OT2025 GSEL-B, to the south of the Tartwaup Hinge (Figure 3). The Caroline field located in the east of this setting produced CO_2 from this reservoir for nearly 50 years, demonstrating its suitability.

Over the portion of OT2025 GSEL-B north of the Tartwaup Hinge the Laira Formation in the Tantanoola Trough may also be a target for gas storage.

OT2025 GSEL-C surrounds Nangwarry 1 which discovered CO_2 in the Pretty Hill Sandstone in 2019/2020. The section above the free water level comprised 16.8 m TVD of net reservoir with an average porosity of 14%, clearly indicating that the Pretty Hill Sandstone would act as a suitable reservoir for gas storage.

GEOTHERMAL

Around the globe, temperature increases with depth, typically by 10–50 °C/km. The bulk of this heat is derived from the Earth's mantle and is residual heat left over from Earth's formation 4.6 billion years ago. A significant amount of heat is also generated via the radioactive decay of naturally occurring potassium, thorium and uranium isotopes present in both the mantle and the Earth's crust. In the past exploitation of geothermal energy, particularly for electricity production, has been limited to geological settings such as tectonic boundaries and active volcanic areas where localised magmatic heat sources and associated hydrothermal activity including geysers and hot springs occur. At present geothermal energy is used for electricity generation and direct use applications in over 45 countries, including the western USA, Japan and New Zealand.

Although Australia is not currently volcanically active, the continent has potentially vast geothermal energy resources which fall into two general categories – Engineered Geothermal Systems (EGS or Hot Rock) and hydrothermal resources from relatively hot groundwater (also known as Hot Sedimentary Aquifers). Further details can be found on the DEM Geothermal webpage.

South Australia has significant potential for geothermal energy and the State Government is leading Australia with an effective regulatory and approvals framework under the ER Act. The Department for Energy and Mining provides geoscientific and engineering information and data to support industry exploration and development, as well as responsibility to ensure compliance with the provisions of relevant legislation.

There are currently three active Geothermal Exploration Licences investigating the opportunity (GEL 744, GEL 745 and GEL 780). DEM now offers OT2025 GEL-A for further exploration over the southernmost portion of the onshore Otway Basin.

Jorand et al. (2010) conducted a Hot (and Warm) Sedimentary Aquifers study covering the deep aquifers, from Jurassic to Late Cretaceous, of the onshore and offshore Otway basin spanning the southern parts of the states of Victoria and South Australia. One of the conclusions of this study was that locally temperatures above 100 °C occur at economically viable depths (2–2.5 km) in the onshore Otway Basin; all of the acreage offered as OT2025 GEL-A is at or above 100 °C at the top of the Crayfish Subgroup, with much of it being well over 150 °C (see Top Crayfish Grp Projected Temperatures map on page 123 of Jorand et al. 2010). Based on these results, geothermal exploitation of the deep aquifers in the Otway Basin would appear to be economically viable for a large range of direct-use purposes throughout the basin and potentially locally also for power generation.

DATA AND INFORMATION

A comprehensive summary of the Otway Basin is available from the Otway Basin webpage and in The Petroleum Geology of South Australia Volume 1. Otway Basin (2nd Edition) by Boult and Hibburt (2002). This volume includes chapters on structural and tectonic history, litho- and biostratigraphy, source rocks and maturity, reservoirs, seals, trap development, discovered reserves, field reviews, undiscovered potential, and exploration history.

Information on the DEM Otway Basin Petroleum Systems Model 2023 is available at https://www.energymining.sa.gov.au/industry/energy-resources/data-centre/basin-data-compilations-and-interpretations/otway-basin. This includes links to download the following:

- Core logs and plots
- Depositional environment and gross depositional environment metadata, diagrams and maps
- Source rock geochemistry metadata, maps and Trinity modelling project
- ESRI ArcGIS and Petrosys mapping projects
- Seismic package including TWT, depth and isopach maps

Metadata and the Petrosys project for the 2024 DEM Otway Basin play analysis project can be downloaded from the SARIG catalogue.

The following datasets can be accessed from the SARIG catalogue:

- Acreage release blocks tenement maps – OT2025 acreage
- Geographic information system (GIS) datasets including wells, seismic, tenements, pipelines and ESRI ArcGIS project for the OT2025 acreage
- Selected references relevant to OT2025 acreage

Seismic data are available from Workstation-ready seismic data | Energy & Mining:

- Workstation-ready 2D SEGY dataset for the SA Onshore Otway Basin.
  This includes SEGY files, JPEG files, a shapefile layer for the 2D seismic lines and file header information
- Workstation-ready 3D SEGY dataset for the SA Onshore Otway Basin

Well data including Well Completion Reports, Composite Logs and digital well logs (DLIS/LIS format) are all available from Petroleum Exploration and Production System (PEPS-SA).

SARIG (map.sarig.sa.gov.au) provides an interactive map window to view, query and download data including spatial data such as regional seismic horizon maps of key Otway Basin horizons, tenement data etc. More information on products and data can be found through the Energy Resources data centre.

Other useful links:

- Energy Resources Act 2000
- Energy Resources Regulations 2013
- Licensing approvals process
- Environmental Impact Assessment Criteria
- Information Sheet 001 *Holders of energy resources tenements in South Australia*
- Natural hydrogen in South Australia
- Carbon capture and storage
- Geothermal
- Previous onshore releases

LAND USE AND ACCESS

The climate in the southeast of South Australia is characterised by mild dry summers and cold wet winters, consequently exploration activities are generally conducted in the summer and autumn months of December through to April. However, with advanced preparation of sites it is possible to conduct activities year-round. For more information on weather in the region visit http://www.bom.gov.au/climate/averages/tables/cw_026036.shtml

History of petroleum operations in the southeast of South Australia

The entire extent of the Otway Basin in South Australia has been held within petroleum licences (almost continuously) for decades. Petroleum exploration in the region dates back to the 1880s.

Exploration and production of gas and oil has been conducted for over one hundred years in the southeast of the South Australian extent of the Otway Basin. This includes over 110 petroleum wells drilled (since 1915) and gas production through the Katnook gas processing facility between 1991 and 2022. Furthermore, 10,495 line kilometres of two-dimensional (2D) geophysical surveys and 5,262 km^2 of three-dimensional (3D) geophysical surveys have been acquired in the southeast of South Australia (Figure 2).

There is a demonstrable history of the petroleum industry operating safely and in coexistence with various agricultural activities and primary industries in southeast South Australia (Figure 15).

Regulatory framework

South Australia's framework under the ER Act is widely recognised for efficiently and effectively deploying leading practice regulation through:

- The grant of an ER Act licence provides a unique entitlement to progress relevant petroleum, natural hydrogen, geothermal and gas storage projects and operations;
- Gaining approval for on-ground activities is a separate (case-by-case) step that follows the grant of an ER Act licence. South Australia's regulatory framework involves robust stakeholder consultation, ensuring that the concerns of potentially affected people, enterprises and organisations are taken into account when decisions are made to approve (or otherwise) on-ground activities regulated under the ER Act;
- The exploration and development of energy resources will not be permitted in agricultural areas of South Australia unless regulated substances licensees address all valid impacts, underpinned by considerable research on the natural, social and economic environment (which must include for example impacts on the tourism, food, wine and fibre industries). Indeed, approval for on-ground operations will only be gained (if gained) after South Australia's regulators are satisfied that:
    - regulated activities that have (actually or potentially) adverse effects on the environment are properly managed to reduce environmental damage as far as reasonably practicable;
    - licensees eliminate as far as reasonably practicable the risk of significant long term environmental damage; and
    - licensees ensure that land adversely affected by regulated activities is properly rehabilitated.

For a licensee to undertake operations in accordance with the ER Act, an Environmental Impact Report (EIR) must be prepared by the licensee in consultation with all potentially affected people, enterprises, and organisations. This document addresses the potential impacts on the social, natural and economic environments (which includes public health and impacts on brands) and considers the significance of impacts, after implementation of relevant controls in accordance with the environmental impact assessment criteria;

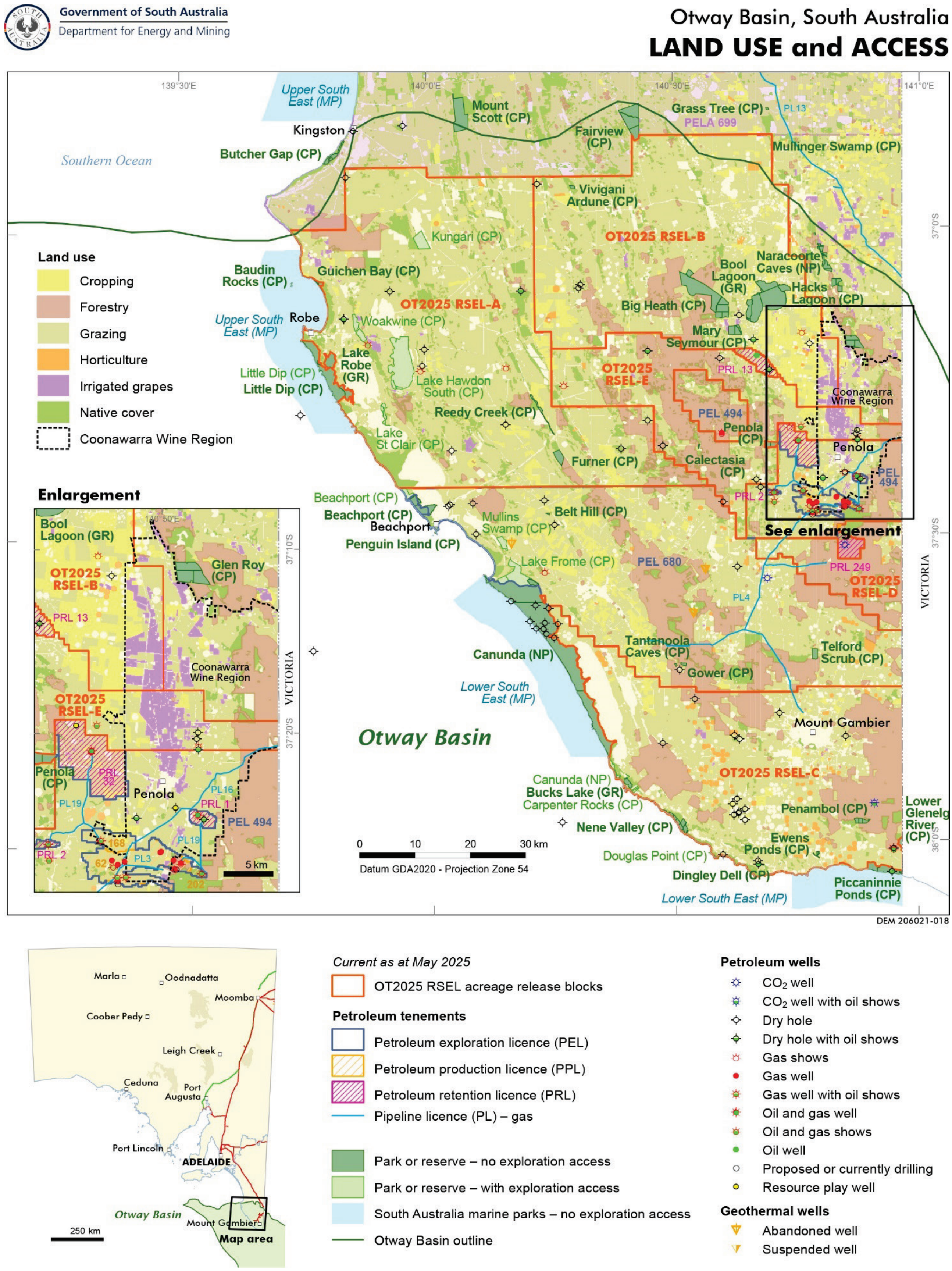


Figure 15. Otway Basin land use and access, showing OT2025 RSEL release acreage only.

- On the basis of the information provided in the EIR and in accordance with Section 97 of the ER Act, the EIR is reviewed by experienced professionals in the Department for Energy and Mining in consultation with other relevant co-regulatory agencies, including but not limited to: the Department for Environment and Water (DEW); Landscapes Boards, the Environment Protection Authority (EPA); SA Health; Department of Infrastructure and Transport (DIT); Safework SA, Attorney-General's Department - Aboriginal Affairs and Reconciliation; and Primary Industries and Regions South Australia (PIRSA);
- A Statement of Environmental Objectives (SEO) must then be prepared, which states the environmental objectives to be achieved in carrying out specified activities, as well as the assessment and leading performance criteria used to assess whether the objectives have been achieved by the licensee;
- The EIR/SEO must demonstrate how potential negative impacts are prevented through appropriate design, construction, and modelling and importantly how this will be measured and monitored. Approval decisions for an EIR/SEO will only be made following a minimum 30 business day public consultation process as required under Section 105A of the ER Act. If a licensee cannot demonstrate compliance with these regulatory requirements, then approval for the project will not be granted. This holds true for all projects regulated under the ER Act; and
- In addition to the requirements of the ER Act, SEOs refer to requirements of co-regulation (for example for the protection of water) of other Acts. In this way, non-compliance with relevant co-regulation becomes a non-compliance under the ER Act. In short, the SEO is a co-regulatory instrument that allows South Australia to be efficient and effective, without duplicative processes to assess and regulate land access for all proposed energy resource, geothermal energy and gas storage exploration, development, and production projects.

The successful bidder will be required to meet South Australia's leading practice environmental requirements before being approved to conduct exploration activity on the block. Further details can be found on the DEM approvals process webpage.

An objective-based co-regulatory approach applies in South Australia for the regulation of the upstream petroleum industry to reduce compliance costs and deliver better environmental outcomes.

All existing EIR and SEOs for area-specific and activity-specific upstream energy resource operations in the Otway Basin can be found on the Environmental Register.

National parks and reserves

There are a number of national parks and other areas of remnant native vegetation in the area, in some of which exploration is permitted. The typically small size of the no exploration access parks makes it possible to work around them (Figure 15). The reserves have been created to conserve the best examples of vegetation and landforms in the region. There are three types of South Australian reserves including conservation parks, national parks and regional reserves. The conditions of access vary from park to park, based upon the type of reserve classification, the activity proposed and its likely impact on the environment.

Primary industries

The Department of Primary Industry and Regions SA (PIRSA) regards the southeast region of South Australia as a highly modified landscape where broad-scale land clearance and extensive cross- catchment drains have converted what was once a wetland dominated landscape into agricultural and forestry production on a vast scale (Figure 16).

For a detailed description of the landscape and drainage system in the southeast of South Australia see History of the South East Drainage System.

Beef cattle production is the most significant product in the southeast, forestry is the second largest, followed by sheep and lambs, wine grapes and milk production. The region produces nearly one third of the value of South Australia’s agricultural produce from only 2% of its land mass.

The southeast is characterised by a near-surface unconfined aquifer which is the main water supply for the landholders, and this requires consideration and protection while conducting exploration activities.

European heritage

A number of sites of European heritage significance such as historic buildings and structures and geological monuments occur in the region. These are indicated on environmental sensitivity maps held by DEM. The majority of the sites are small and easily avoided by exploration activities.

Aboriginal heritage and native title

In South Australia it is an offence to disturb or destroy Aboriginal sites, objects or remains. Standard procedures for determining the presence of Aboriginal heritage prior to the commencement of activities have been determined. These procedures involve consulting with the relevant Aboriginal organisation(s) and maintaining a watch for sites, objects or remains during activities. Licence holders are encouraged to develop a dialogue with regard to Aboriginal heritage and related matters with Aboriginal people having associations with the lands coincident with their licence area(s). Native title as referenced in the *Commonwealth Native Title Act 1993*, may be applicable on e.g. non-freehold or non-perpetual leasehold land. Native title is not likely to be a significant issue in the South Australian Otway Basin area, as most land is freehold or perpetual leasehold. Heritage must nonetheless be well protected.

Geothermal Exploration Licences

A number of Geothermal Exploration Licences (GELs) coincide with petroleum exploration and production licences in the Otway Basin region (Figure 1c and 1a respectively). The GEL licensee must be notified of activities in PELs/RSELs and may object to the activity and claim compensation if their activities or resources are affected. Likewise, the GEL holder must notify the PEL/RSEL holder of their activities, and the PEL/RSEL holder may also object and claim compensation.

Associated Activities Licences

Associated Activities Licences (AALs) are available under the ER Act to allow explorers/producers to undertake activities (e.g. seismic surveys or flowline construction) associated or in proximity to the primary energy resources exploration, retention and production licences.

BIDDING AND AWARD PROCESS

Winning bidders will be selected on the basis of the total five-year work program bid. The work program must be completed within the overall area of the RSEL, GSEL or GEL. It must include a statement of exploratory operations the applicant proposes to carry out in the first five-year licence term. It is expected that at least one exploration well would be included in the program.

The specific scoring scheme is detailed in OT2025 Bid Assessment Policy.

Relevant Application and Award procedures and forms can be accessed at the following links:

- OT2025 RSEL-A Application Form
- OT2025 RSEL-B Application Form
- OT2025 RSEL-C Application Form
- OT2025 RSEL-D Application Form
- OT2025 RSEL-E Application Form

- OT2025 GSEL-A Application Form
- OT2025 GSEL-B Application Form
- OT2025 GSEL-C Application Form
- OT2025 GEL-A Application Form
- OT2025 Acreage Release Application and Award Procedures

In general, it is important to note that the timing of well drilling and seismic or other data acquisition will be taken into account. Key assessment criteria include but are not necessarily limited to:

- the number of exploration wells to be drilled in the RSEL, GSEL or GEL, their nature of subsurface targets to be drilled and their timing
    - A key motivation for the acreage release is the looming shortfall in energy supply in the southeast Australian gas market. Therefore, exploration wells for hydrocarbons will count more than wells for natural hydrogen.
- the extent to which proposed wells are supported by existing or new programmed seismic data
- the amount and nature of seismic surveying (i.e. 2D versus 3D) to be carried out and its timing
- other data acquisition (e.g. gravity, aeromagnetic, soil gas sampling or other geochemical surveys)
- seismic reprocessing to be carried out
- the adequacy of the applicant's financial resources and technical expertise to satisfactorily undertake the proposed work program and overall regulatory compliance.

In addition to the above criteria, where bids are similar, the benefits of the introduction of new explorers into the area may be taken into account. In the case of cascading bids (i.e. multiple or hybrid bids by one applicant or joint venture), only the highest bid will be considered.

Refer to the section above describing South Australia's regulatory framework to gain an appreciation of the activity approvals process that follows the grant of a petroleum licence pursuant to the ER Act.

CLOSING DATE AND TIME

The closing date for OT2025 RSEL-A to E, OT2025 GSEL-A to C and OT2025 GEL-A applications is 5.00 pm Australian Central Daylight Time on **Friday 31 October 2025**.

The Minister is expected to announce the winning bidder(s), together with details of work programs, by the end of 2025.

APPLICATIONS

Applications should be made **via email only** to:

Executive Director, Regulation and Compliance Division, Department for Energy and Mining

Email DEM.EnergyResourcesAcreageRelease@sa.gov.au

Submissions should be marked '**Confidential — contains RSEL application**', '**Confidential — contains GSEL application'** or '**Confidential — contains GEL application'** as appropriate.

CONTACT AND ENQUIRIES

Comments and enquiries for all blocks should be addressed to:

Director, Geological Survey of South Australia, Department for Energy and Mining

Email DEM.energyresourcesacreagerelease@sa.gov.au

Website https://www.energymining.sa.gov.au/industry/energy-resources

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ACKNOWLEDGEMENT OF COUNTRY

As guests here on Kaurna land, the Department for Energy and Mining (DEM) acknowledges everything this department does impacts on Aboriginal country, the sea, the sky, its people, and the spiritual and cultural connections which have existed since the first sunrise. Our responsibility is to share our collective knowledge, recognise a difficult history, respect the relationships made over time, and create a stronger future. We are ready to walk, learn and work together.

FURTHER INFORMATION

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SOUTH AUSTRALIA

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