COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Petroleum Search Subsidy Acts

PUBLICATION No. 84

Permit No. 39, Papua
Marine Seismic Survey, 1966

BY

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PHILLIPS AUSTRALIAN OIL COMPANY
SUNRAY DX OIL COMPANY
CANADIAN SUPERIOR OIL (AUST.) PTY LTD
AND
ANACAPA CORPORATION

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Minister for National Development
1969

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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

MINISTER: THE HON. DAVID FAIRBAIRN, D.F.C., M.P.

SECRETARY: R. W. BOSWELL, O.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

DIRECTOR: J. M. RAYNER, O.B.E.

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FOREWORD

Under the Petroleum Search Subsidy Act 1959-1964, agreements relating to subsidized operations provide that the information obtained may be published by the Commonwealth Government six months after the completion of field work.

The Bureau of Mineral Resources, Geology and Geophysics is required, on behalf of the Department of National Development, to examine the applications, maintain surveillance of the operations, and in due course prepare the reports for publication. The growth of the exploration effort has greatly increased the number of subsidized projects and this increase has led to delays in publishing the results of operations.

The detailed results of subsidized operations may be examined at the office of the Bureau of Mineral Resources in Canberra (after an agreed period) and copies of the reports may be purchased.

This Publication deals with a marine reflection seismic survey conducted by Western Geophysical Company of America in the Gulf of Papua, Territory of Papua and New Guinea. It contains information furnished by Phillips Australian Oil Company and edited in the Petroleum Exploration Branch of the Bureau of Mineral Resources. The final report, dated October, 1966, was written by C.R. Fjelstul, N.C. Tallis and J.O. Erickson of Phillips Australian Oil Company. The methods employed in the survey and the results obtained are presented in detail.

J.M. RAYNER
Director

CONTENTS

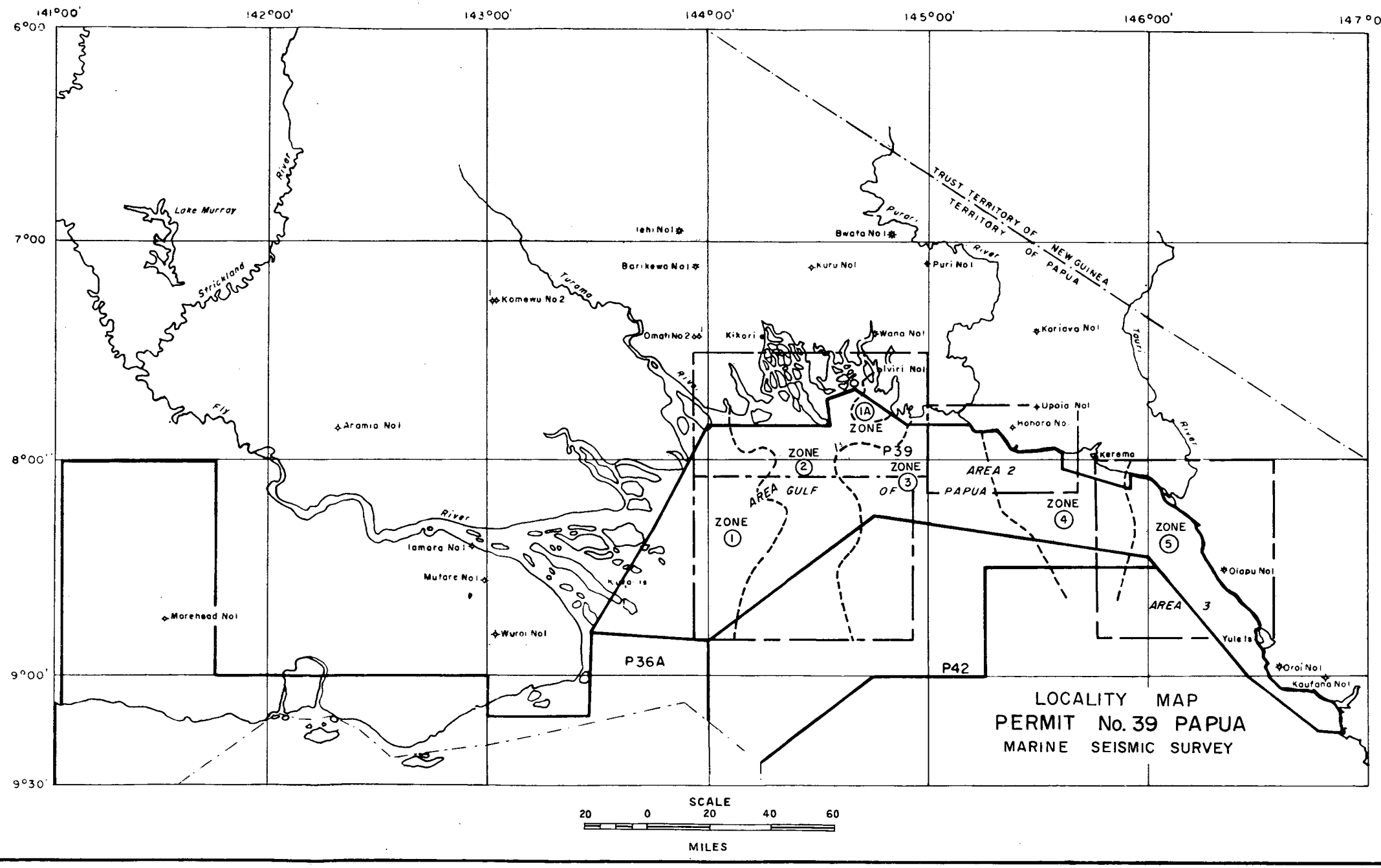
ILLUSTRATIONS

FIGURES

CONTENTS (Cont'd)

PLATES

Fig.1


141°00'
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9°30'
Lake Murray
Strickland River
Fly River
Aramia No1
Iehi No1
Barikewa No1
Komewu No2
Turama River
Omati No2
Kikori
Kuru No1
Bwata No1
Puri No1
Purari River
TRUST TERRITORY OF NEW GUINEA
TERRITORY OF PAPUA
Wana No1
Iviri No1
Koriava No1
Upoia No1
Honoro No.
Keremo
Tauri River
ZONE (1A)
ZONE (1)
ZONE (2)
ZONE (3)
ZONE (4)
ZONE (5)
P39
AREA GULF OF PAPUA 2
AREA 3
Iamara No1
Mutare No1
Morehead No1
Wuroi No1
Kiwai Is
Oiapu No1
Yule Is
Oroi No1
Kaufana No1
P36A
P42
LOCALITY MAP
PERMIT No. 39 PAPUA
MARINE SEISMIC SURVEY
SCALE
20 0 20 40 60
MILES

SUMMARY

A detailed marine reflection seismic survey was carried out by Western Geophysical Company of America, Party 87, for Phillips Australian Oil Company, Sunray DX Oil Company, Canadian Superior Oil (Aust.) Pty Ltd, and Anacapa Corporation between 22 January and 24 April 1966. The survey covered 1505 line miles over the Papuan Basin, in the Gulf of Papua, within Oil Permits Nos 39 and 42, and Oil Licence No. 4 (see Fig. 1).

The objective of the seismic survey was to obtain more detailed information on structures indicated by previous reconnaissance seismic work, with a view to determining drilling sites, and to extend the reconnaissance in the area.

Navigation and shot-point location services were provided by Offshore Raydist, Inc., using a Raydist Type 'N' Radiolocation System. Raydist base stations were located at Maer Island, Kiwai Island, and Goaribari Island. Ten permanent markers were erected at points along the coastline to serve as future Shoran station locations for locating proposed drilling sites. These markers were incorporated into the Raydist system.

Western's 'Dual Purpose' detector cable, which allows simultaneous recording from 1200-1200 metre and 600-600 metre 24-trace geophone spreads, was used in the survey. The cable was equipped with 36 seismometer groups of four seismometers per group, twelve groups being common to both long and short cables. Two different cable suspension systems were used during the operation. One, the floating type, was used in water depths of less than 50 feet and the other, the deep running type, was used in water depths exceeding 50 feet.

Interpretation of the seismic survey data has delineated three areas of particular interest including a shelf area associated with what may be reef limestone development, on the west, and a tectonically disturbed area on the east. An attempt has also been made to postulate the eastern limit of Miocene limestone development.

The detailed seismic survey was successful in outlining favourable structural and assumed reef prospects for drilling and several areas have been mapped in sufficient detail for the selection of drilling sites. These areas include the probable reef developments along the margin of the western shelf and in the Deception Bay area - considered very favourable prospects - and the anticlinal structures of the tectonically disturbed area of the eastern slope.

This geophysical operation carried out in the Gulf of Papua in 1966 was subsidized under the Petroleum Search Subsidy Act 1959-1964.

GENERAL INFORMATION

Purpose of Seismic Survey and Location

A detailed marine seismic survey was undertaken in Permit No. 39, Papua, to delineate prospective areas resulting from the reconnaissance survey made in 1964-65 by Western Geophysical Company for Phillips Petroleum Company and associated companies in the offshore part of the Papuan Basin.

Three lines were shot as part of this survey in co-operation with Australasian Petroleum Company Pty Ltd. This information, from the Iviri River and Era Bay areas of Oil Licence No. 4, is included as part of this report.

The 1966 interpretation maps cover three areas as shown on Figure 1. Area 1 covers the Western Shelf area to Deception Bay where 60 percent of the detailed programme was carried out. Area 2 covers 14 percent of the programme, and Area 3 the remaining 26 percent of detailed work.

Co-ordination and Flow of Data

Phillips Australian Oil Company was the operating company for a group which included Sunray DX Oil Company, Canadian Superior Oil (Aust.) Pty Ltd, and Anacapa Corporation.

The Western Geophysical Company crews shipped to the Western Geophysical Company, New Orleans office, the following basic data:

(i) S.L.E. FM magnetic and IBM digital tapes on the long spread recordings;

(ii) Field monitor records of the long spreads in 1-62 filter;

(iii) Fathograms;

(iv) Pelorus readings giving the azimuth to the tail buoy of the long spread as observed from the recording boat;

(v) Recorders field data, analog and digital;

(vi) Shot field data;

(vii) Raydist observers' data; and

(viii) Co-ordinators' daily operations log.

The Western Geophysical Company in New Orleans timed and labelled the field recordings and shipped the analog information to Phillips Petroleum Company in Bartlesville, Oklahoma, where the record sections were processed. Corrected record sections were sent to Western's interpretation staff and to the Brisbane office of Phillips for interpretation.

Surveying

The positions of the recording boat were controlled by Raydist navigation and positioning service, provided by Offshore Raydist, Inc. (ORI) of New Orleans, Louisiana.

A detailed discussion of the Raydist system employed is given in the final report by ORI (Appendix 2 to this report).

The need for numerous land stations positioned with the Raydist net and compatible with shot point locations, plus additional ties to government trigonometric stations, was considered essential during this survey. ORI erected ten permanent monuments along the coast for future reference and obtained Raydist co-ordinates on seven trigonometric stations established by the Royal Australian Engineer Corps. These stations and ties are indicated on the base maps and described in the ORI report.

Base Maps

The base maps constructed for the 1965 survey were used for this report and reference is made to the report of that survey (de Jong, Aart, 1965). The 1966 detailed survey is shown on the Water Depth Maps by the plot of every third shot point.

The positions of the shot points were machine calculated and plotted by Offshore Raydist, Inc. These positions were derived from the observed recording boat positions after the application of the proper 'stepback', corrected for cable drift, where the cable drift information was available and applicable.

In order to reduce the number of interpretation maps the original base maps were spliced to form the map areas shown in Figure 1. The line numbers for the 1965 work are circled.

Record Sections, Velocities, and Quality of Seismic Results

Western Geophysical Company's computing office in New Orleans received the basic data, performed the basic preparations, and shipped stacking programmes, monitor records, and magnetic tapes to Phillips Petroleum Company's processing centre in Bartlesville, Oklahoma.

Phillips, Bartlesville, prepared the record sections in dual display (variable amplitude - variable density), six-fold stacked, filtered in either Phillips playback filters F-F50 or F10-50.

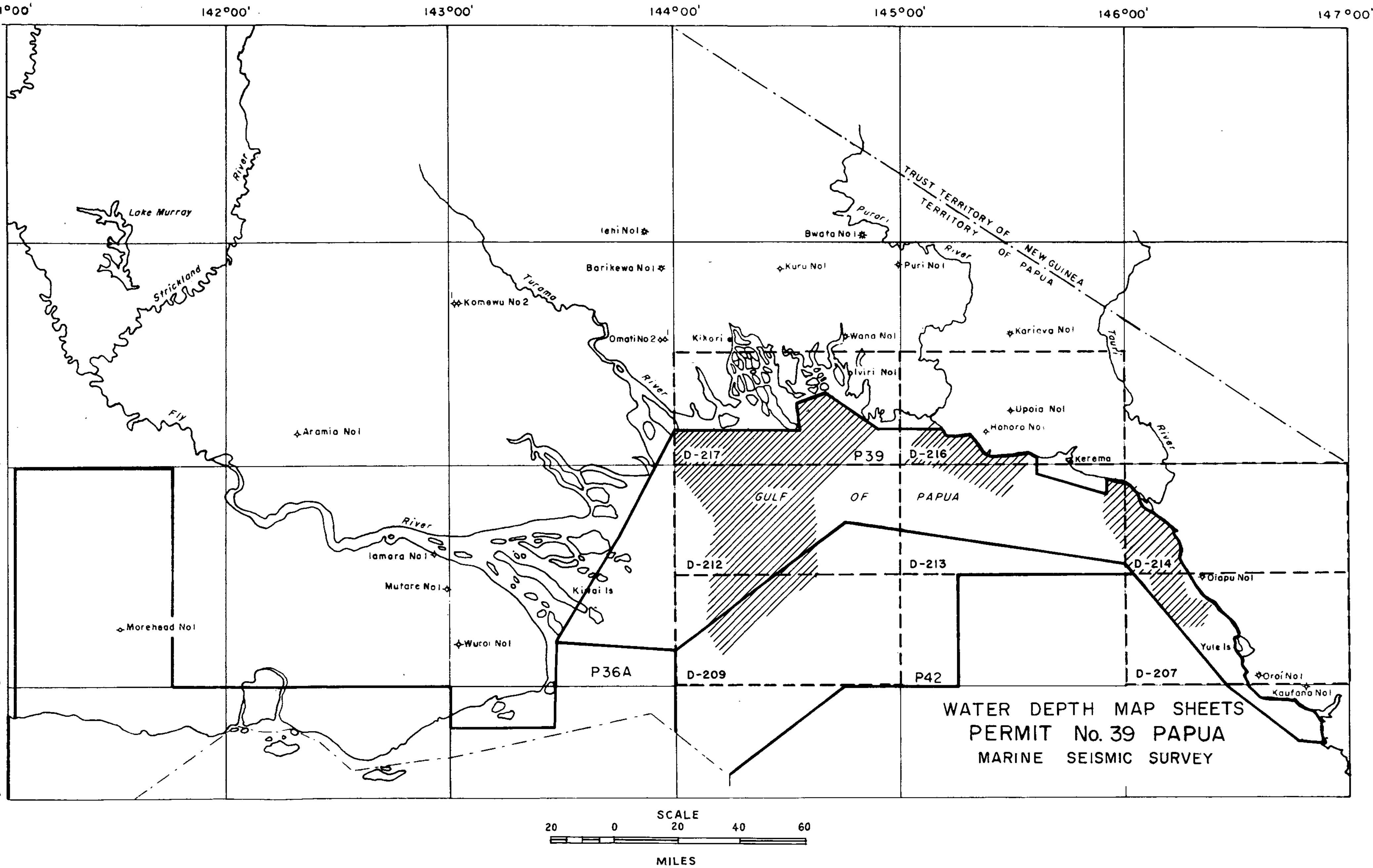
The vertical time scale for work sections was four inches per second and films of these sections were also prepared at half-scale (2 in./sec.) in the variable density mode.

Quality of the six-fold stacked sections from the analog tapes is good. Small scale uncorrected record sections on the boat (short spread), corrected short spread sections (100% Lines A, 58, 73, 91, 132, 134, 137, 140, and 142) and digital processed sections (600% Lines A, B, D, 79, 103, 153, and 155A) were also used in critical areas to determine reflection continuity and correlation.

Dynamic corrections in the Deception Bay area were based on the Iviri No. 1 Well velocity and in the remaining areas corrections were determined according to T-ΔT analysis (Figs 4 and 5). Velocity variations greatly affect the determinations of the pre-Miocene horizons and further study is being undertaken to evaluate the true structural picture.

Reflection quality may be considered satisfactory to good and reflection character on principal marker horizons has been maintained. Locally, the quality of the six-fold stacked sections may have been affected by cable drift in excess of ten degrees.

Fig. 2



WATER DEPTH MAP SHEETS
PERMIT No. 39 PAPUA
MARINE SEISMIC SURVEY

Water Depth Maps

Water depth maps were constructed by Western Geophysical Company using map sheets illustrated in Figure 2.

These maps have been assembled using fathometer recordings, taken on the recording boat, corrected for a 'stepback' to the pertaining shot point, assuming in-line relationship between recording boat, spread, and shot point. This information is not corrected to a tide datum.

PREVIOUS EXPLORATION AND GEOLOGY

The geology of the Papuan Basin has been described in the Journal of the Geological Society of Australia, Volume 8, Part 1: 'Geological Results of Petroleum Exploration in Western Papua 1937-1961', compiled by the Australasian Petroleum Company Proprietary Limited. With the exception of data from Iviri No. 1 Well, no additional published geological information directly pertaining to Permit No. 39 is available.

Additional geological information onshore in Papua was obtained through the courtesy of officers of the Bureau of Mineral Resources, Marathon Petroleum Australia Ltd, The Papuan Apinaipi Petroleum Company Limited, and Australasian Petroleum Company Proprietary Limited. These data were reviewed by N.C. Tallis of Phillips Petroleum Company in 1964 in a report 'Stratigraphic Analysis of the Purari-Redscar Area, Papua'. A photogeological evaluation of the same area was prepared by Geophoto Resources Consultants for Phillips in 1964. Both are unpublished Company reports.

Two previous seismic surveys, both subsidized operations, have been conducted in the Gulf of Papua. In 1961, the Permit 26 survey was shot for B.O.C. of Australia Ltd and associates in the western part of Permit No. 26 (now Permit No. 39). Phillips Petroleum Company and associates conducted a reconnaissance seismic survey across the Gulf in 1965. These surveys indicated the structural configuration across the Gulf and provided seismic structural 'leads' which were detailed this year. Lack of ties to wells in the reconnaissance seismic work prevented a reliable appraisal of the stratigraphy in the offshore area.

A seismic tie to the APC Iviri No. 1 Well (Haw and Skarda, 1965) was shot during the subject survey. The stratigraphic sequence encountered in this well, as reported by the Operator, is shown in the following Table.

Age	Depth Intervals (feet)				Thickness (feet)
Pleistocene to Recent	Surface	to	1,946		1946
Pliocene	1,946	-	5,302		3356
Pliocene/Miocene Transition	5,302	-	5,565		263
Upper Miocene	5,565	-	7,584		2019
Lower Miocene	7,584	-	9,294		1710
Eocene	9,294	-	10,390		1096
Lower Cretaceous (Neocomian)	10,390	-	12,015	(T.D.)	1625

A similar stratigraphic column may be expected in the Deception Bay area of Permit No. 39.

From the present seismic information the Gulf of Papua has been divided into six distinct structural zones (see Fig. 1), described below:

Zone 1 is the Western Shelf area where a relatively thin Tertiary section is present, dipping gently eastward and structurally undisturbed. Local Miocene reef development is suggested along the basinward edge of this zone.

Zone 1A is similar to the Western Shelf area although there is no proof that they are connected. A Miocene limestone shelf area is interpreted from results of the Iviri No. 1 Well and from seismic data. Mesozoic/Eocene block uplift and Miocene reef development are indicated from seismic information.

Zone 2 is the western slope of the Papuan Basin in which the Tertiary section dips more steeply and thickens rapidly to the east. Within this area the Mesozoic is locally folded and faulted and unconformable to the Tertiary formations.

Zone 3 is an undeformed belt occupying the western part of the mobile Tertiary basin, which has subsided rapidly since early Miocene time. The Mesozoic and Eocene strata dip moderately to strongly eastward without interruption. Local faulted structures are recognized in the older rocks only along the very deep eastern edge of this zone, and shallow gentle folding is present in strata tentatively identified as upper Miocene and Pliocene.

Zone 4 is the seaward extension of the Aure Trough; it is a complex fold belt characterized by gentle synclines and sharp, asymmetric thrust-faulted anticlines. The anticlines are probably faulted at the axes and flowage of incompetent mudstones has resulted in diapiric movement in the cores of the anticlines. Regional dip across the folded belt is westward.

Zone 5 is the mobile eastern shelf and slope province where there is good evidence for thrust faulting associated with the eastern shelf of the Aure Trough.

A diagrammatic cross section (Plate 7) across the Gulf of Papua was prepared from marine seismic data and onshore geological information.

RESULTS AND INTERPRETATION

Area 1 - Western Shelf to Deception Bay

This area encompasses the shelf (Zone 1), the western slope (Zone 2) and the anomalous Deception Bay area (Zone 1A).

Three different mapping horizons were selected over whole or part of the area:

(i) Top of Miocene Limestone Horizons (Plate 1)

(ii) Cretaceous-Tertiary Unconformity Horizon (Plate 2)

(iii) Near Base of Mesozoic Horizon (Plate 3)

(i) Top of Miocene Limestone Horizons (Plate 1):

This map is a composite of two horizons - middle Miocene in the west (Zone 1) and lower Miocene on the east (Zones 2 and 1A).

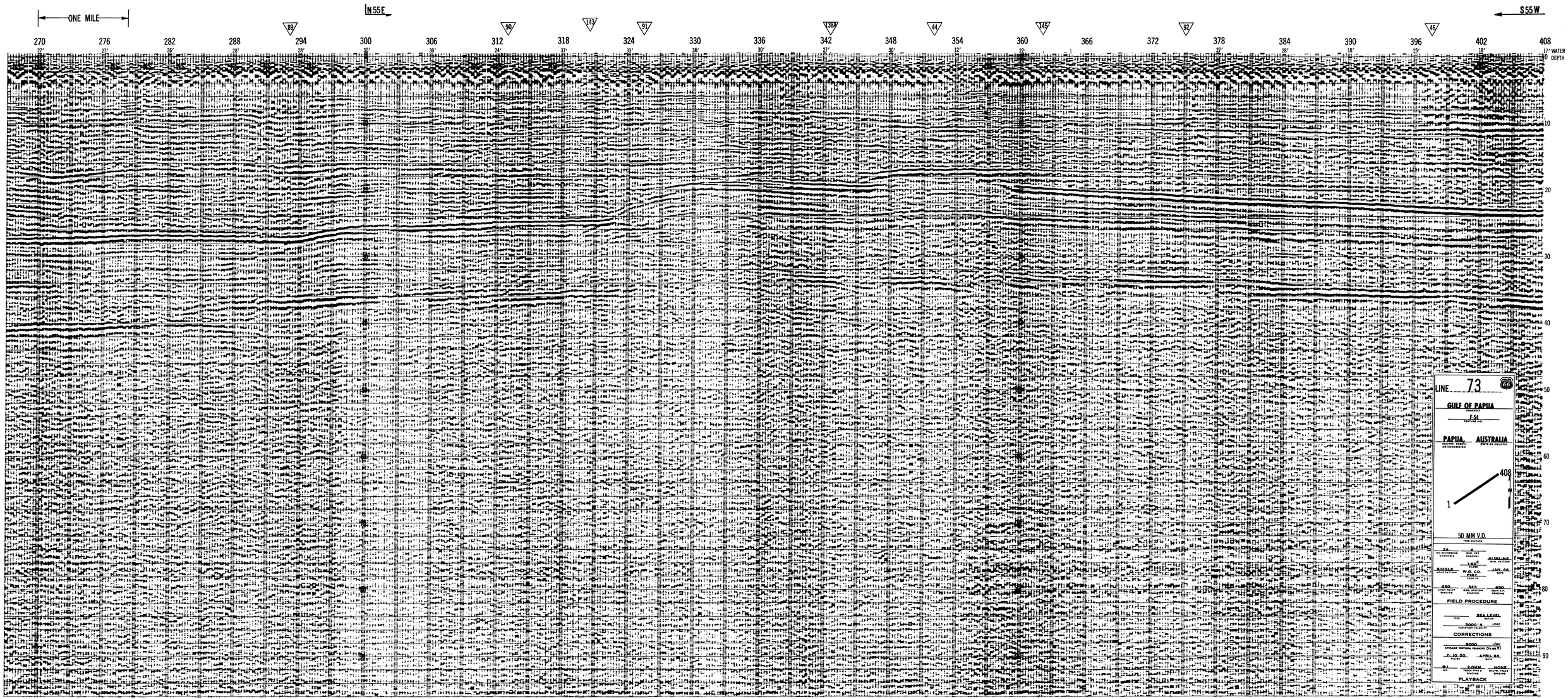

ONE MILE
N55E
S55W
89
90
143
91
388
44
145
92
45
270 276 282 288 294 300 306 312 318 324 330 336 342 348 354 360 366 372 378 384 390 396 402 408
17' WATER DEPTH
10
20
30
40
50
60
70
80
90
LINE 73
GULF OF PAPUA
F-54
PAPUA AUSTRALIA
408
1
50 MM V.D.
24
4
41 INLINE
1-SAT
SINGLE
WESTCO
JAN. 66
650
328
650
FIELD PROCEDURE
SEA LEVEL
8000
CORRECTIONS
8000
F-10-50
APRIL 66
64
8 MM
NONE
PLAYBACK

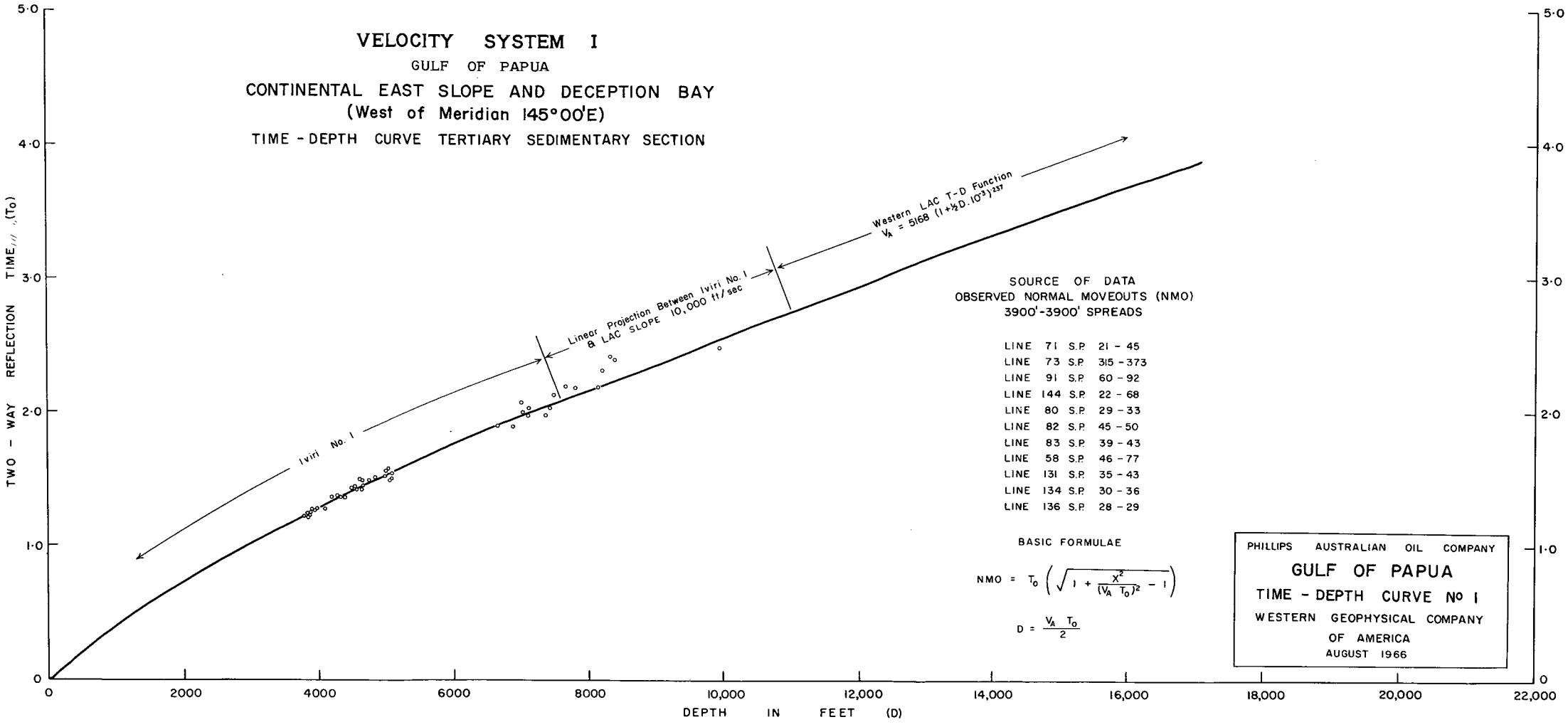
Fig. 4

VELOCITY SYSTEM I

GULF OF PAPUA

CONTINENTAL EAST SLOPE AND DECEPTION BAY
(West of Meridian 145°00'E)

TIME - DEPTH CURVE TERTIARY SEDIMENTARY SECTION



SOURCE OF DATA
OBSERVED NORMAL MOVEOUTS (NMO)
3900'-3900' SPREADS

LINE 71	S.P.	21 - 45
LINE 73	S.P.	315 - 373
LINE 91	S.P.	60 - 92
LINE 144	S.P.	22 - 68
LINE 80	S.P.	29 - 33
LINE 82	S.P.	45 - 50
LINE 83	S.P.	39 - 43
LINE 58	S.P.	46 - 77
LINE 131	S.P.	35 - 43
LINE 134	S.P.	30 - 36
LINE 136	S.P.	28 - 29

BASIC FORMULAE

$$NMO = T_0 \left(\sqrt{1 + \frac{X^2}{(V_A\ T_0)^2}} - 1 \right)$$

$$D = \frac{V_A\ T_0}{2}$$

PHILLIPS AUSTRALIAN OIL COMPANY

GULF OF PAPUA

TIME - DEPTH CURVE No 1

WESTERN GEOPHYSICAL COMPANY OF AMERICA

AUGUST 1966

Fig. 5

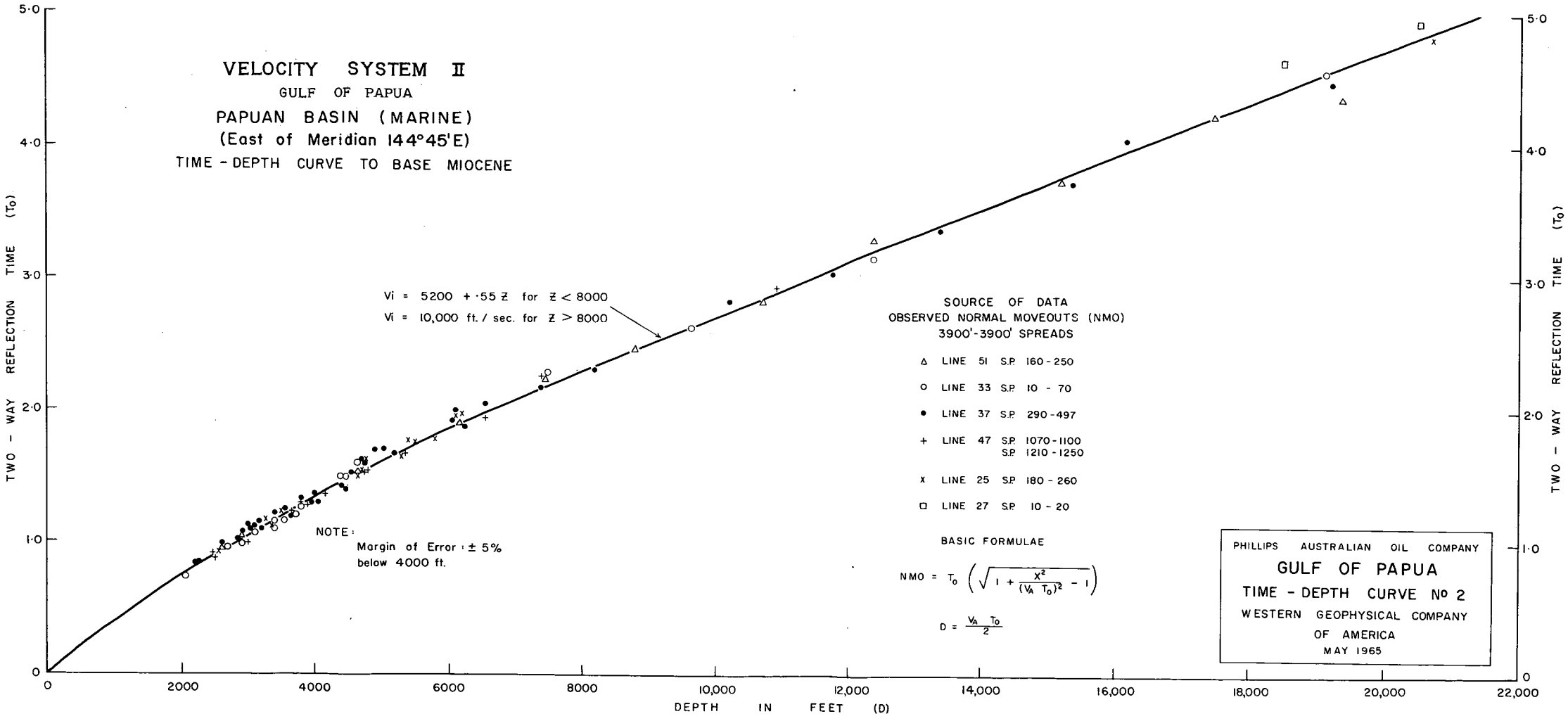
VELOCITY SYSTEM II

GULF OF PAPUA

PAPUAN BASIN (MARINE)

(East of Meridian 144°45'E)

TIME - DEPTH CURVE TO BASE MIOCENE



SOURCE OF DATA
OBSERVED NORMAL MOVEOUTS (NMO)
3900'-3900' SPREADS

- △ LINE 51 S.P. 160 - 250
- ○ LINE 33 S.P. 10 - 70
- ● LINE 37 S.P. 290 - 497
- \+ LINE 47 S.P. 1070 - 1100, S.P. 1210 - 1250
- x LINE 25 S.P. 180 - 260
- □ LINE 27 S.P. 10 - 20

BASIC FORMULAE

$$NMO = T_o \left(\sqrt{1 + \frac{X^2}{(V_A T_o)^2}} - 1 \right)$$

$$D = \frac{V_A T_o}{2}$$

PHILLIPS AUSTRALIAN OIL COMPANY

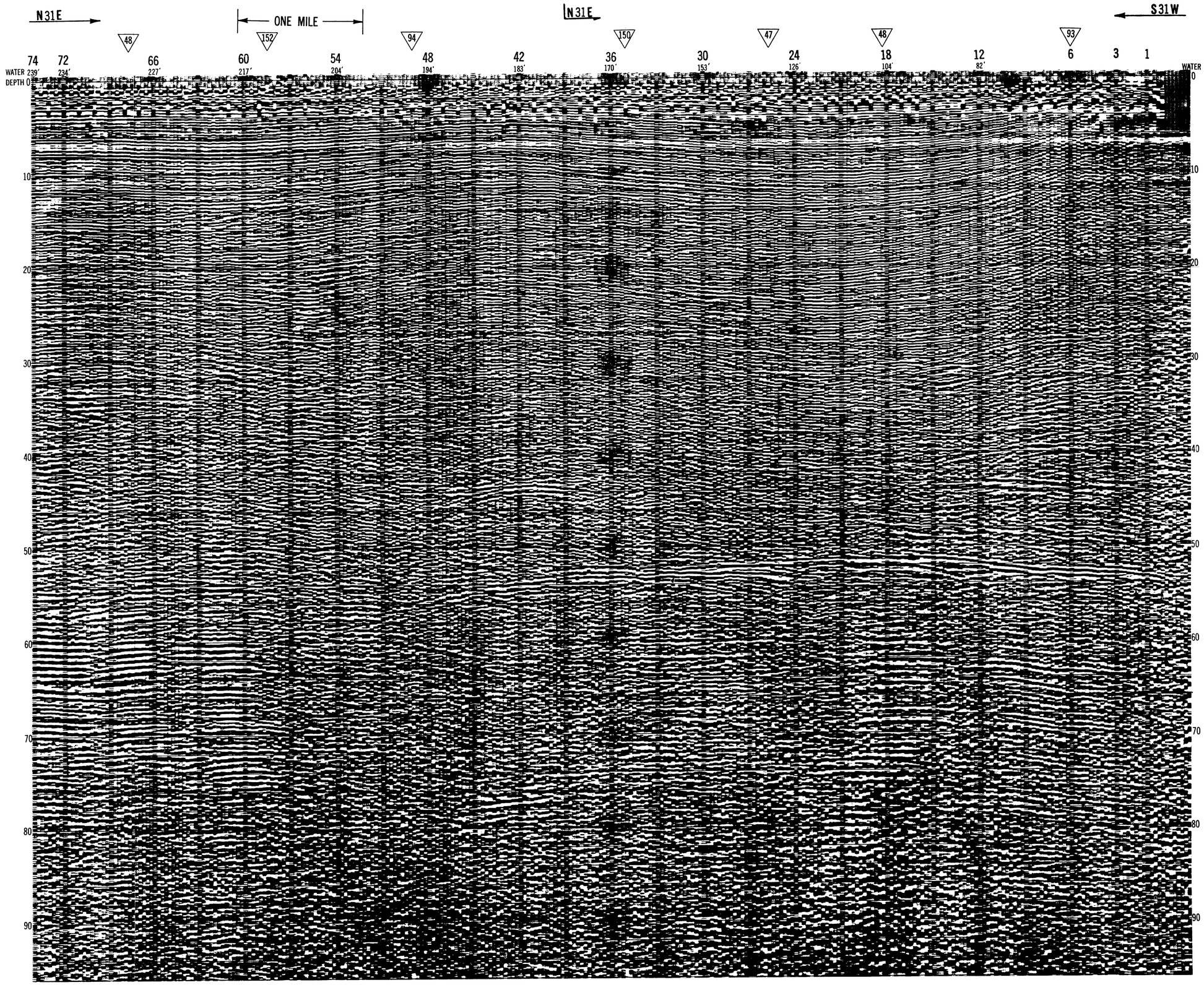
GULF OF PAPUA

TIME - DEPTH CURVE No 2

WESTERN GEOPHYSICAL COMPANY OF AMERICA

MAY 1965

Fig. 6



LINE 98

GULF OF PAPUA
PROSPECT

F-54
FEATURE NO.

PAPUA COUNTY, PARISH, OR CONCESSION — **AUSTRALIA** STATE OR COUNTRY

1
74

50 MM V.D.
TYPE SECTION

24 NO. RECORDING CHANNELS	4 GEO. PER CHANNEL	
	2-62² FILTER	41 INLINE GEO. PATTERN
SINGLE HOLE PATTERN	W.G. CO. P/87 SHOT BY	MARCH 66 DATE
650 SHOT POINT SPACING	325 GEO. STATION SPACING	650 MAIN S.P. SPACING

FIELD PROCEDURE

TYPE	SEA LEVEL DATUM
5000' S ELEVATION	1/SEC VELOCITY

CORRECTIONS

8000 1/SEC AVERAGE VERTICAL VELOCITY (Vo OR V)		
F-F-50 FILTER		MAY 66 DATE
6:1 MIX	2.0 TRACE TYPE & SPACING	NONE GALVO. TRACE SPACING

PLAYBACK

The Middle Miocene Horizon is based on a strong reflection which terminates abruptly eastward from the shelf edge. Gentle eastward dip is demonstrated. A series of structural anomalies exist along the shelf edge and are tentatively interpreted as resulting from reef buildups. Two of these features were adequately detailed and are considered suitable for drilling.

The Lower Miocene Horizon is mapped from a good reflection of outstanding character. The seismic tie to Iviri No. 1 indicates that this reflection originates from the top of the lower Miocene limestone within Zone 1A. A marked discontinuity of seismic energy occurs around the perimeter of the Deception Bay limestone shelf; however, there appears a good reflection character correlation across this discontinuity (refer to Line 73, Fig. 3.). Extension of this reflection westward places it below the middle Miocene horizon and within the thick Miocene limestone sequence on the shelf in Zone 1. The anomalous high area of Zone 1A is interpreted as reef buildup on a Mesozoic-Eocene platform.

(ii) Cretaceous-Tertiary Unconformity Horizon (Plate 2):

This horizon is mapped on a seismic energy band correlated with the base of the Eocene limestone at Iviri No. 1 Well. This energy band persists across the embayment separating Zone 1A and Zone 1. Reflections from the Cretaceous section underlying this energy band are poor and may be considered characteristic of a predominantly shale section. This horizon as mapped on two-way reflection times has little value as a structural horizon because of wide variations in thickness of overlying limestone. More accurate regional velocity information is needed to convert this horizon to a depth map.

(iii) Horizon near Base of Mesozoic (Plate 3):

This horizon occurs near the base of an apparent sedimentary section as interpreted from the seismic work in Zone 1A, and is represented by a strong reflection in this area. The reflection deteriorates in quality west and south of Zone 1A. The map is actually a composite of a very good reflection horizon and a very poor phantom horizon. The Mesozoic is highly faulted and many of the faults are interpreted solely from this good near-basement reflection.

This time map has little value as a true structural representation because of the variations in thickness and velocity of the overlying Tertiary limestones. The large apparent displacements on seismic sections across the edge of the Deception Bay platform diminish appreciably when converted to depth.

Structure in Zone 2, east of the shelf edge, is disguised on the time map because of the westward thickening wedge of Tertiary limestones. This variation in thickness of high velocity media is associated with a decreased thickness of low velocity upper Miocene/Pliocene sediments as the shelf edge is approached. To define accurately true Mesozoic structure in this area will require a far greater refinement in velocity information than is available at this time.

The Mesozoic seismic band becomes very distorted by noise patterns at the edge of the Tertiary shelf in Zone 1. No reliable reflection correlation across the shelf margin is possible. This margin has been broadly interpreted as being coincident with major Mesozoic faulting.

Area 2 - Orokolo Bay (Zone 3)

The Orokolo Bay detailed area occupies a portion of structural Zone 3. Two mapping horizons were selected:

(i) Horizon within Pliocene (Plate 4)

(ii) Lower Miocene Limestone and Eocene (?) Limestone Horizon (Plate 5)

(i) Horizon within Pliocene (Plate 4):

This horizon is based on a poor reflection energy band occurring near the lower part of the Pliocene section. Pliocene sediments crop out near the crest of the Hohoro anticline, just onshore from the detail area. The small closed structures are probably the result of obscure thrusting or flowage movements within Miocene mudstones, west of the zone of major thrusting in the complex fold belt (Zone 4).

(ii) Top of Lower Miocene Limestone and Eocene (?) Limestone Horizon (Plate 5):

The contoured surface on this map is constructed from a composite of two prominent reflection horizons. The Eocene horizon is based on a strong reflection occurring near the base of a large interval of very poor seismic information which has been ascribed to the Miocene. It has been tentatively correlated with the top of the Eocene limestone and is estimated to be over 20,000 feet below sea level (refer to the sample seismic section of Line 98, Fig. 6). The zone of thrust-faulting is well portrayed on the seismic sections and there is good correlation of the reflection across these faults. The top of the lower Miocene limestone horizon on the western edge of the map is a continuation of the lower Miocene horizon in Area 1. The eastern edge of this horizon is defined by an abrupt termination of good reflection. The termination of the good reflection is not apparently related to faulting and occurs above a group of steeply eastward-dipping reflections. It is suggested that this seismic discontinuity represents a facies change - the eastward edge of Miocene limestone development.

Area 3 - Eastern Shelf and Slope

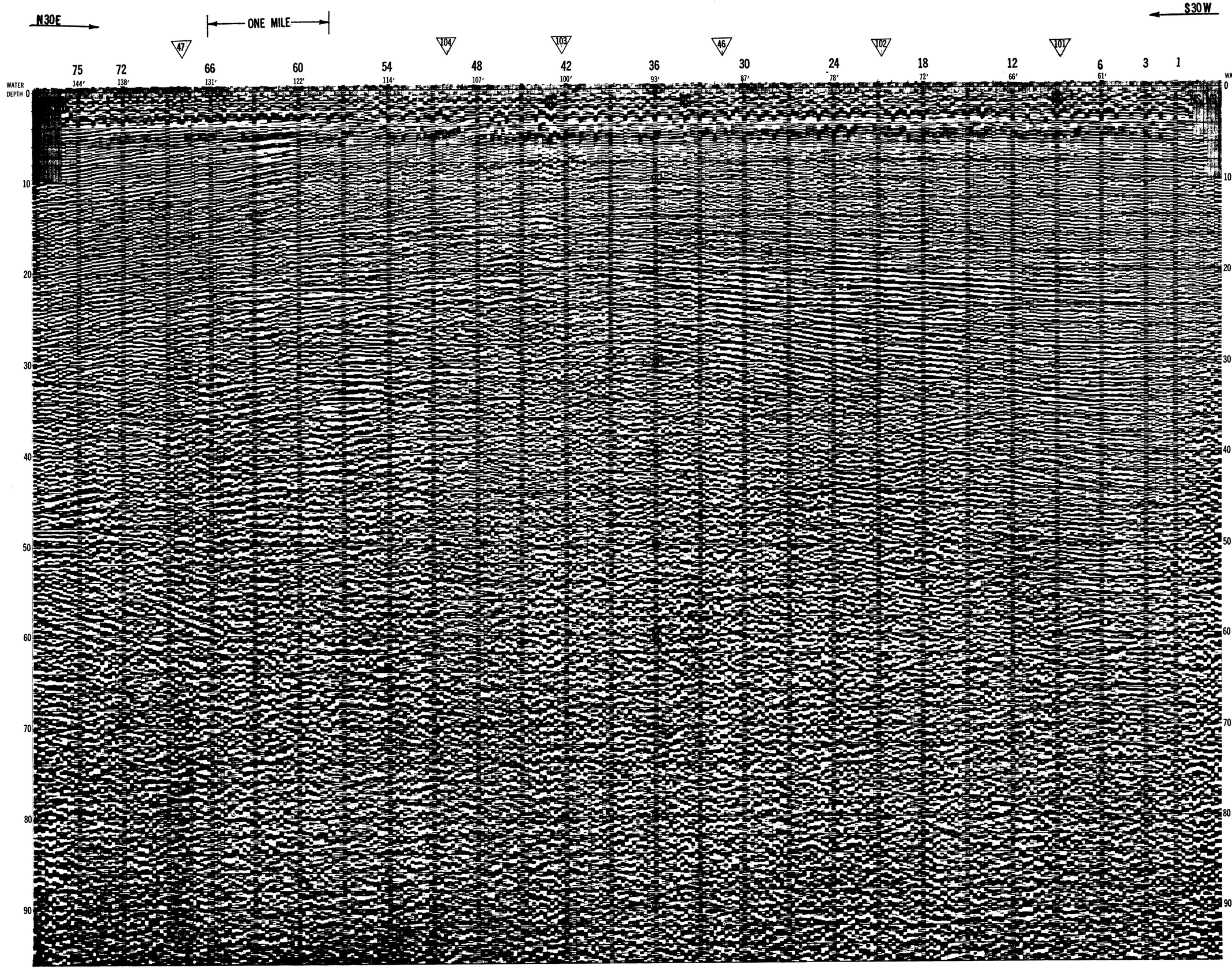
The eastern portion of the Gulf of Papua encompasses structural Zone 5. One horizon only was mapped in this area, and reflection quality is generally poor.

Top of Middle Miocene (?) Horizon (Plate 6):

This map is based on a good reflection which disappears abruptly westward along the line of termination, marked on the map. West of this line, the mapping horizon is a phantom, based on poor to questionable information. Correlation across this zone is possible and age equivalence may be inferred.

Age designation for this horizon must be regarded as tentative but the character and limiting extent of this good reflection are such that it is believed to originate from the upper Miocene mudstone/middle Miocene limestone interface. Record quality does not permit mapping of this horizon south to Yule Island where middle Miocene is exposed partly in limestone facies.

The interpretation of thrust faulting is based on fair evidence throughout the area (refer to the seismic section of Line 111, Fig. 7).



LINE 111

GULF OF PAPUA
PROSPECT

F-54
FEATURE NO

PAPUA, COUNTY, PARISH, OR CONCESSION
AUSTRALIA STATE OR COUNTRY

1
75

50 MM V.D.
TYPE SECTION

24 NO RECORDING CHANNELS	4 GEO. PER CHANNEL	41 IN LINE GEO PATTERN
	2-62 FILTER	
SINGLE HOLE PATTERN	W.G. CO. P187 SHOT BY	MARCH 66 DATE
850 SHOT POINT SPACING	325 GEO. STATION SPACING	850 MAIN S.P. SPACING

FIELD PROCEDURE

SEA LEVEL TYPE / DATUM
8000' S ELEVATION VELOCITY / I/SEC

CORRECTIONS

8000 I/SEC AVERAGE VERTICAL VELOCITY (Va OR V)
F-F-50 FILTER / AUG. 66 DATE
6:1 MIX / 2.0 TRACE TYPE & SPACING / NONE GALVO. TRACE SPACING

PLAYBACK

CONCLUSIONS

The seismic results were recorded in both analogue and digital form using a sixfold multiple coverage technique. Interpretation was based on the results of analogue processing of the six-fold coverage data, which provided record sections of sufficient quality for reliable interpretation in most parts of the three areas covered. Some digital processing was done in selected areas.

The seismic survey mapped reliable reflection horizons to basement on the Western Shalf area of the Papuan Basin, and it has been possible to postulate the eastern limits of the Miocene limestone development on the western slope. The margin of the western Miocene shelf area is clearly distinguishable from the western slope of the shelf, and several barrier-type reef developments along this margin have been interpreted.

In the Deception Bay area at the head of the Gulf of Papua a large atoll-type reef development has been interpreted from the seismic results and it is probable that it extends on shore in the vicinity of the Iviri No. 1 Well.

In the eastern area, a reflection horizon believed to represent the Miocene was mapped and showed strong structural deformation. A series of closed anticlines and associated thrust faults is suggested from the seismic results.

Several areas have been mapped in sufficient detail for the selection of drilling sites. These include the probable reef areas along the margin of the western shelf and in Deception Bay, areas which are considered very favourable prospects, and the anticlinal structures of the tectonically disturbed area of the eastern slope. No further seismic work is considered necessary before at least one well has been drilled in the areas detailed.

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APPENDIX 1

PERMIT NO. 39, PAPUA

MARINE SEISMIC SURVEY, 1966

OPERATIONS REPORT

by

G.O. Miller and V.C. Boyd*

CONTENTS

*Western Geophysical Company of America

GENERAL INFORMATION

Contractors

The seismic survey was made by Western Geophysical Company of America, 933 North La Brea Avenue, Los Angeles 38, California, U.S.A.

Navigation and shot point location services were provided by Offshore Raydist, Inc., Post Office Box 13055, New Orleans, Louisiana, U.S.A.

Area Location

The survey was conducted in the Gulf of Papua, extending from 144 degrees to 146 degrees 30 minutes East longitude, and from 7 degrees 40 minutes to 8 degrees 45 minutes South latitude.

Crew Headquarters

Operational headquarters were maintained in Port Moresby, Papua.

Date of Operations

From 22 January 1966 to 24 April 1966.

CHRONOLOGY

January 21	Crew left Port Moresby for prospect area
22	Shooting underway
February 4	Crew in Port Moresby on break
10	Shooting resumed
23	Completed shallow water shooting
24	Started Iviri River shooting
27	Completed Iviri River shooting
28	Shooting for Australasian Petroleum Company Pty Ltd by agreement with Phillips Petroleum Company
March 1	Crew in Port Moresby on break
9	Shooting resumed
19	Crew in Port Moresby on break
24	Shooting resumed
30	Crew in Port Moresby awaiting repairs to rudder assemblies on 'F.B. Walker'
April 8	Shooting resumed
16	Crew in Port Moresby for powder
18	Shooting resumed
24	Shooting completed

DETECTOR CABLE

Western's 'Dual Purpose' detector cable, which allows simultaneous recording from 1200-1200 metre and 600-600 metre 24-trace geophone spreads, was used in the survey. The cable was equipped with 36 seismometer groups of four seismometers per group, twelve groups being common to both long and short cables.

Two different cable suspension systems were used during the operation. One, referred to as the floating type, was used in water depths of less than 50 feet and the other, referred to as the deep running type, was used in water depths exceeding 50 feet.

With the floating type system the cable is suspended by float members placed at such positions throughout its length that the portions of the cable between seismometer groups will surface at all times, irrespective of whether the cable is in motion or not. The seismometers with this type of cable suspension surface during towing operations only and are so balanced that they will submerge as soon as the cable comes to rest.

The deep running cable is buoyed and balanced in such a manner that the seismometers remain at any desired depth, in this case 35 feet, at all times, irrespective of the movement of the cable.

OPERATING PROCEDURES AND TECHNIQUES

In operation, the cable is pulled into position with the recording boat which then backs down, allowing the seismometers to settle to a depth of approximately fifteen feet in the case of the floating type suspension. This back-down period is greatly reduced with the deep running suspension since the seismometers are at the desired depth when the shot location is reached. During the back-down period the shooting boat drops the powder charge at an offset distance of approximately 250 feet from the centre of the cable and moves off. The shot is then electronically detonated from the recording boat and recorded. Powder charges are suspended from plastic bags approximately five feet below the surface.

The use of the deep running suspension system offers several advantages:

(i) Improved signal to noise ratio;

(ii) Constant and consistent seismometer depths at all times;

(iii) Less time spent on shot point location, effectively reducing cable drift; and

(iv) More consistent effective spread length.

INSTRUMENTATION

Amplifiers:	24-trace Western's FA 40, recording short cable
	24-trace Western's FA 50, recording long cable
Tape Transports:	One Western Techno AM unit for short cable One SIE FM unit for long cable
Digital Recorder:	Long cable only
Seismometers:	Western's PS-2 pressure sensitive type

Filtering:	Western's 10-50C for recording on tape from short spread Western's CFv for playbacks from short cable in preparing 70 mm VA record sections in the field Western's 6.5-62 for SIE FM tapes and monitors from long cable until 3 March. Western's 8.5-62 for SIE FM tapes and monitors from long cable after 3 March.
Gain Settings:	Maximum commensurate with signal to noise ratio
A.V.C.:	Tape A.V.C. on all recording
Playbacks:	Constant gain playbacks made at frequent intervals to check tape input on both AM and FM systems.

It has been observed that a lag was introduced on alternate traces of short spread records, shot before 21 April. Means exist for correcting these.

SURVEYING

A Raydist Type 'N' electronic positioning system was used throughout the survey. Raydist stations were located at Maer Island, Kiwai Island, and Goaribari Island, with relay originally located at Umuda Island. After the first trip, relay was moved to Vailala, which move provided the operation with extended Raydist hours of stable signals.

A twin-motored Cessna Model 337, equipped with a transistorized mobile Raydist receiver, flew lane counts to the crew at regular intervals or at any time a count was requested from the recording boat. Good survey practices were observed at all times, so that no portion of the area was evacuated without a lane count check on the final day of shooting in that area. Further details of Raydist operations are given in Appendix 2.

Ten permanent markers were erected at points along the coastline to serve as future Shoran station locations for locating proposed drilling sites. These markers were run in with the Cessna aircraft and incorporated into the Raydist system. Certain trigonometric points were similarly tied into the system. Descriptions of these points are given in the final report submitted by Offshore Raydist, Inc.

DATA PRESENTATION

Field

Variable Area record sections were made aboard the recording boat from 70 mm playbacks of the short cable tapes.

Field interpretations were made by Phillips' representatives from Brisbane.

Processing

All short cable AM tapes were sent to Brisbane and retained there.

All long cable FM tapes were sent to Bartlesville, Oklahoma via New Orleans, Louisiana, for processing.

All digital recordings were sent to New Orleans for storage.

EQUIPMENT

Recording Boat		'Western Geophysical 1'
	Length:	105 feet
	Hull:	Steel
	Power:	Twin V-12 GM Diesels
	Speed:	11 knots
	Additional:	R.C.A. Radar Fathometer Sperry Gyro Compass with repeaters R.C.A. ship-to-shore radio
Shooting Boat		'F.B. Walker'
	Length:	87 feet
	Hull:	Steel
	Power:	Twin 6-110 GM Diesels
	Speed:	10 knots
	Additional:	R.C.A. Radar Fathometer R.C.A. ship-to-shore radio
	Capacity:	130,000 lb. powder

Pelorus Compass

A Pelorus compass was installed on the recording boat. This compass is equipped with a Sperry Gyro Compass repeater connected to the main compass.

The azimuth of the centre buoy or the farthest visible buoy or float of the cable was read on this Pelorus compass to determine the cable drift.

The Pelorus compass was inoperative or provided erratic readings on a number of lines because of a faulty bearing. This was remedied during the survey.

KEY PERSONNEL

Phillips Supervisory Personnel

C.R. Fjelstul	C. Porter
J.O. Erickson	C. Rhodes
N.C. Tallis	

Western Personnel

Supervisor	V.C. Boyd	Co-ordinators	L.J. Schmidt
Operations Manager	G.O. Miller		L.P. Cooper
Ass't Operations Manager	C.C. Hansborough	Shooter	J. Clingan
		Observers	K. Pederson
			J. O'Carroll

Offshore Navigation

Supervisors	M.J. Hock	First Operators	J. O'Reilly
	T.V. Patro		D. Haverloe

STATISTICAL SUMMARY

Line No.	Shot Points	Profiles	Coverage (%)	Coverage (miles)
55	1 through 79	79	600	9.875
56	1 " 80	80	"	10.000
57	1 " 85	85	"	10.625
58	1 " 50	50	"	6.250
	44A " 377	334	"	41.750

Line No.	Shot Points			Profiles	Coverage (%)	Coverage (miles)
59	1	through	202	202	600	25.250
60	1	"	85	85	"	10.625
61	1	"	164	164	"	20.500
	158A	"	184	27	"	3.375
62	1	"	182	182	"	22.750
63	1	"	86	86	"	10.750
64	1	"	218	218	"	27.250
65	1	"	84	84	"	10.500
66	1	"	205	205	"	25.625
67	1	"	240	240	"	30.000
68	1	"	206	206	"	25.750
69	1	"	243	243	"	30.375
70	1	"	66	66	"	8.250
71	1	"	415	415	"	51.875
72	1	"	112	112	"	14.000
73	1	"	408	408	"	51.000
	366A	"	370A	5	"	0.625
74	1	"	93	93	"	11.625
75	1	"	115	115	"	14.375
	157	"	396	240	"	30.000
76	1	"	78	78	"	9.750
	89	"	111	23	"	2.875
77	1	"	62	62	"	7.750
	56A	"	67	12	"	1.500
	60B	"	88	29	"	3.625
	82A	"	160	79	"	9.875
78	1	"	20	20	"	2.500
	14A	"	132	119	"	14.875
	126A	"	132A	7	"	0.875
	133	"	170	38	"	4.750
79	1	"	9	9	"	1.125
	3A	"	269	267	"	33.375
80	1	"	50	50	"	6.250
81	1	"	46	46	"	5.750
82	1	"	51	51	"	6.375
83	1	"	48	48	"	6.000
84	1	"	52	52	"	6.500
85	1	"	48	48	"	6.000
86	1	"	204	204	"	25.500
87	1	"	48	48	"	6.000
89	1	"	207	207	"	25.875
90	1	"	133	133	"	16.625
91	1	"	93	93	"	11.625
92	1	"	191	191	"	23.875
93	1	"	130	130	"	16.250
	124A	"	255	132	"	16.500
94	1	"	223	223	"	27.875
95	1	"	53	53	"	6.625
96	1	"	84	84	"	10.500
97	1	"	61	61	"	7.625
98	1	"	74	74	"	9.250
99	1	"	80	80	"	10.000
100	1	"	102	102	"	12.750

Line No.	Shot Points	Profiles	Coverage (%)	Coverage (miles)
101	1 through 51	51	600	6.375
	45A " 170	126	"	15.750
	164A " 317	154	"	19.250
102	1 " 84	84	"	10.500
103	1 " 62	62	"	7.750
104	1 " 181A	182	"	22.750
	168 " 229	62	"	7.750
105	1 " 128	128	"	16.000
106	1 " 211	211	"	26.375
107	1 " 86	86	"	10.750
108	1 " 67	67	"	8.375
109	1 " 60	60	"	7.500
110	1 " 76	76	"	9.500
111	1 " 75	75	"	9.375
112	1 " 52	52	"	6.500
113	1 " 50	50	"	6.250
114	1 " 57	57	"	7.125
115	1 " 63	63	"	7.875
116	1 " 69	69	"	8.625
117	1 " 66	66	"	8.250
118	1 " 115	115	"	14.375
119	1 " 89	89	"	11.125
120	1 " 106	106	"	13.250
121	1 " 40	40	"	5.000
	34A " 128	95	"	11.875
122	1 " 117	117	"	14.625
123	1 " 116	116	"	14.500
124	1 " 51	51	"	6.375
125	1 " 95	95	"	11.875
126	1 " 60	60	"	7.500
127	1 " 106	106	"	13.250
128	1 " 5	5	"	0.625
	1A " 85	85	"	10.625
129	1 " 113	113	"	14.125
130	1 " 55	55	"	6.875
131	1 " 46	46	"	5.750
132	1 " 64	64	"	8.000
133	1 " 47	47	"	5.875
134	1 " 57	57	"	7.125
135	1 " 46	46	"	5.750
136	1 " 59	59	"	7.375
137	1 " 48	48	"	6.000
138A	1 " 60	60	"	7.500
140	1 " 70	70	"	8.750
142	1 " 76	76	"	9.500
143	1 " 49	49	"	6.125
144	1 " 71	71	"	8.875
145	1 " 12	12	"	1.500
	1A " 74	74	"	9.250
146	1 " 50	50	"	6.250
147	1 " 42	42	"	5.250
148	1 " 153	153	"	19.125

Line No.	Shot Points	Profiles	Coverage (%)	Coverage (miles)
149	1 through 52	52	600	6.500
150	1 " 177	177	"	22.125
151	1 " 85	85	"	10.625
152	1 " 128	128	"	16.000
153	1 " 49	49	"	6.125
	43A " 89	47	"	5.875
154	1 " 71	71	"	8.875
155A	1 " 86	86	"	10.750
156A	1 " 63	63	"	7.875
78	171 " 329	159	"	19.875
		11,847	Totals	1480.875

Iviri River Prospect

Line No.	Shot Points	Profiles	Coverage (%)	Coverage (miles)
A	1 through 66	66	600	8.250
	60A " 82	23	"	2.875
B and C	1 " 80	80	"	10.000
D	1 " 29	29	"	3.625
		198	Totals	24.750

Grand Total - All reflection shooting, miles 1505.625

Total reflection profiles shot	12,045
Total powder consumed	549,524.66 lb.
Total powder used per reflection profile	45 lb.
Total reflection miles shot	1,505.625
Total powder used per mile	365 lb.

APPENDIX 2

PERMIT NO. 39, PAPUA

MARINE SEISMIC SURVEY, 1966

RAYDIST REPORT

by

M.J. Hock and T.V. Patro*

CONTENTS

*Offshore Raydist, Inc. January, 1966.

INTRODUCTION

The Raydist Type 'N' Radiolocation System was used to position the geophysical vessels used by Western Geophysical Company for their seismic party 87. A description of the Type 'N' System is given below.

DESCRIPTION OF RAYDIST SYSTEM

The Raydist radiolocation method of horizontal control employs the principle of continuous wave phase comparison in which pairs of transmitters located on shore generate hyperbolic lines of position. Receiving and phase comparison equipment aboard the geophysical vessels records the intersection of two such lines of position, thus determining a point of position.

Four base station positions are used for a network. The Center Station used in common with each End Station provides the two pairs of transmitters which generate the hyperbolic lines of position. The fourth station called the Relay is a reference point of phase comparison which causes the hyperbolic line to be fixed in space.

In a continuous wave phase comparison system such as Raydist, the phase comparison instruments will read accurately any fraction of a lane formed by two lines of position. However, it is impossible with phase meters alone to determine the correct lane that is being read. Thus arises the problem of 'lane counting' or 'lane identification'. This situation is solved by use of a two-channel, continuously operating, Magnetic Oscillograph. The pens of the oscillograph are driven from small potentiometers connected directly to the shafts of the phase meters. As the phase meter moves through 360 degrees of rotation, the pens will trace a readily identifiable sawtooth pattern on the oscillograph tape. By leaving at a known location point in the Raydist System with the correct lane count and adding or subtracting lanes each time the phase meter goes through 360 degrees of rotation, as shown on the oscillograph tape, the Raydist operator is able to identify properly each lane occupied.

As a further aid to positive lane identification, the party also employed the use of an additional unit of Raydist receiving and phase comparison equipment installed in a separate survey aircraft. At frequent intervals throughout the work period, this plane would carry a lane count from a known point in the system out to the seismic boat.

AREA OF OPERATIONS

Operations were conducted in the Gulf of Papua, Papua. The coverage map, Figure 8, shows the areas of operation. Port Moresby was the base of operations.

DATES OF OPERATIONS

Raydist equipment was installed on the M/V 'Western Geophysical 1' on 13 and 14 January. The Raydist Net No. 5, originally installed on 12 December 1964, was reactivated and became operational on 19 January 1966. The calibration was accomplished on 21 January. Seismic operations commenced on 22 January and were completed on 24 April, 1966.

CHARTS AND PLOTTING

One hyperbolic chart at a scale of 1:250,000 and all preplots were prepared in New Orleans.

The recomputing and final mapping of the shot-point locations were also accomplished in New Orleans. These shot-point locations were placed on maps that had previously been constructed for the original Phillips work done in 1965.

BASE STATION CO-ORDINATES WITH PERTINENT COMPUTATIONS

All three base stations involved in the mathematical computations of the Raydist System were surveyed using astronomical methods. The Green Station (Maer Island) was surveyed by M.A. Nicholas and Associates, 96 Mill Point Road, South Perth. The Red Station (Goaribari Island) and Center Station (Kiwai Island) were surveyed by a territorial government team from Port Moresby. Co-ordinates of the stations are the same as those used for the operation in 1965. Station descriptions are available for inspection at the Bureau of Mineral Resources, Canberra.

Gulf of Papua Area Net No. Five (5)

Australian Belt 7

False Easting = 1,000,000 Yards

CM = 146°E.

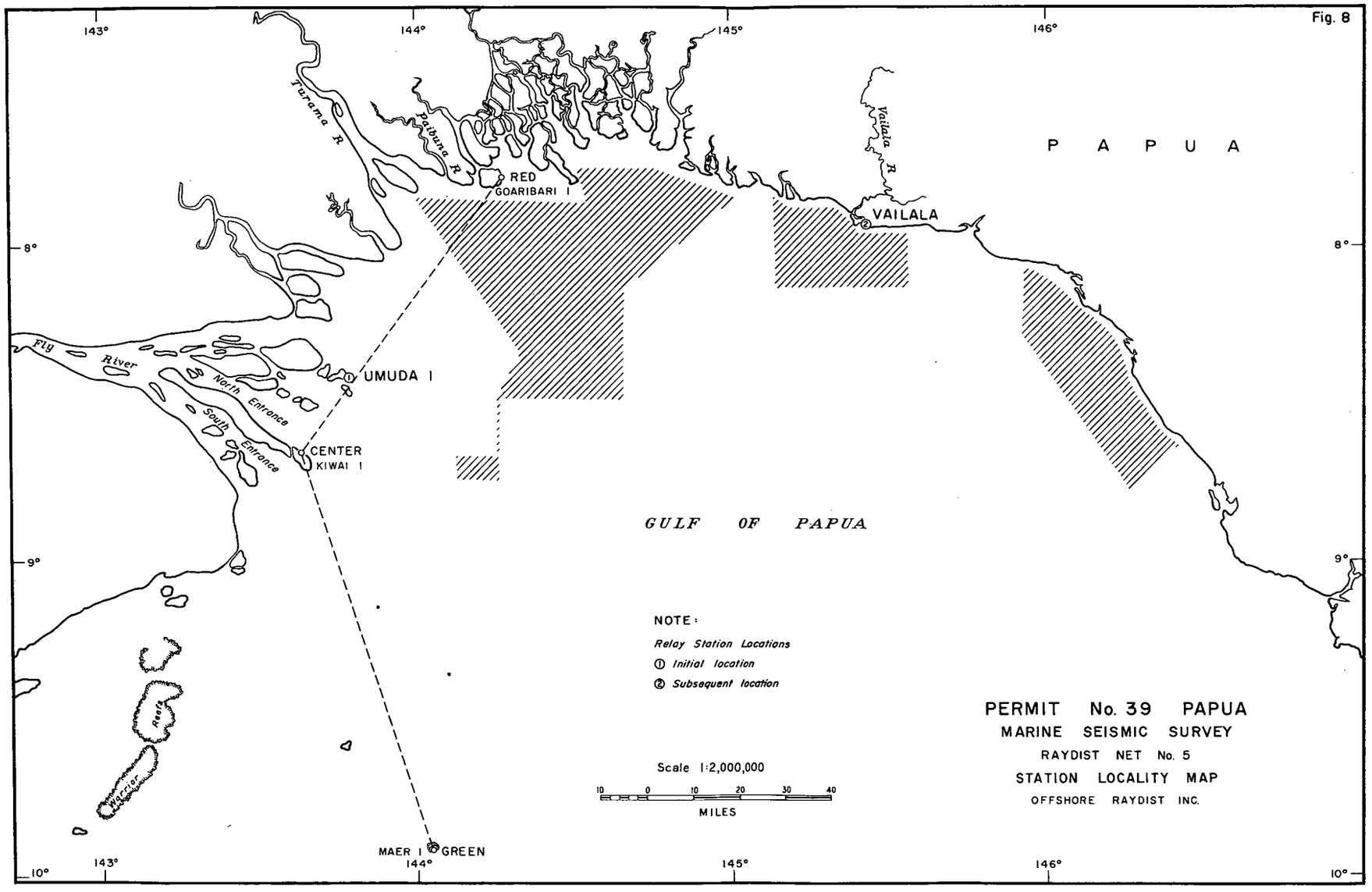
GREEN STATION	Ø =	9°54'44.00" S.	A = 144°03'44.00" E.
(Maer Island)	X =	767,542	Y = 3,716,445
CENTER STATION	Ø =	8°39'47.41" S.	A = 143°38'42.23" E.
(Kiwai Island)	X =	716,472	Y = 3,867,317
RED STATION	Ø =	7°46'33.41" S.	A = 144°16'22.15" E.
(Goaribari Island)	X =	791,615	Y = 3,975,074

True Green B/L	= 159,170 Yards
True Red B/L	= 131,285 Yards
True Green W/L	= 191.38466 Yards
True Red W/L	= 191.37572 Yards
Grid Green B/L	= 159,281 Yards
Grid Red B/L	= 131,370 Yards
Grid Green W/L	= 191.51812 Yards
Grid Red W/L	= 191.49962 Yards
Computed Lanes on Green B/L	= 1663.35
Computed Lanes on Red B/L	= 1372.01
Actual Lanes on Green B/L	= 1663.35
Actual Lanes on Red B/L	= 1371.67

CALIBRATION AND LANE COUNT

Calibration of the mobile equipment was accomplished by circling the Center Station with Raydist equipped aircraft so as to cross the zero ends of the baseline extensions and then setting the phase meters to correspond. Readings were based on this zero; zero calibration was in turn transferred to the seismic vessels. A baseline length is measured by traversing the baseline from its extension at one end to its extension at the other end. The point of crossing the extension is immaterial since the minimum (zero) lane is the baseline extension at the Center Station and extends indefinitely and the maximum lane is the baseline extension at the End Station and extends indefinitely. The total number of lanes traversed is a measure of the baseline length. The crossing of the extensions is marked pronouncedly, for the Raydist phase meter will come to a complete stop on the extension and then change direction of rotation after the crossing.

Fig. 8


143°
144°
145°
146°
8°
9°
10°
Turama R
Purtuna R
Vailala R
P A P U A
RED
GOARIBARI 1
VAILALA
Fly River
North Entrance
South Entrance
UMUDA 1
CENTER
KIWAI 1
GULF OF PAPUA
Pearson Reefs
MAER 1
GREEN
NOTE:
Relay Station Locations
① Initial location
② Subsequent location
Scale 1:2,000,000
10 0 10 20 30 40
MILES
PERMIT No. 39 PAPUA
MARINE SEISMIC SURVEY
RAYDIST NET No. 5
STATION LOCALITY MAP
OFFSHORE RAYDIST INC.

Lane counts on the seismic recording vessels were kept overnight by mooring buoys in the prospect. The aircraft conducted frequent checks with the seismic vessels throughout the prospect.

SURVEY OF SHORAN GROUND BASE STATIONS

At the request of Phillips Petroleum Company, positioning of locations for future Shoran Base Station sites was accomplished by using the Raydist equipped aircraft. This survey included a number of trigonometric stations.

Survey results and station descriptions are available for inspection at the Bureau of Mineral Resources, Canberra.

Raydist computed co-ordinates, compared with published co-ordinates of the trigonometric stations, are given below.

Australian Trigonometric Stations

Surveyed by Raydist Net Five (5)

Descriptions obtainable from the

Australian Government

	AUSTRALIAN TRANSVERSE MERCATOR CO-ORDINATES			
	CO-ORDINATES OBTAINED BY RAYDIST		PUBLISHED CO-ORDINATES	
AA007	1,108,579	3,794,583		
AA080	956,869	3,971,903		
AA008	1,082,299	3,838,153	1,082,295	3,837,970
AA009	1,056,738	3,870,935	1,056,671	3,870,795
AA010	1,042,835	3,894,983	1,042,789	3,894,873
AA011	1,034,995	3,923,009	1,034,939	3,922,945
AA012	1,016,079	3,943,620	1,015,937	3,943,595

GENERAL INFORMATION

During the 1965 operations a skywave condition existed on the Red Station (Goaribari Island), curtailing the amount of productive hours.

The location of the Red Station was such that a portion of the signal transmission path was overland to the Relay Station. It was proposed that this station should be moved to a position affording a complete overwater transmission path. This proposal was rejected since the system geometry would have been changed and may not have been compatible with the 1965 programme. Another proposal was to move the Relay Station from its location at Umuda Island to a position near Vailala village. This plan would afford complete overwater transmission paths to all three stations, but would extend the path from the Green Station (Maer Island) to the Relay Station to 135 nautical miles.

This relay station may have created a Green Sky Wave condition because of the long path, but it was decided to try the move. The move was accomplished during the break period commencing 6 February 1966. It proved successful by extending the working time approximately three hours each day.

In addition to the previously planned programme for Phillips Petroleum Company, Offshore Raydist, Inc. was advised to do additional plotting for the Deception Bay area. These instructions were received from Western Geophysical Company and Phillips Petroleum Company in the field. Included in these instructions was the advice that Phillips Petroleum Company and Australasian Petroleum Company Pty Ltd were joined in this venture.

One chart at a scale of 1:50,000 was submitted to Mr M.J. Hock in Port Moresby and forwarded to New Orleans, where a hyperbolic chart to this scale was constructed with Green and Red lanes and returned to Port Moresby. Three lines, A, B, and C were preplotted by hand in Port Moresby for Era Bay and Iviri Inlet.

On completion of shooting, lines A, B, and C were forwarded to Offshore Raydist, Inc., in New Orleans for postplotting on the 1:100,000 charts already constructed for Phillips Petroleum Company and turned over to Western Geophysical Company in New Orleans.

PERSONNEL

Key Raydist personnel assigned to this operation were M.J. Hock, Jr., Supervisor during the planning stage, and T.V. Patro, supervisor during the field operations; D.E. Haverlo, mobile navigator, and J. O'Reilly, aircraft navigator.

APPENDIX 3

PERMIT NO. 39, PAPUA

MARINE SEISMIC SURVEY, 1966

ADDITIONAL DATA FILED IN THE

BUREAU OF MINERAL RESOURCES

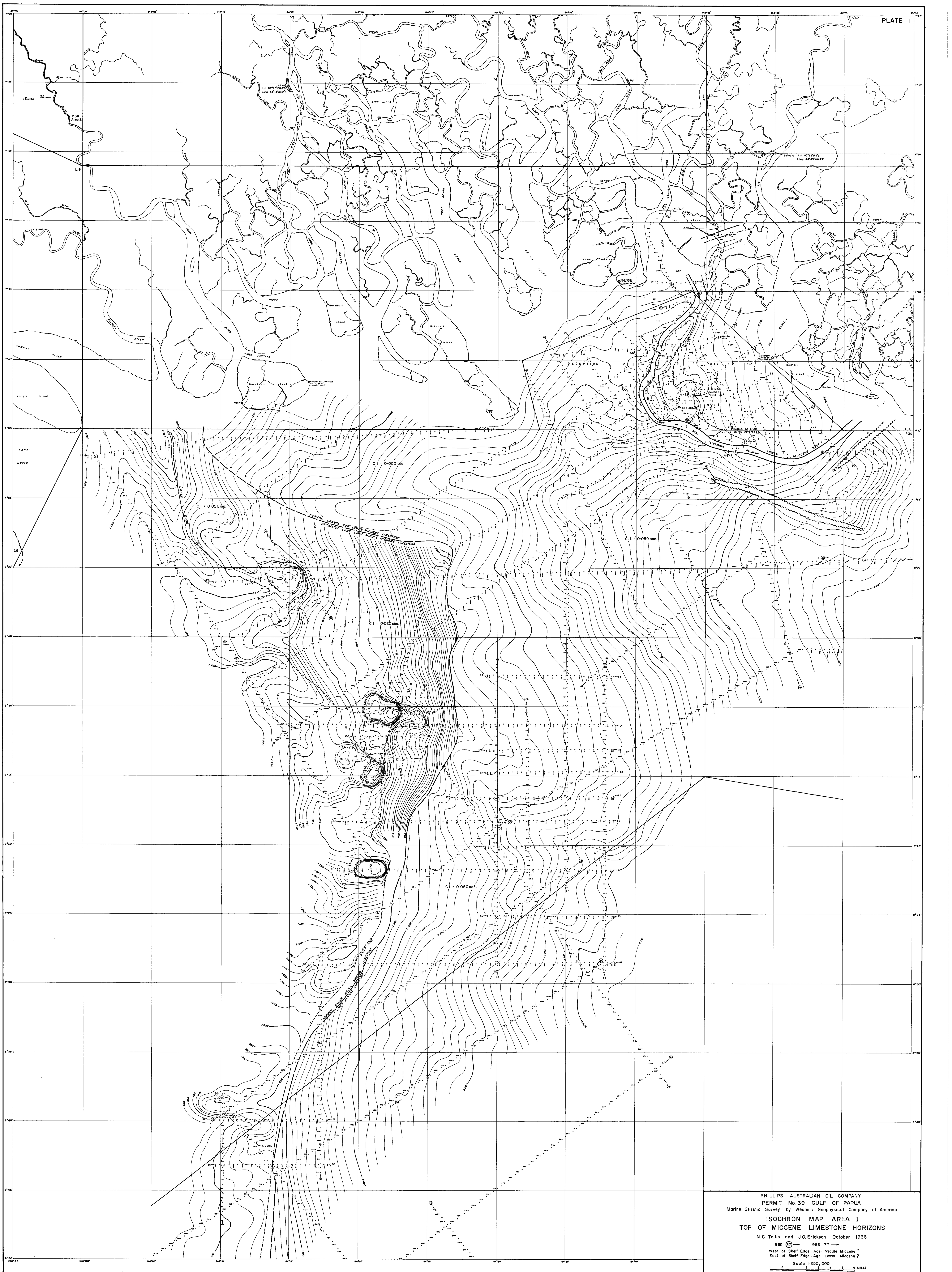
The following additional data relevant to the Permit No. 39, Papua, marine seismic survey have been filed in the Bureau of Mineral Resources, Canberra, and are available for reference:

(i) Water depth maps, Gulf of Papua.

(ii) Record sections, Variable Area.

(iii) Record sections, Variable Density.

(iv) Fathometer charts.



PHILLIPS AUSTRALIAN OIL COMPANY

PERMIT No. 39 GULF OF PAPUA

Marine Seismic Survey by Western Geophysical Company of America

ISOCHRON MAP AREA 1

TOP OF MIOCENE LIMESTONE HORIZONS

N.C. Tallis and J.O. Erickson October 1966

1965 (37)→ 1966 77→

West of Shelf Edge Age: Middle Miocene ?
East of Shelf Edge Age: Lower Miocene ?

Scale 1:250,000

1 0 1 2 3 4 5 6 MILES

PLATE 2

PHILLIPS AUSTRALIAN OIL COMPANY
PERMIT No. 39 GULF OF PAPUA
Marine Seismic Survey by Western Geophysical Company of America

ISOCHRON MAP AREA 1
CRETACEOUS - TERTIARY UNCONFORMITY HORIZON

N.C. Tallis and J.O. Erickson October 1966

1965 (37) → 1966 77 →

Scale 1:250,000

1 0 1 2 3 4 5 6 MILES

PHILLIPS AUSTRALIAN OIL COMPANY
PERMIT No. 39 GULF OF PAPUA
Marine Seismic Survey by Western Geophysical Company of America

ISOCHRON MAP AREA 1
NEAR BASE MESOZOIC HORIZON

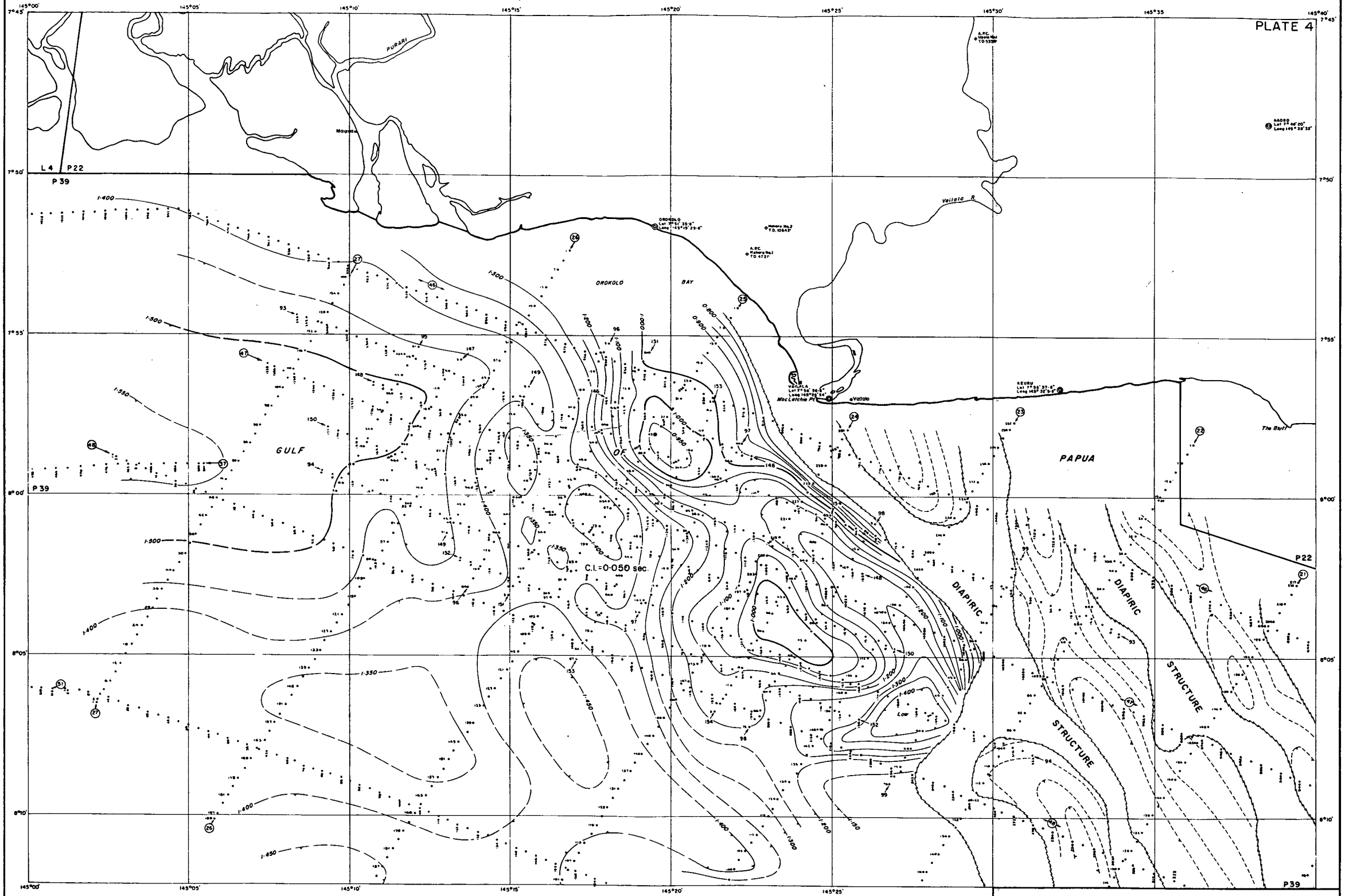
N.C. Tallis and J.O Erickson October 1966

1965 (37)→ 1966 77 →

Scale 1:250,000

0 1 2 3 4 5 6 MILES

PLATE 4



Note: Form lines only between diapiric structures

◎ Raydist calculated ground points

PHILLIPS AUSTRALIAN OIL COMPANY

PERMIT No. 39 GULF OF PAPUA

Marine Seismic Survey by Western Geophysical Company of America

ISOCHRON MAP AREA 2

HORIZON WITHIN PLIOCENE

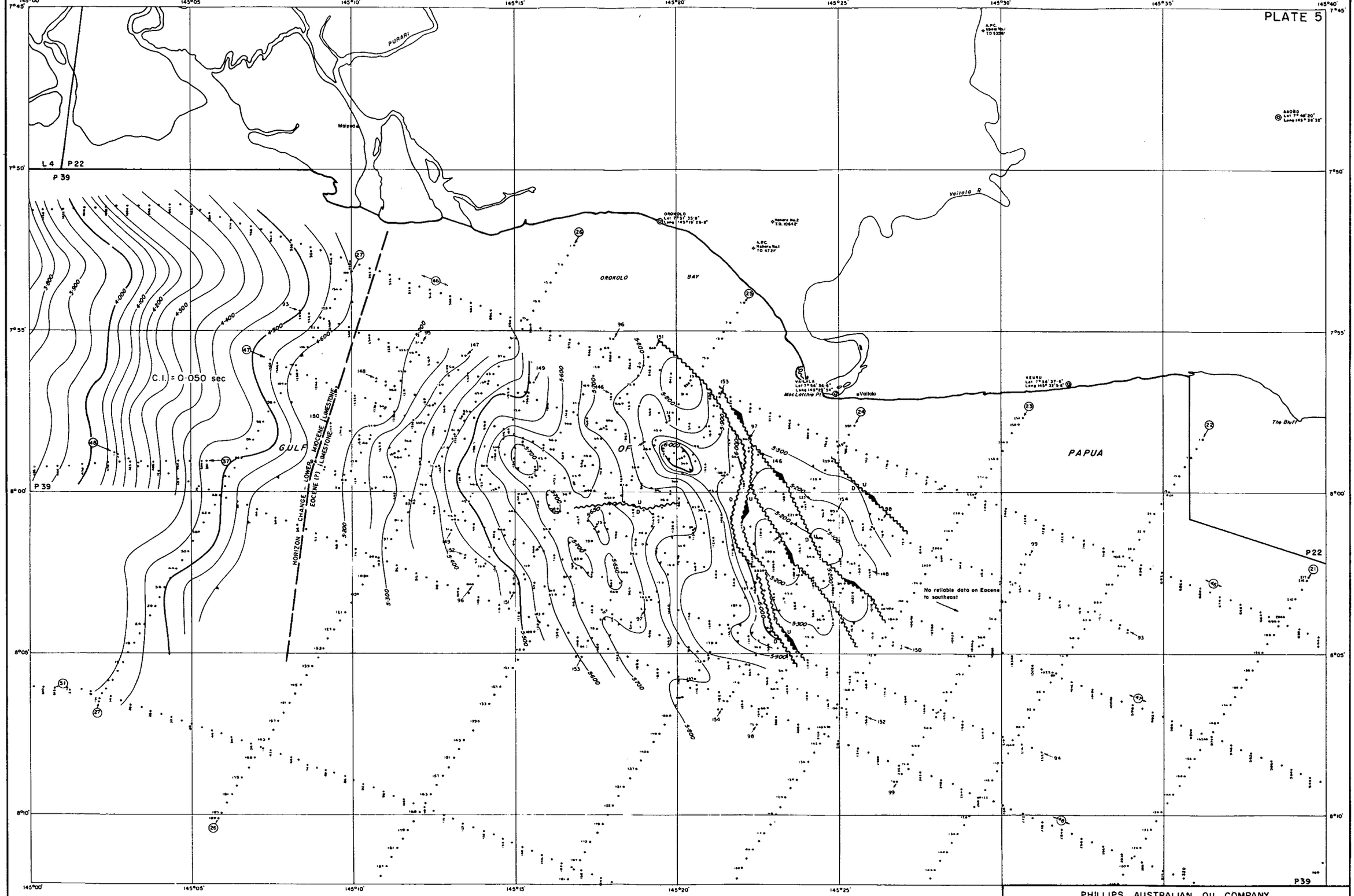
J. O. Erickson October 1966

1965 (37)→ 1966 77→

Scale 1:250,000

1 0 1 2 3 4 5 6 MILES

PLATE 5



Note: ◎ Raydist calculated ground points

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ISOCHRON MAP AREA 2
LOWER MIOCENE LIMESTONE AND EOCENE (?) LIMESTONE HORIZON

J. O. Erickson October 1966

1965 (37) → 1966 77 →

Scale 1:250,000

1 0 1 2 3 4 5 6 MILES

PLATE 6

Dashed contours depict structural form only - interpretation subject to change

C.I. = 0·050 sec

EASTERN EDGE OF ZONE

P22

P39

P39 P22

Seismic information too poor to interpret

Note: – – – Western limit of reliable mapping horizon

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ISOCHRON MAP AREA 3

TOP MIDDLE MIOCENE (?) HORIZON

N. C. Tallis October 1966

1965 (37) → 1966 77 →

Scale 1·250,000

1 0 1 2 3 4 5 6 MILES

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DIAGRAMMATIC CROSS SECTIONS

GULF OF PAPUA