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OTWAY/KING PART-X*

EXPLORATION IN THE GIPPSLAND, BASS & OTWAY BASINS AUSTRALIA

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1. INTRODUCTION

(a) Location & Permit Status

Three major Mesozoic Tertiary basins exist along the continental shelf area of southeastern Australia, known as the Bass Strait area (Fig. 1). They are the Gippsland (east of the longitude of Melbourne) Otway (west of Melbourne) and the Bass (underlying central Bass Strait between Victoria and Tasmania). The total area, both onshore and offshore, is approximately 100,000 square miles.

In March 1960, the Broken Hill Pty. Co. Ltd. acquired exploration title to the continental shelf areas of the Gippsland, Bass and Otway basins from the States of Victoria and Tasmania. The title to that part of the Otway Basin in South Australian waters was granted in July, 1961. Other exploration permits, being 8 miles wide in Gippsland, held by Woodside (L.E.) Oil Co. N.L., and 15 miles wide along the southwest coast of Victoria, held by Mobil-BP-Interstate Oil (Frome-Broken Hill Co. Pty. Ltd.), were in existence prior to granting the B.H.P. title. Subsequently, Shell, B.H.P., Esso and Magellan have been granted title to the remaining areas of the continental shelf in the basins under discussion. Figure 2 shows the petroleum titles current in this area of the continental shelf. In three separate agreements, negotiated between 1964 and 1966, Esso obtained farm-in rights to B.H.P.'s Gippsland, Bass and Otway permits.

(b) Significance of Area

1. The area is the most actively explored offshore area in Asia and the Far East outside of the old established production centres of Indonesia, Sarawak and Brunei.

2. Significant reserves of both oil and gas have been discovered in this area in the past 4 years.

(c) Objectives of Paper

1. To give a broad geological summary of the area.

2. To outline the basic exploration sequence of B.H.P. and Esso's operations.

3. To document the work carried out by Esso-B.H.P. to date and assess the results.

2. GEOLOGICAL FRAMEWORK

The three basins extend, end to end, approximately 700 miles in an east-west direction across the continent (Fig. 1). This direction represents the initial breakdown of the southern margin of the continental mass of Australia and was probably initiated in the late Jurassic or early Lower Cretaceous time to accept sediments of essentially Lower Cretaceous age.

The eastern portion of the continent of Australia was built up by accretion of geosynclinal sediments of the Tasman geosyncline which ranged in age from Ordovician to Lower Devonian. Several periods of orogeny marked the final phase of the geosyncline, but in all cases, strike trends, orogenic belts and granite emplacement were along meridianal areas; i.e. ranging from northwest to northeast trends. Permian and Upper Devonian sediments are known in subcrop, but there is no significant distribution except as infill along previous orogenic trends.

Evidence exists along the whole of the southern margin of Australia in support of the east-west breakdown, probably associated with the continental drifting of continental Antarctica from Australia. The Diamantina Trench in the south Indian Ocean, the alignment of the modern-day continental slopes across the Great Australian Bight, the Elliston Trough established by Shell from magnetics and seismic (Reference 1) and the seismic delineation of the earliest features in the Otway-Gippsland Basins, may be cited as evidence.

3. STRUCTURAL AND STRATIGRAPHIC SUMMARY

A. Gippsland Basin

The Gippsland Basin (Fig. 1) is defined as an east-west trending graben-like feature filled with a 15,000'+ wedge of sediments ranging in age from Upper Cretaceous to Recent (Fig. 3). Where observed, these sediments rest on an unconformable surface whose underlying rocks range in age from Lower Cretaceous to Paleozoic and whose lithologies vary from completely unaltered sediments to igneous and metamorphic rocks.

The southern margin of the basin (Fig. 5) is clearly observed as a series of east-southeast, west-northwest trending down-to-the-north normal faults, whose en-echelon type pattern results in a general east-west trending southern margin. The intensity of this faulting was greatest during Upper Cretaceous to Paleocene, but had practically ceased by Upper Eocene time. The extreme southern margin of the basin extends south of this fault zone and consists of a veneer of Upper Eocene to Miocene sediments gently onlapping basement.

The northern margin of the basin is structurally more complicated than the southern margin. There is ample evidence to suggest it developed in a similar manner to its southern counterpart during Upper Cretaceous to Paleocene time (Fig. 5), but with a down-to-the-south aspect. However, considerable post-Eocene movement (Figs. 8 & 9) occurred in the northern half of the basin and this has greatly complicated a reconstruction of the geological history of this area. Similar to the southern margin, another veneer of Upper Eocene to Miocene sediments laps onto basement on the extreme northern margin.

To the west there is a general thinning of the overall section, and on land the Upper Cretaceous and Paleocene are only sporadically observed. To the east the older sediments extend as far as the continental slope which is mainly an expression of the limit to Middle and Upper Miocene sedimentation.

Development of the Gippsland Basin began in early Upper Cretaceous time by the initiation of rapid subsidence and contemporaneous deposition of the fluvio-deltaic sequences of clastics and coals. Deposition, primarily from the north, of non-marine sediments continued without major interruption from early Upper Cretaceous through the end of Eocene time (Figs. 5, 6 and 7). Sediments deposited during this time reached a maximum thickness of 10,000'+ and are known as the Latrobe Complex. Approximately 30% of these deposits are coarse grained, well sorted, sandstone deposited by braided and meandering streams. Deposits of this type are distributed throughout the sequence and are the primary reservoir rock from which oil and gas are produced. The remainder are fine grained sandstones, siltstones, shales and coals. The shale and coal are the primary hydrocarbon source rock in the basin, with the shales being important also as seals which act as traps for those hydrocarbons within the Latrobe. The Latrobe is divided on the basis of palynology into four primary time-stratigraphic zonations, which correspond roughly to Upper Eocene, Lower Eocene-Upper Paleocene, Lower Paleocene and Upper Cretaceous. Good correlations are obtained between the primary palynological breakdown and the regional seismic interpretation. Both methods are used for more detailed breakdowns, but, due to data limitations, this is often only effective over localized areas. In a regional sense the various age Latrobe depocentres have migrated in a general east to west direction from Upper Cretaceous to Upper Eocene time.

The close of Latrobe deposition in the Upper Eocene heralded a period of submarine canyon or channel erosion which developed an eroded topographic surface at the Latrobe top (Fig. 8). These canyons are readily observable on seismic sections and trend in a general north-west-southeast direction, the canyon head being to the northwest in each case. The channel systems become quite complicated in certain areas, younger canyons cutting down into older canyons which have already been filled with sediments. The oldest canyon-fill sediments range in age from Upper Eocene to Lower Oligocene. The canyons' configurations and the type of sediments deposited within the canyons are very important, since it is the combination of true structural configuration and canyon erosion which develops the major hydrocarbon traps at the Latrobe Topographic Surface.

During Lower Oligocene (Fig. 8), the marine transgression eventually took the form of a major inundation by Lakes Entrance seas, which resulted in the deposition of the Lakes Entrance mudstone onto a predominantly Eocene topographic surface. This mudstone unit, which reaches a maximum thickness of approximately 2000', while providing a very effective seal for much of the Latrobe, is considered to be only a fair to poor source rock.

Marine conditions persisted throughout the Miocene (Fig. 9), with the deposition of up to 7000' of calcareous mudstone and marls. Another period of severe submarine canyon erosion occurred during the Middle Miocene and at least two distinct canyon systems can be identified.

Basin-wide structural movement during Latrobe deposition was almost entirely confined to normal faulting accompanied by significant block tilting (Figs. 5 and 6). Much of the faulting was contemporaneous with deposition, especially in the Upper Cretaceous and Paleocene, and during this period the dominant fault trend was northwest-southeast. Between the Upper Eocene and Upper Miocene significant structures trending between east-west and northeast-southwest developed in the northern half of the basin (Fig. 9). These structures consist of a large wrench fault system (which generally results in a variable down-to-the-north throw) and a series of significant anticlinal folds, all of which are thought to be associated with a right lateral shear acting in the northern portion of the basin.

B. Bass Basin

The Bass Basin (Fig. 1) is primarily an Upper Cretaceous and Tertiary basin containing up to 12,000' section of sediments which lies almost entirely offshore between Tasmania and Victoria (Fig. 3). No Lower Cretaceous sediments were encountered in the only two wells which completely penetrated the sedimentary section, but it is considered likely that Lower Cretaceous sediments were deposited in some of the major rifts which developed in the earliest phase of the basin's tectonic evolution (Fig. 4). True basement probably comprises a variety of rock types, ranging in age from Triassic to Paleozoic.

The Bass Basin is effectively a large graben or rift type feature which has been subsiding since at least Upper Cretaceous time. Large scale tensional release has been provided by a system of normal faults which trend northwest to southeast on the northeastern and southwestern flanks of the basin (Figs. 5 and 6). On the northeastern flank a veneer of Eocene to Miocene sediments extends beyond these faults and laps onto basement, and though present to some degree, this situation is not nearly as evident on the southwestern flank. The basin is divided to the northwest by the Mornington-King Island basement high (Figs. 1 and 7). However, the northwestern boundary of the Bass Basin proper lies in the Torquay area at the depositional edge of the Tertiary. Thus, the Torquay Sub-basin, despite having geographical association with the Otway Basin during Lower Cretaceous time is considered part of the Bass Basin because of a common depositional history during much of the Upper Cretaceous and Tertiary when they were interconnected for long periods. (Fig. 1)

The basal section of the Bass Basin is a fluvio-deltaic complex of similar type and age to the Latrobe of the Gippsland Basin. It probably exceeds 6000' in thickness and includes Upper Cretaceous to lowermost Upper Eocene sediments. It has been tentatively referred to as the Easternview Complex. The distribution of the Upper Cretaceous is largely speculative since it has only been encountered in one well. However, it is inferred that thick sequences of this age rock are present particularly in the southeast (Fig. 5). The Paleocene to Lower Eocene section (Figs. 6 and 7) is made up of alternating coals, silts, carbonaceous shales and quartzose sandstones. It is considered that this complete fluvio-deltaic sequence filled up the basin depocentre in a prograding mass, sourced primarily from the south and east. Within this section a localized angular unconformity occurs in places at the base of the Eocene. Elsewhere there appears to be complete conformity with the younger sediments. Upon completion of the true fluvio-deltaic deposition, a transitional sand facies of Upper Eocene age was deposited. It is regarded as a thin transgressional sequence between the fluvio-deltaic sedimentation and the offshore facies, characterized by the Demons Bluff Formation. This latter unit has a maximum thickness in excess of 500' and is a silty mudstone and siltstone of restricted marine origin and of Upper Eocene age. It is probable that this interval occurs throughout the central portion of the basin, but it does not overstep the rim, except across the Mornington-King Island High, where it occurs in the Torquay Sub-basin. The Oligocene (Fig. 8) consists primarily of silty mudstone, siltstone with minor sandstone and volcanics, and reaches a maximum thickness of 2000'+. The environment of deposition was generally one of restricted marine conditions. No major basin-wide depositional break is apparent between the Oligocene and the Eocene, as is the case in the Gippsland Basin. However, the Oligocene in Bass, similarly marks the first major Tertiary marine transgression. The Miocene (Fig. 9) reaches the maximum thickness of 3000'+ and comprises limey mudstones, calcarenites and tuffites. It is correlative with the Miocene of Gippsland and is, in part, probably continuous with it.

Structures involving the Tertiary section are directly involved with basement block faulting. The main structural movement during the Tertiary was subsidence of the central part of the basin with the fault blocks along the flanks staying relatively stable. Two periods of relatively abrupt tectonic adjustment occurred in late Oligocene and mid Miocene and this probably contributed to the volcanic development.

C. Otway Basin

The Otway Basin (Fig. 1) is defined as a Lower Cretaceous to late Tertiary basin, trending east-west across southwest Victoria into South Australia. It lies almost at right angles to the major trend in the underlying basement rocks. It differs significantly from Gippsland and Bass basins in that it is primarily a Cretaceous basin, and not a Tertiary basin, possessing a definable sequence of Lower Cretaceous rocks which are fundamental to the geological evolution of the basin (Fig. 3). During the Cretaceous the various depocentres were aligned roughly parallel to the present coastline and in a gross regional sense migrated to the southwest with each successively younger period of sedimentation.

The Lower Cretaceous Otway Group (Fig. 4) unconformably overlies older Jurassic or Paleozoic rocks of various types. The Otway Group consists of non-marine greywackes, mudstones and coal deposited in a northwest-southeast trending trough, which was parallel to the present coast of Victoria and South Australia from Gippsland to Cape Jaffa. (Fig.12) The thickness of the Group is probably in excess of 15,000' in more basinal areas. These clastics were probably derived from the uplifted Mesozoic and Paleozoic highlands, then present to the north and south of the depositional trough. A clean quartzose sandstone of Lower Cretaceous age has been observed along the northernmost margin of the basin. This sand, tentatively named the Pretty Hill sandstone, may be the age equivalent of typical Otway Group greywackes to the south. The top of this Pretty Hill sandstone member is generally marked by an angular unconformity, and is overlain by younger Otway Group greywackes.

The Upper Cretaceous sequence (Fig. 5) in the Otway Basin represents a complete sequence, starting with a major marine transgression and ending with prograding sandy units. The total sequence is known as the Sherbrook Group. This sequence consists of a basal sandstone called the Waarre Formation, an overlying ferruginous sandstone called the Flaxmans Beds, which in turn is overlain by mudstones of the Belfast Formation. This mudstone grades upward into shallow water marine sandstones and siltstones of the Paaratte Formation, overlain by non-marine sandstones and coal of the Curdies Formation. The total Upper Cretaceous is believed to be well over 12,000' thick in the depositional centres of Upper Cretaceous sedimentation. At the close of Upper Cretaceous time, the area was subject to some uplift and accompanying erosion.

The total Tertiary section (Figs. 6, 7, 8 and 9) in the Otway Basin may attain thicknesses of up to 6000'. Clastic deposition resulted in lagoonal to shallow neritic mudstones, sandstones and conglomerates named the Wangerrip Group and Mepunga Formation, during Paleocene to Upper Eocene time.

At the top of the Wangerrip Group a regional unconformity is generally recognized and is diachronous from Upper Paleocene to Middle Eocene in age. The sands overlying this unconformity are called Mepunga Formation and represent the last phase of clastic regression before the major transgression of the overlying marl sequence. This terminology is primarily for the Port Campbell area, (Fig. 12) but overall unconformity, clastic deposition and transgression relationships exist throughout the basin. This Paleocene to Upper Eocene section can attain thicknesses up to 4000' thick.

During Upper Eocene to Pliocene time the overall transgression of the sea covers the sandy regressive phase with a thick marl sequence which culminates in a Miocene shelfal limestone.

During Pliocene time tectonic movement uplifted southeastern Australia and the sea began to regress. Extensive vulcanism also occurred during Pliocene time, resulting in extensive lava flows which now cover large areas of the onshore Otway Basin.

The three major stratigraphic intervals, Lower Cretaceous, Upper Cretaceous and Tertiary, were deposited during quite different periods of structural evolution.

The Lower Cretaceous (Fig. 4) was a period of significant basement block faulting, resulting in the formation of large stable blocks, surrounded by areas of major subsidence. Significant tilting occurred within the various blocks.

A prominent monoclinal downwarp or hinge line quite clearly indicates the beginnings of major Upper Cretaceous deposition. This hinge line crosses the South Australia coastline near Beachport and trends (Fig. 1) roughly parallel to the present day coast, occurring a few miles inland from the coastline. South of this hinge is an area of tilted normal fault blocks of considerable density (Fig. 6). Most are parallel to the hinge line and downthrown to the southwest. In the South Australian area of the Otway Basin, movement on these faults persisted into the Paleocene and Eocene, but in general the Tertiary rocks are only slightly deformed by post-depositional movement and for the most part merely assume south regional dip (Figs. 6, 7, 8 and 9).

a) Regional Evaluation

Early exploration for oil along the southern coast of Australia concentrated on the Lakes Entrance area and around Torquay, southwest of Melbourne (Fig. 1). The oil discovered at Lakes Entrance within the Gippsland Basin in 1924 was approximately 15° API and was possibly a fossil remnant of oil accumulation. This discovery led to approximately 100 wells being drilled near Lakes Entrance and later, early in World War 11, the Government of Victoria drilled several wells to approximately 4000' in the deepest part of the basin onshore. These were unsuccessful, but did provide a great deal of stratigraphic information in assessing the Tertiary section overlying a tight Lower Cretaceous sequence, the Strzelecki Group. This was regarded as economic basement and present-day exploration has not changed this concept.

Several wells were drilled by private companies in the area around Torquay where early Tertiary sediments outcropped in coastal cliffs.

The modern exploration phase, which commenced in 1954, as a result of the discovery at Rough Range in Western Australia, was able to utilize geophysical methods in an area where there is little or no surface outcrop. The most active exploration companies again concentrated on the coastal basins of Victoria and drilling entered a new phase when several wells were taken deep into the Strzelecki Group (or the equivalent Otway Group). Traces of gas, oil and condensate were found there but were usually associated with fracture porosity.

Geophysical exploration onshore developed quickly and gravity and magnetic surveys were carried out by industry and Government Departments to assist in outlining the area of basin deposition. The successful application of these methods led the Commonwealth Bureau of Mineral Resources to extend the magnetic coverage to the offshore and in 1955-56 an airborne magnetometer survey was flown offshore from the Gippsland coast. This survey was the first major attempt at understanding sedimentary basins beneath the continental shelf, but the complete evaluation of the results was not available until after exploration companies had commenced their operations. (Ref. 2)

B.H.P. acted on the advice of Lewis Weeks, a petroleum geological consultant from Connecticut, U.S.A., who applied the concept of extending the areas of favourable young sediments known on land to acquire exploration permits on the continental shelf. In addition, it was reasoned that the large central area of Bass Strait could hold a sedimentary basin having similar depositional history to those already known on land.

The first problem to arise in evaluating the potential of the offshore acreage was to establish the limits of basin deposition to allow the more definitive marine seismic method to be better allocated in future surveys. Although some initial doubts were considered as to the ability to interpret magnetic results, it was decided that an airborne magnetometer survey over the whole of the offshore areas would provide the best means of assessing the depth to basement. Two stages of the magnetic survey were necessary. In the central part of Bass Strait there was only minor evidence of sedimentation and the strike trends of the basement rocks were not well defined. A short reconnaissance flight was undertaken several months ahead of the main survey to allow better planning of the flight line direction. This survey and the major one which followed, were carried out by Aero Service Corporation and a total of 18,000 miles of flying were completed by December 1961.

Regional interpretation of the less than 2000' depth of basement contour provided a usual method of determining the margins of sedimentation. In the Gippsland area, the northern half of the basin was well documented prior to the survey. Data from the Commonwealth surveys, integrated with the 1961 work, showed a basin margin extending southeast from Wilson's Promontory to north of Flinders Island (Fig. 11). The basin was interpreted to be almost symmetrical with an estimated basin deep of over 14,000' of sediments in the central part of the basin.

In the Otway Basin the onshore boundary was already well defined, and the magnetics extended it southerly from King Island to the west coast of Tasmania. (Fig. 1)

The central part of the Bass Strait area indicated a large saucer-shaped basin elongated northwest to southeast with a basin deep in excess of 10,000'. The basin appeared to be completely confined to the area in that basement ridges separate it from the Gippsland Basin on the northeast and from the Otway Basin on the west. (Ref. 3)

b) Acreage Assessment

The marine seismic method is the best geophysical tool available to determine the attitude of the offshore sediments and to delineate a drilling target. It has been the main basis of all Esso-B.H.P.'s exploration activity since 1962, and has been also extensively used in the development phase since 1967.

The petroleum titles available to B.H.P. covered approximately 63,000 square miles. Within the area 3 sedimentary basins had been outlined during the period of regional evaluation. A program of marine seismic surveys was carried out by B.H.P. on a reconnaissance scale in each of the 3 basins in 1962-63. The contractor was Western Geophysical Co. A large grid was adopted and after assessing the results in the field, the more attractive areas were quartered to provide added control. Data quality in the single coverage analog records varied considerably from basin to basin.

In the Gippsland Basin 1005 miles were shot, resulting in an approximate 10 x 10 mile grid. Good reflections were generated in the upper Latrobe Complex providing a good mapping horizon. However, they also generated significant multiples which destroyed the deeper signal. Reverberations were also a significant problem. The overlying beds of the Lakes Entrance

Formation and the Gippsland Formation were characterized by lack of reflection continuity, though there was ample signal at this level.

There was sufficient seismic coverage of fair data in this initial survey to indicate two important things -

1) that the aeromagnetic interpretation of a thick sedimentary section offshore was correct;

2) that several large, fairly simple anticlines with definite closure existed, and that several other promising structural leads were present. (Reference 4)

On this basis, B.H.P. was able to present the acreage to industry for farm-in offers in 1963, knowing that it had the potential to generate several interesting exploration plays.

In the Bass Basin 1683 miles were shot, resulting in about a 12 x 12 mile grid. Here the data was better than in Gippsland, with less obvious multiple generation, but still with significant reverberations. Valid reflections were obtained from basement around the margins of the basin and up to 8000' in the centre of the basin. The data was of sufficient quality and the reflection character of sufficient consistency that similarities to the Gippsland upper Tertiary section could be interpreted with some confidence. The survey indicated three important things -

1. That the aeromagnetic interpretation of a thick sedimentary basin between Tasmania and the mainland was correct.

2. That very few anticlinal leads, let alone structural closures, were present.

3. That a series of reflection build-ups occurred in the Miocene, which could be interpreted variously as reef build-ups, pyroclastic build-ups, igneous intrusions, etc. (Reference 4)

Despite the lack of structure, B.H.P. decided that there was enough good data available for industry to assess the basin's potential and decided to put the basin up for farm-in offers in 1964.

In the Otway Basin 750 miles were shot, but only in the South Australia portion. Data quality was generally poor with multiples and reverberations being prominent. The interpretation was quite difficult, but indicated a complicated structural picture, dominated by intense faulting parallel to the coast. (Reference 5) B.H.P. decided that a second seismic survey was necessary, and in 1964-65 they shot 484 miles of single fold analog and 1390 miles of 3-fold C.D.P. analog. This second survey covered the whole offshore basin area with about 15 x 15 mile grid. Whilst the 3-fold stack helped with some multiple cancellation, data quality was not good, though the interpretation could be made with more confidence than previously. The survey indicated two important things.

1. That the concept of a thick Upper Cretaceous and Tertiary section in the offshore was probably valid.

2. That though the structure appeared quite complicated, several promising structural leads were present. (Reference 5)

At this point in 1965 B.H.P. decided for the same reason as in Bass, to put the basin up for farm-in offers.

It is important to note that -

1. Of the three basins, only in Gippsland were obviously drillable structures mapped at the time of farm-in.

2. No commercial hydrocarbon had been discovered anywhere in the area onshore or offshore when Gippsland and Bass were offered for farm-in.

3. Esso obtained the farm-ins of the three areas individually, and in open competition with the rest of industry.

The major terms of the farm-in agreement can be summarized as follows -

1. In Gippsland an undertaking to drill a minimum of five exploratory wells and then maintain a continuous exploration program.

2. In Bass an undertaking to drill a minimum of three exploratory wells and then maintain a continuous exploration program.

3. In Otway an undertaking to drill a minimum of eight exploratory wells and shoot a minimum of 2000 miles of seismic, and then maintain a continuous exploration program.

c) <u>Detailed Evaluation</u>

The detailed evaluation period in each basin started with Esso's operations and is continuing at the present time. Only in the Gippsland Basin has a Development phase been reached. (Ref. 28)

In general terms the exploration effort in this period consisted of -

a) A continuing vigorous seismic effort which was aimed at determining specific drilling locations, defining drillable prospects and developing an understanding of the regional geology. (Refer 6 to 18 inclusive)

b) A continuing wildcat drilling program, interrupted by some stepout or confirmatory drilling. (Refer 19 to 27 inclusive)

The seismic effort with Western Geophysical Co. and Geophysical Services International as the prime contractors was emphatically geared towards quality as well as quantity. The following table clearly indicates the trend towards digital CDP shooting as the technique became available. In the poorer data areas and in Otway in particular, it has only been very recently that a clear understanding of the geology has been obtained, and this is directly attributable to better seismic data quality.

SEISMIC COVERAGE

Year	Analog Single fold MILES	Digital Single fold MILES	Analog CDP MILES	Digital CDP MILES
GIPPSLAND BASIN				
1962-63	1005	-	-	-
1964	81	-	641	-
1966	296	-	528	225
1967	-	-	-	1298
1968	-	-	-	795
June 1969	-	-	-	1506
Gippsland totals	1382	-	1169	3824
BASS BASIN				
1962-63	1683	-	-	-
1964				
1965	37	-	432	-
1966	779	347	299	118
1967	-	-	-	215
1968	-	-	-	518
June 1969	-	-	-	584
Bass totals	2499	347	731	1435
OTWAY BASIN				
1962-63	750	-	-	-
1964-65	484	-	1390	-
1966	-	-	-	2364
1967	-	-	-	971
1968	-	-	-	1162
June 1969	-	-	-	-
Otway totals	1234	-	1390	4497
GRAND TOTALS	5115	347	3290	9756

The presently available grid size in each basin is very variable and also misleading since much of the 1965 and older shooting is now ignored. Some areas are gridded on about a ½ mile by ½ mile basis whilst in others it could be still termed regional. Decisions to develop discoveries were dependant on the seismic interpretation and in one case platform development plans were formulated on the basis of only the discovery well.

Up to June 1969 a total of 25 wildcat wells and 8 stepout wells have been drilled from essentially two floating rigs, the Glomar 111 and the Ocean Digger (Figs. 10, 11, 12). The details are listed below -

FLOATER DRILLING STATISTICS *

Year	# of Wildcat Well Starts	# of Stepout Well Starts	Total Footage Drilled
GIPPSLAND BASIN			
1964	1	0	8,701
1965	2	1	22,040
1966	0	2	15,852
1967	3	1	35,944
1968	5	2	66,152
June 1969	7	2	67,695
	18	8	216,384
BASS BASIN			
1965	1	0	7,717
1966	1	0	5,910
1967	1	0	7,978
1968	0	0	0
June 1969	0	0	0
	3	0	21,605
OTWAY BASIN			
1967	1	0	10,486
1968	3	0	29,237
June 1969	0	0	0
	4	0	39,723
GRAND TOTALS	25	8	277,712

Table 3

* Excluding Bream-1

In addition to the floater wells, two wildcats have been drilled from platforms.

5. EXPLORATION RESULTS

The overall exploration results have been quite disappointing outside of the northern half of the Gippsland Basin. Of the total of 25 wildcat wells drilled, only two have resulted in definitely commercial oil discoveries; Kingfish and Halibut. Proved and probable oil reserves are on the order of 1.5 billion barrels. Two gas fields are being developed; Barracouta and Marlin. Gas reserves from these fields plus other indicated discoveries are on the order of 10 trillion cubic feet, with alternate development depending on commercial markets. (Reference 28) It is significant that of all the wells with shows only one was situated outside of the northern half of the Gippsland Basin.

The current assessment of the results of the detailed evaluation period can be summarized as follows.

In the Gippsland Basin the potential of the large anticlinal features at the top of the Latrobe has been largely fulfilled. Major oil and gas accumulations have been discovered in several of these structures. In addition, encouraging shows of both oil and gas have been encountered, both in smaller top of the Latrobe structures, and in intra-Latrobe structures. The exploration drilling activity has been largely confined to the northern half of the basin, where the structural situation is more favourable.

In the Bass Basin the Miocene reflection build-ups were proved to be pyroclastic in origin by Bass 1. Two good Tertiary structures were drilled by Bass 2 and Bass 3, but the only shows encountered were in the Paleocene section of Bass 3. The general lack of large Tertiary closure remains a negative feature of the basin, though the Tertiary stratigraphy offers some encouragement.

In the Otway Basin, the intensely complicated structural and stratigraphic history is only just now beginning to be understood. There is no doubt that much of the area is quite unattractive from an offshore oil exploration viewpoint, because of the very low probability that the right combination of source, seal, reservoir and structure can be encountered, reducing the chance of success. A few localized areas may hold more promise.

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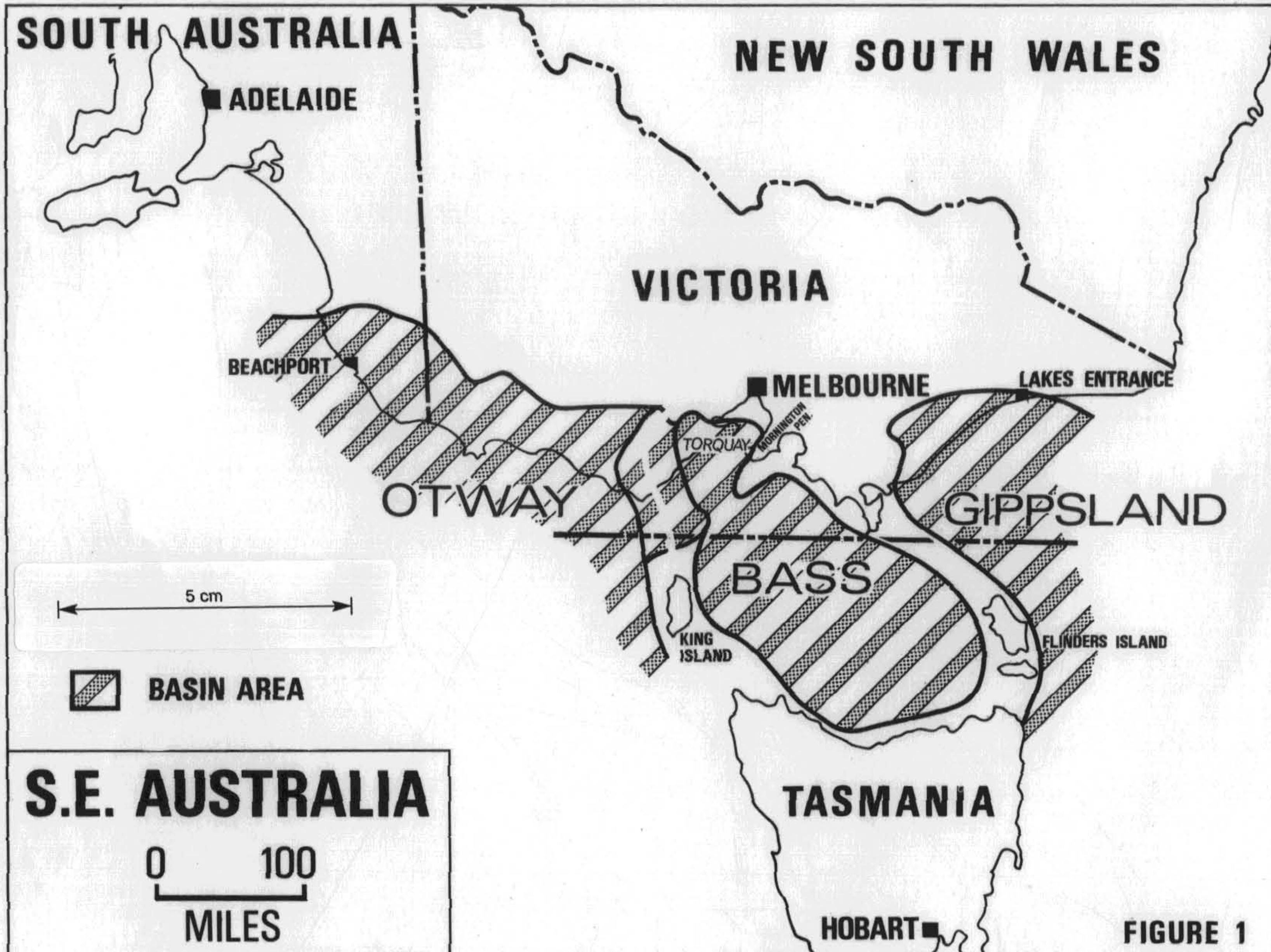
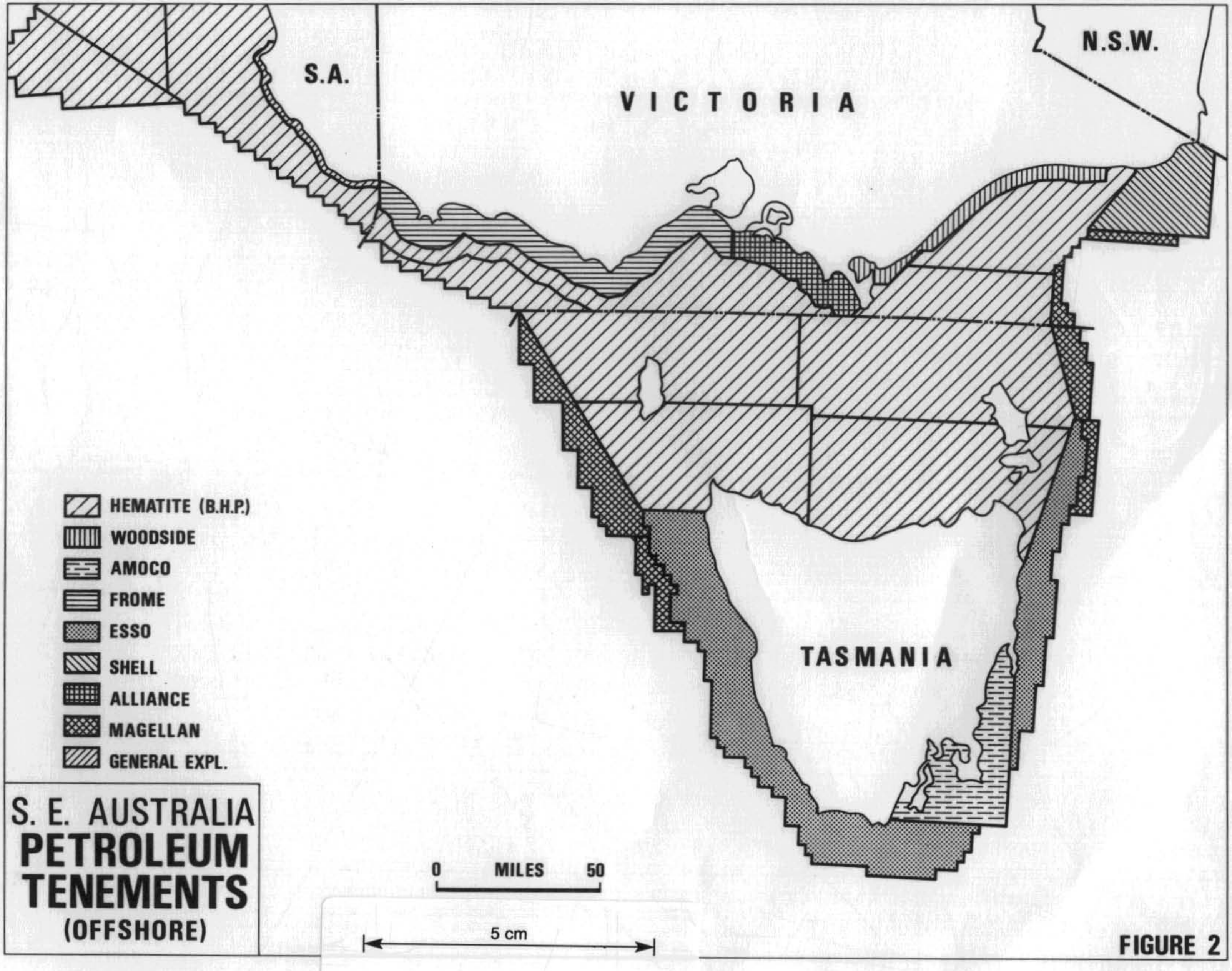

SOUTH AUSTRALIA
ADELAIDE
NEW SOUTH WALES
VICTORIA
BEACHPORT
MELBOURNE
LAKES ENTRANCE
TORQUAY
MORNINGTON PEN.
OTWAY
GIPPSLAND
BASS
5 cm
KING ISLAND
FLINDERS ISLAND
BASIN AREA
S.E. AUSTRALIA
0 100
MILES
TASMANIA
HOBART

FIGURE 1

030021



S. E. AUSTRALIA
PETROLEUM TENEMENTS
(OFFSHORE)

FIGURE 2

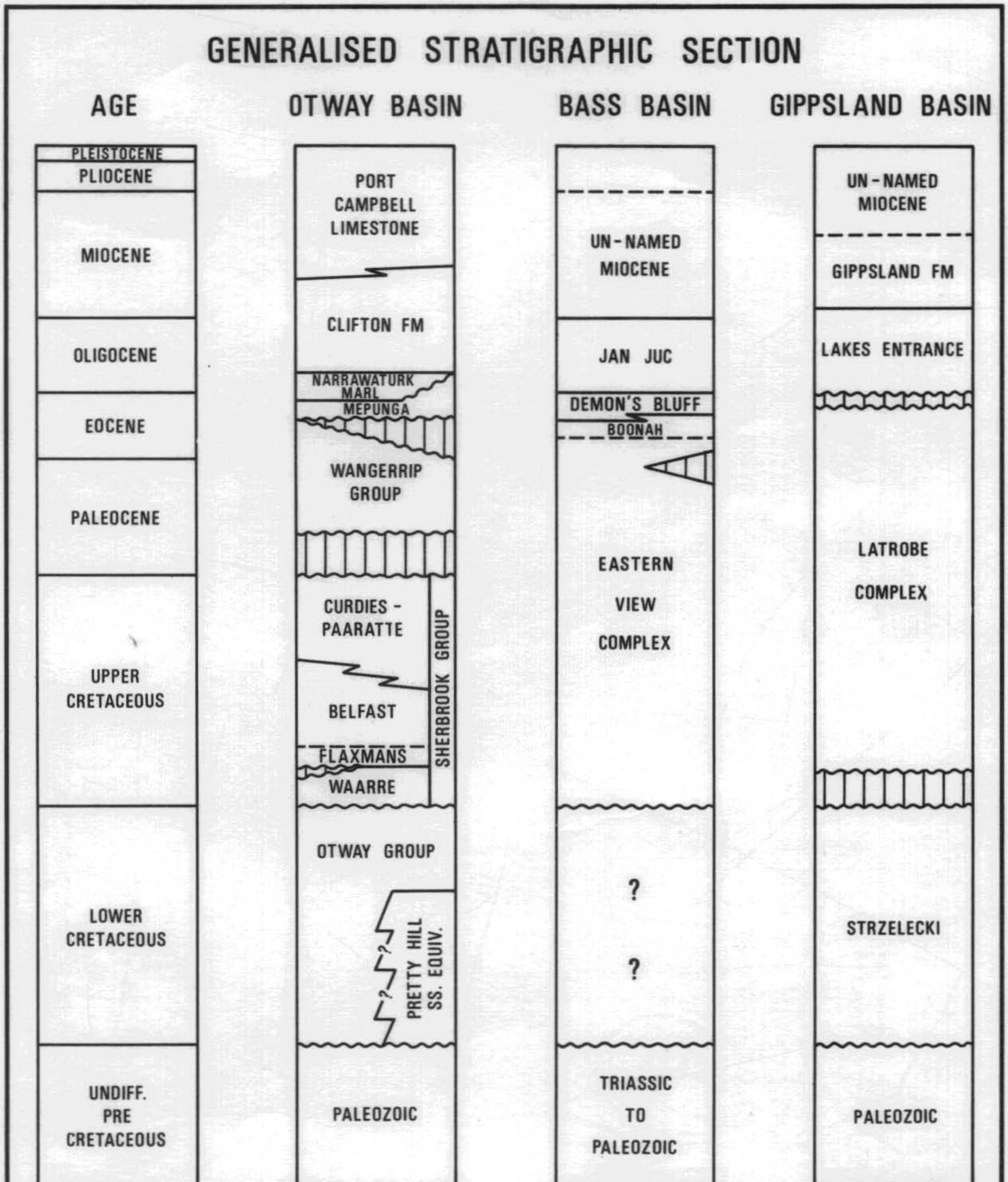
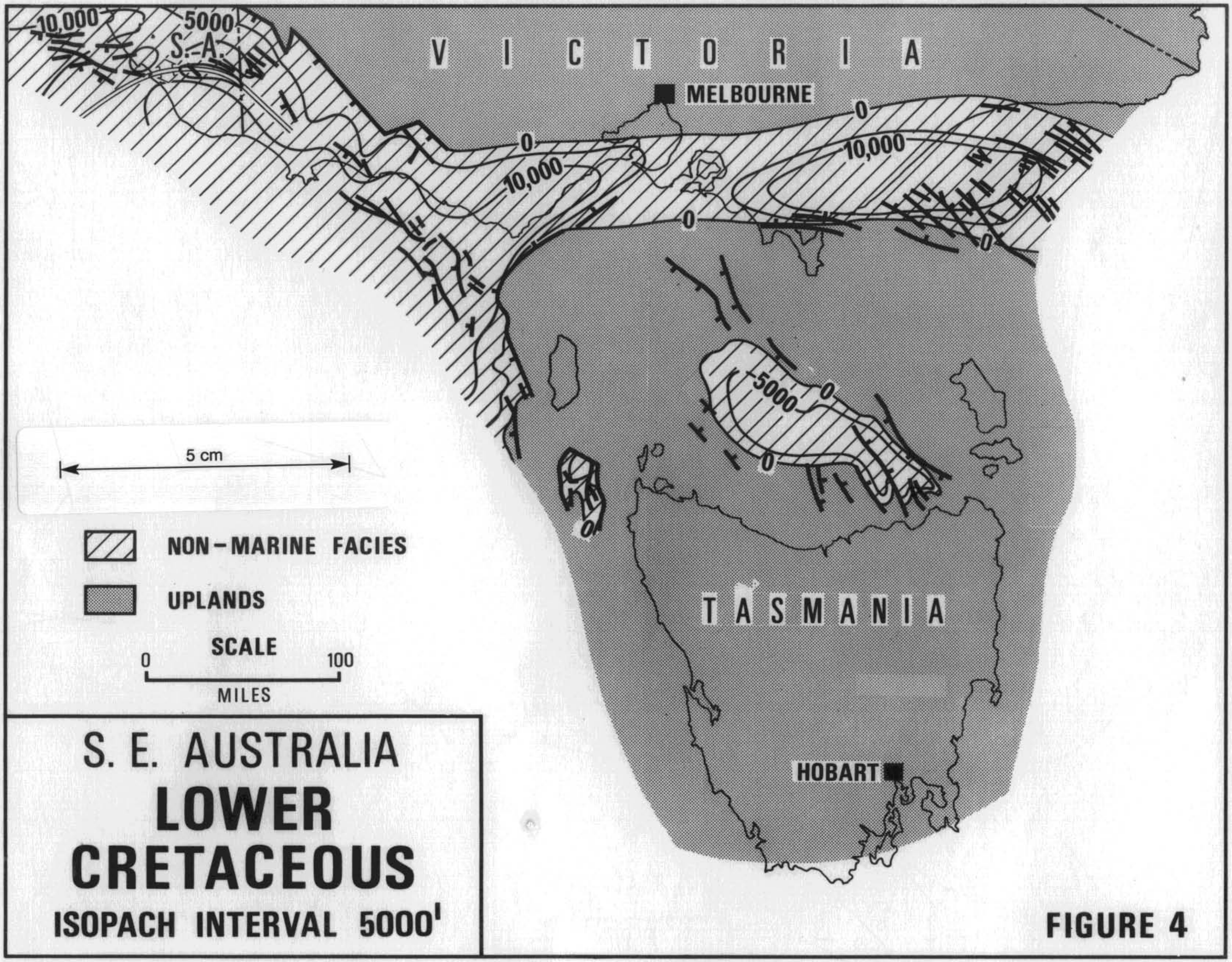

GENERALISED STRATIGRAPHIC SECTION
AGE
OTWAY BASIN
BASS BASIN
GIPPSLAND BASIN
PLEISTOCENE
PLIOCENE
MIOCENE
OLIGOCENE
EOCENE
PALEOCENE
UPPER CRETACEOUS
LOWER CRETACEOUS
UNDIFF. PRE CRETACEOUS
PORT CAMPBELL LIMESTONE
CLIFTON FM
NARRAWATURK MARL
MEPUNGA
WANGERRIP GROUP
CURDIES - PAARATTE
BELFAST
FLAXMANS
WAARRE
SHERBROOK GROUP
OTWAY GROUP
PRETTY HILL SS. EQUIV.
?
PALEOZOIC
UN-NAMED MIOCENE
JAN JUC
DEMON'S BLUFF
BOONAH
EASTERN VIEW COMPLEX
?
?
TRIASSIC TO PALEOZOIC
UN-NAMED MIOCENE
GIPPSLAND FM
LAKES ENTRANCE
LATROBE COMPLEX
STRZELECKI
PALEOZOIC

FIGURE 3



S. E. AUSTRALIA
LOWER CRETACEOUS
ISOPACH INTERVAL 5000'

FIGURE 4

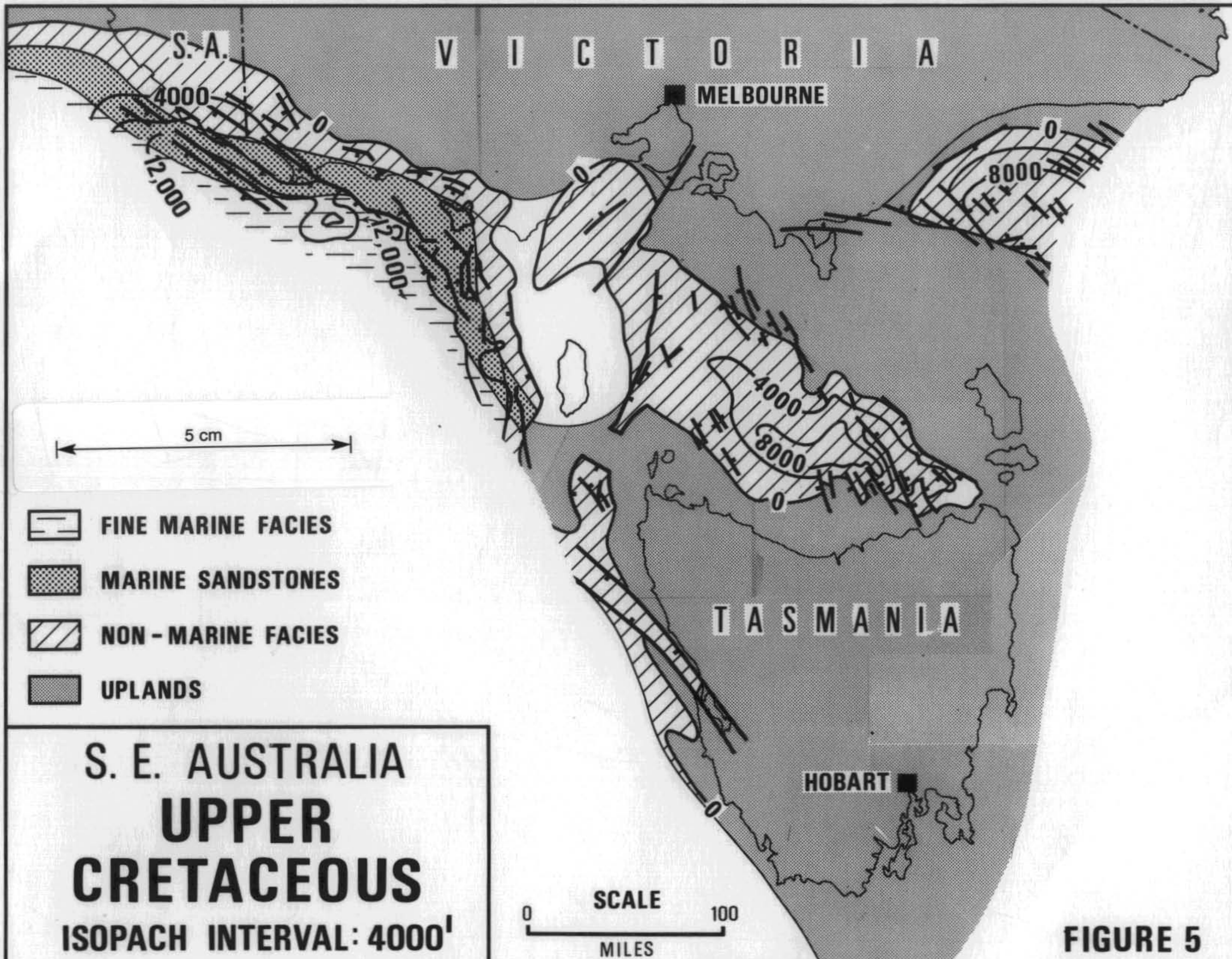
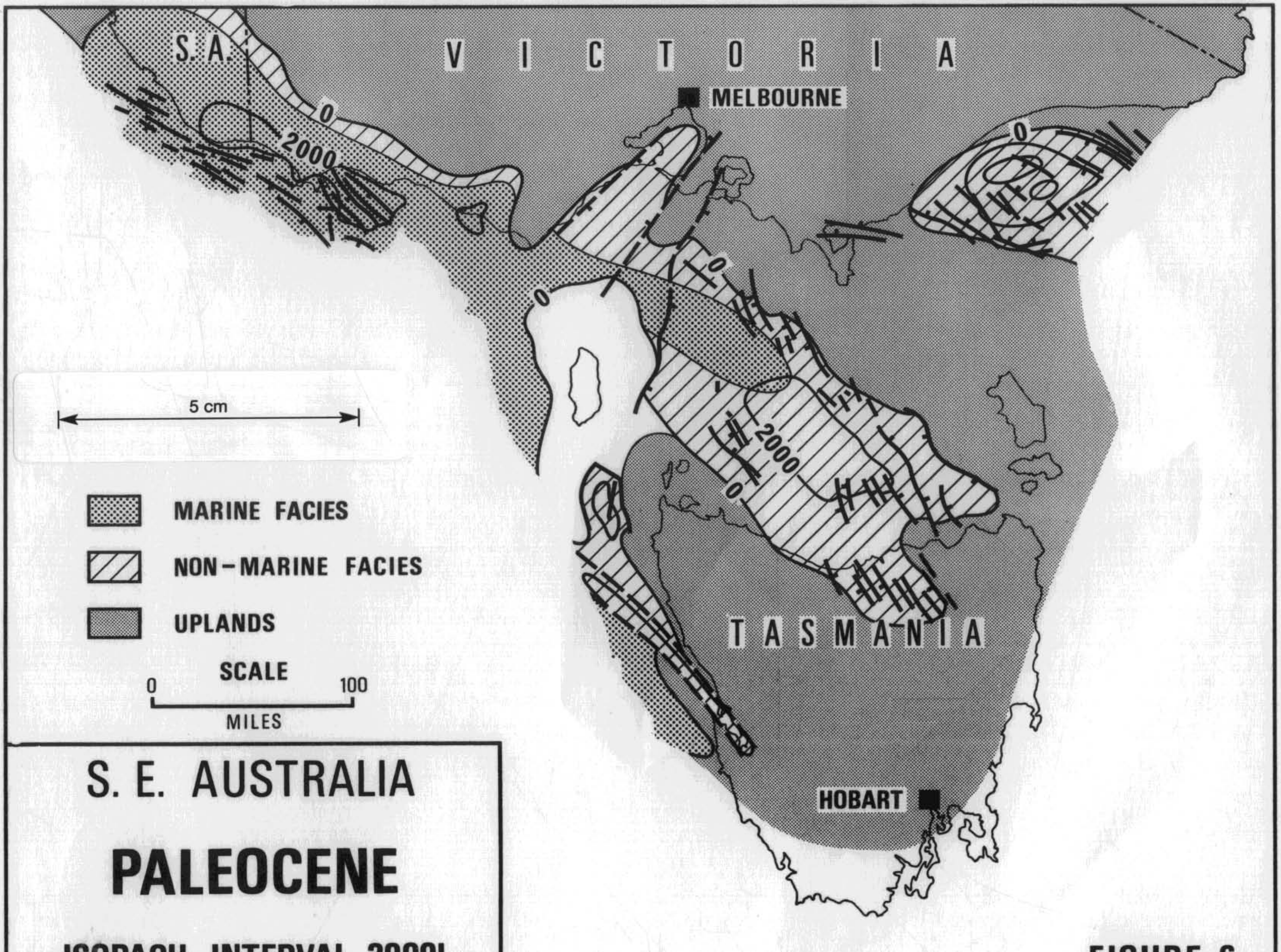

S.A.
V I C T O R I A
MELBOURNE
TASMANIA
HOBART
4000
12,000
8000
0
5 cm
FINE MARINE FACIES
MARINE SANDSTONES
NON-MARINE FACIES
UPLANDS
S. E. AUSTRALIA
UPPER CRETACEOUS
ISOPACH INTERVAL: 4000'
SCALE
0
100
MILES

FIGURE 5

030025



S. E. AUSTRALIA

PALEOCENE

ISOPACH INTERVAL 2000'

FIGURE 6

030026

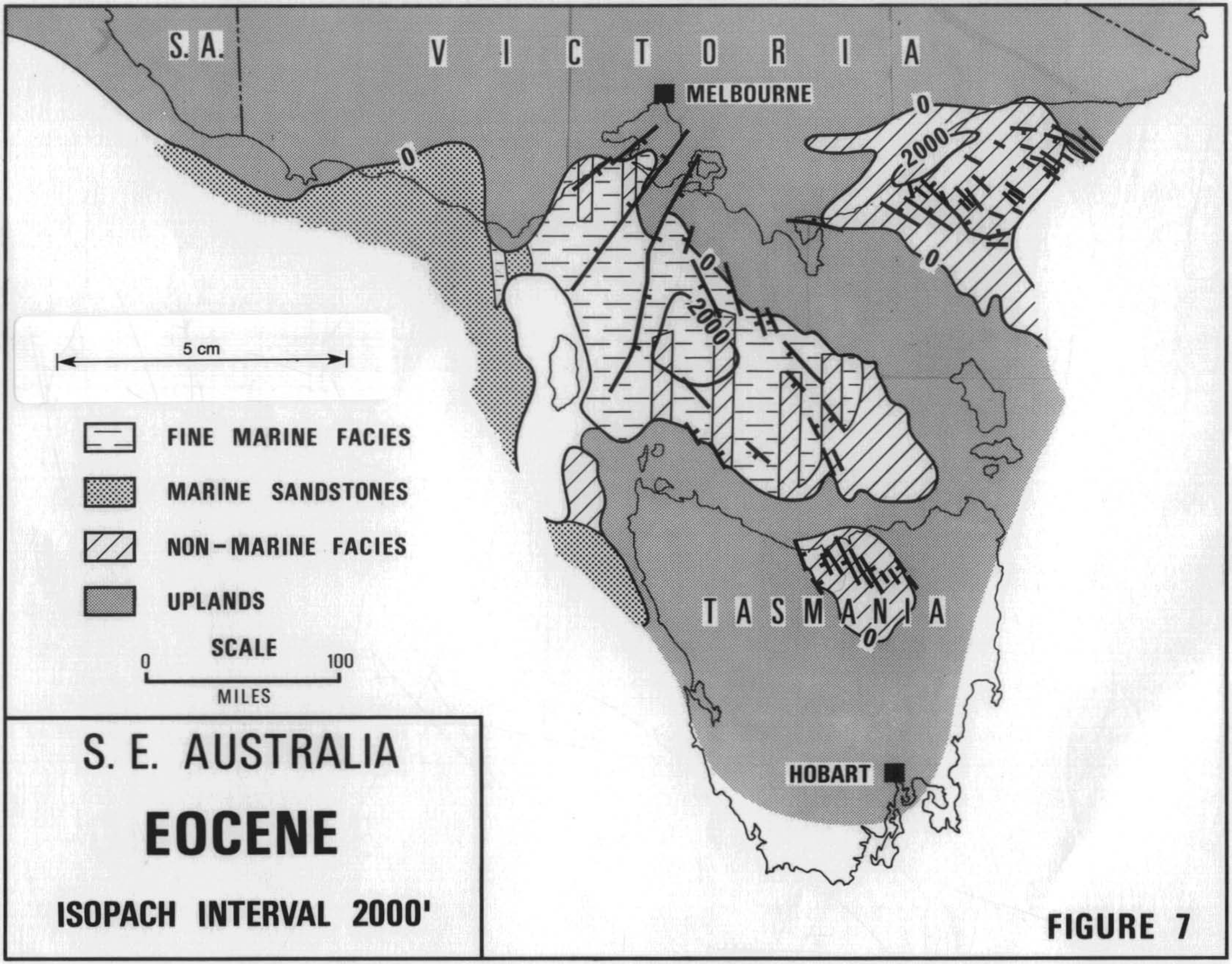
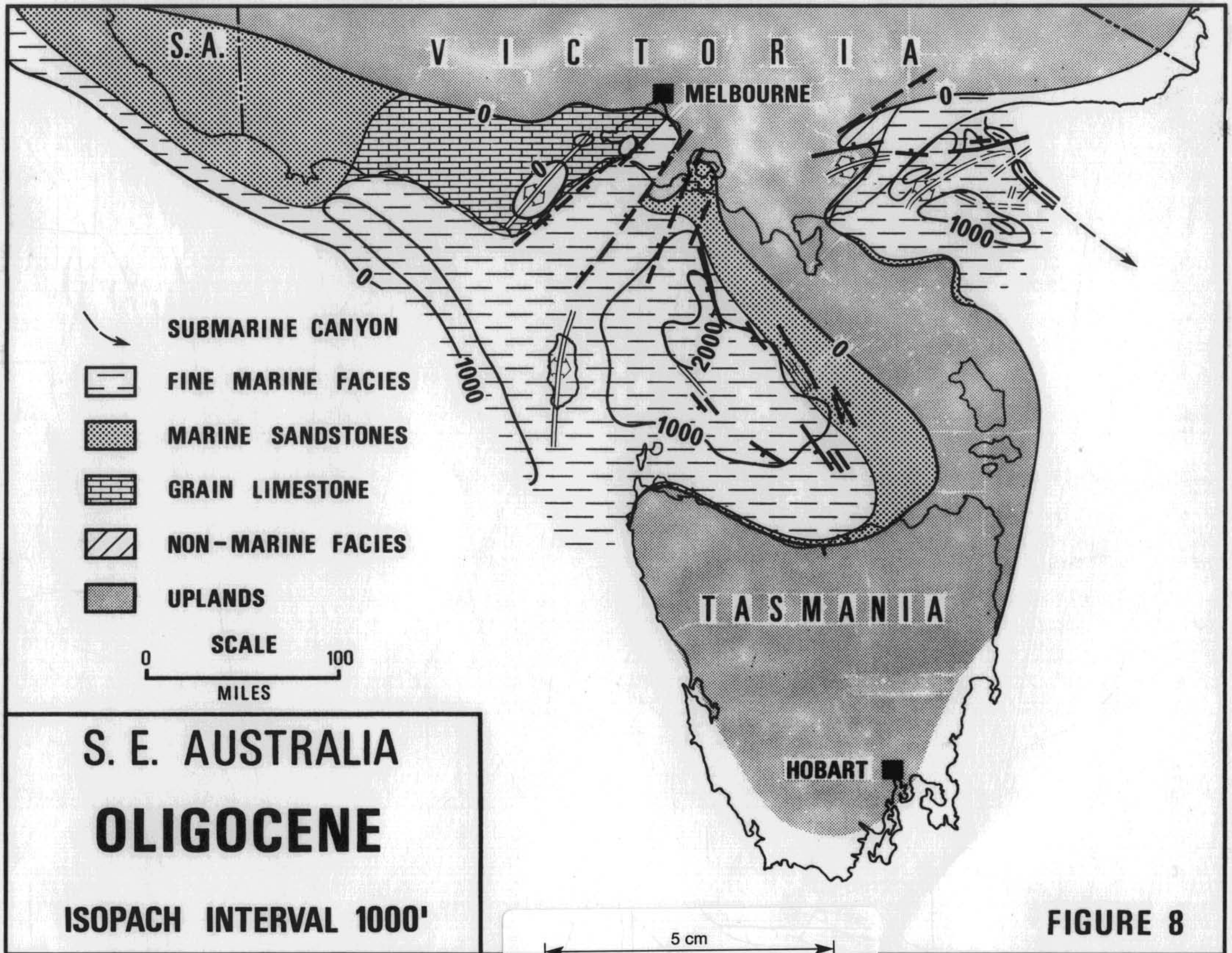


FIGURE 7

030027

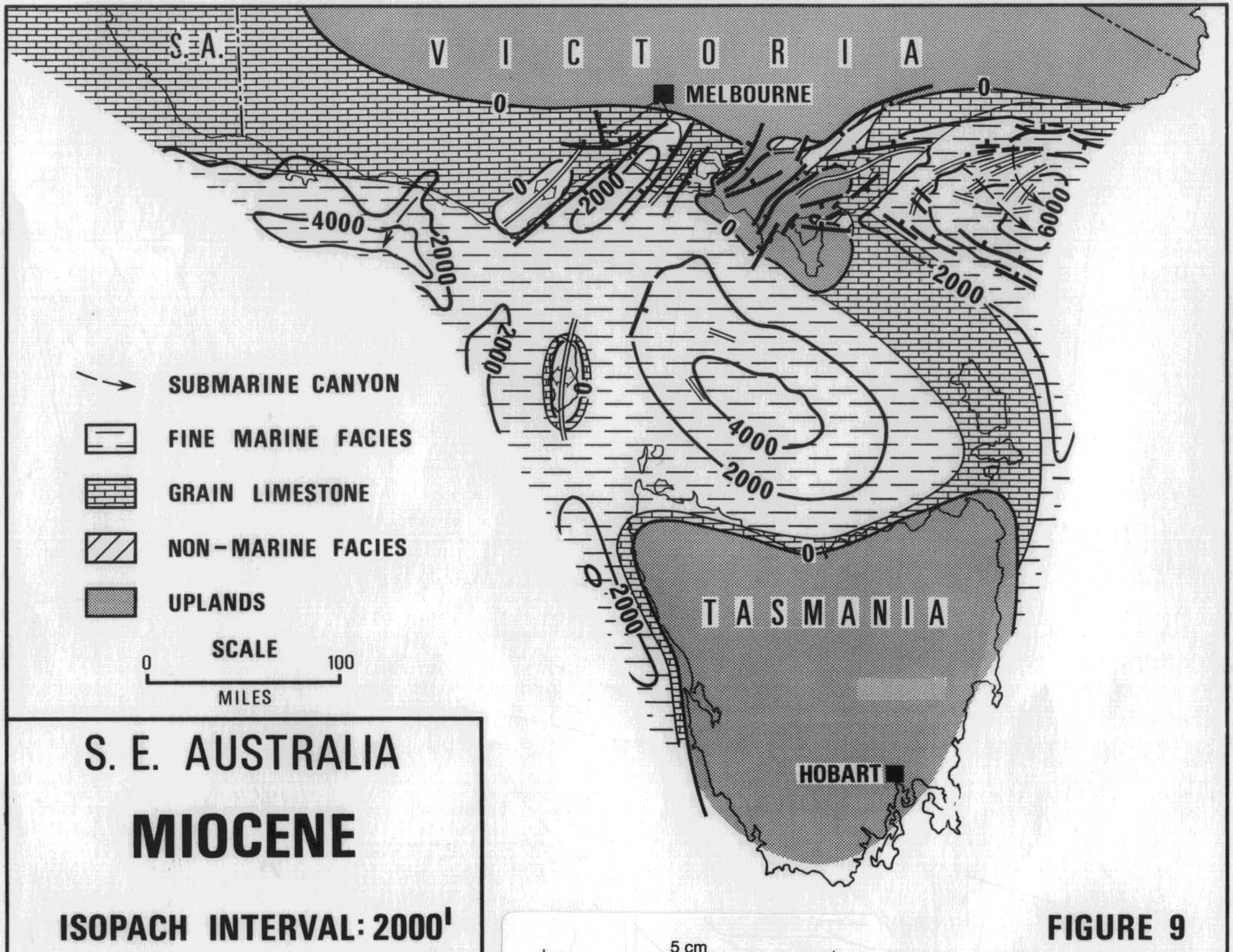


S. E. AUSTRALIA

OLIGOCENE

ISOPACH INTERVAL 1000'

FIGURE 8



S. E. AUSTRALIA

MIOCENE

ISOPACH INTERVAL: 2000'

FIGURE 9

5 cm

030029

5 cm

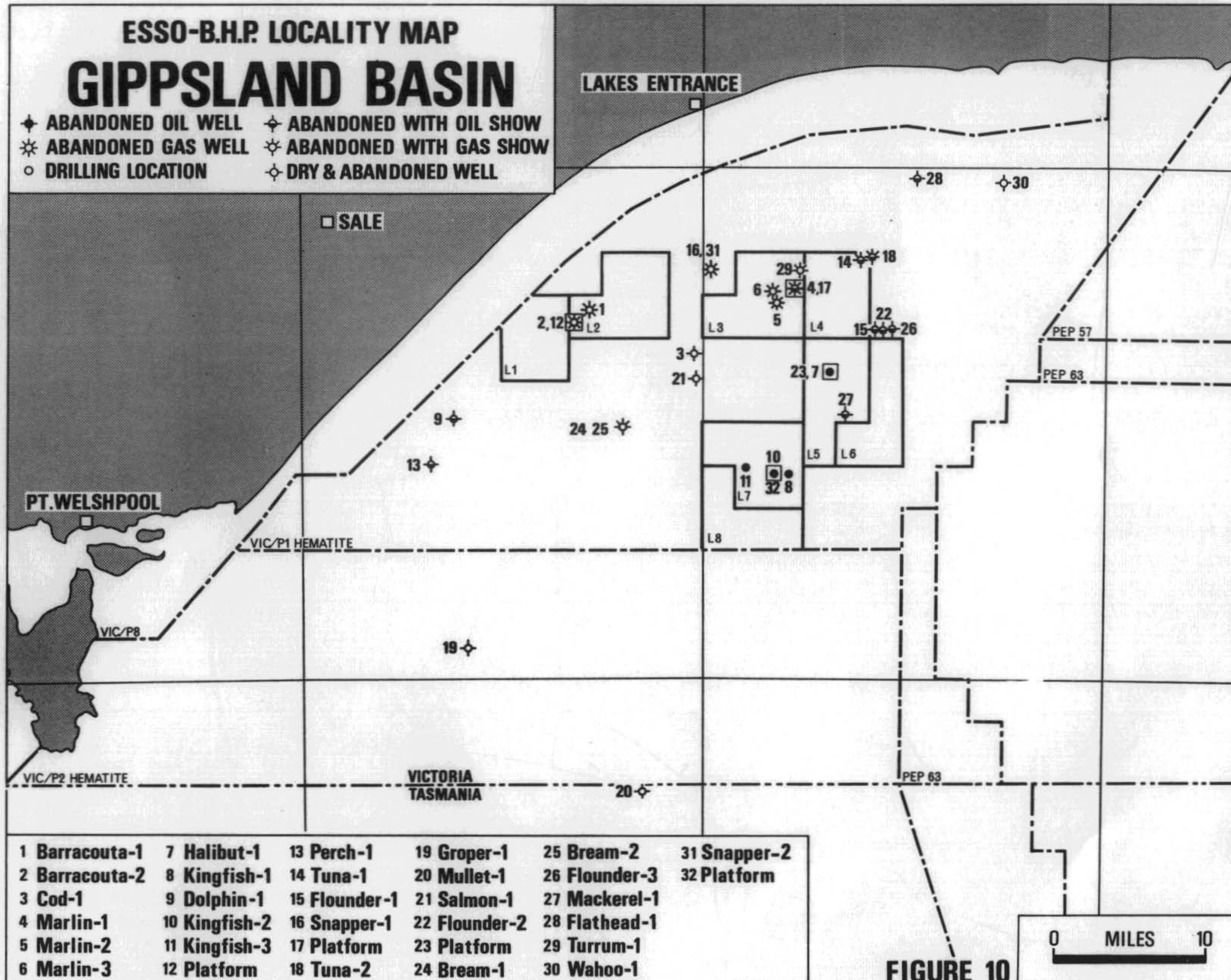


FIGURE 10

030030

5 cm

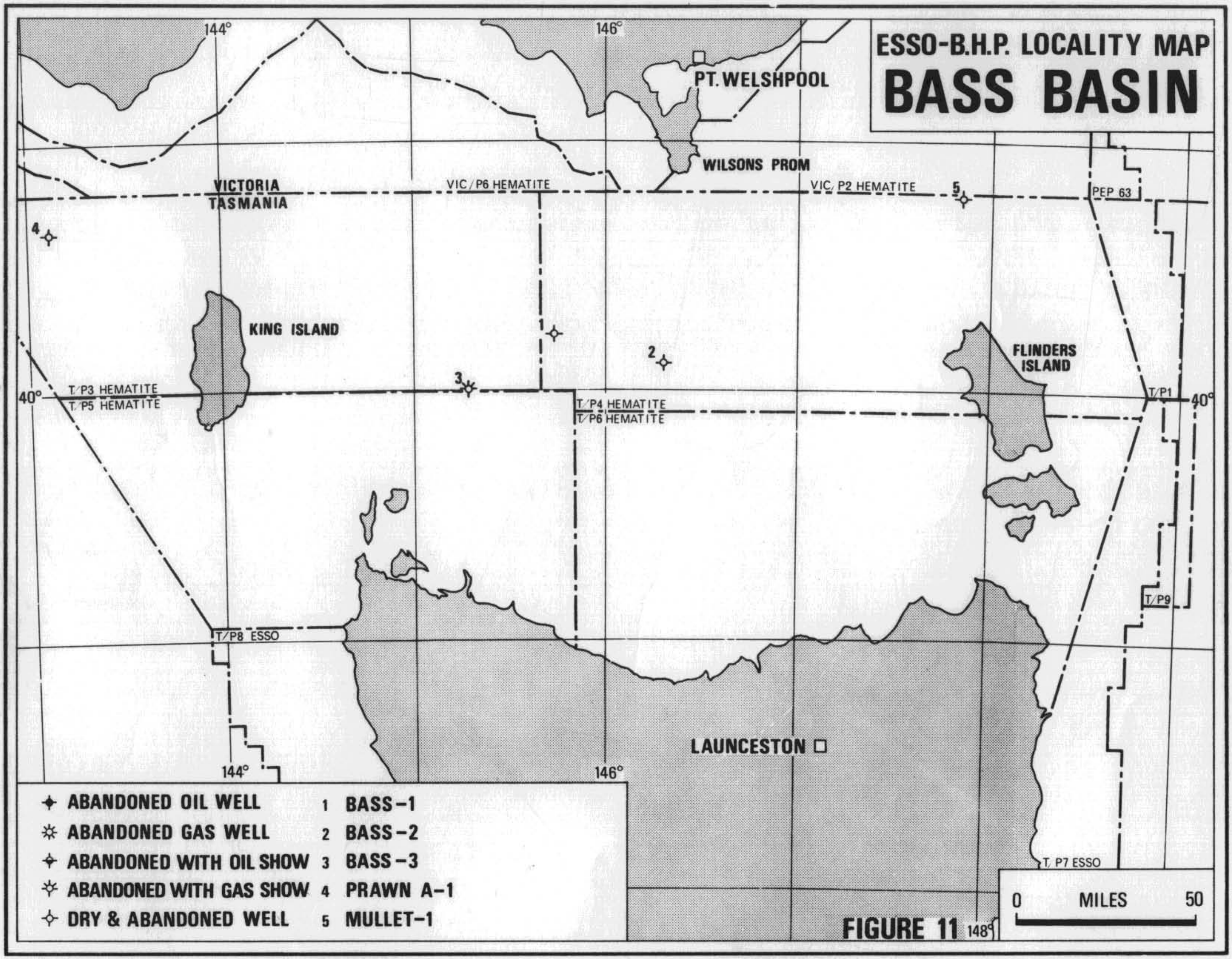


FIGURE 11

030031

5 cm

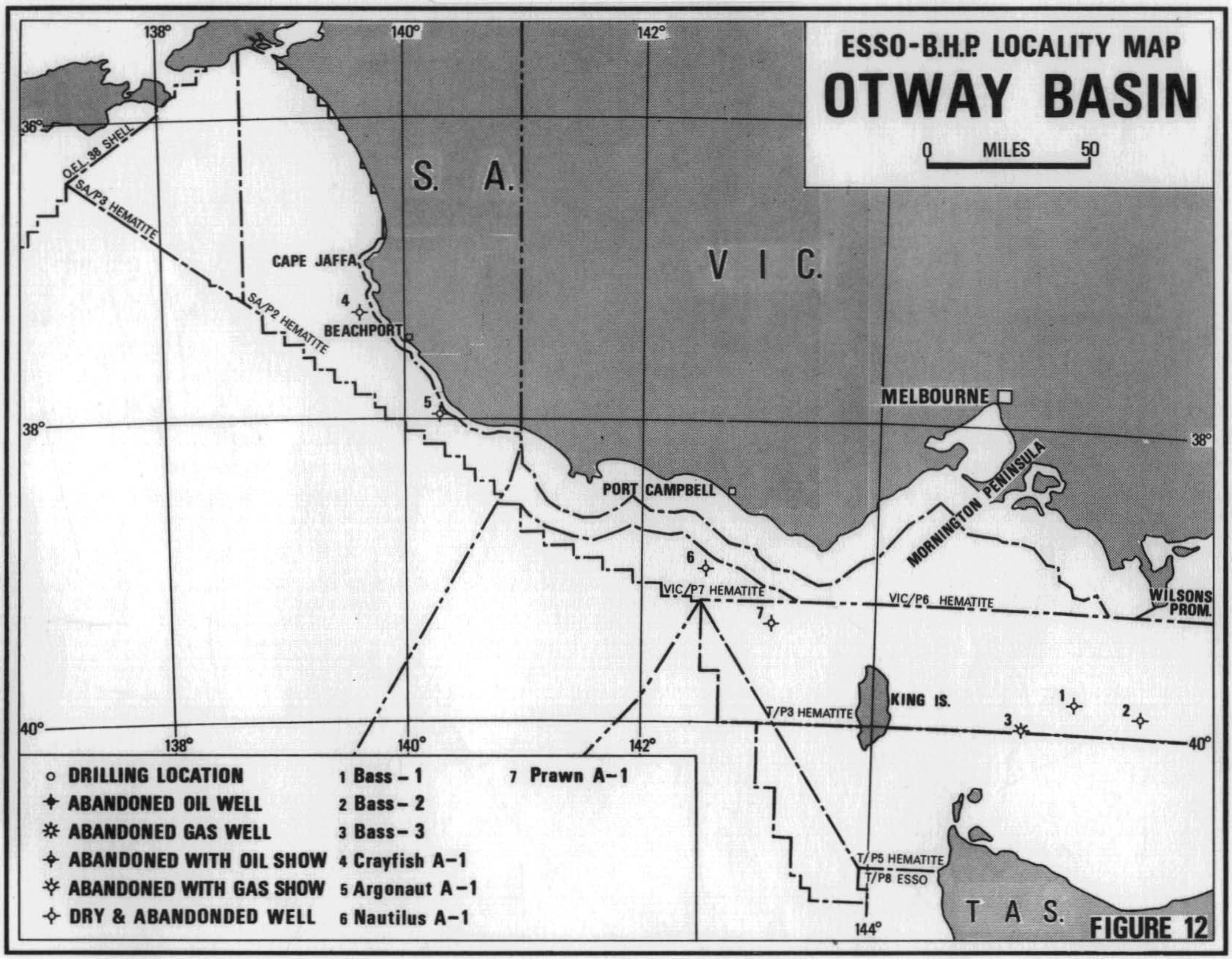


FIGURE 12