Part 4

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GEOLOGY AND ECONOMIC POTENTIAL OF THE WEST TASMANIA BASIN AND THE MACQUARIE GRABEN

TERRA MARINE PACIFIC, INC.

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T/12P
part 4

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GEOLOGY AND ECONOMIC POTENTIAL OF THE WEST TASMANIA BASIN AND THE MACQUARIE GRABEN

TERRA MARINE PACIFIC, INC.

INTRODUCTION

The West Tasmania Basin is located offshore western Tasmania, Australia, between latitudes 41°45' South and 42°35' South. Directly to the east, the Macquarie Graben underlies Macquarie Harbour and adjacent lands (Figure 1).

The West Tasmania Basin was discovered by regional geophysical reconnaissance consisting of an airborn magnetometer survey in 1967 and a seismic line shot along the entire west coast of Tasmania in 1968. A second reconnaissance geophysical program revealed the basin to be a depression extending for forty miles along the continental shelf and established the fact that the basin deepens from the shoreline westward to the shelf edge and beyond. A third survey in 1970 defined the basin in general, outlined several structures and demonstrated that a separate graben trends toward Macquarie Harbour. The West Tasmania Basin has deep faults on the north, east and south. The younger sediments extend beyond the deeper faults, overlapping onto older rocks. The westernmost seismic data shows the basin continuously thickening seaward beyond the shelf edge. The wedge of sediments will be totally marine westward, grading and fingering to shore facies eastward. Basement rocks plunge sharply below the base of the four second seismic records. The depth of the basin is therefore much greater than 20,000 feet. Large folds exist deep in the basin. The shallower structures are roll-overs into down-to-the-basin growth faults (Plates 1 and 2).

There are no wells drilled in the basin, or even close by, the closest well being 110 miles to the north. The sedimentary column is believed to be more or less evenly divided between the Cretaceous and Tertiary on the flanks of the basin as is the Gippsland Basin to the north (Figure 2). Thick, probably early Cretaceous rocks occupy the deepest part of the basin. A small portion of the Tertiary section outcrops in the Macquarie Graben, but otherwise the prospective rocks exist only offshore.

The character of the seismic data tend to correlate with data from the Gippsland Basin (Figure 2) leading one to believe that similar geologic conditions and a similar stratigraphic sequence are present. This would be a logical assumption even without corroborating data since the geologic history of the areas are parallel. The provenance of each of the basins sediments was previously eroded deposits of the Tasman Geosyncline.

REGIONAL GEOLOGY

Pre-Cretaceous rocks probably form economic basement in the West Tasmania Basin. Although pre-Cretaceous rocks are sedimentary, they have suffered too much deformation to be considered prospective for oil and gas accumulation.

The late pre-Cambrian and the Paleozoic saw the development of the Tasman Geosyncline in which 30,000 feet of sediments were accumulated. The pre-Cambrian sediments consist of relatively unmetamorphosed orthoquartzites and mudstones in western Tasmania. The Cambrian rocks are varied in lithology. Greywacke turbidites, acid and basic volcanics and orthoquartzites are found along with small thickness of other sediment types.

The Ordovician, Silurian and Devonian sequence is composed of siliceous conglomerate, sandstone and siltstone at the bottom; a limestone in the center, followed by shale, siltstone and sandstone. The Mississippian, Pennsylvanian and Permian contain tillites with glacio-marine mudstone and scattered limestone interbedded with lacustrine sequences containing coal measures. These rocks are similar to units of the same age in Bolivia from which oil and gas are produced.

In the area surrounding Macquarie Graben, the only significant igneous rocks are a large granite batholith of Devonian age and Jurassic dolerite. A Cretaceous age syenite stock is present and a few scattered Tertiary plateau basalts occur in the northern part of the area, probably as outliers from a large basalt covered area in northern Tasmania.

The Cretaceous and Tertiary sediments of the West Tasmania Basin were derived from pre-existing sedimentary rocks very favorable as a source for clean shales and sands. The basin must contain an abundance of reservoir rocks and thick sections of good hydrocarbon source rocks. Little or no volcanic activity is evident within the basin. There is sufficient age and depth for thermal maturation of organic material into liquids.

The West Tasmania Basin could easily be as rich as the Gippsland Basin which has generated and trapped an unusually large volume of oil and gas for a basin so small.

GIPPSLAND BASIN

Several excellent papers on the Gippsland Basin have been been published. The basin is about twice the size of the West Tasmania Basin, but like the West Tasmania Basin the seaward extent is not known, at least to this author (Figure 1).

The Gippsland Basin is very rich. The following list shows the fields discovered and developed by 1975. New discoveries have been made since, and the operators are planning further development. Geophysical work has recently been done in the basin both on the shelf and beyond, where water depth is greater than 200 meters. Fioures are from Esso.

Field	Discovered	Gas Trillion Cu. Ft.	Crude Oil Million Barrels	Condensate and LPG Million Barrels
Barracouta	1968	1.2 TCF	10	53
Flounder	1970	0.166 TCF	58	25
Marlin	1966	2.7 TCF	3	200
Kingfish	1967	0.205 TCF	952	104
Halibut	1967	0.019 TCF	640	22
Snapper	1968	2.5 TCF	---	157
Tuna	1968	0.5 TCF	84	23
Mackerel	1969	0.021 TCF	256	33
Golden Beach	1971	0.1 TCF	---	---
TOTAL		7.41 TCF	2003	617

Typical Oil: 45° API Gravity
0.1% Sulfur
60° F Pour Point
Gasolines 40%
Kerosines 7.5%
Gas Oils 18%
Residues 32.5%

Typical Gas: 980 - 1100 BTU
2 Grains per 100 Cubic Feet Sulfur

Figure 2 is a generalized correlation chart of the sedimentary rocks in the Gippsland, Bass and Otway Basins correlated into units apparent on seismic data in the West Tasmania Basin.

In the Gippsland Basin most of the oil and gas production is from the Eocene and older Latrobe Group, a thick, non-marine, lacustrine and fluvial deposit interpreted to have been a delta plain during the Eocene. The Latrobe is overlain unconformably by the Lakes Entrance Formation, a marine mudstone of Oligocene age which grades upward to Miocene calcareous mudstone and marl.

A complex channel system was cut into the Latrobe surface prior to deposition of the Lakes Entrance Formation. Some of these channels cross plunging anticlinal folds and are the effective traps for hydrocarbons. The Marlin fold is interrupted by a distinctive channel. The Halibut, Kingfish and Tuna fields are partly controlled by the unconformity. It appears that the traps are filled to the spill point.

The Lakes Entrance Formation is not considered to be a good source rock for hydrocarbons. The origin of the Gippsland Basin oil and gas is apparently still in doubt, but the source beds must be in the older parts of the Latrobe Group, the underlying non-marine Strzelecki Group or offshore marine equivalents of either one.

The Oligocene and younger beds of the Gippsland Basin are predominantly flat lying, capped by the massive Pliocene limestones. The mid-Cretaceous to Eocene rocks are gently folded into structures with relief of normally less than 300 feet. Older beds below an unconformity are more strongly folded.

Large faults flank the south side of the basin and to a lesser extent the north side. The faults increase in throw and significance with depth. Smaller faults occur within the basin and in some cases form traps for hydrocarbons. The basin wedges to the west and thickens seaward.

BASS BASIN

The Bass Strait between Tasmania and Victoria states is all shallower than 200 meters. The Bass Basin occupies the central part of the strait lying in a general northwest southeast trend. King Island on the west and Flinders Island on the east are high points on basement ridges, each of which extend to the Victoria mainland.

The Bass Basin has a lower sedimentary unit which is non-marine similar to the Latrobe Group, but totally continental in character (Figure 2). These beds, the Eastern View Coal Measures, overlie lower Cretaceous shales and sandstones called Otway Group, but strangely less arkosic and immature than the Otway Group of the Otway Basin.

There was no strong unconformity following the Eastern View Coal Measures deposition as there was in the Gippsland Basin involving the Latrobe Group. The overlying beds are a more restricted unit as one would expect in an inland basin.

The Bass Basin contains a large volume of volcanic rocks scattered throughout the section from bottom to top. Several igneous features are seen on the seismic data from the basin. Some were drilled in the belief they were potential trapping structures.

Twenty-two wells have been drilled in the Bass Basin. At least one gas field was discovered and several questionably economic discoveries of oil and gas were made. Esso-BHP are presently drilling a four to six well program in the basin. The oil and gas shows have all been in sands of the Eastern View Coal Measures both in the upper unit and in the lower unit below a median unconformity. The lower Cretaceous has been suggested as having source rocks since it appears to be marine in part.

The Bass Basin does not seem to have simple folds as do the Gippsland and the West Tasmania Basins. The volcanism in the basin has probably resulted in poor reservoirs. While the basin is obviously not as rich as the Gippsland Basin, significant discoveries could still be made once the complex timing of generation, migration and entrapment in the basin is determined.

OTWAY BASIN

The Otway Basin lies onshore and offshore Victoria west of the Bass Strait to Cape Jaffa (Figure 1). The basin is composed of a gently dipping wedge of sediments that have very little structural deformation. Numerous relatively small tensional faults, generally parallel to strike, contribute to what few closed structures are present.

The Tertiary deposits in the Otway Basin are fresh water flushed where porous. For the most part the Tertiary marine sections are not deeply enough buried to generate oil. The basin is not as deep as the West Tasmania Basin or the Gippsland Basin, both of which have large downthrown faulted areas filled with older rocks. The deepest test in the Otway Basin is 12,923 feet, well into Cretaceous age rocks.

The Upper Cretaceous Sherbrook Group is a transgressive-regressive sequence that has marine shale in the middle. It is found in the western part of the Otway Basin and is equivalent to the Eastern View Coal Measures found in the eastern Otway Basin.

Eighteen of the forty-five wells drilled in the basin have had oil or gas shows, nearly all in the Lower Cretaceous. The Lower Cretaceous Otway Group is composed of non-marine clastics grading to marine offshore in the eastern part of the basin. The unit is unconformable below the Sherbrook Group.

The more recent exploration in the basin has been directed towards locating stratigraphic traps and towards defining deep structures where the erratically developed basal Cretaceous sandstone is present.

WEST TASMANIA BASIN

Figure 2 shows correlation of the colored units of Figure 3 with the nearby basins. There is no direct seismic tie from the West Tasmania Basin to wells or seismic lines in any other basin. The correlations must be tentative therefore, but are geologically logical. The sequence of events as exhibited by the seismic data in the West Tasmania Basin follows that of the Gippsland Basin and the seismic sections themselves are similar.

The yellow beds of Figure 3 onlap the pink unit. They are well bedded, flat lying only becoming disturbed beyond the shelf edge, but do not exhibit fore-set beds even on the slope. They must be marl or limestone. No interval velocities are available at present. The yellow is probably upper Miocene-Pliocene to Recent in age.

The pink unit is much like the yellow in being even-bedded near shore and disturbed seaward. Fore-sets are not evident, however. The disturbed beds in the pink unit appear more like channels than anything else, but are not obvious. The pink unit is believed to be Oligocene-Miocene. The pink beds are fairly uniform, but do thicken into the growth faults.

The red marker is a correlatable thin unit present throughout the basin. It is interpreted to be a basal transgressive unit of the Tertiary. It overlies the green unit with considerable unconformity in places. The red marker was called the top of the Cretaceous by Esso and is so named on Plate 1 which is a time contour map of the red marker. The red marker, which is more related to the base of the pink unit, is believed by this author to represent the base of the Oligocene.

The green unit exhibits slightly greater structure than younger deposits, particularly in folded areas. It thickens strongly into the growth faults and appears to be slightly eroded on the top of structures. Minor faults that do not break the overlying rocks first appear in the green unit. It exhibits uneven bedding in places, but a consistent pattern could not be determined. The green unit is correlated with the Latrobe Group and upper unit of the Eastern View Coal Measures.

The blue horizon is at an unconformity with moderate relief in places. It is at the base of the fairly good seismic data, below which no continuous horizon can be carried. Dips are stronger below the blue horizon and strong thickening is exhibited along some of the faults. Plate 2 is a time contour map of the blue horizon and represents the deepest mappable data. Even it is questionable in places. Rocks older than blue horizon never lap onto the basement but are faulted against it.

Plate 2 is a time contour map of the blue horizon. It was not possible to follow the correlation with much greater accuracy than the gross contour interval suggests.

It is postulated herein that the Lower Cretaceous is not recognizable on the West Tasmania Basin seismic sections. There is certainly room for it in the deeper parts of the basin, but the seismic quality is very poor at depth. There are some indications of a stronger unconformity with a bedded sedimentary unit below. The blue horizon is here correlated with the top of the Upper Cretaceous because of the mild unconformity it represents. It is believed the mid-Cretaceous unconformity and the Lower Cretaceous beds are present, but the data at hand is not adequate for consistently separating them.

The most favorable structure at the red horizon lies at the junction of lines 26 and 7. This fold has 750 feet of closure at its crest most of which is natural roll over into a growth fault. The fault is the bounding fault for the pre-Oligocene basin placing all Eocene and older rocks against basement. The basement shows no signs of bedded rock, so therefore is igneous or metamorphic. The structure here named the 7-26 structure is approximately 19,000 acres in size. If 100 feet of pay were present at 300 barrels of oil per acre foot the structure would have 570 million barrels of reserves. If the structure were full as the Gippsland Basin structures are, it would hold over two billion barrels of oil. Drilling depth at the junction of lines 26 and 7 would be about 10,000 feet. A well at this location would test about one-half of the green unit and be at the highest structural position on the red marker. If the correlations are correct, this should coincide with the producing horizon in the Gippsland Basin.

Additional seismic data is needed to delineate a location for a test of the blue horizon. The deeper section cannot be tested at the same location as the shallow on the 7-26 structure. The stratigraphic information gained from present day shooting and processing techniques will aid in a decision on which horizon to test first.

The structure at the junction of lines 9 and 32 does not migrate with depth and would offer a location to test all horizons, but the 9-32 structure is not as attractive as the 7-26 structure. If the West Tasmania Basin is as rich as the Gippsland Basin, several of the fault traps and stratigraphic traps will also have oil and gas accumulations.

MACQUARIE GRABEN

The existence of the Macquarie Graben is predicated on indirect lines of evidence. Tertiary rocks of Paleocene age are present near Strahan, the town at the north end of Macquarie Harbour. These rocks are in contact with various Paleozoic units where the contact is seen on the surface. Lithology is interbedded sandstone. siltstone, clay and conglomerate with a few lignite beds. Tertiary rocks are not present outside of the Macquarie Graben area.

A Bouger Gravity map, Plate 3, shows a steep gradient along the western coastline of the bay and a definite low in the bay area. The gravity indicates a graben with the largest fault on the west side.

North of Macquarie Harbour the offshore seismic data show a graben trending toward the harbour. A short reconnaissance seismic program will be shot in Macquarie Harbour at the same time the additional offshore work is done.

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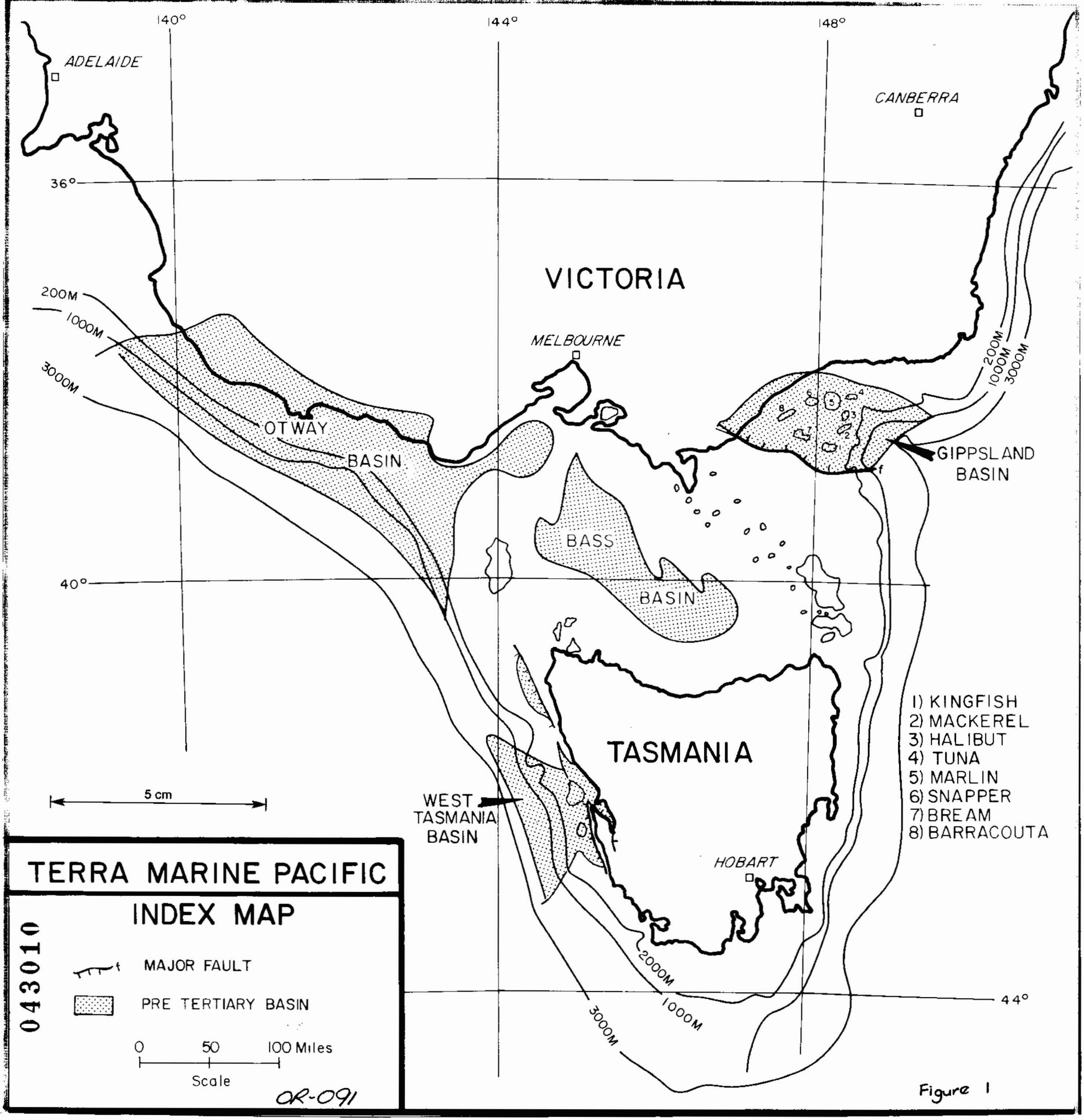
140°
144°
148°
36°
40°
44°
ADELAIDE
CANBERRA
VICTORIA
MELBOURNE
OTWAY
BASIN
BASS
BASIN
GIPPSLAND
BASIN
TASMANIA
WEST
TASMANIA
BASIN
HOBART
200M
1000M
3000M
2000M
5 cm
1) KINGFISH
2) MACKEREL
3) HALIBUT
4) TUNA
5) MARLIN
6) SNAPPER
7) BREAM
8) BARRACOUTA
TERRA MARINE PACIFIC
INDEX MAP
MAJOR FAULT
PRE TERTIARY BASIN
0
50
100 Miles
Scale
OR-091
043010

Figure 1

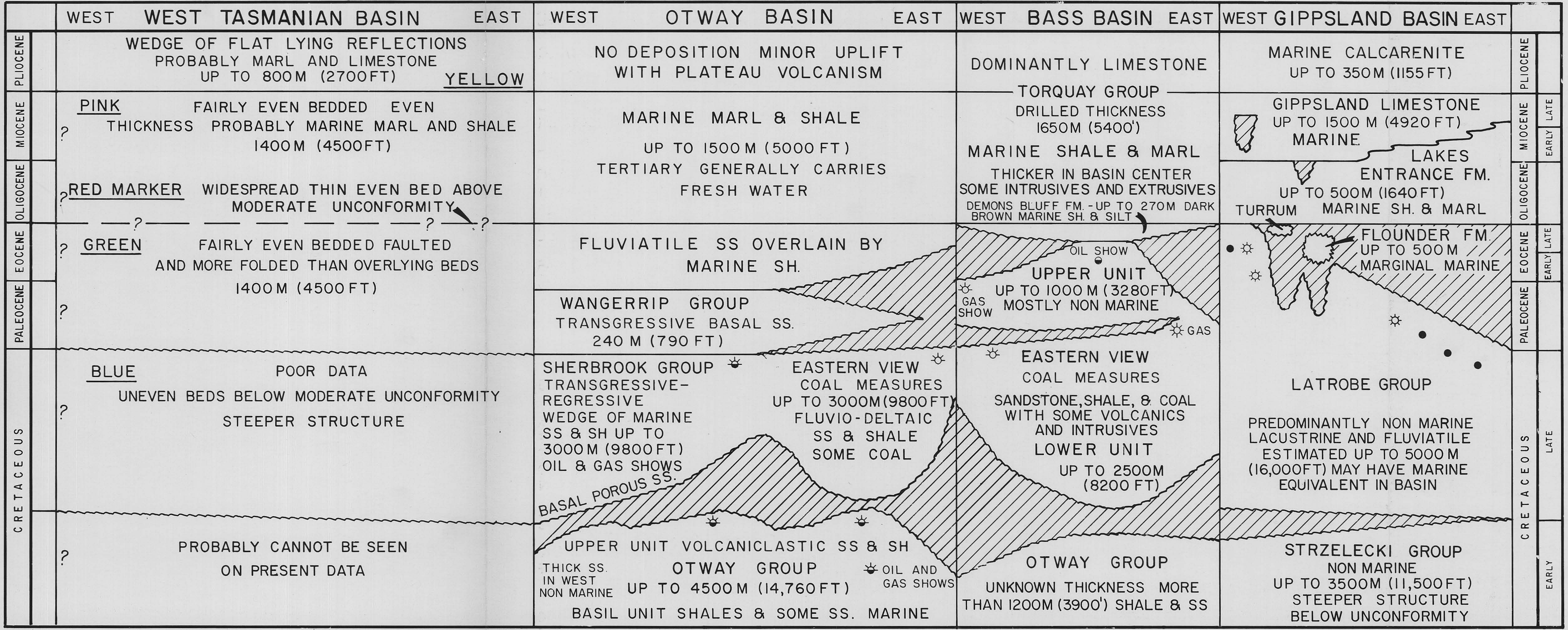

Figure 2 OR-091

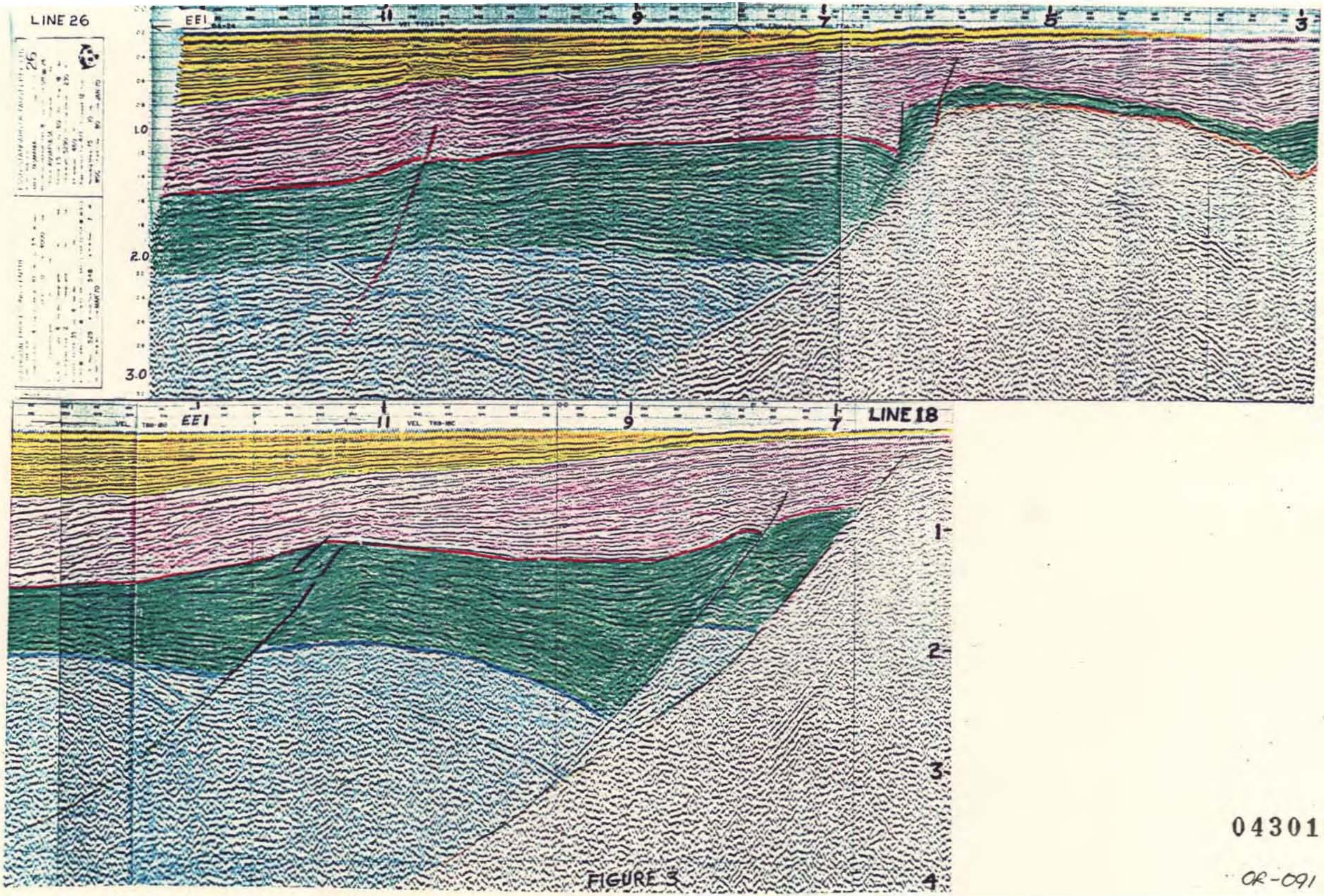

FIGURE 3

043012

OR-091

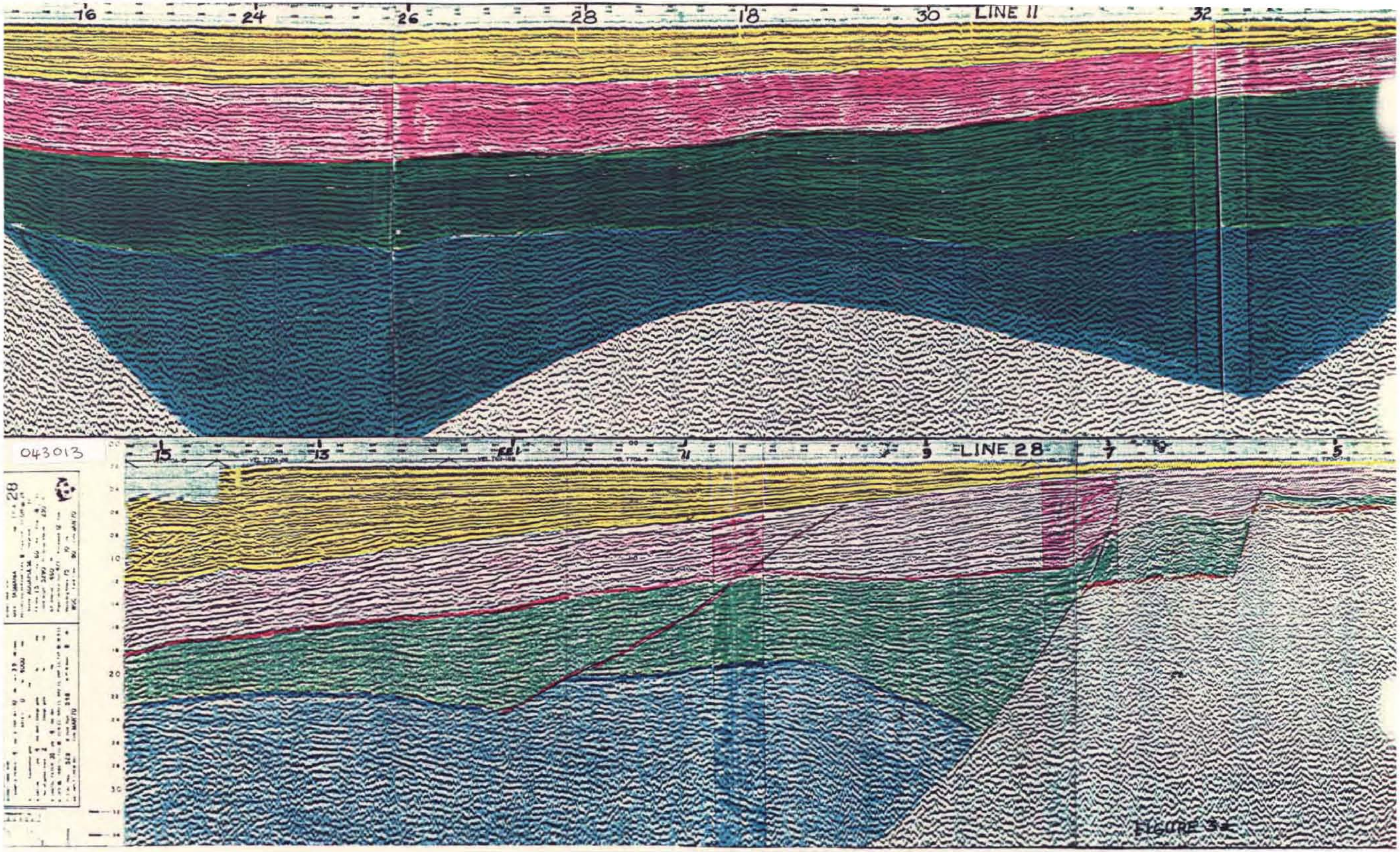

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FIGURE 3

144°30'
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INDIAN OCEAN
Macquarie Ha
TERTIARY ON BASEMENT
TERTIARY ON BASEMENT
TERTIARY ON CRETACEOUS
STRAHAN
HIGH
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OR-091

TERRA MARINE PACIFIC INC.
Suite 386 Denver Club Bldg. • 518 17th Street • Denver, Colorado 80202
WEST TASMANIA BASIN
AUSTRALIA
1:100,000
MILES
5 cm
TIME STRUCTURE
TOP CRETACEOUS
Interpretation by: C. J. Gudim
Datum Plane:
Contour Interval:
Map Scale: 1" = 8,333.3'
Date: August, 1978
LEGEND
ONSHORE LICENSE BOUNDRY
OFFSHORE PERMIT BOUNDRY
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DG - DEVONIAN GRANITE
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42°35'

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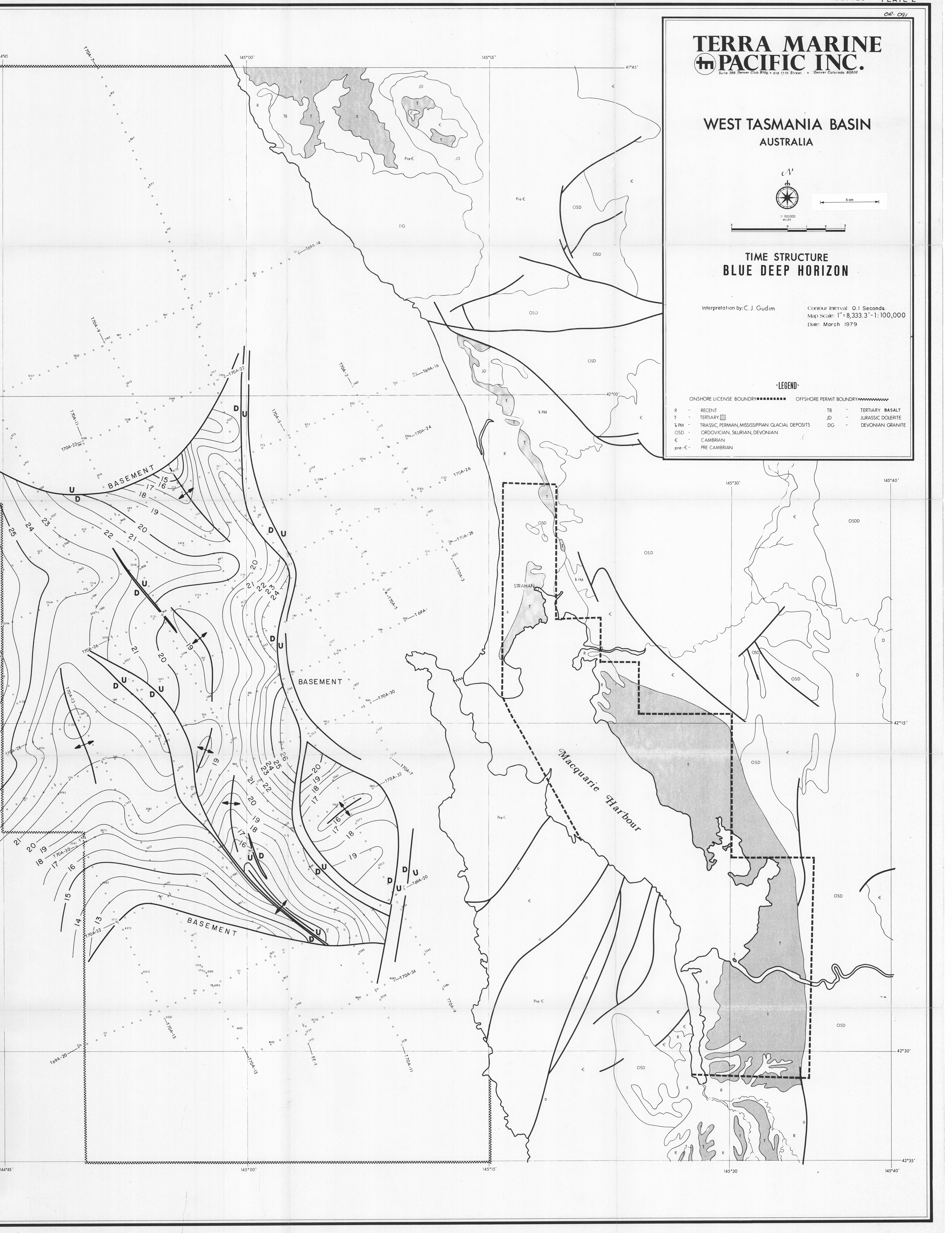
043015 PLATE 2



043016 OR-091

TERRA MARINE PACIFIC INC.

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WEST TASMANIA BASIN

AUSTRALIA

BOUGUER GRAVITY

Interpretation by: C. J. Gudim
Datum Plane:

Contour Interval: 5 mgals.
Map Scale: 1" = 8,333.3'
Date: August, 1978

‹LEGEND›

ONSHORE LICENSE BOUNDRY ▪▪▪▪▪▪▪▪ OFFSHORE PERMIT BOUNDRY ﹏﹏﹏

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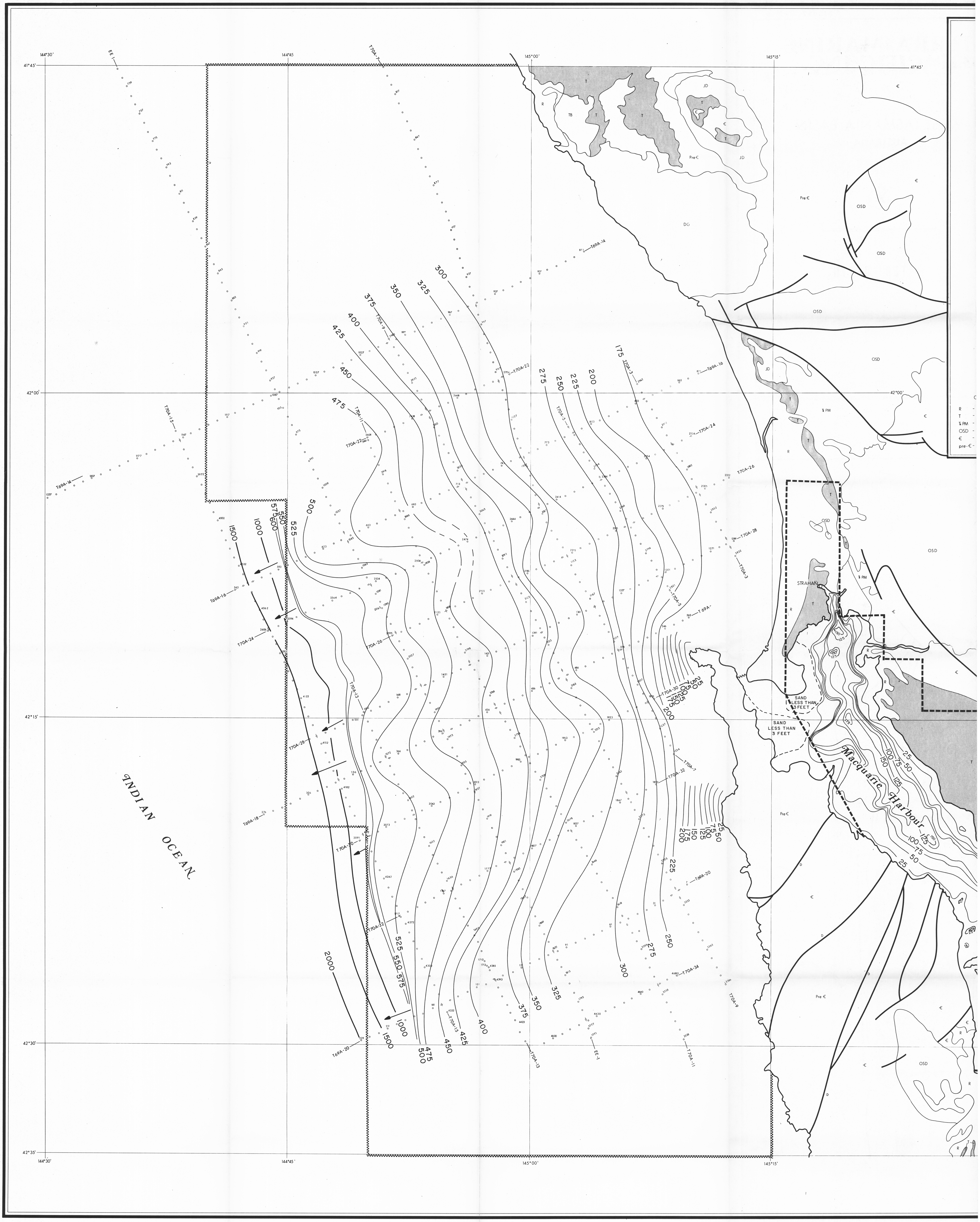
T	-	TERTIARY	JD	-	JURASSIC DOLERITE
₮ PM	-	TRIASSIC, PERMIAN, MISSISSIPPIAN GLACIAL DEPOSITS	DG	-	DEVONIAN GRANITE
OSD	-	ORDOVICIAN, SILURIAN, DEVONIAN			
€	-	CAMBRIAN			
pre-€	-	PRE CAMBRIAN			



INDIAN OCEAN
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SAND LESS THAN 3 FEET
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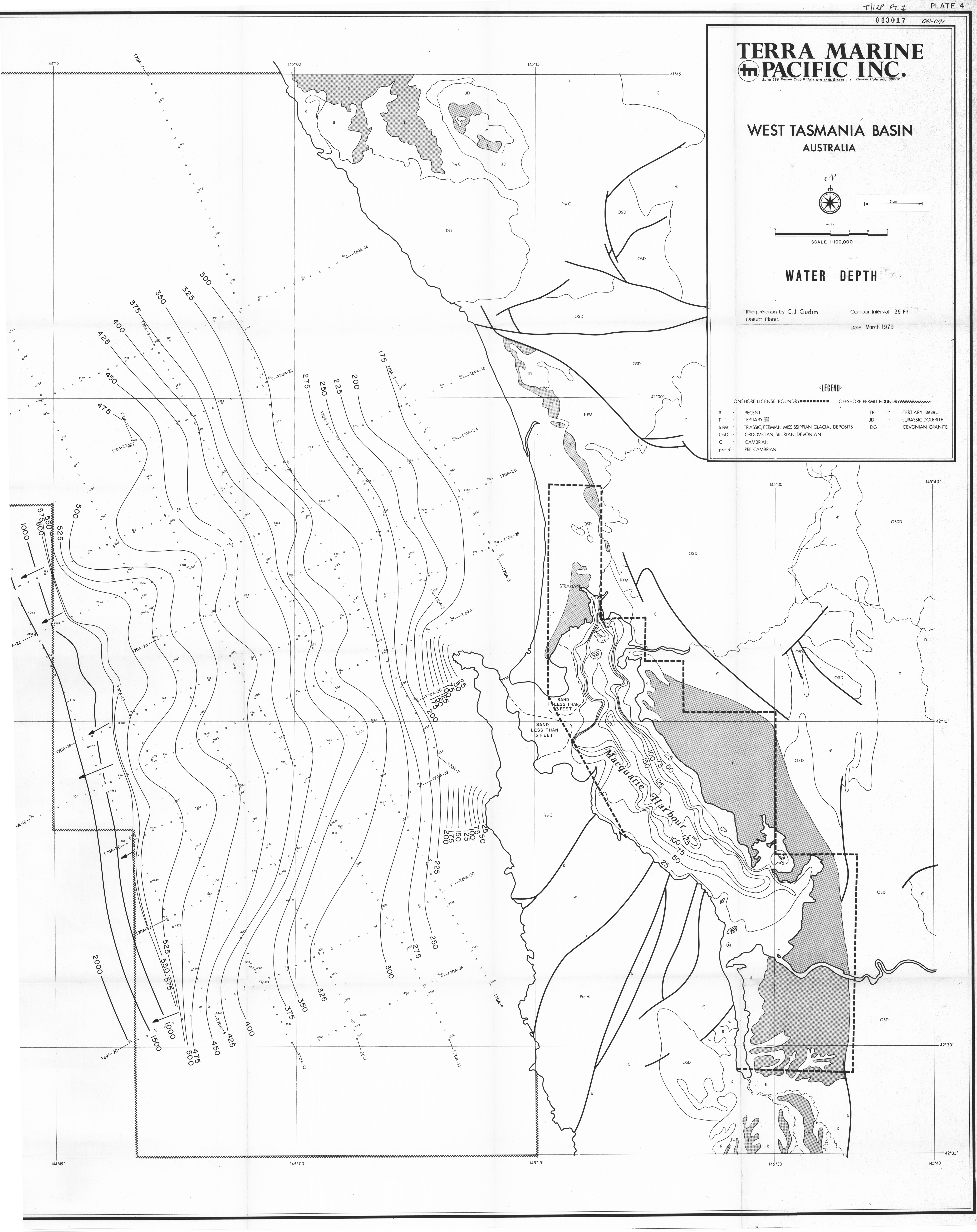
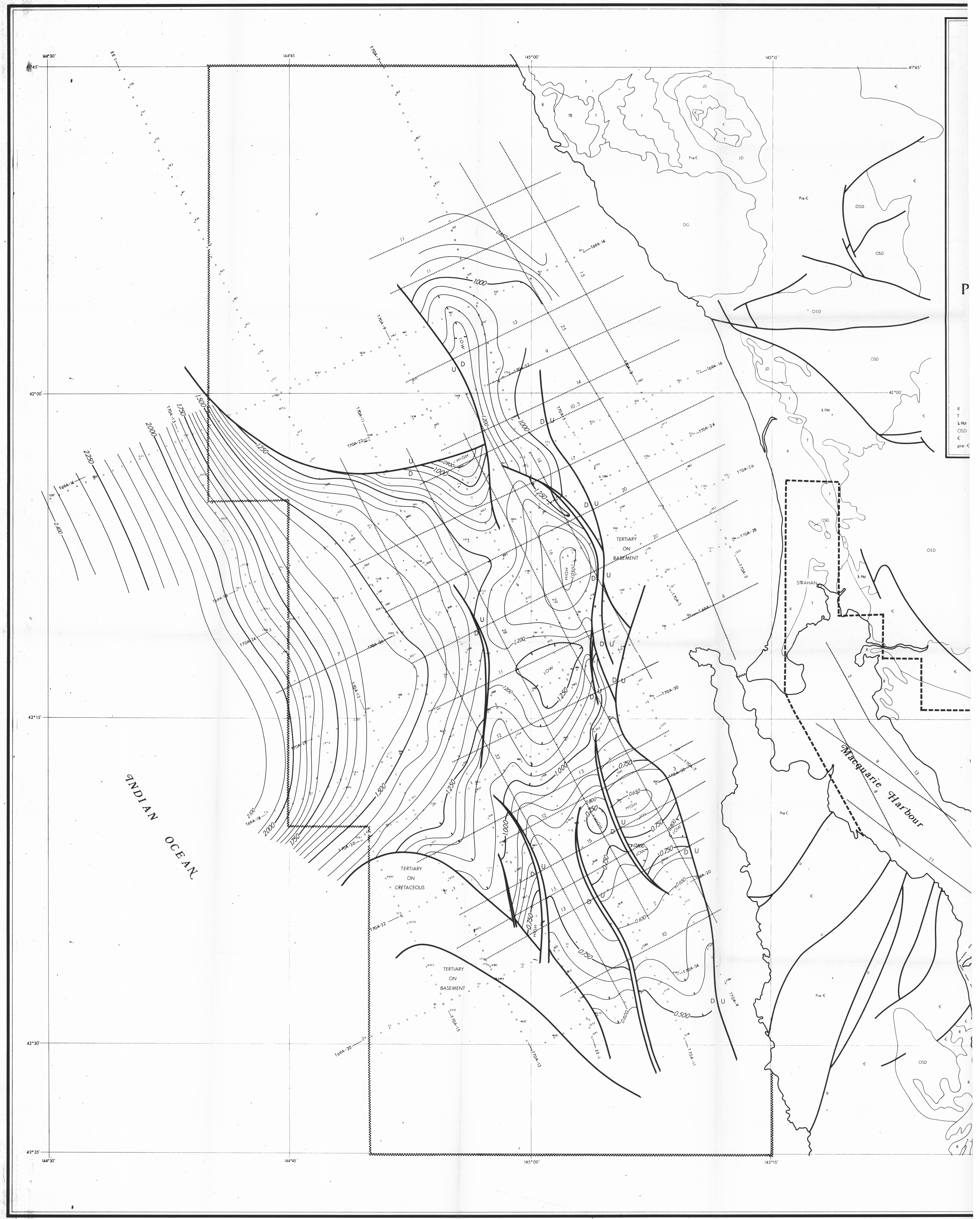
T/12P PT. 1

043017 OR-091





144°30'
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INDIAN OCEAN
Macquarie Harbour
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TERTIARY ON CRETACEOUS
TERTIARY ON BASEMENT
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043018 T112P PT. 1 PLATE 5

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