COMPAGNIE GÉNÉRALE DE GÉOPHYSIQUE

AUSTRALIAN AQUITAINE PETROLEUM PTY. LTD.

CAPE HAY - CAPE FORD MARINE SEISMIC SURVEY.

(Flexotir Method)

September - December 1966

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

FIGURES

PLATES

9	Bathymetric Chart		:	scale	1/250,000
10	Time contour map	: Horizon 2	:	scale	1/100,000
11	Time contour map	: Horizon 3	:	scale	1/100,000
12	Time contour map	: Horizon 4	:	scale	1/100,000
13	Time contour map	: Horizon 5	:	scale	1/100,000
14	Time contour map	: Horizon 7	:	scale	1/100,000
15	Time contour map	: Horizon 8	:	scale	1/100,000
16	Time contour map	: Horizon 2	:	scale	1/250,000
17	Time contour map	: Horizon 3	:	scale	1/250,000
18	Time contour map	: Horizon 4	:	scale	1/250,000
19	Time contour map	: Horizon 5	:	scale	1/250,000
20	Time contour map	: Horizon 7	:	scale	1/250,000
21	Time contour map	: Horizon 8	:	scale	1/250,000
22	Isopach Contour map	: Horizons "2 - 4"	:	scale	1/250,000
23	Isopach Contour map	: Horizons "4 - 5"	:	scale	1/250,000
24	Isopach Contour map	: Horizons "7 - 8"	:	scale	1/100,000
25	Regional Interpretation	: Horizon 2	:	scale	1/500,000
26	Regional Interpretation	: Horizon 5	:	scale	1/500,000
27	Regional Interpretation	: Horizon 8	:	scale	1/250,000

PLATES NOT INCLUDED IN THIS REPORT

- Variable Area cross-sections made on board the vessel.
- Processed V.A. cross-sections made in the C.G.G. processing centre in France, except lines CF-CH 18, PPA 3 and QCA 15.
- Sparker sections (except line CH 20).
- Depth Sounder sections.

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ABSTRACT

In a two and a half month seismic survey, COMPAGNIE GENERALE DE GEOPHYSIQUE carried out a semi-detailed and detailed programme in OP 83 and in the offshore part of OP 2, on behalf of AUSTRALIAN AQUITAINE PETROLEUM PTY. LTD. A.A.P. is the operator in these permits under farm-out agreements with ASSOCIATED CONTINENTAL PETROLEUM N.L. and ASSOCIATED AUSTRALIAN OILFIELDS N. L. the respective licence holders for the areas.

The programme as planned provided for:

I. Detailing work on a previous structure in the Queens Channel area.

II. Additional control of several faulted structures west of Pearce Point.

III. Locating possible structures in the Cape Hay - Cape Ford area especially along the north north-west / south south-east high trends previously found.

The results confirmed the existence of a small structure of low relief in the Queens Channel area and enabled its shape to be well defined.

In the Pearce Point area, one structure of an intrusive character (A2) was found.

Northward, a well closed anticline A4 was well delineated. Also several high zones (A3 and south eastern part of A5) were suggested.

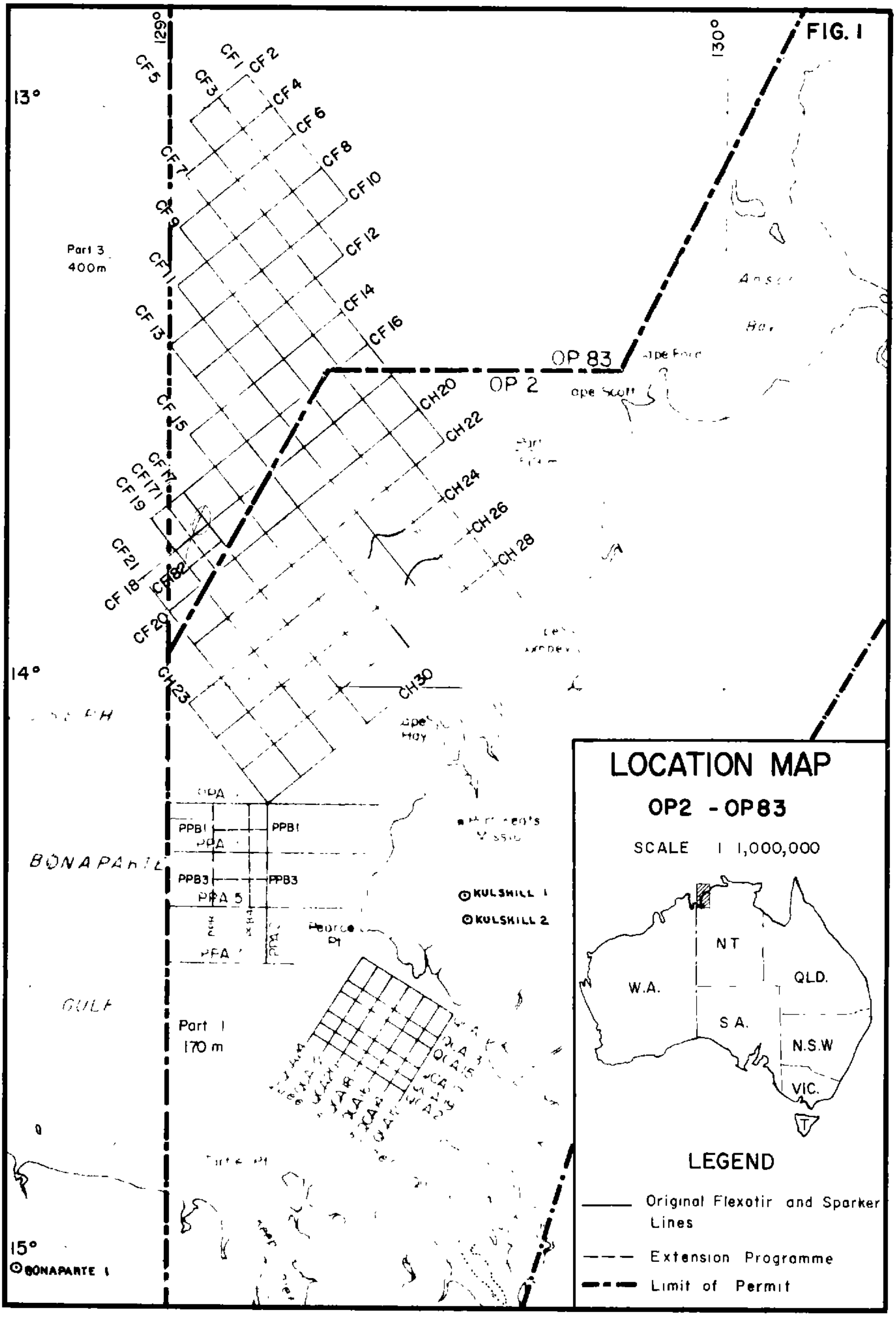


FIG. 1
LOCATION MAP
OP2 - OP83
SCALE 1 1,000,000
LEGEND
Original Flexotir and Sparker Lines
Extension Programme
Limit of Permit
129°
130°
13°
14°
15°
OP 83
OP 2
Part 3
400m
Part 1
170 m
CF1
CF2
CF3
CF4
CF5
CF6
CF7
CF8
CF9
CF10
CF11
CF12
CF13
CF14
CF15
CF16
CF17
CF18
CF19
CF20
CF21
CH20
CH22
CH23
CH24
CH26
CH28
CH30
PPB1
PPB3
PPA 5
KULSHILL 1
KULSHILL 2
BONAPARTE 1
GULF
W.A.
NT
QLD.
S.A.
N.S.W
VIC.
T

INTRODUCTION

A marine seismic survey, the subject of the present report, was carried out by COMPAGNIE GENERALE DE GEOPHYSIQUE on behalf of AUSTRALIAN AQUITAINE PETROLEUM PTY. LTD. in OIL PERMITS 2 and 83 in the Bonaparte Gulf of the TIMOR SEA.

This survey was called the CAPE HAY - CAPE FORD SURVEY and followed several seismic, gravity and aeromagnetic surveys.

The party used the French designed Flexotir or Cage-Shooting method and E.G.& G. Boomer equipment.

The TORAN System with lane identification was used for radiopositioning of the vessel.

Calibration of the TORAN system was made between the 14th. and the 21st. of September.

Seismic operations were carried out between the 22nd. September and the 2nd. of December. They were interrupted for one week to perform a short test in an adjacent area for ARCO LTD.

Supervision was secured from Brisbane and aboard the ship, by Y. GODECHOT for A.A.P. and J. M. CUNIN for C.G.G.

CHAPTER I

GEOLOGICAL AND GEOPHYSICAL DATA

(Information supplied by AAP)

I. REGIONAL GEOLOGY

The Queens Channel, Pearce Point and Cape Hay offshore are part of the Bonaparte Gulf Basin, which consists of sedimentary rocks ranging in age from Lower Cambrian to Triassic.

STRATIGRAPHIC NOMENCLATURE OF THE BONAPARTE GULF BASIN

Established by D. TRAVES and later modified by J. VEEVERS et al. (B.M.R.) and by Australian Aquitaine Petroleum.

AGE		FORMATION	
CRETACEOUS		No Stratigraphic name applied	
TRIASSIC ?		Lingula Shales	
LOWER PERMIAN		OLDHAMIA UPPER MARINE BEDS FOSSIL HEAD BEDS	
		UNCONFORMITY ?	
LOWER PERMIAN	PORT KEATS GROUP	SUGARLOAF FORMATION	)-Shale Member)-Sandstone Member
LOWER PERMIAN	PORT KEATS GROUP	KULSHILL FORMATION	)-Greywacke Member)-Microconglomeratic) Shale Member)-Basal Silicified) Sandstone Member
LOWER PERMIAN to LOWER CARBONIFEROUS	PORT KEATS GROUP	UNNAMED BEDS	
		UNCONFORMITY	

Continued:

Continued:

	-UNCONFORMITY
LOWER CARBONIFEROUS	BORDER CREEK FORMATION POINT SPRING SANDSTONE TANMURRA FORMATION MILLIGAN BEDS (Members I to IV)
	UNCONFORMITY ?
	ZIMMERMAN FORMATION
	LOCAL UNCONFORMITY
	SEPTIMUS FORMATION ENGA FORMATION
	LOCAL UNCONFORMITY
	BURT RANGE FORMATION
	-UNCONFORMITY
UPPER DEVONIAN	NIMBING LIMESTONE COCKATOO FORMATION (Subdivided into several Members)
	-UNCONFORMITY
LOWER ORDOVICIAN	PANDER GREENSAND
MIDDLE to UPPER CAMBRIAN	CLARK SANDSTONE PRETLOVE SANDSTONE SKEWTHORPE FORMATION HARTSPRING SANDSTONE TARRARA FORMATION BLATCHFORD FORMATION
	-UNCONFORMITY
LOWER CAMBRIAN	ANTRIM PLATEAU VOLCANICS
	-UNCONFORMITY
PROTEROZOIC	

The Upper Devonian and Lower Carboniferous have been proved, in the southern part of the basin, to contain some good source rocks and reservoir beds.

After Kulshill Wells Nos. 1 and 2 and Moyle No. 1, it appears that Lower Permian units as well as the Upper Section of the Lower Carboniferous (Tanmurra Formation) have to be regarded as the most interesting oil prospects of the OP 2, mainly in respect of the offshore part. In the Queens Channel area it is possible to find Lower Carboniferous and Devonian reservoir formations, but westward from Port Keats, these targets would be probably too deep to be reached by drilling. Some marine formations of the Upper part of the Lower Permian (Fossil Head beds and Oldhamia Upper marine beds), which are eroded on the top of the Kulshill structure, but nevertheless outcropping along the west, are probably increasing in thickness towards the sea and could be good source rocks.

The Mesozoic formations which are not very well known on shore, are dipping towards the sea and may reveal some interest in the off-shore area. Apart from a thin veneer of Cretaceous, only 300 feet of Lingula Shales, possibly Triassic in age have been encountered in Port Keats coal bore. Such a sequence could also provide a source rock as well as an excellent cap rock for the underlying Sandstone of the Sugarloaf Formation, one of the best Paleozoic reservoirs found by drilling. Seaward not only a thicker Mesozoic sequence may be expected but also a more complete series including Jurassic formations.

The various faults and/or fault systems existing in this zone are considered to have already moved during the Paleozoic sedimentation, thereby influencing the nature of the deposits especially during the Paleozoic period.

II. GEOPHYSICAL DATA

II.1 Gravity Information (Fig. 2)

From 1955 to 1957, several gravity surveys were carried out by the B.M.R. and Mines Administration Pty. Ltd. on shore, on both sides of Queens Channel, and in the Channel itself by a B.M.R. team using underwater gravity meters.

A number of regional and detailed gravity surveys have also been made along the western and southern coastal areas of Joseph Bonaparte Gulf by the B.M.R. and the various lease-holders, the latest one being a Marine Sparker and Gravity Survey in 1965 by the B.M.R. covering a large part of the Bonaparte Basin.

The most striking feature of the results, map (Fig. 2), was the large positive anomaly which occupies the central part of the area. As this anomaly did not appear either on the aeromagnetic nor on the seismic maps, its origin might be a high density change of the material in the basement, not accompanied by a change of magnetic content of the rocks.

The Queens Channel appeared to be an area of gravity culmination along a trend of low, the direction of which was approximately north-south.

II.2 Aeromagnetic Surveys (Fig. 3)

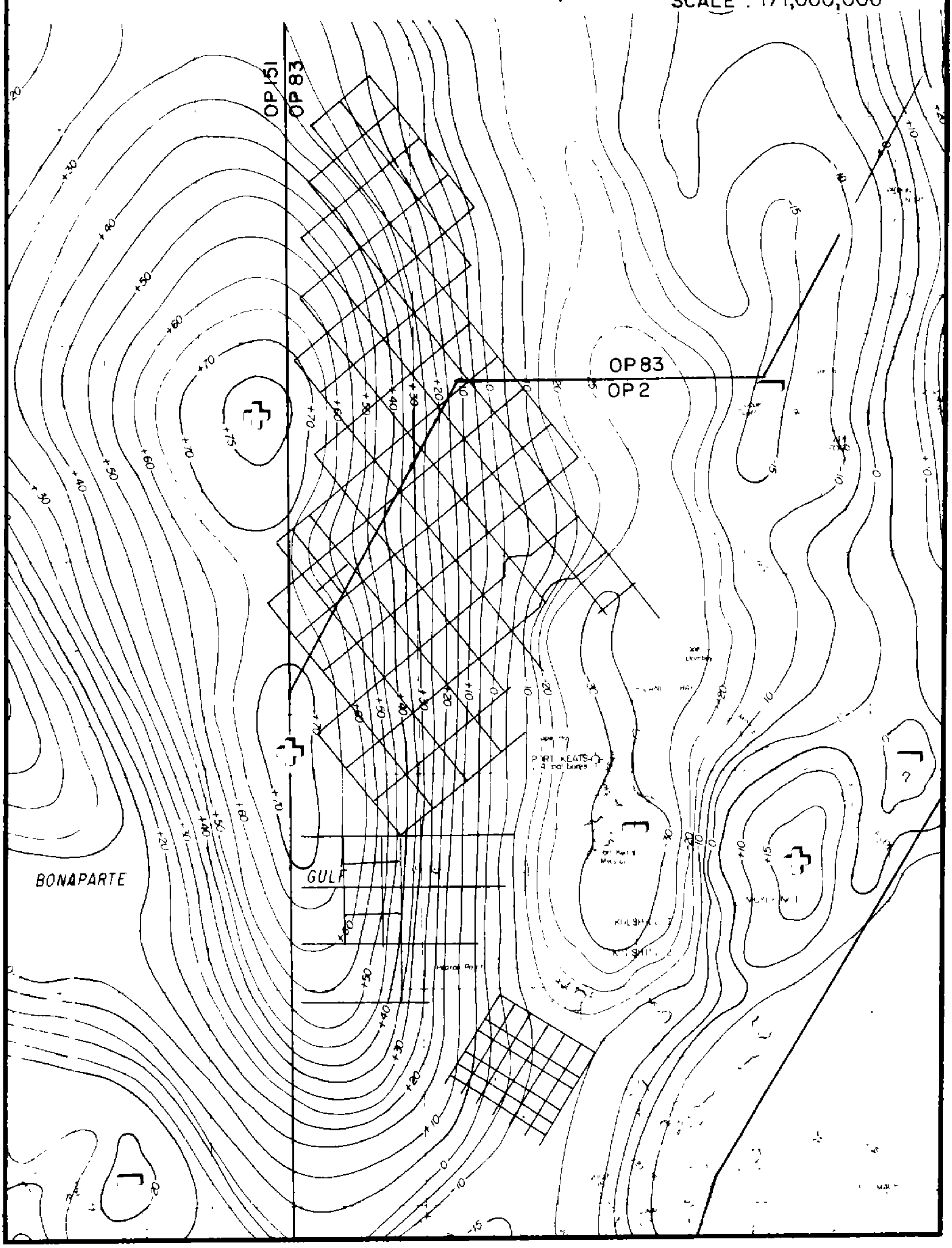
Various local aeromagnetic surveys have been carried out over the surrounding zone of the Bonaparte Gulf Basin since 1959. Among them, we should mention the 1963 Anson Bay Aeromagnetic Survey carried out by Adastra for MINAD, covering the whole of OP 83 and the extensive survey which was made

FIG. 2

GRAVITY DATA

(MARINE GRAVITY AFTER B.M.R.)

SCALE : 1/1,000,000

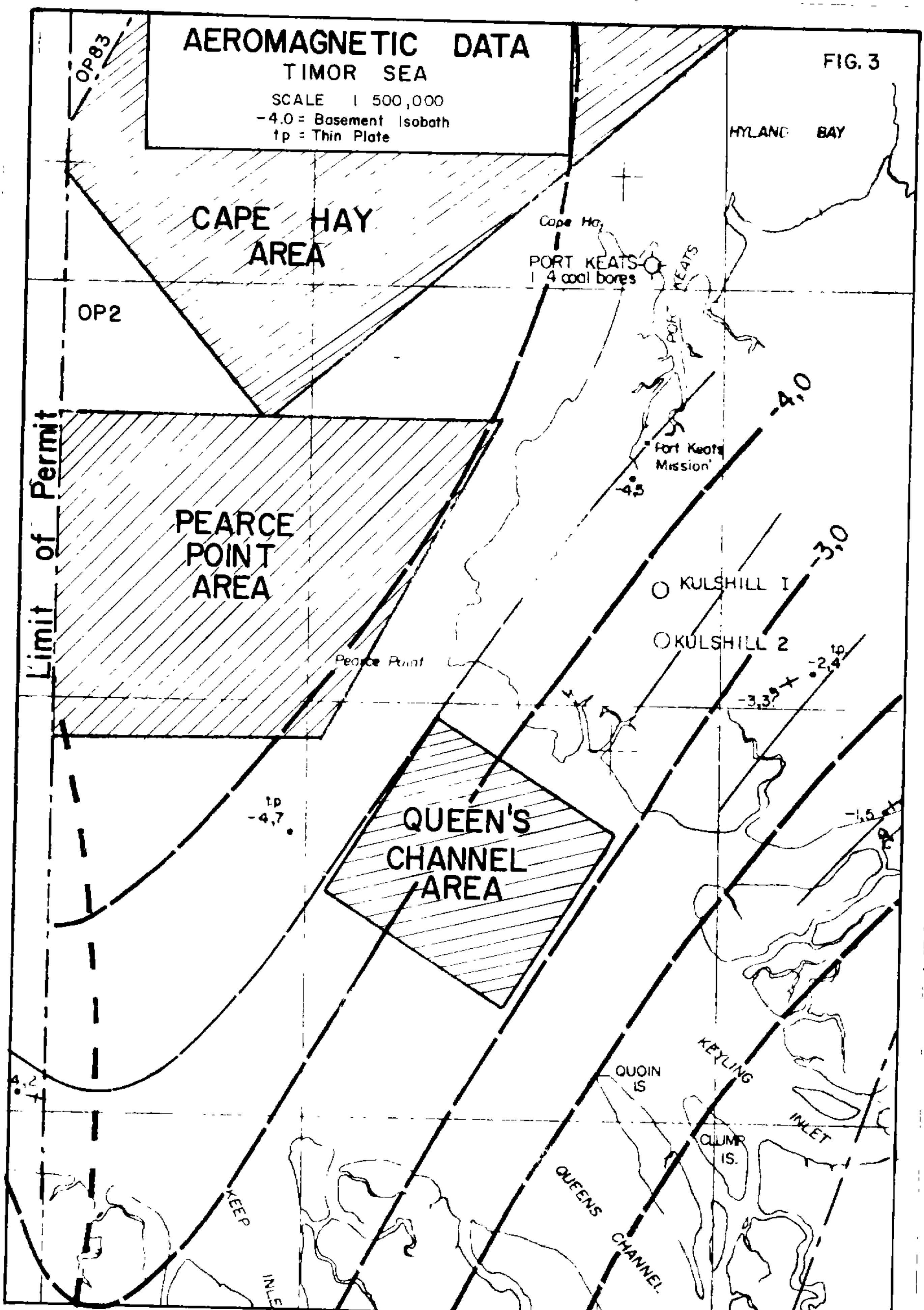


by ARCO-AAP in 1965, covering most of the continental shelf of the Timor Sea. The first one showed an apparent increase in depth of the Magnetic Basement to the north north-west of OP 83. The second one was tied to the Port Keats area by a few lines and completed by a two lines survey over the Queens Channel. In this part of OP 2, it was found that the Magnetic Basement was regularly deepening towards the north west, reaching a depth of about 5000 metres in the main Joseph Bonaparte Gulf. However, in the north west part of the permit, the basement seemed to be deepening to the west.

II.3 Seismic Data (Fig. 4)

In 1961, Seismograph Service Ltd. conducted a seismic survey for the Associated Group which showed an increasing thickness of the sedimentary section from Cape Dombey to Quoin Island in the Queens Channel. This was confirmed in 1964 by the Queens Channel Seismic survey of which one object was to establish the existence of a high in the Queens Channel. In fact, a possible structural feature was found but was not very well defined. However, its position was coincident with the gravimetric threshold found by previous surveys.

Meanwhile the Flat Top Bank Marine Seismic Survey in the north and the west of Cape Hay, showed from a few lines that the Bonaparte Basin was thickening and steadily deepening to the west. These preliminary results were confirmed by the "Timor Sea, Joseph Bonaparte Gulf Area Survey" conducted by Geophysical Associates for the Bureau of Mineral Resources. Three main continuous horizons could be followed. The upper one might be Mesozoic, the lower two being located in the Permian. The survey gave some structural indications which needed some complementary information: existence of several anticlines dipping south east to north west in the southern part of OP 83 and the

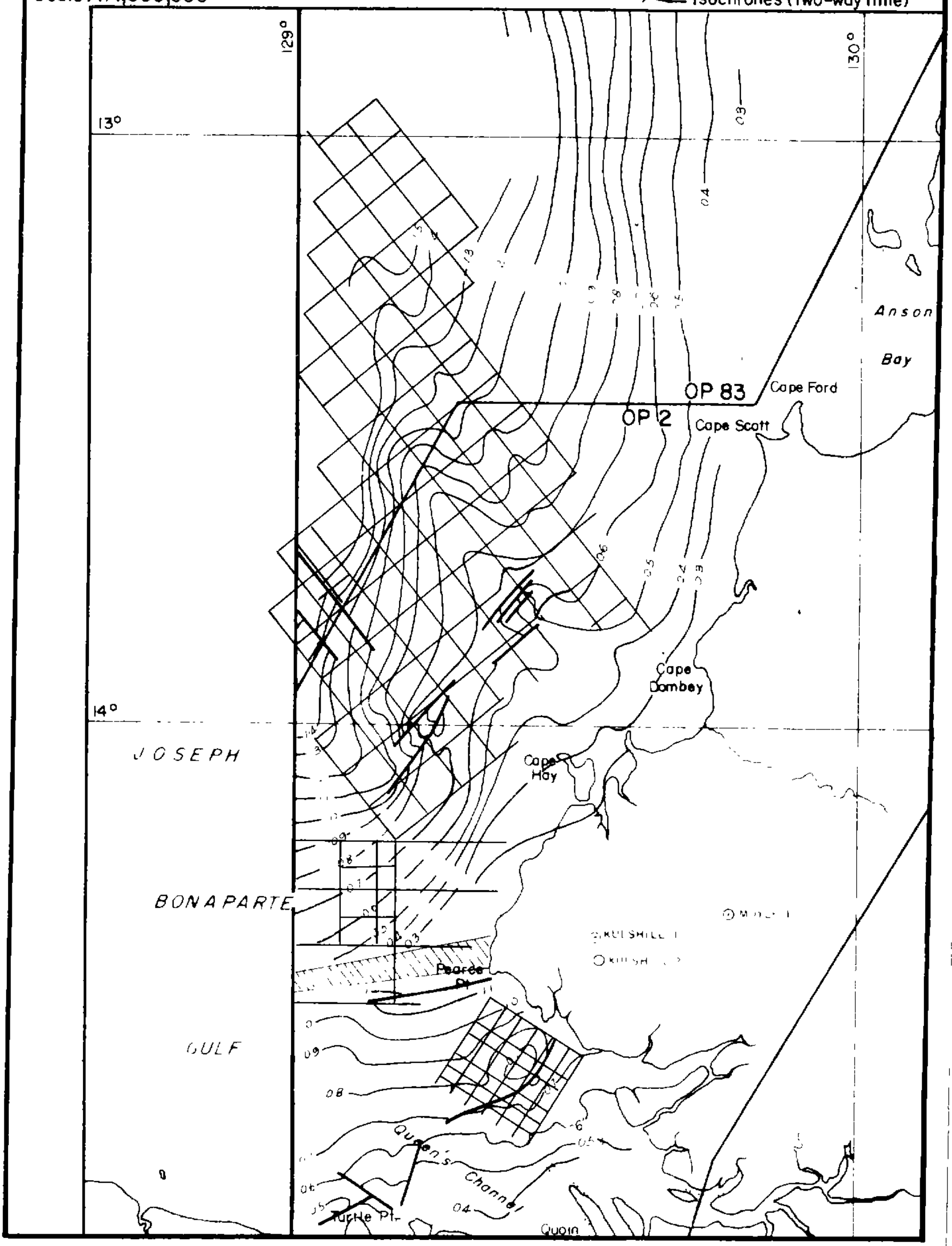

AEROMAGNETIC DATA
TIMOR SEA
SCALE 1 500,000
-4.0 = Basement Isobath
tp = Thin Plate
FIG. 3
OP83
HYLAND BAY
CAPE HAY AREA
Cape Hay
PORT KEATS
1 4 coal bores
PORT KEATS
OP2
-4,0
Port Keats Mission
-4,5
Limit of Permit
PEARCE POINT AREA
-3,0
KULSHILL 1
KULSHILL 2
tp -2,4
-3,3
Pearce Point
tp -4,7
QUEEN'S CHANNEL AREA
-1,5
KEYLING INLET
QUOIN IS
CLUMP IS.
-4,2
KEEP INLET
QUEENS CHANNEL

north west part of OP 2, and of some faulted features in the central part of OP 2 but without a very well defined direction. However, the large positive gravity anomaly which was found along the 129° longitude parallel was not related to any seismic high, moreover, the Permian horizons reached a depth of more than 1700 ms two way time in the western part of OP 2.

FIG. 4

SEISMIC DATA

Scale: 1/1,000,000



CHAPTER II

REASONS FOR THE SURVEY AND PROGRAMME

(Supplied by A. A. P.)

The area to be investigated can be divided into three different areas;

I. In the Queens Channel area, the survey was designed to outline the shape, and define the faulting system of the structure previously located in the area of the Mermaid Bank. A 170 mile grid of seismic lines was planned. Permian and Sub Permian horizons were expected to be followed.

II. West of Pearce Point, a wide area had not been covered sufficiently to allow a good definition of several faulted structures previously encountered. It was thought that 5 seismic lines, totaling 110 miles, would give adequate coverage of the Port Keats offshore area.

III. In the north of OP 2 and in the south-west of OP 83, the survey was to try to find structural closures on the long noses dipping to the north west, along the eastern flexure of the Bonaparte Gulf Basin. To do so, the programme consisted of a grid of orthogonal lines north east-south west and north west - south east in directions. The planned mileage was about 920 miles.

Few changes were made to the initial programme during the progress of the survey.

Several parts of lines were twisted or had to be abandoned in a shallow reef area west of Cape Dombey.

A few short lines were added to obtain additional control of structures (CF 182, CF 171, PPB 1, PPB 2, PPB 3 and PPB 4).

CHAPTER III

TECHNIQUES AND OPERATIONS

I. TECHNIQUES

I.1 Flexotir Technique

This new method has been developed by the Institut Francais de Petrole (IFP) in co-operation with Compagnie Generale de Geophysique.

In marine operations, the signal amplitude of the seismic waves originating from an explosive charge increases with the depth of the shot below the surface (up to 40 feet). However, in deep water, the explosion generates a "bubble effect" which disturbs the records.

In conventional marine, the "bubble effect" is cancelled by shooting near the surface, but most of the explosive energy is wasted when the bubble blows out at the surface.

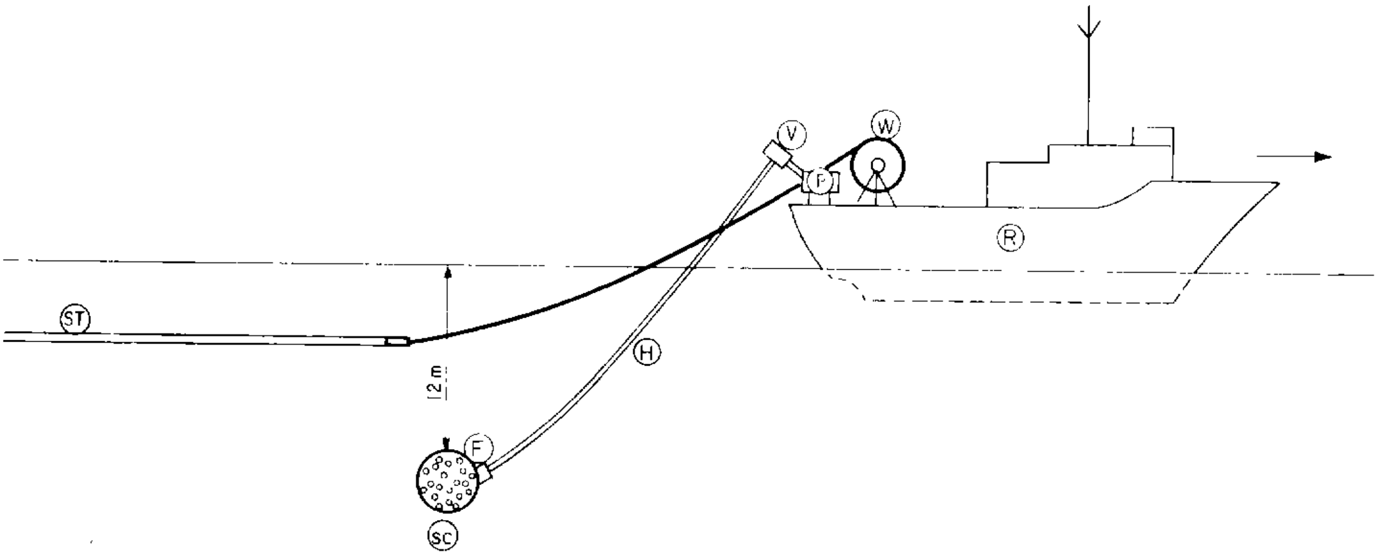
With the Flexotir system (Fig. 5), the cancellation of the bubble effect is obtained by shooting in a steel sphere, perforated with small holes. These holes damp the movement of the water driven out by the gas of the explosion, thus dissipating most of the oscillation energy, though the acoustic energy is not reduced. Therefore it is possible to shoot at the optimum depth and save a considerable amount of explosives.

The loading system allows a high shooting rate (up to 3 shots per minute). The charge is driven into the sphere through a flexible hose by water under high pressure. A special device maintains it in the centre of the sphere and also fires it. After the explosion the cartridge is completely destroyed.

FIG. 5

FLEXOTIR

OPERATING TECHNIQUE



R — RECORDING SHIP

W — WINCH

ST — STREAMER

SC — SHOOTING CAGE

H — LOADING HOSE

F — FIRING SYSTEM

V — VALVE

P — PUMP

Another advantage of the Flexotir method is that it does not endanger the sea life.

Any type of streamer can be used with the flexotir system as the signal spectrum is similar to that of a normal explosion. Single trace, six trace and 24 trace streamers have been successfully tested. The best sections are obtained using a 24 trace streamer, two shooting spheres and 6 or 12 fold coverage. These sections are similar to a dynamite survey with multiple coverage.

Data recording and processing is similar to that of conventional methods.

I. 2 Sparker Technique (Information provided by E.G.& G. INC.)

The E.G.& G. Boomer Profiling System is a low frequency device capable of providing valuable data on geological interfaces beneath the ocean floor.

The basic system comprises a sound source section, and a receiving - recording section (Fig. 6).

I. 3 Radio Positioning Technique (Fig. 7)

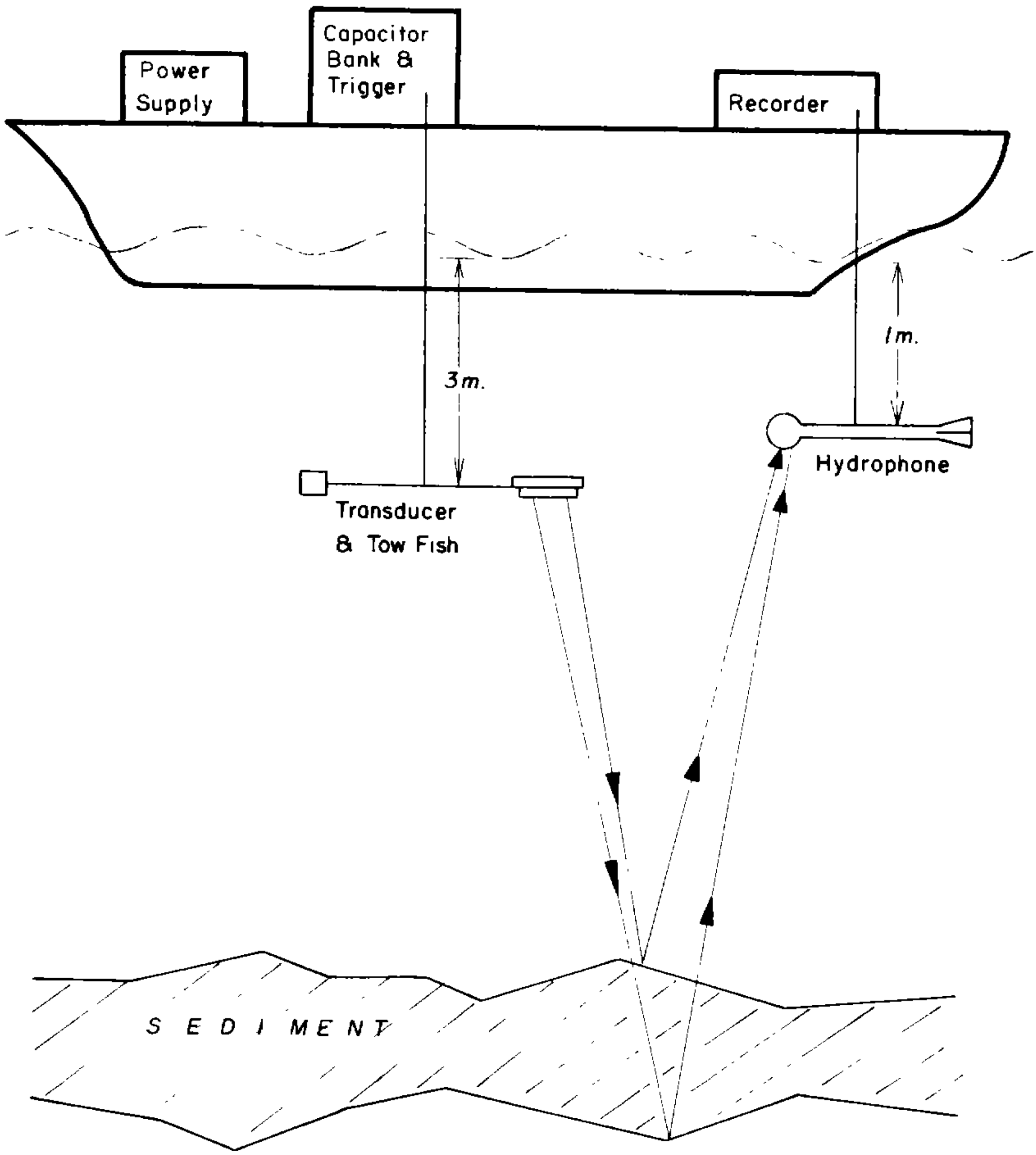
The TORAN is a hyperbolic system based on the principle of the measurement of the phase of a low frequency beat signal derived from two high frequency signals which are radiated from two fixed transmitter stations.

I. 3. 1 Generation of a Hyperbolic Network

Two fixed transmitters A and B radiate an unmodulated continuous wave. These transmitters are simple free-running oscillators, they are neither synchronised nor phase or frequency locked.

FIG. 6

BOOMER PROFILING SYSTEM



Frequencies Fa and Fb, of the order of 2 mc/s, are chosen very close to each other, so that their difference is a low frequency f of about 100 cycles.

$$Fa - Fb = f$$

The receiver of a mobile station M is tuned to the intermediate frequency of Fa and Fb. Waves Fa and Fb leave their antennae with respective phases φa and φb which are constantly variable. They arrive at the receiver M with phases:

$$\varphi a + Fa \frac{MA}{V}$$

and

$$\varphi b + Fb \frac{MB}{V}$$

V being the wave propagation velocity.

The low frequency beat signal is selected by appropriate filtering. Its phase φm is equal to the difference in phase of the component signals:

$$\varphi m = \varphi a - \varphi b + Fa \frac{MA}{V} - Fb \frac{MB}{V} + km$$

km is a constant phase shift introduced by the receiver and tied to φ m.

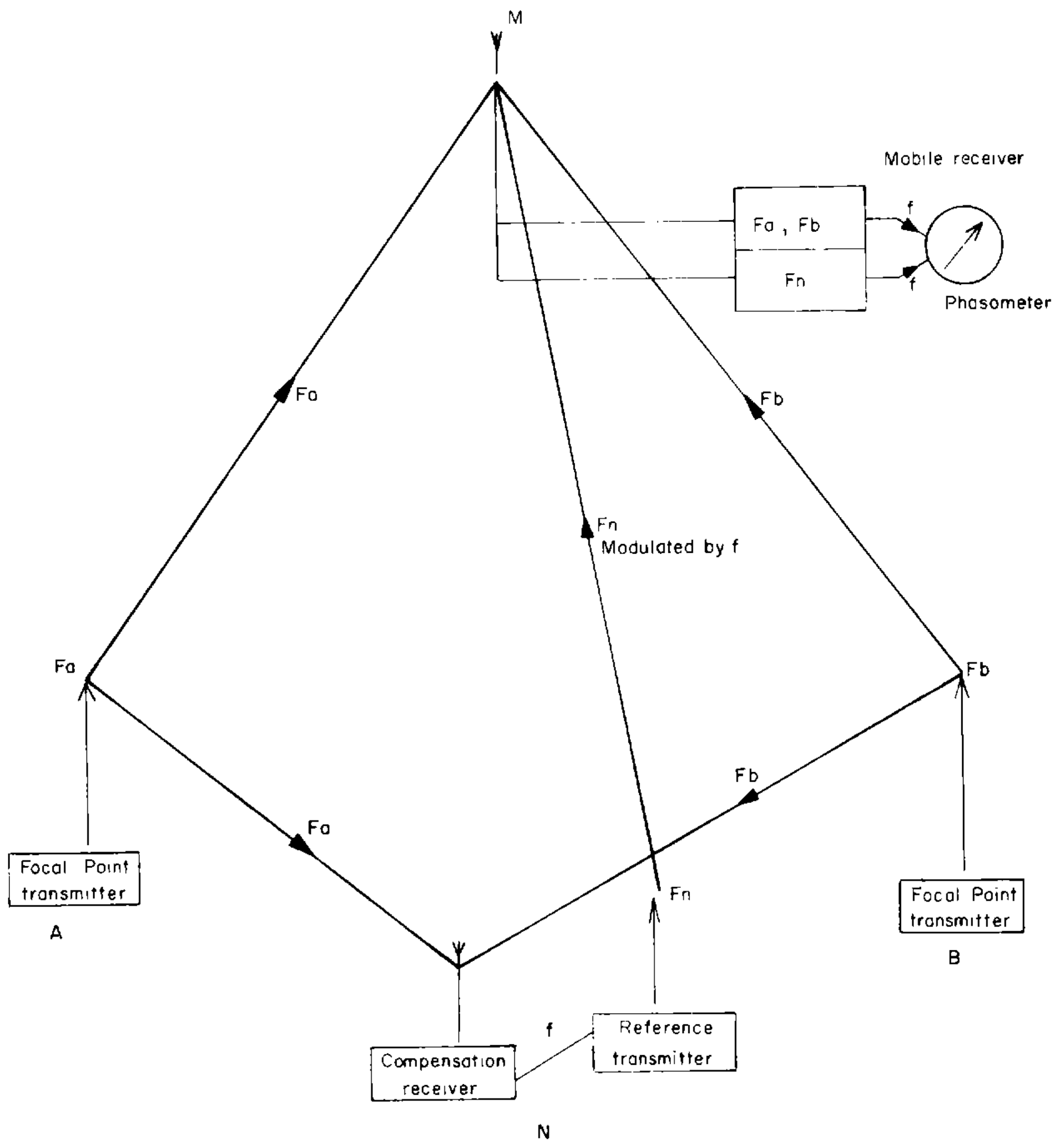
Taking into account the relation $f = Fa - Fb$

$$\varphi m = \varphi a - \varphi b + \frac{Fa}{V} (MA - MB) + \frac{f}{V} MB + km$$

This expression of φm cannot be used such as it is, due to unknown terms φa and φb. In addition, a time or phase reference would

FIG. 7

PRINCIPLE OF TORAN



be necessary at M for determining the φm value. These two problems are solved as follows.

I. 3. 2 Reference and Compensation

Another receiver located at a fixed point N produces the low frequency signal f with a phase φn.

$$\varphi n = \varphi a - \varphi b + \frac{Fa}{V} (NA - NB) - f \frac{NB}{V} + kn$$

kn is a coefficient similar to km.

A transmitter placed very close to N radiates a frequency Fn different from Fa and Fb and modulated by the signal f produced by receiver N.

The mobile receiver M is equipped with a second reception channel tuned to Fn. The phase φ nm received in M is:

$$\varphi nm = \varphi a - \varphi b + \frac{Fa}{V} (NA - NB) - f \frac{NB}{V} + f \frac{MN}{V} + knm + kn$$

where knm is a coefficient similar to km and kn.

A phasemeter connected to the outputs of both channels of the receiver M indicates the phase difference

$$\varphi = \varphi m - \varphi nm$$

$$\varphi = \frac{Fa}{V} (MA-MB) - \frac{Fa}{V}(NA-NB) + \frac{f}{V} (MB-MN) - \frac{f}{V} NB + km-kn-knm$$

In this equation,

$\frac{Fa}{V}$ (MA-MB) is a hyperbolic term of focuses A and B.

$\frac{Fa}{V}$ (NA - NB), $\frac{f}{V}$ NB, km, kn, kmn are constant terms which are eliminated when calibrating the system.

$\frac{f}{V}$ (MB - MN) is practically negligible since the ratio $\frac{f}{Fa}$ # 1/20,000. When necessary this term is taken into account as a correction term in the computation of the hyperbolic network.

The double function of station N is indicated by the terms "Compensation Receiver" and "Reference Transmitter" given to the two parts of this station.

Finally, after elimination of the constant terms the indication of the phasemeter M represents the phase

$$\varphi = \frac{Fa}{V} (MA - MB)$$

which defines one hyperbolic coordinate.

I.3.3 Toran Couples and Chains

Focus transmitters A and B and the compensation-reference station N constitute a TORAN couple, and define one coordinate.

One second coordinate is supplied by a second couple.

A third pair may be used to supply an additional coordinate, either to make up a "triangle of error" or to secure a better coverage of a wide area or an area of complicated configuration.

I.3.4 Lane Identification System.

The principle is to realise a fictitious network with lanes 10 and 100 times wider than those of the basic working network.

For one couple A - A' using the frequency F1, the lane identification frequencies are:

$$F2 = \frac{90}{100} F1$$

and

$$F3 = \frac{99}{100} F1$$

The corresponding readings on the phasemeter M are:

$$\varphi_1 = \frac{F1}{V} (MA - MA')$$

$$\varphi_2 = \frac{F2}{V} (MA - MA') = \frac{90}{100} \frac{F1}{V} (MA - MA')$$

$$\varphi_3 = \frac{F3}{V} (MA - MA') = \frac{99}{100} \frac{F1}{V} (MA - MA')$$

The computations of the differences:

$$\varphi_1 - \varphi_2 = \frac{1}{10} \cdot \frac{F1}{V} (MA - MA')$$

$$\varphi_1 - \varphi_3 = \frac{1}{100} \cdot \frac{F1}{V} (MA - MA')$$

give the values of the phases in a fictitious network of focuses A and A' with frequencies $\frac{F1}{10}$ and $\frac{F1}{100}$ (lanes 10 and 100 times wider than those of the basic network using the frequency F1).

Therefore the difference $\varphi_1 - \varphi_2$ enables to determine the units figure of the hyperbola number and the difference $\varphi_1 - \varphi_3$ the tens figure.

II. OPERATIONS

II.1 Natural Conditions

The prospect is a typically tropical area and the survey was carried out during the oncoming of the monsoon. Weather was mostly fine from September to mid-November. From then on, numerous atmospheric disturbances occured. Depressions caused strong gales (40 to 50 knots) but short in duration. Weather was heavily overcast with storms and squalls.

Sea conditions were good to fair throughout the survey.

II.2 Navigation

The surveyed area can be divided into two different zones:

In the area north of line PPA 1 the sea-bottom was generally smooth and almost flat. The depths measured were in agreement with those indicated on the nautical charts, except north of line PPA 1 where many reefs were found. Problems were encountered with navigation in this area, as the reefs were apparently not very well located on the charts.

In the southern area, numerous banks made coastal navigation somewhat dangerous. Also strong streams, especially in the Queens Channel, made water muddy and prevented spotting of the banks. A systematic pre - reconnaissance survey of this prospect with a depth-sounder would have eliminated these navigational problems. Unfortunately, time was too short to do so.

II.3 Logistics

The only place with adequate harbour and supplies facilities in the area was Darwin to the north east of the prospect area.

A C.G.G. base was established there with an administrative office and a workshop for the maintenance of the seismic equipment.

Food, water and fuel supplies for the "CAPRICORNE" were obtained from Darwin without difficulty.

An explosives' depot was located at Adelaide River, 72 miles south of Darwin.

II.4 Communications

Daily radio contact with the Darwin Base was maintained through the TORAN station which was closest to Darwin.

Data was forwarded from Darwin to Brisbane or to the C.G.G. processing centre in France after each cruise had been completed.

II.5 Toran Operations

II.5.1 Lay-Out of Toran Stations

Two TORAN chains were used for this survey:

- Two couples of the 3G type chain with lane identification already set up for the SAHUL SHELF Marine Sparker Survey (ARCO - AAP).
- Two couples of a 3P type chain without lane identification laid out in the Queens Channel.

The lay-out of the 3G and 3P stations is shown on Fig. 8. The couples used for this survey were:

- 2 couples 3P (EE'.FF') and 1 couple 3G (BB') in the Queens Channel area.

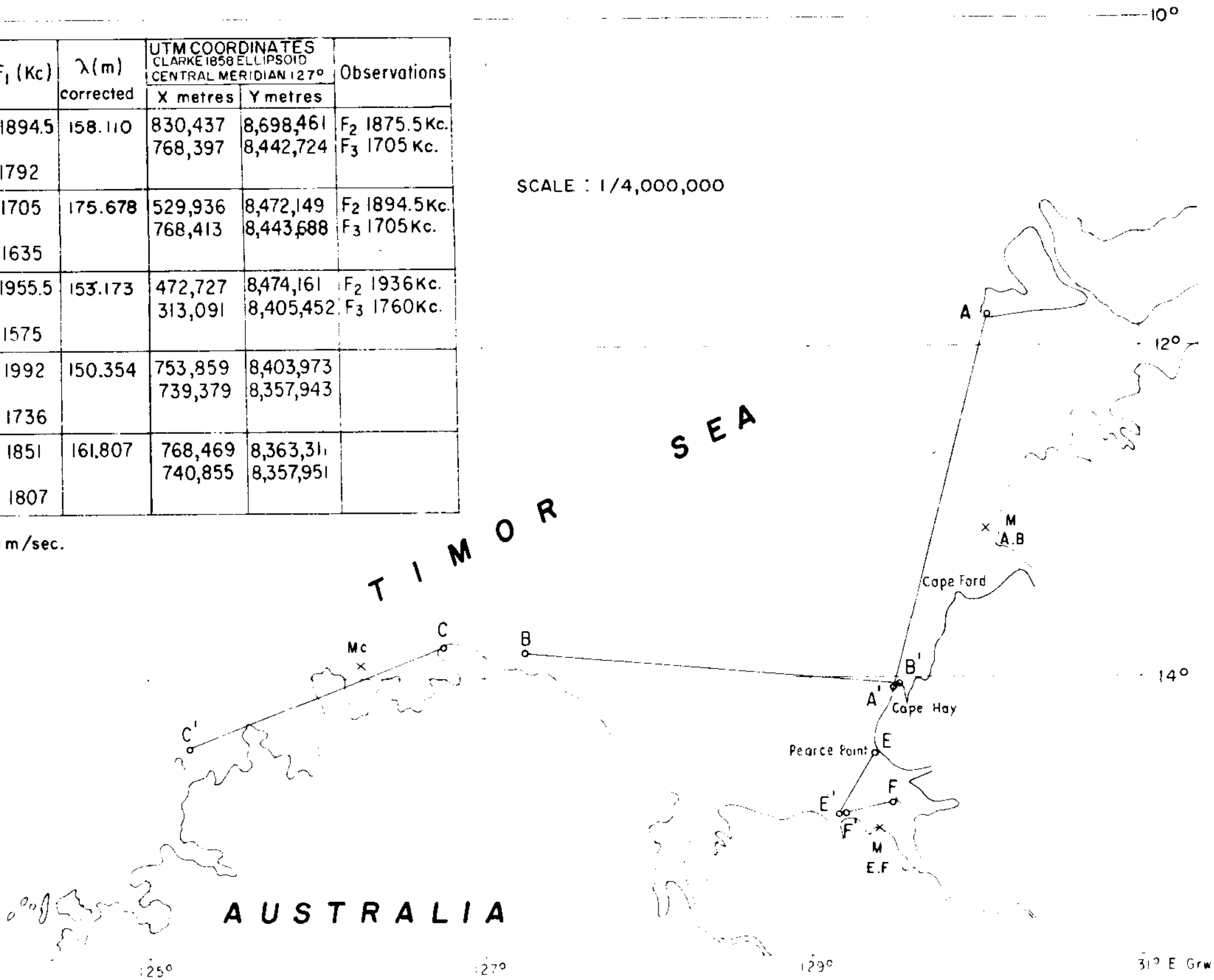
AUSTRALIA - TIMOR SEA

TORAN CHAINS

FIG. 8

Couple		Station	F_1 (Kc)	λ(m) corrected	UTM COORDINATES CLARKE 1858 ELLIPSOID CENTRAL MERIDIAN 127° X metres	Y metres	Observations
AA'	A A' M_A	Fourcroy Cape Hay Peron	1894.5 1792	158.110	830,437 768,397	8,698,461 8,442,724	F_2 1875.5 Kc. F_3 1705 Kc.
BB'	B B' M_B	Lesueur Cape Hay Peron	1705 1635	175.678	529,936 768,413	8,472,149 8,443,688	F_2 1894.5 Kc. F_3 1705 Kc.
CC'	C C' M_C	Talbot Prudoé Eclipse	1955.5 1575	153.173	472,727 313,091	8,474,161 8,405,452	F_2 1936 Kc. F_3 1760 Kc.
EE'	E E' M_E	Pearce point Turtle point	1992 1736	150.354	753,859 739,379	8,403,973 8,357,943	
FF'	F F' M_F	Quoin Isl. Turtle point	1851 1807	161.807	768,469 740,855	8,363,311 8,357,951	

V = 299,650 m/sec.



- 1 couple 3P. (EE') and 2 couples 3G. (AA'. BB') in the Pearce Point area.
- 2 couples 3G. (AA'. BB') in the Cape Ford - Cape Hay area.

All stations were set up on islands or on the mainland shore. Their locations were selected along the coast, according to the suitability of the site. All the coordinates (stations of the 3G and 3P chains) were those given by the tellurometric surveys in the Timor Sea (April - May 1965 - September 1965) and were tied to the Australian National Mapping First Order Network.

One barge hired from Darwin was used for setting up the stations and for bringing in periodical supplies.

II. 5. 2 Toran Calibration and Operation

The locations and coordinates of the control stations as well as the frequencies used are indicated on Fig. 8.

- TORAN 3P Chain (Couples EE' and FF')

The calibration was performed between the 14th. and the 21st. September by the crossings of the base-lines, the mobile unit being on board the supply boat "VAGABOND".

Couple EE'	Calculated values	Readings	
Base line south of Turtle Point (E')	5320.69	5320.69	(phasemeter (calibrated on (this base line)
Base line north of Pearce Point (E)	4679.31	4679.43	
	641.38	641.26	

Δ = 0.12 or 12 hundredths.

Couple FF'	Calculated Values	Readings
Base line west of Turtle Point	5173.70	5173.70
Base line east of Quoin Island	4826.30	4826.72
	347.40	346.98

= 0.42 or 42 hundredths.

This large misclosure is due to the location in Quoin Island where it was not possible to find the mark of the previous Shoran station and of the tellurometric station (very muddy soil, big erosion of the coastline and very strong tides at the time of the survey). We were obliged in Quoin Island to set up the Toran station on a stand 6 feet high above the ground in order to have the equipment beyond reach of the high tide. As the survey was very close to the shore station with a very good crossing of the hyperbolic networks the displacement of Quoin Island was without significant effect on the location of the lines.

A checking of the locations in Turtle Point and Pearce Point showed that these locations were good according to the tellurometric survey.

Three buoys were dropped and carefully located in the TORAN network. As the Toran 3P has no lane identification, these buoys were used to position the ship.

Reference Buoy	E = 4747.03	F = 4956.26
Pearce Point Buoy	E = 4748.77	F = 4956.11
Quoin Island Buoy	E = 5003.23	F = 4902.80

During the survey in the Queens Channel no atmospheric disturbance was noticed during working hours and there was no interference with the wave propagation due to the proximity of the Toran stations and the use of only one frequency for each couple.

- TORAN 3G Chain (Couples AA' and BB')

The 3G TORAN Chain was calibrated in April 1966 for the ARCO-AAP Sparker survey with the vessel "NORANGO". Therefore the only calibration required was to adapt the mobile unit of the "CAPRICORNE" to the 3G hyperbolic network and to check the lane identification.

In the first stage we used a frequencies simulator and made a number of measurements to compare the readings of the "Norango's" and "Capricorne's" mobile units. Then the "Capricorne's" phasemeters were calibrated in order to obtain similar readings to those of the "Norango" with the same simulation in all frequencies used.

In the second stage the "Capricorne" made a number of lane identification tests in some locations, fixed and checked by the "Norango". Identical results were found and the mobile unit of the "Capricorne" could be used in the 3G hyperbolic network.

II.6 Flexotir Operations

II.6.1 Shooting

The charges fired were 50 grammes (less than 2 oz.) of dynamite and 6" long detonators, manufactured by ICI in Melbourne, were used.

Shooting operations were hampered by a number of faulty cartridges, thus slowing down the progress of the crew.

II. 6. 2 Streamer

In normal recording conditions, the streamer was submerged between 10 and 15 metres below the surface. The noise level was less than 8 microvolts with a speed of 4. 5 knots thanks to an elastic shock absorber fitted between the streamer and the vessel.

The streamer was used two different ways:

Six trace recording (Fig. 9a)
Two successive sets of 20 geophones were connected in parallel to make up each recording trace.

One trace recording (Fig. 9b)
After the streamer was damaged on shallow reefs, three groups of geophones were connected together in parallel and one trace only was recorded from the 25th. of November.

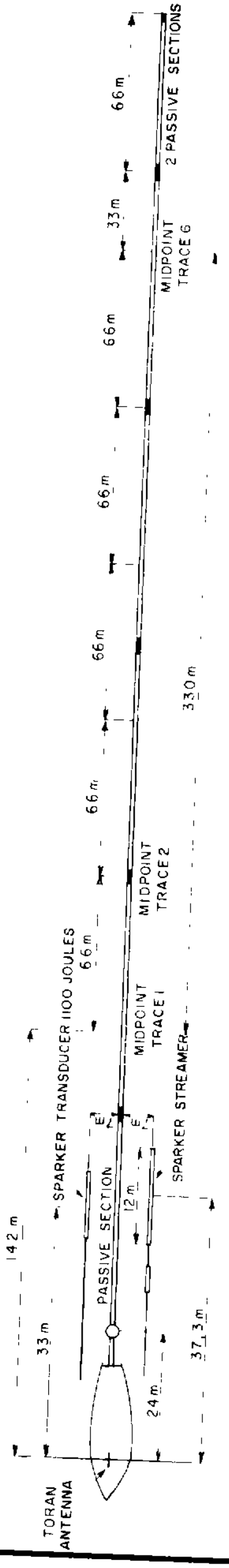
II. 6. 3 Recording

The instrument settings were as follows:

Filters	: 14 - 40 or 14 - 55 cps.		
Individual AGC :	Initial gain	:	-10 to max.
	Final gain	:	maximum.
	Delay	:	100 to 350 ms for traces 1, 2, 3 and 4.
	Delay	:	200 to 450 ms for traces 5 and 6.
Common Gain :	Level	:	0. 32 to 0. 56 microvolt.
	Initial gain	:	-50 to -55 db.
	Final gain	:	maximum.
	Delay	:	150 to 250 ms.

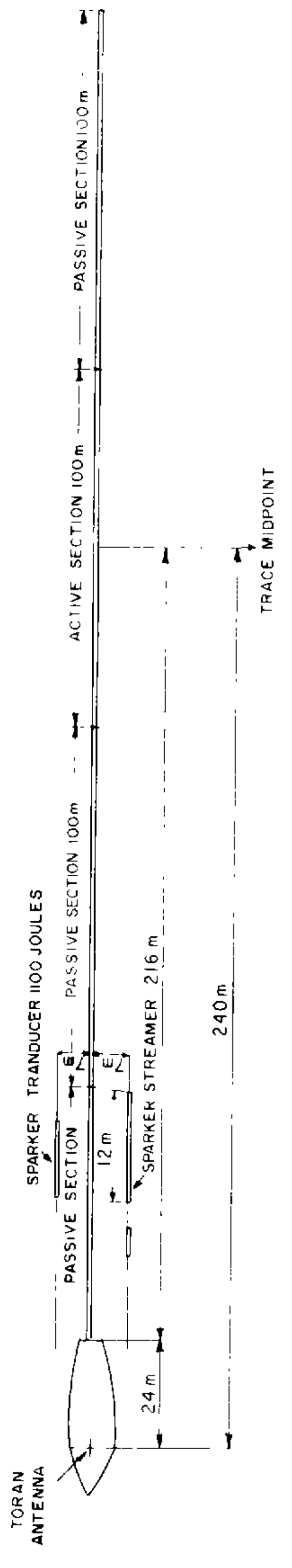
6 TRACE STREAMER

FIG.9a



I TRACE STREAMER

FIG.9b



II.7 Depth-Sounding

The SCAM 610 Fathometer was fitted in the hull of the vessel, about 2.5 metres below the sea level.

II.8 Sparker Operations

The E.G.& G. Boomer Profiling System enabled continuous recording of the sub bottom of the sea.

The firing rate chosen was 250 milliseconds.

CHAPTER IV

DISCUSSION OF THE RESULTS AND INTERPRETATION

I. QUALITY OF THE RESULTS

I.1 Flexotir Results.

The quality of the results was generally good throughout the survey and can be compared favourably with thoseobtained from previous surveys using the conventional seismic method. However, a loss of quality has been noticed on all north east - south west lines in the Queens Channel area. This could be due to strong cross currents which caused a large drift of the hydrophones cable and precluded 3 fold coverage recording. On these lines, the streamer was used as shown on Fig. 9b.

Most of the surveyed area is characterized by recording two good strong reflections (Horizons 4 and 5) approximately 100 milliseconds apart. They were followed from 200 milliseconds down to more than 1 second one way time.

North west of Pearce Point very little organised energy was noticeable below these reflectors except multiple reflections which mask most of the other possible primary reflections.

However, on the border of the basin in the Pearce Point area, it was possible to follow Horizon 7 below Horizon 5. To the north, Horizon 7 deepens and shows less and less energy. To the south, Horizons 7 and 8 were picked in areas where Horizon 5 is very shallow or absent.

It must be noticed that the recording parameters did not allow the horizons to be followed above 200 milliseconds (one way time). Therefore it was not possible to determine in this section whether the series are progressively thinning to the east or pinch out onto underlying sediments.

Singing did not greatly affect the records in the surveyed area except on local parts of lines CH 5, CF-CH 7, CF 10, CF-CH 17 and CF-CH 19.

I.2 Sparker Results (Pl. 5)

The sparker results were fair to poor and were not of much help for the interpretation. However, a detailed examination of the sections enabled some very shallow reflections to be picked.

II. VELOCITY ANALYSIS

A velocity analysis showed that reflection step-outs in the surveyed area were well corrected using three different velocity functions.

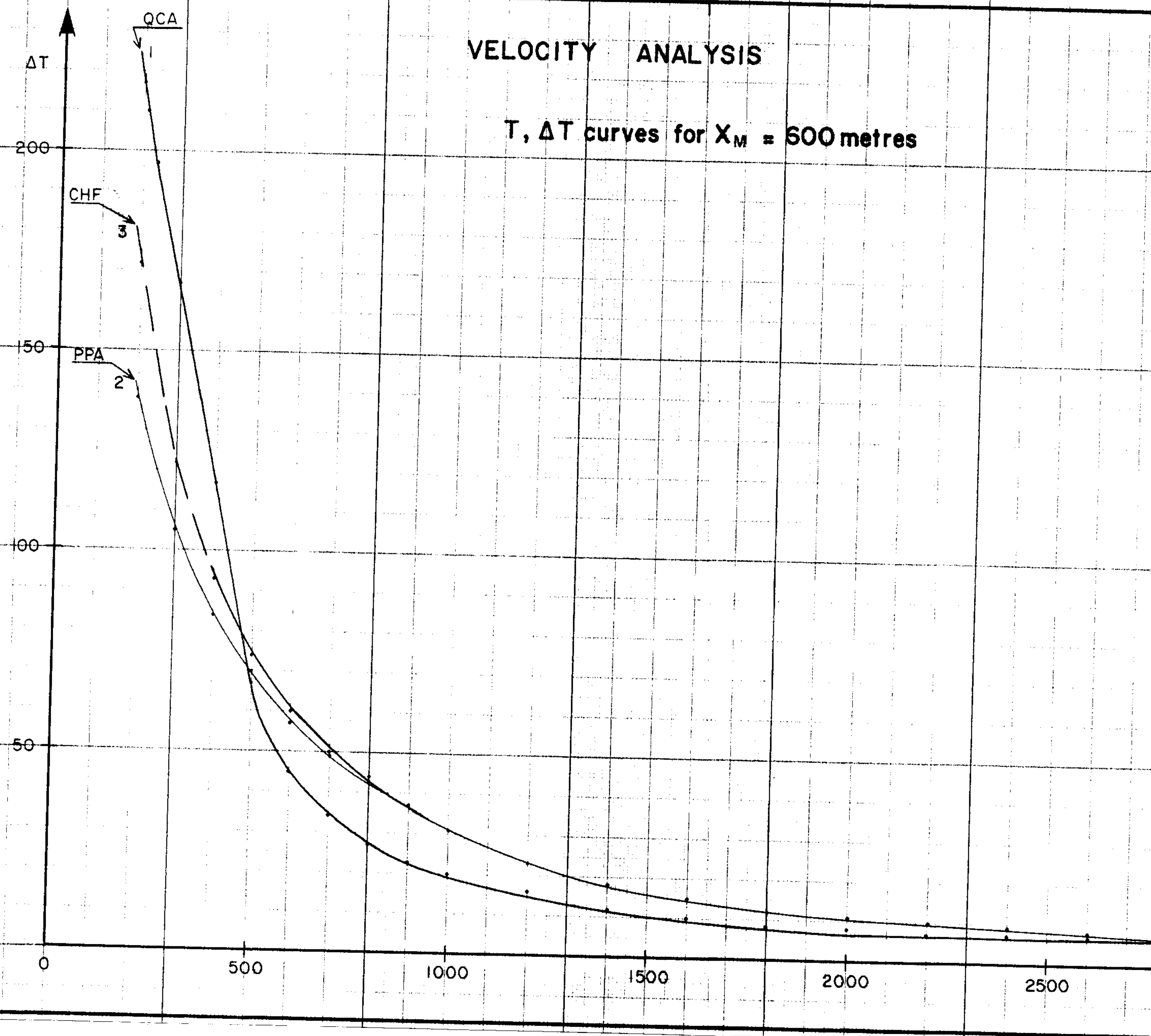
Fig. 10 shows T - ΔT diagrams and the corresponding velocity functions.

Two of them are quite similar (Cape Hay - Cape Ford and Pearce Point areas). The third one, in the Queens Channel area, shows possibly slower velocities for the shallow sediments (between 0 and 200 milliseconds, one way time). The average vertical velocity increases more rapidly, with depth, than in the other areas.

This is in relation with the regional picture of the permits which showed older sediments with presumably higher velocities in the Queens Channel area.

III. BATHYMETRY

Depth of the water below the recording boat was recorded with an echo-sounder. From these measurements the depth of water at the actual reflector points, midway between the shot point and the hydrophones, have been estimated.


VELOCITY ANALYSIS
T, ΔT curves for X_M = 600 metres
ΔT
QCA
1
CHF
3
PPA
2
200
150
100
50
0
500
1000
1500
2000
2500
3000
3500
4000
milliseconds
(two-way time)

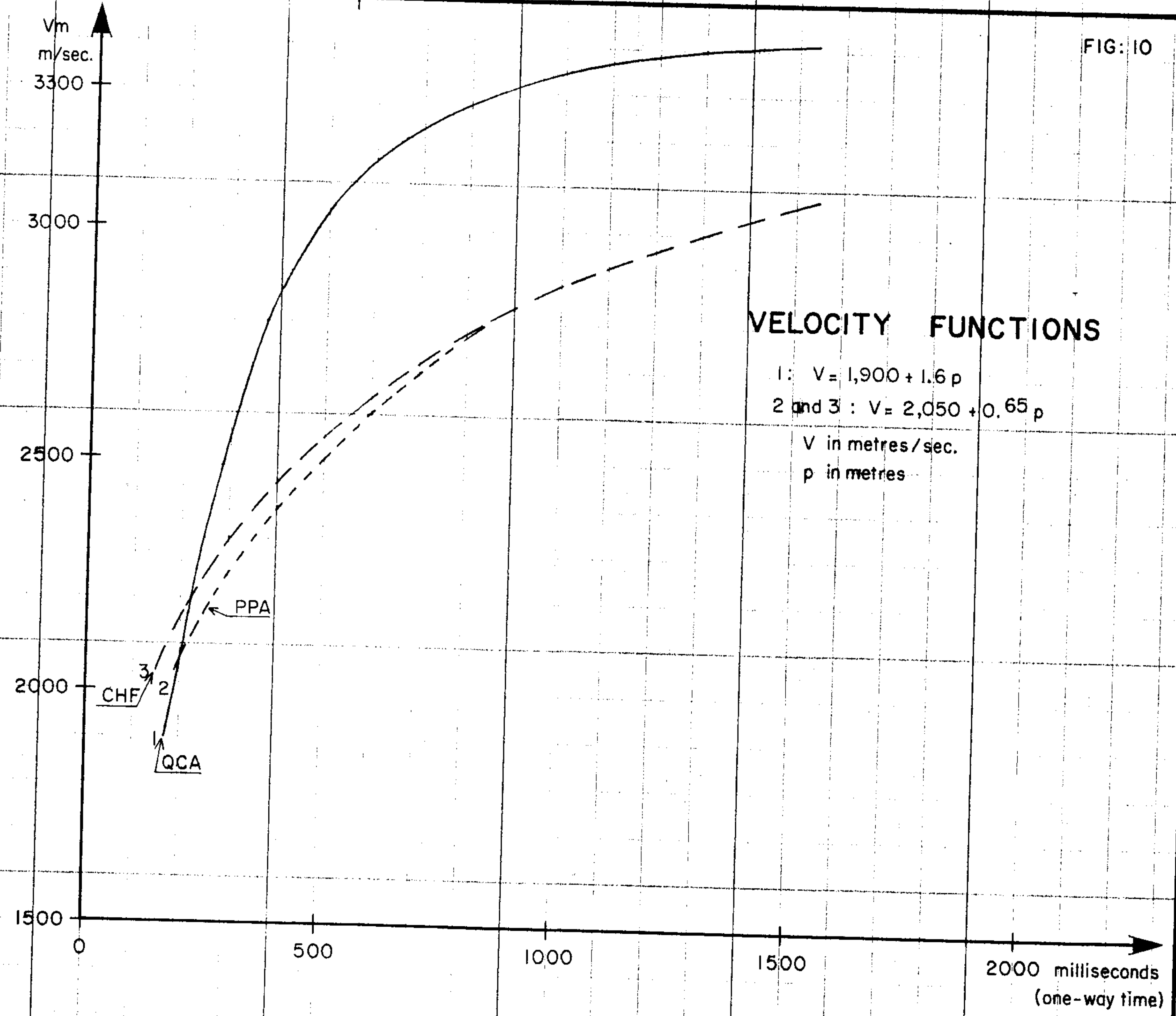

Vm
m/sec.
3300
3000
2500
2000
1500
0
500
1000
1500
2000
milliseconds
(one-way time)
PPA
3
CHF
2
1
QCA
VELOCITY FUNCTIONS
1: V= 1,900 + 1.6 p
2 and 3 : V= 2,050 + 0.65 p
V in metres/sec.
p in metres

FIG: 10

The bathymetric chart (Pl. 9) shows that over the greater part of the surveyed area, there are no large changes in water depths. The water is relatively shallow, averaging 40 metres with limits of 10 and 75 metres.

The sea bed is generally smooth in the Cape Hay - Cape Ford area and progressively deepens to the north west. A shallow reef was found south east of line CH 11 which had to be turned.

In the southern part of the survey, especially in the Queens Channel, the sea bottom was rough with shallow banks. There is a high trend with a north north-west / south south-east direction. It is bordered by two narrow channels which appear to be extensions of the estuaries of the Fitzmaurice and Victoria rivers. The later may extend to the Pearce Point area.

IV. CHARACTERISTICS OF THE HORIZONS

Horizon 2 was picked in the north and west parts of the prospect. It is a shallow horizon, unconformable with the underlying series (see Pl. 6). Its characteristics, except its energy level, were not consistent, however, it may be considered that this horizon gives a fairly accurate picture of the unconformity.

Horizon 3 was one of the first reflections pickable below horizon 2 (Pl. 6). It is thought that this horizon delineates the top of conformable series occuring below Horizon 2. Its low frequency cycle and constant energy level enables it to be mapped with good accuracy.

Horizons 4 and 5 may be considered as the reference horizons for this survey. They are strong and consistent reflectors and generally allow reliable correlations across faults (Pl. 6). With the exception of the Queens Channel they were recorded over most of the surveyed area.

Horizon 6 was picked among the last energetic cycles following Horizon 5. Its characteristics were rather inconsistent. As it appeared generally conformable with Horizon 5, it was not mapped.

Horizon 7 (Pl. 7 and 8), was followed in the Queens Channel and Pearce Point areas but not below about 900 - 1000 milliseconds, one way time. Northward, it was interferred with energetic multiple reflections originating from Horizons 4 and 5, and could not be picked.

It is one of several phases, which are of low frequency and often energetic.

In the Pearce Point area, unconformities were noticed with overlying horizons.

In the Queens Channel area this horizon corresponds to a good reflector especially on 3 fold CDP lines.

Horizon 8 (Pl. 8), was the deepest horizon followed during this survey. It was picked in the Queens Channel area only. Its quality ranges from fair to poor, therefore plotting of this horizon is questionable in places. However, it is believed to give an approximate overall configuration of the corresponding series.

V. TIME CONTOUR MAPS

All the interpretative maps are presented with two different scales, 1/250,000 and 1/100,000. Results from previous surveys in the same areas are included.

V.1 Horizon 2 (Pl. 10 and 16)

The contour maps show a steady west to north west dip with gentle local folding and faulting. The limit of recording to the east depended on the recording parameters and ranged from 160 to 300 milliseconds one way time.

Two anticlinal features, A4 and A6 are suggested in the southern part of OP 83 and in the area defined by lines CF 6, CF 8, CF 5 and CF 7. A4 shows a north west-south east trend, whereas A6 appears to lie along a north-south direction.

V.2 Horizon 3 (Pl. 11 and 17)

As might be expected, this map extends further to the east than that of Horizon 2. The limit of extension corresponds roughly to the 200 millisecond contour and is again determined by the recording parameters.

Horizon 3 appears as a monocline, dipping to the north-west with some folding and faulting.

The main feature of the map is the A4 anticline which shows a 15 to 25 milliseconds closure (one way time). This structure is bordered by a network of faults and a strongly dipping western flank (57 ms/km).

The A6 anticline found on the upper horizon 2 is confirmed at this level. It extends south-eastward to the limit of recording on line CH 7. However, no closure has been found although several changes in dips might suggest local small features.

One more anticline structure A5 is suggested between A4 and A6. Its extension and closure to the south-east is not known due to the shallowness of the horizon in this area (less than 200 ms).

Horizon 3 was not followed south of line PPA 1; it was picked on only a short part of this line, near the crossing with lines CH 23 and CH 30. Its absence on the western part of line PPA 1, may be due to its continuing shallowness in the area and could indicate an uplift of the sedimentary basin to the south.

V.3 Horizon 4 (Pl. 12 and 18)

In areas where horizon 3 was recorded, both contour maps are similar. The main differences are a further shifting to the east and to the south of the recording limit at the 200 milliseconds mark (one way time), and a greater extension and better delineation of folding (especially A5) and faulting (F3 and F5 for example).

Over most of the area, the time contours follow the outline of the shore: they are generally north north-east / south south-west north of line PPA 1, and to the south are deflected in an east-west direction parallel to the south coast of the Bonaparte Gulf.

The contour map can be divided into two areas which appear different in tectonics:

V.3.1 The area north east of line CH 15 shows folding tectonics. Two main trends north-north-west / south south-east in direction, could have been caused by regional side thrusts east north-east / south south-west, resulting in the two high axes A5 and A6 slightly offset.

A5 could originate from the shore (Cape Hay area) but it dies out north of line CF 14. Although only one small closure has been mapped north of line CF 18, more may exist to the south east, especially near the crossing of lines CH 11 and CH 26 where the presence of a large reef suggests possible stratigraphic traps. More detailing work would be necessary to investigate this area.

A6 arises near line CH 22 and develops well to the north of this prospect.

V.3.2 The area south and east of line CH 15 shows more local tectonics which do not seem to affect the overall configuration of the basin.

Three high zones A2, A3 and A4 were found in this area. Folding is stronger than in the northern area and many faults, of varying size, have been found. The correlation of these faults between lines is often questionable but they can be classified in two groups. The first one includes mostly radial faults lined up between A3 and A4. The second group is made of a complicated network of minor faults along the direction A2 - A3.

The A4 structure in the south-east corner of OP 83 is well confirmed at the level of Horizon 4. Its closure is well secured to the north, west and south. A reliable 40 milliseconds (one way time) closure to the east makes this structure the best prospect of the survey.

The high zone A3 is a complex structure of low relief with possibly three small culminations A3, A'3 and A"3. None of them have been confirmed completely closed except probably A"3 against a small up dip fault. The closure to the east of A3 and A'3 has not been checked by this survey. However, lines 4 and QC 9 of previous surveys indicate a possible closure to the east for A3 which then would be a shallower target than A4.

Southward, in the Pearce Point prospect, a small anticline A2 was found on line PPA 3 (Pl. 7). It is very close to a high anomaly on line PPB 4 and could be related to a lower anticline on line PPB 1. These three anomalies probably form only one high zone which suggests either an intrusive or a buried reef origin. Neither the bathymetric chart nor the sparker sections show any high which could be related to these deeper structures.

V.4 Horizon 5 (Pl. 13 and 19)

This horizon is quite conformable with Horizon 4, therefore, the contour maps show the same overall configuration.

It was recorded to the eastern end of the lines, and to the south, the 200 milliseconds recording limit was reached just north of line PPA 7.

All the other features of the Horizon 4 contour map were found at the Horizon 5 level with approximately the same relief. A4 shows the same 40 millisecond closure.

V.5 Horizon 7 (Pl. 14 and 20)

This horizon was followed in the southern part of the surveyed area (Queens Channel and Pearce Point prospects) i.e. in the shallow basin area.

The horizon is dipping to the north and the validity of the section picks became more questionable as the quality of the reflection decreased.

In the Pearce Point area, the contour map is roughly similar to that of overlaying horizons. However, some dips are not so steep, especially on the east of lines PPA 1, PPA 3 and PPA 5 where picking of the horizons was accurate. This could then suggest a tilting of the basin after the corresponding sediments were deposited.

The A2 structure was found again but its very steep flanks seem to have dislocated the deeper horizons. There is no evidence of pinch out against the structure at this level. However, Horizon 7 could be hidden by strong diffracted arrivals which were recorded on either side of the anomaly.

In the Queens Channel area, folding is not very strong and the horizon is gently dipping to the north west. The anticline found by a previous survey has been delineated with more accuracy. This structure (A1) appears now as a long shaped anticline with its axis on line QCA 18. Its closures to the north and west are well secured. The closures to the east and south are about 15 milliseconds one way time. It is bordered on the east side by a fault north east - south west in direction which disappears progressively to the south.

Further east the continuity of the horizon is interrupted by several minor faults which are difficult to correlate from one line to the other.

V.6 Horizon 8 (Pl. 15 and 21)

The overall structural picture of this horizon is broadly similar to that of Horizon 7 but the poor quality of the data at this level makes it somewhat questionable.

The representation of the anticline A1 is slightly different: the top of the structure appears to be shifted to the north east on line QCA 13 (SP 1790) and its closure to the east could be as little as 10 milliseconds. Although picking of Horizon 8 was not reliable in the area, it seemed locally unconformable with Horizon 7 on line QCA 13.

The other features of the map are approximately the same as that of Horizon 7.

VI. ISOPACH CONTOUR MAPS

These maps have been made for the intervals between Horizons 2 and 4, 4 and 5, 7 and 8.

The map of the interval 2 - 4, which are slightly unconformable horizons, show a general thickening to the west as depths are increasing (Pl. 22).

Horizons 4 and 5 are generally conformable (Pl. 23). In the north eastern part of the survey, folding did not cause any significant change in thickness of the series between the high (A5 and A6) and low trends. In the south western area, changes of thickness occur on the top of the anticlines (especially A2 and A3): the series between both horizons are slightly thinner than in surrounding areas. The differences can reach 30 milliseconds.

The isopach map between horizons 7 and 8 shows a thinning of the series in the north-east corner of the Queens Channel and on line QCA 13 near the top of the structure. The results shown on this map may be questionable since Horizon 8 picking is not absolutely reliable.

ACHIEVEMENT OF THE OBJECTIVES AND CONCLUSIONS

The two and a half month marine survey carried out during 1966 in OP 2 and OP 83 added valuable detailed information to that already known in this area.

The results enabled the prospect to be divided into two tectonically different areas:

The northern part is broadly folded along a north north-west / south south-east trend and shows smooth tectonics with conformable series.

The southern area is affected by local sharp features and shows several interesting structures.

The objectives of the survey were successfully met:

I. In the Cape Hay - Cape Ford area, no important closure was found along the noses A5 and A6 dipping to the north-west. However, the southern part of A5 was not surveyed because of shallow water with dangerous reefs. This area showed on the south eastern end of line CH 11 a high probably related to a large reef and appears worth further investigation.

Another structure A4 was found in the southern corner of OP 83. This closed anticline seems to be the best prospect of the survey with an appreciable size and a reliable closure of 40 milliseconds one way time.

The A3, A'3 A''3 faulted high area appears more complex. It is assumed that the A3 culmination would be closed from the results of previous surveys. However, some detailing work would be necessary to define its actual closure and size.

II. West of Pearce Point, a sharp strong high anomaly A2 was found. It looks like a buried reef or an intrusion and could have originated stratigraphic traps along its flanks.

This area is on the edge of the deep sedimentary basin extending to the north. Southward, the basin rises to the Queens Channel area.

III. In the Queens Channel area, the survey confirmed the existence of the anticline previously found. Its closure of only 15 milliseconds one way time and shape were well defined at the level of the Permian series.

A Sub Permian horizon was tentatively followed and mapped.

From the results of this survey, and following the last improvements, the Flexotir method appears to be a valuable tool in Australian waters. However, the Flexotir method is not suitable for shallow water surveys.

Respectfully submitted.

A. BRAJON

J. M. CUNIN
Australian Branch Manager.

APPENDICES

APPENDIX I

PERSONNEL

I. SEISMIC CREW

I. 1 Aboard the Vessel

One Party Chief	R. ARGIRAKIS (to 22nd. October)
	J. MICHEL (from 23rd. October)
One Senior Observer	P. HELLIO
One Junior Observer	R. FEENAGHTY
One Observer Assistant	P. GILLY
One Shooter	K. REITMAYR
One Radio navigation technician	J. C. PASCAL

1. 2 Darwin Office

One Administrative Assistant	F. SELLIES

1. 3 Interpretation Staff (Brisbane)

One Chief Seismologist	A. BRAJON
One Seismologist	J. DUPARAY

II. RADIO POSITIONING CREW

Two Party Leaders	G. BERMON (3G Chain)
	A. JOSPIN (3P Chain)

III. VESSEL

One Captain	CAPT. NAGELIN
One First Officer	
One Chief Engineer.	

APPENDIX II

EQUIPMENT

I. SEISMIC EQUIPMENT

I.1 Depth Sounder

- One SCAM 610 Fathometer capable of recording depths to 600 metres.
- One Electroacoustic Sonar.

I.2 Sparker System

- One EDGERTON, GERMESHAUSEN & GRIER Boomer Profiling System 1000 joules.
- One EDGERTON, GERMESHAUSEN & GRIER Model 254 Recorder (11" Alden Alfax).
- One C.G.G. Streamer with 8 MP7 hydrophones.

I.3 Flexotir System

- Two complete FLEXOTIR units including loading heads, hoses and shooting-cages.
- One hydrophone streamer, 12 traces, 20 PKS 4 hydrophones per trace with a 33 metre (108 ft.) spacing, between consecutive traces, and 3 spare sections.
- One GSC Model HS-400 High Cut Filter Preamplifier.
- One C.G.G. AS 626 X set of amplifiers including one common gain programmer.
- Two complete Techno Magnetic Recording Units, adapted to the Flexotir technique.

I. 3 Flexotir System (continued)

- Two switching boxes allowing automatic selection of either magnetic recorders.
- One SIE VRO-6D recording camera.
- One SIE SCD 2000 BA shooting box.
- One CGG SBT 1000 shooting box.
- One timing device.

II RADIO LOCATION SYSTEM

- Two TORAN 3G couples with lane identification system. Each transmitter had a 300 watts radiated power.
- Two TORAN 3P couples with a radiated power of 60 watts.
- One mobile receiver unit on the vessel including two receivers with one lane identification system and three phasemeters and one Linax phase recorder.
- One photo unit on board.

III VESSEL - M/S "CAPRICORNE"

- Length	138 ft.
- Beam	23 ft.
- Draft	9 ft.
- Gross tonnage	296 Tx
- Nett tonnage	139 Tx
- Engines	2 Diesel 500 h.p. each
- Propellers	2
- Maximum speed	12 knots

- Double Wooden Hull.

III VESSEL - M/S "CAPRICORNE" (Continued)

Vessel Equipment

- One DECCA 303 Radar.
- One radio-goniometer.
- One radio-transmitter.
- Accommodation for the crew and 13 people.

APPENDIX III

HISTORY AND STATISTICS (Fig. 11)

The main dates of the survey are as follows:-

QUEENS CHANNEL AREA

First shot	22nd. September
Last shot	30th. September

PEARCE POINT AREA

First shot	7th. October
Last shot	11th. October
Programme Extension	
First shot	30th. November
Last shot	2nd. December

CAPE HAY - CAPE FORD AREA

First shot	12th. October
last shot	29th. November
Programme Extension	

Carried out on the 2nd. December.

The survey was interrupted from the 13th. October to the 19th. October to shoot line TS 14 of the SAHUL BANK SURVEY for ARCO-AAP in the Timor Sea.

One streamer was lost on shallow reefs on the 25th. November.

STATISTICS

CAPE HAY – CAPE FORD SEISMIC SURVEY

FIG.11

A.A.P. K 3803

OP2 - OP83

FLEXOTIR – SHOTS

MONTH	LINES	New: 3 Fold C.D.P.	New: Single Coverage	New: Total	Missed: 3 Fold C.D.P.	Missed: Single Coverage	Missed: Total	Total: 3 Fold C.D.P.	Total: Single Coverage	Total: Total	Reshot: 3 Fold C.D.P.	Reshot: Single Coverage	Reshot: Total
September	QCA 11-12-13-14-15-16 17-18-19-20-21-22-24	2,038	2,885	4,923	8	13	21	2,046	2,898	4,944	10	727	737
October	PPA 1-2-3-5-7 CH19 CF,CH21 CF1-2-3-4-6-8-10-12-14-16-18	10,258	-	10,258	35	-	35	10,293	-	10,293	112	-	112
November	PPB4 CF,CH5-7-9-11-13-15-17-20 CH22-23-24-26-28-30 CF19-21-171-182	11,388	3,256	14,644	44	27	71	11,432	3,283	14,715	36	9	45
December	PPB1-2-3 CH9-28	-	1064	1064	-	4	4	-	1068	1068	-	10	10
TOTAL		23,684	7,205	30,889	87	44	131	23,771	7,249	31,020	158	746	904
Queen's Channel	QCA	2,038	2,885	4,923	8	13	21	2,046	2,898	4,944	10	727	737
Pearce Point	PPA, PPB	2,618	988	3,606	22	4	26	2,640	992	3,632	-	12	12
Cape Hay - Cape Ford	CH CF	19,028	3,332	22,360	57	27	84	19,085	3,359	22,444	148	7	155

FLEXOTIR – KILOMETRES

MONTH	New: 3 Fold C.D.P.	New: Single Coverage	New: Total	Missed: 3 Fold C.D.P.	Missed: Single Coverage	Missed: Total	Total: 3 Fold C.D.P.	Total: Single Coverage	Total: Total	Reshot: 3 Fold C.D.P.	Reshot: Single Coverage	Reshot: Total
September	134.508	144.250	278.758	0.528	0.650	1.178	135.036	144.900	279.936	0.660	36.350	37.010
October	677.028	-	677.028	2.310	-	2.310	679.338	-	679.338	7.392	-	7.392
November	751.608	205.936	957.544	2.904	1.782	4.686	754.512	207.718	962.230	2.376	0.594	2.970
December	-	70.224	70.224	-	0.264	0.264	-	70.488	70.488	-	0.660	0.660
TOTAL	1,563.144	420.410	1,983.554	5.742	2.696	8.438	1,568.886	423.106	1,991.992	10.428	37.604	48.032
Queen's Channel QCA	134.508	144.250	278.758	0.528	0.650	1.178	135.036	144.900	279.936	0.660	36.350	37.010
Pearce Point PPA, PPB	172.788	65.208	237.996	1.452	0.264	1.716	174.240	65.472	239.712	-	0.792	0.792
Cape Hay - Cape Ford CH CF	1,255.848	210.952	1,466.800	3.762	1.782	5.544	1,259.610	212.734	1,472.344	9.768	0.462	10.230

SPARKER KILOMETRES, TORAN HOURS, TIME HOURS, STATISTICS and DAYS, EXPLOSIVES

MONTH	Sparker: New	Sparker: Missed	Sparker: Total	Sparker: Reshot	Toran: Worked	Toran: Breakdown	Toran: Stand-by	Working Days	Recording	Breakdown	Travelling and Streamer	Days in Darwin	Days at Sea	Travelling Days	Total km. per Day at Sea	Km. per Working Day	Month	Explosives kg	6" Detonators Number
September	311.828	-	311.828	36.350	150h10	3h10	-	9	53h42	23h13'	30h48	-	12	3	23.328	31.104	September	34.050	5,681
October	679.358	35.838	715.196	42.730	242h	0h30	16h30	14	104h40	7h50'	69h30'	6	19	5	35.754	48.524	October	520,250	10,405
November	962.230	-	962.230	-	284h35	3h15	3h	20	121h48'	28h33'	69h21	6	24	4	40.092	48.111	November	831,950	14,755
December	70.488	-	70.488	-	29h30	1h10	-	2	8h41	2h00'	12h05	-	3	1	23.496	35.244	December	53,900	1,078
TOTAL	2,023.904	35.838	2,059.742	79.080	706h15	8h05	19h30	45	287h11	61h36	181h44	12	58	13	34.344	44.266	TOTAL	1,690.150	31,919
Queen's Channel QCA	311.828	-	311.828	36.350	150h10	3h10	-	9	53h42	23h13'	30h48							284.050	5,681
Pearce Point PPA, PPB	239.712	35.838	275.550	35.838	135h15	3h15	17	7	38h56	2h10'	43h25							182,100	3,642
Cape Hay - Cape Ford CH CF	1,472.364	-	1,472.364	6.892	420h50	1h40	2h30	29	195h13	36h13	107h31							1,224,000	22,596

TOTAL KILOMETRES OP 2

Single coverage: 391.278
3 fold CDP : 835.626
TOTAL : 1,226.904

TOTAL KILOMETRES OP 83

Single coverage: 31.828
3 fold CDP : 733.260
TOTAL : 765.088

APPENDIX IV

REDUCTION AND PRESENTATION OF DATA

The Datum Plane was the Mean Sea Level.

I. DEPTH-SOUNDER DATA

The water depth was continuously recorded on electrosensitive paper $8\frac{1}{2}$" wide. Documents obtained were profiles of the sea bottom.

Two vertical scales were used:

0 to 50 metres and 0 to 100 metres.

Depths recorded were corrected by about 2.5 metres representing the depth of the system below the surface.

Tidal variations were not corrected.

II. SPARKER DATA

The model 254 E.G.& G. recorder provided cross sections on electrosensitive paper 11" wide.

The horizontal scale depended on the speed of the ship. It varied between 1/10,000 and 1/14,000.

The vertical scale was 40 milliseconds between reference lines.

Water depths obtained from the Fathometer were plotted on the sections.

III. FLEXOTIR DATA

III.1 Sections Made on Board

All shots were recorded on magnetic tapes. The tapes were played back on

III. FLEXOTIR DATA (III.1 Sections Made on Board - continued)

board after the daily field work to provide non-corrected variable area cross sections. These sections were made using only one trace per shot. Trace 2 was first chosen, but the noise level appeared to be generally lower on trace 3, as the disturbances due to the ship, decrease with the distance.

The play back filters were: 1/14 - 1/40

Presentation of the cross-sections was completed in the Brisbane interpretation office.

III.2 Processed Sections

All magnetic tapes were processed in the C.G.G. processing centre in France. Final interpretation was based on these documents.

Only analog processing was used without anti-singing filters: variable area cross sections were produced with filters.

1/14	- 1/40	in the Queens Channel area.
1/28	- 1/56	in the other areas.

No static corrections were made.

Normal Move Out corrections were applied from velocity functions determined by the processing office for each area. The values adopted, referring to a distance shot point - hydrophone of 600 metres, were plotted on the right hand side of each section.

Single coverage sections were made from single trace records with scales:

Horizontal: 1/50,000 approximately.

Vertical : 7.5" to 1 sec, one way time.

III. FLEXOTIR DATA (III. 2 Processed Sections - continued)

Six trace records enabled stacking one three fold coverage cross section with common depth points 33 metres apart.

The scales were:

Horizontal: 1/25,000 approximately

Vertical : 7.5" to 1 sec, one way time.

III. 3 Water Depth Corrections

These corrections were applied to times read on the processed cross sections. Their algebric values (c) are given by the formula:

$$c = h \left(\frac{1}{Vo} - \frac{1}{Vw} \right)$$

where h is the depth of water

Vw is the propagation velocity in the water - Vw = 1,500 m/sec.

Vo is the propagation velocity in sub bottom sediments - Vo = 1,800 m/sec.

APPENDIX V

CORRELATION OF SEISMIC AND GEOLOGICAL HORIZONS

(by Y. Godechot - AAP)

Figure (12) shows the possible correlation between offshore and onshore horizons at the present time.

Interpretations of data from the Sahul Shelf and OP. 2 - OP. 83 surveys are being done simultaneously by C.G.G. and as far as possible the known horizons are mapped in both areas. This is facilitated by several intersections between lines from each survey.

Excepting Line PK 1, from the Port Keats Marine Seismic survey, 1962, no marine seismic line approaches sufficiently near the coast to give a good tie between the offshore and onshore work. However, some good correlations can be made between lines closest together with a good possibility of these correlations being correct.

The onshore horizons have been thoroughly tied to Kulshill No. 1 and No. 2 and Moyle No. 1 from sonic logs and synthetic seismogrammes.

HORIZON 8 - B

The break between onshore line K 33 and offshore QCA 24 is about 4 miles but extrapolating the dip of horizon B from K 33, it appears that this horizon could be the same as horizon 8 on QCA 24.

HORIZON 7 - A

Extrapolation of the dip of Horizon 7 from offshore lines PPA to onshore lines PP, and the similarity in character, show that Horizon 7 and Horizon A are probably identical or very close.

HORIZON 6

No correspondance has been found onshore. Horizon 6 from Sahul Shelf though far away from the OP. 2 - OP. 83 border, appears to be different and deeper than the one mapped on the Cape Hay - Cape Ford survey.

HORIZON 5

On lines PPA 1, 3, 5 and on line PK 1, Horizon 5 appears to reach the "dromochronics zone" on the onshore sections. In fact, it could be found and followed from place to place, on some lines such as K 18, K 24 and SM 2. But, going up, it soon disappears towards the East. Its extension and its zone of disappearance suggest that it could be near the base of the Upper Permian Marine Beds, which are Argilaceous Sandstones with Oldhamia.

HORIZON 4

Horizon 4 is fairly visible on line PK 1, near the Port Keats Coal Bore at an average depth of 280 ms two way time, which is about 500'. Thus, Horizon 4 should not be far from the base of the lingula shales (Upper Permian to Trias) which is estimated at a depth of 600' in the Port Keats Coal Bore.

HORIZONS 3, 2 and 1.

Above Horizon 4, the problem of datation of the different levels is made of suppositions which are more or less based on their behaviour over underlying sediments.

Horizon 2 is characterised by a discordance on subjacent horizons, down to

4 and 5 on the north western part of OP. 83. This, and the fact that it is extending under shallow thickness of sediments let us suppose that Horizon 2 might be representative of Mesozoic discontinuity of the Cretace.

Horizon 1 also presents the same characteristics as of a discordance. It has been supposed to be the possible figure of a Tertiary discontinuity.

SUGGESTED HORIZONS CORRESPONDANCE IN BONAPARTE GULF

Fig. 12.

Sahul Shelf	OP.2 – OP.83 Marine	OP.2 after MOYLE RIVER SURVEY		GEOLOGICAL FORMATION	
AAP and CGG	AAP and CGG	AAP – SNPA	CGG	Place of Datation	Age
1					Tertiary discontinuity?
2 a					?
2 b					?
2	2				Mesozoic discontinuity (Cretaceous)
3	3				Mesozoic (?)
4	4			Line PK 1 and Port Keats Coal Bore	Base of Lingula Shales Trias to Upper Permian
5	5			Extrapolated to the coast. Followed on several lines of Kulshill survey	Argilaceous sandstones with oldhamia. Base Upper Permian Marine Beds.
	6				?
	7 Lines PPA – Lines PP # 4 miles	A	"2"	Kulshill 1 and 2 wells and synthetic seismograms	Top of microconglomer-atic member
	8 Lines QCA – QC – K33 Lines # 4 miles	B	(Not Drawn)	Kulshill 1 and 2 wells and synthetic seismograms	Base of unnamed formation Base of Lower Permian.
		C	"4"	Kulshill 1 and 2 wells and synthetic seismograms	Calcareous sandstones Milligan Beds member 3 (Visean)
6 (?)		Z	"5"	Moyle No. 1	Basement (Proterozoic)

APPENDIX VI

REGIONAL INTERPRETATION

(by Y. Godechot - AAP)

I. HORIZON 2 - CONTOUR MAP - Scale 1/500,000 (Pl. 25)

This map is a reduction of Horizon 2 contour map at the 1/250,000 scale which is a composite of the results of various surveys particularly the B.M.R.- 1965 Sparker survey. This allowed the extension of the contours to the north of OP 83 up to line P 20. It shows that the dip of Horizon 2 is generally east - west, and steeper on the south of OP 83 than on the north around the A6 structural feature.

Eastward, Horizon 2 is too shallow to be followed on either the Flexotir or the Sparker lines.

II. HORIZON 5 - CONTOUR MAP - Scale 1/500,000 (Pl. 26)

This map is a compilation of the results from the different surveys which have been performed on OP 2 and OP 83 including the last Flexotir survey and some of the onshore profiles on which Horizon 5 was believed to appear.

Due to the quality of the results from the former Sparker survey which are poor, Horizon 5 could not be followed to the north of line P 13A below 800 milliseconds one way time. Southward Horizon 5 is too shallow to be carried over the Queens Channel.

However, the map shows that Horizon 5's dip is generally towards the west on the northern part of OP 83 and with no apparent structural anomalies.

II. HORIZON 5 - CONTOUR MAP (continued)

Going north, the interval between Horizon 5 and 4 is thinning and the overlap of Horizon 5 by Horizon 4 occurs along a line roughly east south-east / west north-west. Towards the north-east, Horizon 5 and Horizon 4 vanish at the unconformity typified by the overlap of Horizon II.

Over the newly surveyed area, previous work was useful in the interpretation, particularly on the structural feature A, between CH 26 and CH 28, where a system of radial fractures seems to be developing. It appears that the Port Keats river estuary coincides with a syncline at the level of Horizon 5.

III. HORIZON 8 - CONTOUR MAP - Scale 1/250,000 (Pl. 27)

This map is a compilation of the results from various surveys performed over the Queens Channel and the Kulshill on shore area. It shows that there is a good probability that Horizon B in the Kulshill area is the same as Horizon 8 Queens Channel. This map has been extended to the western boundary of OP 2 mostly with the Queens Channel survey previous lines.

As far as it is reliable, Horizon 8 is generally deepening towards the north, but it is possible that some structures appear on the western part of Queens Channel which are worth some complements. Eastwards, if our correlation is good,the onshore structural feature (Providence hill) west of Kulshill No. 1 and 2 could be thoroughly closed to the south.