DEPARTMENT OF MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1974/136

CONTINENTAL MARGIN SURVEY:

PREVIEW REPORT FOR EASTERN TASMANIA AND THE NSW COAST

by

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FOREWORD

This preview report was prepared in draft form in late 1970 and was used in planning the survey which took place in 1971. The report has been completed as a BMR Record in order to provide a permanent record of the information relating to the survey area and the planning of the survey operations.

SUMMARY

The Bureau of Mineral Resources will carry out a contract marine geophysical survey to collect bathymetric, six-fold c.d.p. seismic, gravity, and total-field magnetic data over the continental shelf and continental slope. This work will form the first extensive segment of a systematic marine geophysical survey to cover most of the Australian continental margin. This part of the survey will be carried out during the first three months of 1971 and cover an area between 142°E and 152°E and from south of the Tasmanian coast to 50°S. Surveying will continue along the eastern seaboard of Australia as far as Sydney.

The geological structures within the continental slope are almost unknown except for depth recordings along reconnaissance lines from five oceanographic vessels and for three submarine gravity profiles. The main structural feature of eastern Australia is the Tasman Geosyncline. This is overlain by three major sedimentary basins; the Tasmania, Gippsland, and Sydney Basins. The offshore limits of the Tasmania and Sydney Basins are unknown. The Gippsland Basin forms an extensive sedimentary basin at the eastern entrance to Bass Strait but the boundary of this basin on the continental slope is poorly defined. South of Tasmania the continental slope is broken by a broad submarine ridge of unknown shape and origin. The southern part of this survey will be carried out over this unknown structure.

The proposed survey will use a regular east-west grid of traverses spaced 20 nautical miles apart, and the total traverse length covered in the survey period is expected to be about 10 400 nautical miles.

1. INTRODUCTION

A marine geophysical survey from south of Hobart to about the latitude of Newcastle will be the first extensive area surveyed in the Continental Margin Survey. This survey is being carried out by Compagnie Generale de Geophysique (CGG) for the Bureau of Mineral Resources (BMR) to obtain bathymetric, gravity, magnetic and seismic information between the coastline and the foot of the continental slope at about 4000 m depth.

Proposed survey lines are indicated in Plate 1 and total 10 400 n. miles (19 300 km) of traversing. The southern limit of the survey has been set arbitarily at 50°S although a ridge less than 4000 m deep continues further south. The survey will progress northwards from the southern limit of the area between the latitudes 142°E and 152°E, then along the eastern coast of Tasmania, along the Gippsland Shelf area of Bass Strait, and northwards along the New South Wales coast to about 34°S near Sydney. Traverse lines will run east-west with a line spacing of 20 nautical miles (37 km). Two tie lines parallel to the coast will complete the surveying north of Hobart but only one tie line will be used on the southernmost lines.

The prime navigation system will be the ITT satellite Doppler equipment using a Digital Corporation PDP-8 computer to obtain position fixes at roughly two hour intervals. A Marquardt sonar Doppler, a Chernikeeff electromagnetic log and a ship's pressure log will each be input to a Hewlett-Packard 2116B computer to provide independent positioning systems. V.L.F. radio navigation will also be provided.

The gravity meter to be used will be a La Coste and Romberg meter mounted on a gyrostabilized platform, with an analogue computer to make cross-coupling corrections. Digital recording of meter values will be made and analogue records made in case of computer failure.

A Varian proton precession magnetometer with its sensor towed 200 m behind the ship will measure the total magnetic field and a second magnetometer stationed on shore will record the daily variations of the earth's field. Duplicate magnetic recordings will be made using analogue and digital systems as for the gravity data.

Digital values of water depth will be recorded from one of the three depth measuring systems. The Atlas-Edo system will record water depths between 0 and 200+ m, the Elac system will record water depths between 200 m and 4000+ m via the Digitrac digital conversion unit.

The seismic energy source will consist of a 120 kilojoule sparker using four pairs of electrodes. The main seismic cable will be a 6 channel AGM streamer with 200 m between geophone groups. The first channel will be 300 m behind the ship. Geophones in the cable are made up of 48, HC 301 detectors over a group length of 50 m. A light single channel Geotech cable will be used to record high resolution signals from the shallow sub-bottom. The active section of 28 geophones spaced over a 12 m length will be towed 200 m astern.

Seismic signals will be amplified by a Sercel AX626 amplifier using the Common Gain system of gain control. The Geotech signal will be amplified by a Sercel amplifier modified to operate independently on automatic gain control at high frequency.

Refraction profiles will be recorded utilizing Aquatronics sonobuoys and FM radio receiver systems.

Seismic data will be recorded on three graphic display units and on an Ampex 14 channel tape recorder. The tape recorder will use 1 inch magnetic tape, FM modules and a recording speed of 15/16 inch/second. The main cable channel 2 will be displayed at a paper speed of 30 cm/hr. A second recorder will display the Geotech signal at a paper speed of 30 cm/hr.

The second Hewlett-Packard 2116B computer will be used to stack the 6 channels of the main cable and improve the quality of the seismic sections. Seismic sections will be displayed on-line from the computer using an electrostatic paper recorder with paper speed of 30 cm/hr. Stacked records and "spit-out" records will also be recorded by the Ampex tape recorder in analogue form.

This report collates the geological and geophysical information known about the survey area for use as an operations guide and for an aid to future interpretation of the survey results.

2. GEOLOGY

The survey area will cover the offshore extension of three sedimentary basins, the Tasmania, Gippsland and Sydney Basins (Plate 2). The remaining onshore rocks are the Palaeozoic and Triassic rocks of the Tasman Geosyncline. As the three basins are small in extent, only a brief summary will be proved of their geology.

In the south, the central nucleus of the Tasmanian mainland is made up of the Tynnan Block. This block is flanked on the south and east by Permian and Triassic sediments of the Tasmanian Basin which are extensively intruded by Jurassic dolerites. Tertiary faulting in the eastern half of Tasmania has created the north-northwesterly striking horst and graben structures which reach the southern and eastern coasts. These structures are filled with terrestrial deposits and olivine basalts, and these are intruded by syenites.

The Gippsland Basin is a small Tertiary to Mesozoic basin lying within the Palaeozoic Tasman Geosyncline. At its base the sediments rest on Cambrian to Carboniferous metasediments and intrusives and in the south they rest on the Permian of the Tasmanian mainland.

Jurassic to Lower Cretaceous rocks of terrestrial or continental type are deposited in a Mesozoic graben or half graben offshore. About 6 km of Mesozoic and Lower Cretaceous rocks are overlain by about 2 km of Tertiary sediments. The Upper Cretaceous rocks are present offshore and are of freshwater origin. The Upper Cretaceous is eroded locally and gives way in the Eocene to the marine invasion which culminates in the Oligocene. A shallow marine environment continued throughout the Miocene and in the Mid-Pliocene deposits became fluviatile as the seas became shallower.

Structures are generally influenced by the earlier east-west trends developed in the Mesozoic but swing northeast offshore.

The Sydney Basin is a small Palaeozoic Basin consisting of 1200 m of non-marine Triassic rocks overlying 4800 m of Permian sediments. The basin rests on metamorphosed Carboniferous rocks in the north while the lowest Permian marine sequence interfingers with extensive volcanic deposits in the south. Offshore, the basin is reported to shallow seawards. The thickest sequence recorded offshore is about 4800 m near Newcastle.

Structures within the basin are generally north south except where they come under the influence of the faulted northeastern margin and swing parallel to the margin.

3. PREVIOUS GEOPHYSICS

(A) AEROMAGNETIC SURVEYS

Bass Strait and Encounter Bay Aeromagnetic Survey (Hematite Exploration Pty Ltd, 1965) surveyed part of the Gippsland Basin over the Bassian Rise. The magnetic basement trends are generally northeasterly in the southern part of the Gippsland Basin and northwesterly over the Bassian Rise. The basement depths in the Gippsland area are estimated to reach 1100 m offshore.

Terrigal Aeromagnetic Survey (Central Coast Oil, 1964) showed an estimated basement depth of 2800 m in the central Sydney basin near Newcastle. The basement appears to shallow abruptly along the line of the Carboniferous outcrop.

Sydney - Newcastle Aeromagnetic Survey (Shell Development (Aust.) Pty Ltd, 1966) observed the deepest part of the Sydney Basin to be near the coast with a shallowing of the basement along the Continental Shelf. The offshore part of the basin is divided into two embayments, (a) the extension offshore of the Hunter River Valley, (b) the southeastern extension of the Hawkesbury River. A depth of 4600 m is estimated to the basement near Newcastle. The basement rise to the east was to depths of 900 to 2400 m.

East and West Bass Strait Aeromagnetic Survey (Magellan Petroleum Australia Ltd, 1967). This report has not been filed for general reference.

Offshore Tasmania Aeromagnetic Survey by Esso Exploration Australia Inc., and Electrolytic Zinc Co. Aust. Ltd (1966) shows that most of the magnetic anomaly features are the seaward extension of magnetic basement recorded onshore. Two areas of possible sedimentary deposits were located, (a) to the southwest within the 100 fathom line with 4000 m depth to basement, (b) to the south of Tasmania where basement is at a depth of 3300 m. Smaller zones of deep magnetic basement (3000 m) occur along the eastern coast.

(B) GRAVITY SURVEYS

The Helicopter Gravity Training Survey (Lodwick G.D. and Flavelle A.J. 1968) indicates a crustal thinning of the region offshore between latitudes 35° and

36^{o}S. Bouguer values of gravity are greater than 50 milligals along 100 km of coastline.

The Oceanographic traverses of Australia (Reisz, E.J. and Moss, F.J. 1971) shows five ships tracks crossing the survey area. The most extensive gravity coverage by these oceanographic vessels was made by Oceanographer (USC and GSS). The Umitakamaru (Japan), Conrad C-8, C-9 (Lamont), Eltanin G-39 (U.S.N.), Vema U-18 (Lamont) and Telemachus, Bergull and Capitaine (Submarine gravity) all made traverses recording gravity within the proposed 1971 marine survey area.

(C) SEISMIC SURVEYS

Marine seismic exploration has been carried out in the Gippsland Shelf area by Esso and Magellan. These surveys cover most of the Gippsland Shelf area and are contained in subsidised reports listed below.

1964	Gippsland Shelf Marine Seismic Survey By	Esso	(64/4550)
1966	Eastern Bass Strait Seismic Survey	"	(66/11070)
1967	Gippsland EC-67 Marine	"	(67/11184)
1968	Offshore Gippsland Basin E14-68	"	(68/3015)
1968	East Gippsland Basin Marine and Magnetic by Magellan		(68/3049)
1969	Tasmania - Bass Strait Marine Seismic by Magellan		(69/3023)

From these surveys the recorded reflecting horizons have been equated with
1. Gippsland Limestone
2. Lakes Entrance Formation
3. Latrobe Valley Coal Measures
4. Basement

Rapid changes in average vertical velocities have been encountered in the structural high regions. These structural high regions have been drilled for oil. The velocity changes are attributed to lateral changes of marls to limestone and sandstone. The large scale structural changes result in significant lateral velocity variations due, in part, to the variations in thiskness of stratigraphic units. A Palaeocanyon with a southeasterly trend from the Lakes Entrance coast is filled with Eocene Latrobe Valley Coal Measures. The average velocity function used across the Gippsland Basin, excluding the structural highs is given in Appendix II.

Marine seismic surveys carried out in the Sydney Basin area have been conducted by Shell, Magellan and Longreach Oil. The subsidy reports are listed below:

1970 South Sydney Basin Marine Survey by Magellan (70/486)

1967 Offshore Sydney Experimental Seismic by Shell (67/11170)

1964 Offshore Sydney Basin by Shell (64/4565)

1970 South Broken Bay Marine Survey by Longreach Oil (70/803)

1969 Broken Bay Marine Seismic Survey by Longreach Oil (69/3070)

These seismic surveys recorded very poor events over most of the Sydney Basin. The deepest part of the Sydney Basin was found to be close to shore. The prospective section is considered the Permian to Trias deltic section but these rocks are disturbed by faulting, intruded by volcanics and appear to thin eastwards in the offshore region.

(D) BORE HOLE LOGS

The two subsidised wells drilled by Esso are Gippsland Shelf No. 1 and Gippsland Shelf No. 4. Both these wells have velocity logs. The time depth curves calculated from these velocity logs are given in Appendix III. The subsidy reports are:

(1965) Gippsland Basin No. 1 Report Number 64/4124

(1966) Gippsland Basin No. 4 Report Number 65/4183

(E) BATHYMETRY

Ocean Sounding Charts provide a recent compilation of ships tracks and water depths in the region. South of Tasmania these charts contain many tracks radiating from Hobart to the Antarctic. The regular grid of traverses planned in the region to about 50°S and confined by longitudes 142°E and 152°E will cross an extension of the continental slope south from the Tasmanian coast. A second extension of the continental slope is located southeast of Hobart. Traverse lines will be extended from the shore to 152°E to cover this second region.

4. OBJECTIVES AND PROGRAM

The objectives of the survey are:-

(i) to measure water depths along traverses approximately 20 nautical miles apart and out to a depth of 4000 metres.

(ii) to investigate the shallow sub-bottom, the extent of possible offshore sedimentary basins, the sedimentary structures down to some few thousand metres and the basement tectonics in the main areas of operation.

(iii) to evaluate and where necessary modify or develop techniques and systems applicable to this type of multisensor geophysical survey.

The program is devised to survey an area of the Continental Margin between 50°S and 34°S (Plate 1). The east coast of Tasmania and the Gippsland Shelf area of Bass Strait will be the only section north of Hobart to be surveyed during the summer of 1971. South of Hobart the survey will be limited to the area between approximately 142°E and 152°E.

The survey will be split into 3 cruises.

1. The first cruise will follow a short 2 day test run from Hobart. The ship will first make one tie across the area 47°S to 50°S to define where the broad continental slope grades into the oceanic ridge to the south. Regular traversing will start at this transition zone and is expected to consist of 8 traverse lines, each approximately 1½ days long.

2. The second cruise will complete the 11 traverse lines required to cover the remaining area south of Hobart. Traverse deviations are planned to cross the sea mounts already mapped in the area. The area will have three tie lines crossing the main traversing.

3. Cruise 3 will cover the shelf and slope along the eastern coast of Tasmania, the Gippsland Shelf and the Eastern Coast of Victoria and southern New South Wales as far north as Sydney. Tie lines from Sydney to Hobart and return will be needed. These are not drawn on Plate 1. The basement rise between Wilson's Promentary and Flinders Island will not be crossed by the survey work during early 1971.

Coverage: Cruise 1 3200 nautical miles
Cruise 2 3400 nautical miles
Cruise 3 3800 nautical miles

Total 10 400 nautical miles (19 300 km).

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APPENDIX I

VELOCITY INFORMATION, GIPPSLAND SHELF EXCLUDING STRUCTURALLY HIGH AREAS (FROM SEISMIC SURVEYS)

Two-way Time (s) Below water bottom	Depth (ft) Below water bottom	Average Velocity (ft/s)
.100	250	5000
.200	509	5090
.300	839	5593
.400	1211	6055
.500	1598	6392
.600	2004	6680
.700	2466	7045
.800	2963	7407
.900	3529	7842
1.000	4139	8275
1.2	5733	9556
1.4	7606	10865
1.6	9548	11935
1.8	11872	13191
2.0	14753	14753
2.2	16049	16048
2.5	21424	17139
4.0	42754	21377

APPENDIX II

VELOCITY INFORMATION FROM SONIC LOGS

Esso Gippsland Shelf No. 4

Two-way Time (s)	Depth (ft)	Average Velocity (ft/s)
	0	600
0.4	1260	
0.6	2150	
	2175	7260
0.8	3150	
	3475	8050
1.00	4075	
	4490	8225
1.2	5010	
	5075	8375
	5970	8550
1.40	6030	
1.60	7160	
	7470	8990

Esso Gippsland Shelf No. 1

	1200	6000
0.4	1280	
	1500	6500
0.6	2080	
	2500	7320
	3000	7660
0.8	3075	
1.0	3940	
1.2	4890	
	5500	8300
1.4	5860	
	6000	8400
1.6	7050	
	8000	9160
1.8	8330	
	8500	9300

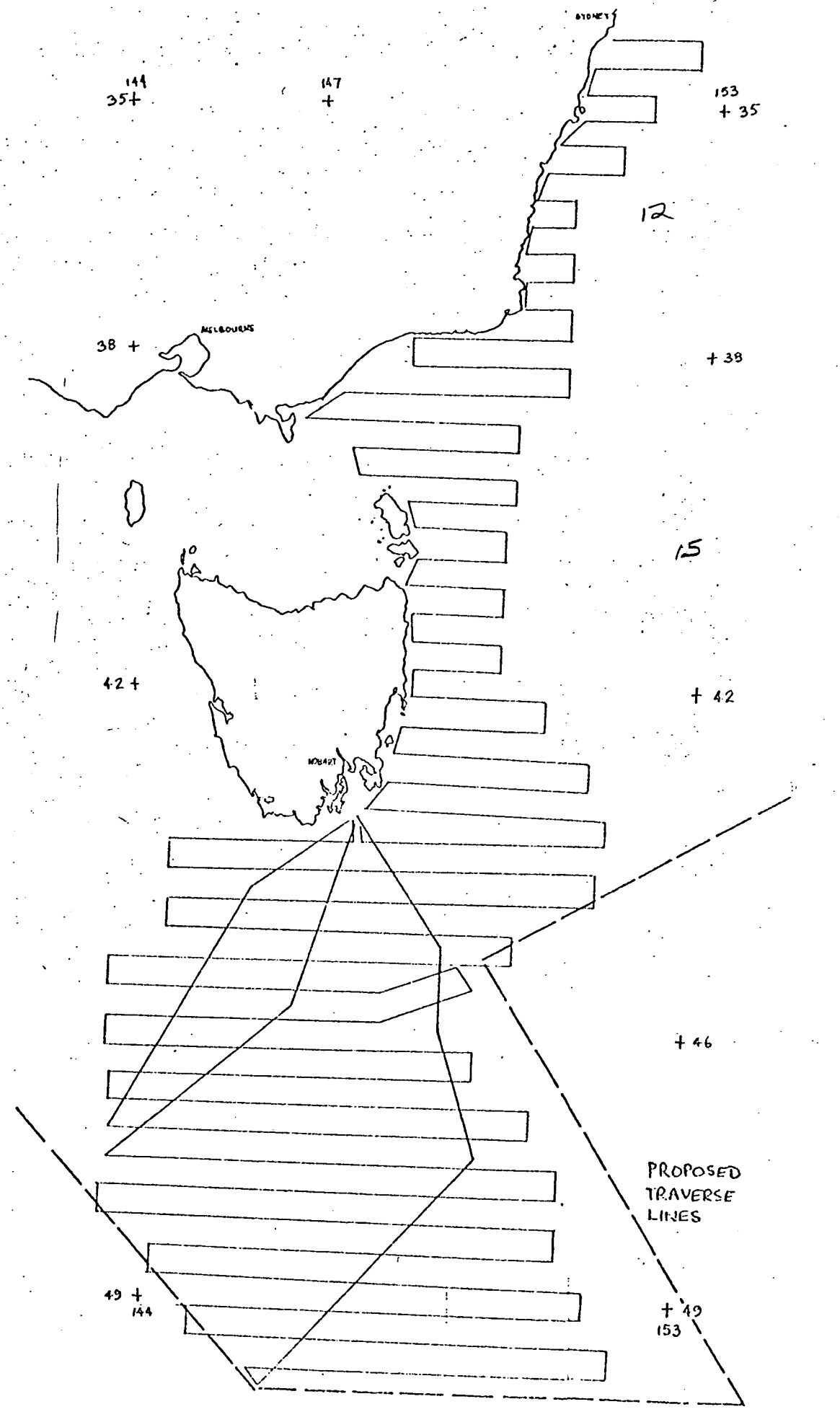
SYDNEY
MELBOURNE
HOBART
144
35+
147
+
153
+ 35
12
38 +
+ 38
10
15
42 +
+ 42
+ 46
PROPOSED
TRAVERSE
LINES
49 +
144
+ 49
153

Plate 1

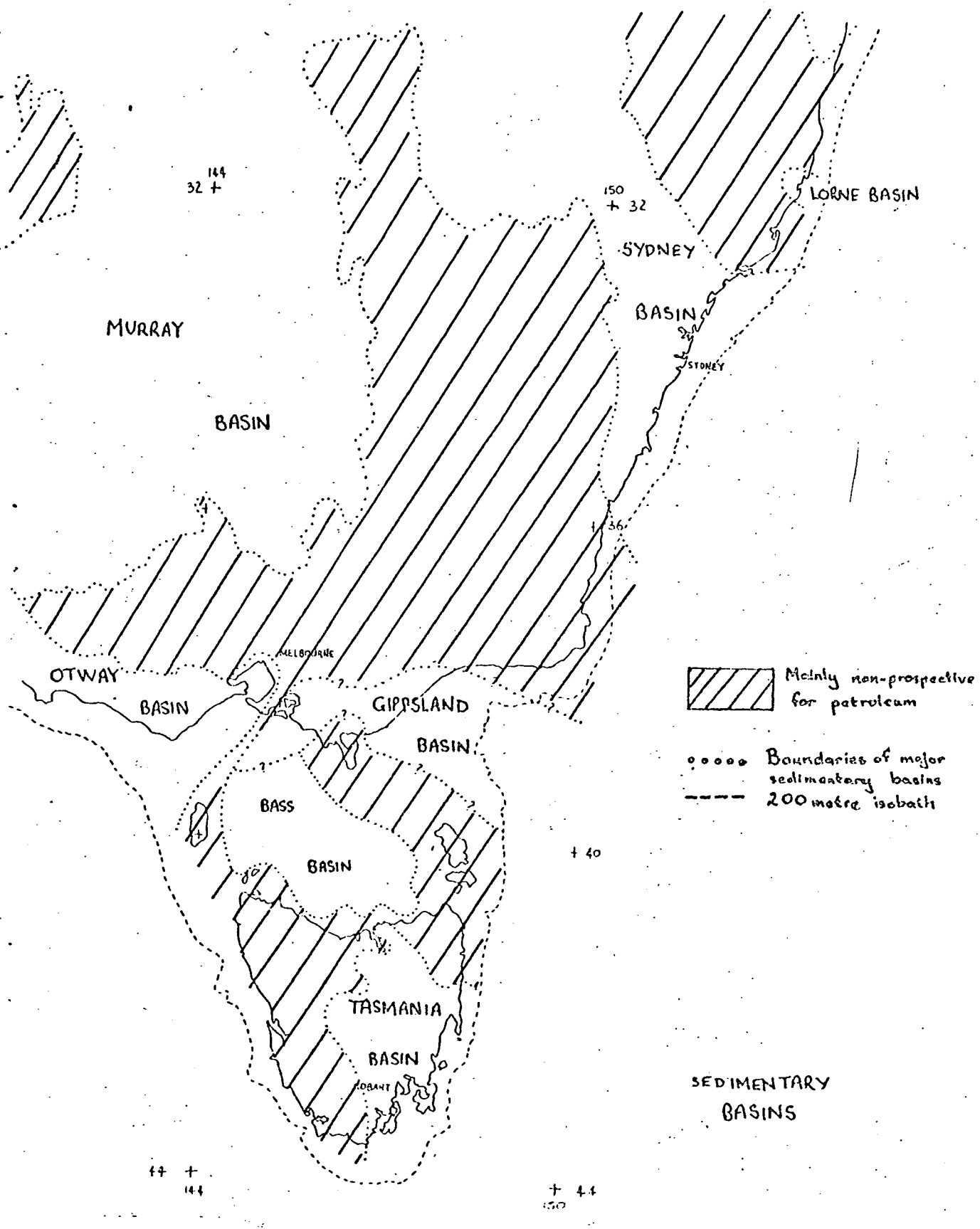
144
32
150
32
LORNE BASIN
SYDNEY
BASIN
MURRAY
BASIN
SYDNEY
36
MELBOURNE
OTWAY
BASIN
GIPPSLAND
BASIN
BASS
BASIN
40
TASMANIA
BASIN
HOBART
Mainly non-prospective for petroleum
Boundaries of major sedimentary basins
200 metre isobath
SEDIMENTARY
BASINS
144
44
150

Plate 2