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FINAL REPORT

EAST GIPPSLAND BASIN AREA

MARINE SEISMIC SURVEY

for

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by

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ABSTRACT

A marine seismic survey was conducted in the East Gippsland Basin area which is situated in proximity to Australia's most prolific oil and gas fields. The objective of the survey was to obtain stratigraphic and structural information for the purpose of locating drillable prospects.

Data quality was generally good and the results of the survey were considered reliable.

Results show the existance of a substantial thickness of prospective section through most of the area. Sediments comprising Top Latrobe Complex to Basement are 2000 feet thick in the northwest corner of PEP63A and thicken to 8000 feet southeastward. These sediments are absent in the area near the boundary between PEP63A and T/1P. Northward and southward from this area they thicken to 7000 feet and 6000 feet respectively.

Structural maps show general south dip in PEP63A, general northeast dip in PEP63B, and predominant east dip in T/1P.

Faulting trends ESE-WNW in the southern portion of PEP63B and in the norther portion of T/1P, changes to N-S in the central part of T/1P, and becomes variable in the southern part of T/1P.

Test drilling is recommended on (1) a large potential stratigraphic trap located in the southern portion of PEP63B and (2) an elongate anticline (Feature VII) located in the west central part of T/1P with 250 feet vertical closure over an area of ten square miles. Several other potential traps in the prospect require additional seismic definition.

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SUMMARY AND CONCLUSIONS

The objective of the East Gippsland Basin survey was to obtain stratigraphic and structural information for the purpose of delineating potential hydrocarbon traps.

Record quality was generally good and satisfactory solutions were found to unusual problems (in processing and depth conversion) associated with variable water depths (200 to 6000 feet) and an irregular sea bottom.

Stratigraphic conclusions based on reflection character, seismic velocity measurements, and isopach interpretations are:

1. Similar stratigraphy to that of the Marlin No. 1 well probably extends through most of PEP63B and possibly extends through PEP63A and T/1P.
2. Latrobe Complex sequences (Eocene, Paleocene and upper Cretaceous) are absent or thin along the southern margin of PEP63B and the northern margin of T/1P.
3. Pre-Oligocene stratigraphy is variable and may change significantly within the southern portion of T/1P. However the unconformity (Horizon B) at the top of this sequence is continuous throughout the area.
4. No definite pre-Miocene channels (of the type that have proven significant in other portions of the Gippsland Basin) are apparent in the East Gippsland Basin Area. Spurious indications of pre-Miocene channels and definite Miocene channels are apparent on some lines but their trends are not obvious. Typical Miocene channels are seen near S.P.'s 4435 and 4505 on Line M40T and near S.P. 5120 on Line M24T.

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5. The Miocene and Oligocene thin southward in PEP63A and eastward in PEP63B and T/1P. The Oligocene is probably absent in the southern portion of PEP63A and in the eastern portions of PEP63B and T/1P.
6. A prospective section of substantial thickness exists throughout the East Gippsland Basin area excepting along the southern margin of PEP63B and along the northern margin of T/1P.

Structural conclusions based on reflection data are:

1. The Miocene, Oligocene and Latrobe Complex sequences show general south dip through PEP63A, general northeast dip through PEP63B, and general east dip through T/1P which reverses and forms a north-south synclinal trend along the eastern margin of T/1P.
2. The Miocene and Oligocene sequences show very limited local folding and no faulting.
3. The top of the Latrobe Complex shows eight significant anticlinal features, some of which are associated with normal faulting.
4. Basement structure is generally conformable to the larger trends of the overlying sediments within PEP63A and within the northern portion of PEP63B. Within the southern portion of PEP63B, and within T/1P complex contour configurations and complex fault patterns are indicated.
5. Two distinct fault systems are shown within the deeper sediments of PEP63B and T/1P. The northern system trending WNW-ESE and the central system trending north-south. In the southern

portion of T/1P fault trends are variable and indistinct.

An attractive stratigraphic trap is located within the southern portion of PEP63B where the 5750 foot contour of Horizon B (Top Latrobe Complex) closes against the area where Latrobe Complex sediments are absent. The area of defined closure is approximately 20 square miles and includes an inferred anticlinal feature (Feature IV). The areal extent could be much greater if contours deeper than 5750 feet close outside of the permit area.

The eight anticlinal features shown at the top of the Latrobe Complex are all potential hydrocarbon traps. All of these potential traps require additional seismic definition prior to test drilling except for Feature VII which is an elongate anticline located in the west central part of T/1P with 250 feet of vertical closure over an area of ten square miles. The features are further discussed in Section VI of this report.

Thinning and foreset bedding within the shallower section indicate that the southern boundry of PEP63(A) and eastern boundarys of PEP63B and T/1P are near the limits of the post-Latrobe basin. There are no indications of the eastern limits of the Latrobe Complex Basin.

RECOMMENDATIONS

1. Test Drilling on:

   a. The potential stratigraphic trap located in the southern portion of PEP63B.
   Location - SP 1152, Line M11B.
   Areal extent of closure - more than 20 square miles.
   Depth of Water - 390 feet.
   Depth to Top Latrobe Complex - 6250 feet B.S.L.
   Depth to Basement - 10580 feet B.S.L.

   b. Anticlinal Feature VII located in the east-central portion of T/1P.
   Location - SP 3715, Line M19T.
   Areal extent of closure - 10 square miles.
   Depth of Water - 320 feet.
   Depth to Top Latrobe Complex - 4643 feet B.S.L.
   Depth to Basement - 6134 feet B.S.L.

2. Integration of results from any new seismic work that comes available from permit areas west of PEP63B and T/1P.

3. Extension of seismic control to further define Anticlinal Feature I in PEP63A; Anticlinal Features III and IV in PEP63B, and Anticlinal Features VII and VIII in T/1P.

INTRODUCTION

A marine seismic survey of 681 line miles was conducted in the East Gippsland Basin Area (see Plate 1) by Western Geophysical Company of America for Magellan Petroleum Southern Pty Limited, during the periods 4-20th December 1968, and 3-13th March 1969.

The area of investigation was situated in proximity to Australia's most prolific oil and gas fields. At least five of these fields have been declared commercial with minimum oil reserves of 2 billion barrels and minimum gas reserves of 6 trillion cubic feet. The nearest and largest oil field is Kingfish, located approximately 11 miles west of PEP63B. Previous geological and geophysical work suggested that the geological phenomena responsible for these fields were also present in this area, thereby emphasizing its petroleum potential. The subject survey was designed to obtain stratigraphic and structural information for the purpose of delineating drillable prospects.

Most of the lines were located in water depths of less than 600 feet along the western sides of PEP63B and T/1P. However, some lines extended into deeper waters. This is quite logical in view of the dynamic developments in deep water operating techniques. An oil well was recently completed in 640 feet of water, another is now drilling in 990 feet of water and a ship is being equipped to drill in 1,600 feet water depths, all in Californian waters. The National Petroleum Council in the United States predicts that industry will have the technical capability to drill and produce wells in water depths up to 6,600 feet within the next ten years. Irregardless of drilling problems, it was considered necessary to extend regional stratigraphic and structural definition into the deep water areas.

The data processing and interpretation were carried out by Geophysical Service International during the period January to June 1969. Conclusions derived in this interpretation are those of the author.

REGIONAL GEOLOGY

The basic contents of the following summary were prepared by the geological staff of Magellan Petroleum Southern Pty. Ltd., on the basis of reports from previously subsidized geophysical operations (see page 11). Minor revisions and additions were made by the author of this report.

The Gippsland basin has proved to be the site of Australia's first large oil field discoveries. It is roughly triangular in shape(with the apex pointing south), considering the known basin boundaries. The north side is bordered by basement type rocks onshore in the hills of Victoria. The southwest side is formed by the basement ridge running from Wilson's Promontory southeast to Flinders Island and northeast Tasmania. The eastern limits are unknown; however, southeastward the basin may merge with a sedimentary trough running along the east coast of Tasmania. The basin is filled with Jurassic through Tertiary sedimentary rocks which thicken to 20,000 feet in the central part of the basin.

Paleozoic sediments along with intrusive and extrusive igneous rocks probably underlie all of the Gippsland basin. The lower Paleozoic rocks, ranging from Cambrian through Lower Devonian, are not prospective for petroleum because of their intensely folded and metamorphosed nature. However, Upper Devonian, Carboniferous and Permain rocks have possible source and reservoir potential.

Overlying the Paleozoic formations is a thick sequence of Mesozoic strata thought to be largely of terrestial origin and consisting of sandstone, mudstone, shale and coal. The Upper Cretaceous-Paleocene (?) is represented by a deltaic (?) unit that apparently is predominantly continental in origin but which contains beds with interstitial salt water.

Next in the sequence is the Latrobe Valley (Eocene) delta sandstones and coal measures. The sandstones contain fresh water on land, becoming more brackish or marine eastward.

The combined sequence composed of the Upper Cretaceous-Paleocene unit and the Latrobe Valley (Eocene) unit are referred to as the "Latrobe Complex".

The Latrobe Valley sequence is overlain by the Lakes Entrance (Oligocene) shales, the first fully marine deposits, which are followed, in turn, by the Gippsland formation (Miocene), consisting of marine sands, marls, muds and predominant limestones. Non-marine Upper Pliocene to Recent sediments comprise the remainder of the stratigraphic section.

Structurally, the Gippsland basin probably began forming during Jurassic time, subsiding along an east-west trend. This was in contrast to the existent north-south trending Tasman Geosyncline, where Paleozoic sediments were collected in a trough along eastern Australia extending from New Guinea to Tasmania.

Uplift occurred at the end of early Cretaceous (Strzelecki) time. Thereafter, periods of sedimentation and uplift, accompanied by folding and faulting, alternated through Eocene time. Orogenic movements became progessively weaker as the Gippsland basin attained its present shape as an east-west trough bounded on the southwest by a down-to-the-north fault system.

After a late Eocene uplift and erosional period, subsidence occurred allowing the sea generally to cover the entire basin until near the middle of the Pliocene.

During this time of predominant marine deposition, river channels and other topographic lows were filled while minor localized folding and faulting took place. The sea

regressed to approximately its present position in mid-Pliocene, and terrestrial deposits ranging in age from Upper Pliocene to Recent were deposited in the coastal area on the mainland.

Commercial hydrocarbon deposits have been found in the western off-shore part of the basin in the Latrobe Valley sandstone members, and good shows occur in the Upper Cretaceous-Paleocene (?) sands. The Lakes Entrance shales, which also serve as cap rock, probably are the primary source rocks. Other possible source deposits are coal and shale beds within or below the early Latrobe Valley formation.

Traps found to date are structural closures or combined uplift and erosional features, wherein part of the closure is influenced by relief on the buried topographic surface at the top of the Latrobe Valley unit. The structural and stratigraphic history of the basin indicates strong possibilities of fault and stratigraphic traps. Bald-headed basement highs where the Latrobe Valley formation has been eroded and subsequently overlapped by the Lakes Entrance shales present interesting stratigraphic trapping possibilities.

The presence of linear features referred to as submarine canyons has been established in previous seismic work in the west adjoining area to Magellan's tenements. One known canyon trends NW-SE to the east of the Marlin No 1 well (Refer enclosure 3). Another is located west of and parallel to the western boundry of T/1P. (Refer enclosure 5). These are thought to be Eocene and/or Oligocene channels subsequently filled with Oligocene and Miocene marine deposits. Although the two presently known submarine canyons appear not to enter PEP 63 or T/1P, others may exist that do.

The lack of well control north of PEP63A precludes making definite statements about the regional geology in that area. However, Latrobe Valley sediments probably occur along this shelf edge as well as possible Cretaceous deposits, all thinning eastward. Southward into the Magellan tenement post-Latrobe sequences appear to thin and Latrobe Complex sequences appear to thicken.

PREVIOUS GEOPHYSICAL WORK

Several aeromagnetic and marine seismic surveys have been completed in the Gippsland basin under the Petroleum Search Subsidy Act. Pertinent report titles related to the following discussion are as follows:

1. Gippsland basin Airborne Magnetic Surveys, Victoria 1951-52/56 by J.H.Quilty, No.95.
2. Bass Strait and Encounter Bay Aeromagnetic Survey, 1960-61. Haematite Exploration Pty. Ltd. 1965, Publication No. 60.
3. Aeromagnetic Survey, Eastern and Western Bass Strait, Magellan Petroleum Southern Pty. Ltd. January 1968.
4. Haematite Gippsland Marine Seismic Survey by Western Geophysical Co. (G lines) August, 1963.
5. Gippsland Shelf Marine Seismic Survey for Esso by Western 1965. (EG lines).
6. Eastern Bass Strait Marine Seismic Survey for Esso by GSI March 1967 (ET lines).
7. Offshore Gippsland Basin Marine Seismic Survey, EC-67; for Esso by GSI May 1968.
8. Offshore Gippsland Seismic Survey, Victoria PEP57, for Shell by GSI, March 1966.
9. Sole Seismic Sparker Survey for Shell by C.G.G., September 1967.
10. Gippsland EH-68 Marine Seismic Survey, for Esso by Western and GSI, December 1968.

Aeromagnetic work (1) in PEP38, west of Magellan's permits, gave early indications of a deep trough extending east of Lake Wellington and containing about 15,000 feet of sediments. This survey was integrated with a later aeromagnetic survey (2) covering all of the Bass Strait but stopping west of Magellan's permits. This survey showed the basement shallowing southward but deepening eastward at the easternmost control.

Magellan's January 1968 aeromagnetic survey (3) of its permits indicated variable thicknesses of sediments, up to about 20,000 feet locally. Several structural anomalies were interpreted in PEP63B and T/1P, which required further evaluation by seismic methods.

The first marine seismic programme (4) in the Gippsland Basin located most of the presently known structural features which subsequently resulted in the prolific Esso-BHP offshore oil and gas fields (Barracouta, Marlin, Kingfish and Halibut). Later surveys (5,6 and 7) gradually refined the structural configuration of the western Gippsland basin and clarified the geology of more complex features such as the "Miocene Channels".

Earliest interpretations indicated little if any Oligocene-Eocene deposits east of PEP38. As more information was obtained, it became clear that this was incorrect, and the bald-headed basement highs (where Latrobe and Lakes Entrance deposits appeared to be missing) were small localized features. With the presence of the Latrobe and Lakes Entrance established, PEP63B and T/1P became favourable area for similar traps to those found in PEP38.

The Shell surveys in PEP57 (8 and 9) immediately north of PEP63A show regional south dip with the strike somewhat parallel to the coast. At least one closed structure (Sole) is also depicted. The sedimentary section - considered to be mostly Tertiary - thickens southward, and approximately 7,000 feet of section is indicated a short distance north of Magellan's permit.

Aeromagnetic (3) indications supported the probability that a substantial thickness of sediments would be found in PEP63A.

INTERPRETATION

A. GENERAL

The general interpretational approach was to start from known geology in the central Gippsland Basin area and to attempt to illustrate and define stratigraphic and structural relationships eastward through the East Gippsland Basin Area.

B. STRATIGRAPHY

1. Synthetic Seismograms

Synthetic seismograms generated from the continuous velocity log of the Marlin No. 1 well provided reflection identification at the north end of line M44B. This provided the starting point for continuous horizon mapping throughout the area.

2. Velocity Studies

Velocity logs from the Marlin No. 1 well show distinct velocity inversion through the gross interval comprised of Lower Miocene, Oligocene, and Upper Latrobe sediments.

Interval velocities from seismic velocity studies (Miocene velocities range from 8000 to 11000 feet per second, Oligocene velocities range from 8000 to 9000 feet per second and Latrobe Complex velocities range from 8500 to 13000 feet per second) indicate the continuation of this inversion southeastward through PEP63B as far as the area near the boundary between PEP63B and T/1P where Horizon B (Top Latrobe Complex) is absent due to on-lap and erosion. Within this onlap area, the inversion is absent. The inversion is shown again south of the onlap area through T/1P where a substantial thickness of sediments below the top of the Latrobe Complex have been interpreted. Within PEP63A the presence or absence of a velocity inversion has not been reliably established.

The occurence of the inversion appears to be associated with the existence of Latrobe Complex sediments.

3. Map Indentification

a. Horizon A

Horizon A ties to a velocity interface within the Miocene at the Marlin No. 1 well. The continuity of specific legs of the Miocene reflections are poor, however general reflection bands are of fair quality. Contours on Horizon A are considered a reliable definition of strucutral conditions within the Miocene.

b. Horizon B

Horizon B ties to the erosional uncomformity at the top of the Latrobe Valley (Eocene) formation at the Marlin No. 1 well. Southeastward through the East Gippsland Basin Area, the rocks immediately below Horizon B vary in age from Eocene to Paleocene to Upper Cretaceous. The combined sequences of these periods is referred to as the "Latrobe Complex". Horizon B is identified as the top of the Latrobe Complex.

c. Horizon C

Horizon C is a basement interpretation based on reflection data that varies widely in reliability. Within PEP63B Horizon C reliably indicates the depth to and general configuration of economic basement.

Within PEP63A and T/1P, Horizon C has been picked along non continuous events that have been interpreted as being the deepest valid reflections recorded. Horizon C reliability in these areas is poor to very poor.

d. Isopach A-B

Isopach A-B represents the interval comprised of Lower Miocene and Oligocene sequences. Reflection data within these sequences indicate that the Oligocene thins eastward and may be absent along the eastern margins of the area.

e. Isopach B-C

Isopach B-C represents the interval from the top of Latrobe Complex to Basement. The principle hydrocarbon discoveries of the Gippsland Basin have been from within this interval. In the southern portion of T/1P, reflection character changes within the deeper portion of this interval suggest possible older stratigraphy and complex tectonics.

The unconformity at the top of this interval (Horizon B) has been interpreted as a continuous horizon from the Marlin No. 1 well through the entire prospect area. Although the exact top of the unconformity is not always clear, it is believed that Horizon B is near the top. Angular unconformity and frequency change (events below Horizon B have a distinctively lower frequency content than those above) were significant criteria in interpreting the horizon level. Near the Marlin No. 1 well this frequency change can probably be associated with the change from the shale-marl interfaces within the Miocene and Oligocene sequences to the coal-sand interfaces within the Latrobe Complex.

C. STRUCTURE

1. General Structure

a. Water Depths

Water depth contours show: a general south slope from 1500 to 4000 feet through PEP63A, a general north east slope from 220 to 5500 feet in PEP63B, and a general east slope from 220 to 6000 feet in T/1P. On Line M5B which ties PEP63A to PEP63B water depths reach a maximum depth of 7950 feet.

b. Horizon A (Within Miocene)

Horizon A contours show general south dip through PEP63A and general northeast dip through PEP63B. The general east dip through T/1P reverses and forms a north-south synclinal trend along the eastern margin of the permit area.

c. Horizon B (Top Latrobe Complex)

Within PEP63A contours on Horizon B show one closed anticlinal feature superimposed over general south dip. Within PEP63B contours on Horizon B show some faulted anticlinal features superimposed over general northeast dip.

Horizon B is shown to onlap basement in an area along the boundary between PEP63B and T/1P.

Within T/1P Horizon B contours show several anticlinal features or trends, superimposed over general east dip which reverses and forms a north-south synclinal trend along the eastern margin of the permit area.

d. Horizon C (Basement)

Contours on Horizon C show general south dip within PEP63A and general northeast dip within PEP63B.

Complex contour configurations and fault orientations are shown within T/1P (refer enclosure 4).

e. Isopach A-B

The A-B isopachs show general northward thickening within PEP63A and general westward thickening within PEP63B and T/1P. Anomalous "thins"are shown over the stronger "highs" of Horizon B. Attention is drawn to anomolous southeastward thickening of the Miocene sequence on the eastern end of Line M23T and on the southern end of Line M41T.

f. Isopach B-C

The B-C isopachs show general southward thickening within PEP63A and general northward thickening within PEP63B. A complex pattern of "thins" and "thicks" is shown within T/1P. (refer enclsoure 6).

2. Anticlines

The table on the next page describes the following anticlinal features of Horizon B:

1. Feature I which is based on reflection dip reversal on Line M3A.
2. Feature II which is based on reflection data on Line M26B in conjunction with contours from a previous subsidized survey to the west.
3. Feature III which is based on reflection data on Lines M8B, M9B, and M29B and on fault indications on Line ET85R from a previous seismic survey.
4. Feature IV which is based on anomolous northwest reflection dip on Line M29B and on northeast reflection dip on Line M14B.
5. Feature V which is based on reflection data on Lines M10B, M11B, M12BT, M13BT and M32T in conjunction with fault indications from previous seismic surveys.

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ANTICLINAL FEATURES (HORIZON B)

Feature Identification	Location	Type	Closure (feet)	Areal Extent (square miles)	Depth BSL Horizon B (feet)	Thickness Isopach B-C (feet)	Water Depth (feet)	Reliability
I	38° 23'S 149° 01'E	Elongate Anticline	150	3½	8500	3250	2100-2800	Poor
II	38° 39'S 148° 31'E	SSE Nosing	?	1½	11000	6000	1200-1300	Poor
III	39° 01'S 148° 31'E	Faulted Nose	250?	5	6265	1500	380-400	Poor
IV	39° 08'S 148° 39'E	Faulted Anticline	?	2	5250	2000	1000-2000	Inferred
V	39° 13'S 148° 32'E	Faulted Nose	250?	9	4500	200	200-300	Poor-fair
VI	39° 13'S 148° 37'E	Nose Onlapping Basement	100?	2½	4750	300	340-400	Poor
VII	39° 32'S 148° 42'E	Elongate Anticline	250	10	4750	1500	320-400	Poor-fair
VIII	39° 45'S 148° 51'E	Elongate Anticline	?	1½	7250	5500	2100-2800	Questionable

6. Feature VI which is based on reflection dip reversal on Line M14BT.
7. Feature VII which is based on reflection dip reversal on Lines M19T, M20T, M21T and M37T.
8. Feature VIII which is based on reflection dip reversal on Line M23T.

Feature VII has anticlinal expression on Horizons A, B and C.

Features III and V have anticlinal expression on Horizon C as well as on Horizon B.

Feature IX is a small anticlinal feature with expression on Horizon A only. This feature is located near the northern boundary of PEP63A.

Features X, XI and XII are anticlinal features that have expression on Horizon C only. These features are located within T/1P.

Other unidentified anticlines shown on Horizon C are poorly defined and are of less significance at this stage of exploration.

3. Faults

The table on the following page describes the 26 normal faults interpreted on Horizon C. Eight of these faults (C, E, F, G, I, J, K, and W) have been interpreted as projecting upward through Horizon B. No faulting has been interpreted on Horizon A.

The interpretation of each fault has been based on one or more of the following criteria:

a. correlation
b. misclosure
c. discontinuity
d. anomalous dips
e. diffractions
f. reduced record quality

FAULTS

Fault Identification	Displacement at Horizon C	Displacement at Horizon B	Criteria (see preceeding paragraph)	Reliability of Interpretation
A	1000'		c, d, f, g	Very poor
B	1000'		a, c	Poor
C	None	None	a, c, d, e	Fair
D	None		a, c, f	Fair
E	700'	300'	a, b, c	Good
F	Not Defined	Not Defined	h	Questionable
G	1500'	None	b, g, h	Fair
H	1000'		b, g, h	Fair
I	Not Defined	None	c, d	Very poor
J	Not Defined	Not Defined	g, h	Questionable
K	2000'	400'	a, b, g, h	Fair
L	250'		b, d, g	Very poor
M	1250'		d, g	Poor
N	1000'		c, d, e	Poor
O	2000'		c, d	Very poor
P	2000'		c, d	Very poor
Q	1500'		c, d, g	Poor - fair
R	300'		c, d, e	Poor
S	500'		c, d	Very poor
T	2500'		c, g	Poor
U	750'		c, d	Questionable
V	1500'		c, d, g	Very poor
W	1000'	400'	c, d, g	Poor - fair
X	3000'		c, g	Very poor
Y	2500'		c, d, g	Very poor
Z	1500'		c, f	Poor

g. change in thickness of reflecting section
h. projection from fault interpretations in adjoining areas

Faults within the southern portion of PEP63B and the northern portion of T/1P show a predominant ESE-WNW trend. Faults G, H, and K are well defined ESE-WNW faults which tie to previous interpretations to the west. Stratigraphic traps could be associated with the increased thickness of prospective section shown on the north side of each of these faults.

Faults within the central portion of T/1P show a predominant north-south trend (Faults M, N, V, U). Faults trends within the southern portion of T/1P are variable.

Several fault orientations shown on the results from previous subsidized surveys west of the boundarys of PEP63B and T/1P have not been confirmed. The orientation of these faults require additional definition.

4. Relation to Magnetics

Comparisons of the Horizon C (Basement) interpretation with (1) the magnetic basement interpretation of the January 1968 aeromagnetic survey and (2) results from magnetics recorded concurrent with the subject seismic survey show the following:

a. In the eastern portion of PEP63A, the northern portion of PEP63B, and the southern portion of T/1P, depths to Horizon C are of the same order as depths to magnetic basement.

b. In the western portion of PEP63A, the southern portion of PEP63B and the northern portion of T/1P, depths to Horizon C are substantially shallower than depths to magnetic basement. This suggests the existence of pre-Upper Cretaceous, non-magnetic rocks within these areas.

c. Horizon C Anticlinal Features VII and X can be directly related to magnetic basement highs.

d. The location and configuration of other Horizon C features show no distinct relationship to magnetic anomalies.

D. HYDROCARBON TRAPS

Features I, IV, VII and VIII are potential hydrcarbon traps of the anticlinal-closure type. All of these features, with the exception of Feature VII, require additional seismic definition prior to test drilling.

Features III and V are potential traps of the fault-nose type. The fault orientation on both of these features require additional seismic confirmation.

Feature VI and the area centered near SP1152 of Line M11B are potential stratigraphic traps which rely upon basement onlap and erosion for their updip components of closure.

DATA PROCESSING

A. EQUIPMENT AND PERSONNEL

The transcription of field data to TIAC format, vertical stack processing and record section displays were carried out on a Texas Instruments Seismic Digital Filtering and Display System Model 870.

All other processing were carried out on a Texas Instruments Automatic Computer (TIAC) Model 827.

Key GSI processing and interpretation personnel were:

K. Graybill	Party Chief
J. Gillard	Assistant Party Chief
P. Connard	Geophysical Engineer

Client Supervision was provided by Mr. A. Sabitay, consultant to Magellan Petroleum Southern Pty. Ltd.

B. TRANSCRIPTION AND VERTICAL STACK PROCESSING

The initial phase of processing accomplished the following:-

1. Applied True Amplitude Recovery (TAR) to the field data on a trace by trace basis.
   In the TAR process, a gain function is computed using input parameters and binary gain information recorded on tapes. The gain function is then applied to the data and affects;
   a. The removal of binary gain applied during recording.
   b. The application of a time varying scaler to compensate for energy loss due to the effects of spherical divergence.
   c. The application of an exponential function to compensate for energy loss due to the effects of inelastic attenuation.

Loss of energy due to spherical divergence is a function of average velocity and time. A constant average velocity of 5000 feet per second was used to compute TAR functions for this area.

An initial gain of 10 db and a rate of 3.5 db per second from time 0 to 4.25 seconds were used to compute the exponential function for correction of inelastic attenuation losses. Where water depths exceded 4000 feet, the application of these parameters resulted in higher than optimum gain at late record times. It is recommended that for future processing of deep water data, the exponential scaler should be applied from a time approximately equal to water bottom.

2. Performed a vertical stack of 4 input records, thus reducing the 48-fold data to 12-fold vertically stacked data.

3. Output the vertically stacked data in TIAC format on 1 inch tape. Following completion of processing the field tapes were stored and the vertically stacked tapes were retained as basic data.

All lines were transcribed and vertically stacked to a record time of 4.254 seconds at a sample rate of two milliseconds.

The resultant vertically stacked data in TIAC format were used as input data for all subsequent processing.

C. WATER DEPTH and WATER REPLACEMENT STATIC CORRECTIONS

Water depths ranged from 200 feet to 6000 feet. Field recorded fathograms were available for water depths up to 1680 feet. Where water depths exceeded 1680 feet, the water depth values were computed from the water bottom reflection time on trace 24 of each vertically stacked record by applying the following formulae;

$$Tx = \frac{Tw}{2} - .012 \text{ sec}$$

$$T = \sqrt{Tx^2 - Ty^2}$$

$$Wd = Vw \sqrt{Tx^2 - Ty^2}$$

$$C = T - \frac{Wd}{Vr}$$

where:

Tw = Two-way water bottom reflection time read from trace 24 of vertical stack records.

Tx = One-way time to water bottom.

Ty = One-way horizontal travel time from energy source to a point mid-way between energy source and group 24.

T = One-way vertical time to water bottom.

Vw = Water velocity = 4850 feet per second.

Wd = Water depth.

Vr = Water replacement velocity = 7000 feet per second.

C = One-way static correction for replacement of water layer.

Travel times through water were computed from known water depths (fathograms) and compared with travel times obtained from vertically stacked records. A statistical analysis of these comparisons indicated an emperical

calibration constant of 12 msecs. Since fathogram readings were in terms of water depth from the surface, this emperical value included an adjustment for the depth of the energy source and depth of the geophones.

The total static correction applied for a given data trace is the C computed for the shot location plus the C computed for the receiver location.

D. EXPERMENTAL and OTHER PROCESSING

1. M-5 Processing

In order to optimally define velocity relationships and to identify and eliminate multiple reflections, it was initially planned to process a network of selected lines through the M-5 space-time varying processing package. However, after several experimental attempts it was found that the M-5 package was unsuited for processing in this area.

The M-5 system is not set up to allow sufficiently frequent variations of many parameters which must be varied in processing marine data with large and rapid variations in water depth.

The principal factor that prevented utilization of M-5 processing was that this system applies water replacement statics before the final residual normal moveout corrections. Large statics at this stage had the effect of destroying the true $T - \Delta T$ relationships.

2. Time Invariant Deconvolution versus Time Variant Deconvolution.

The record section for lineM9B EXP. (Time Invariant Deconvolution) compared to the normal production record section for line M9B (Time Variant Deconvolution) shows little significant difference in data quality. Time variant deconvolution was selected for production processing on the theoritical basis that whitening of data would be more nearly optimum by using time varying deconvolution operators.

3. Near Trace Gather

A near trace gather, (trace 23 and 24 of each vertically stacked input record) equivalent in coverage to 2 12-fold stacked records, was applied from shotpoint 795 to shotpoint 806 of line M6B. The water bottom was extremely rough and steeply sloping. All processing on the record section for line M6B experimental (near trace gather) was exactly the same as for the normal production record section of line M6B, excepting that the near trace gathers were substituted for 12-fold stack. A comparison of these sections shows an improvement of data quality and continuity on the near trace gather records. The results of this experiment indicate that over locations of extreme water bottom variations, the theoretical water replacement statics are inadequate for an optimum stack.

4. Synthetic Seismograms and Comparative Data Traces

All-multiple and multiple-free synthetic seismograms were generated from the constant velocity logs from the ESSO-BHP Gippsland Shelf No. 1 (Barracouta No. 1) and No. 4 (Marlin No. 1) wells. These synthetic seismograms were displayed on the production mode and scale with digital filters of 5-100 cps and 10-50 cps.

Velocity filtered pie-slice traces from 3 depth points at shotpoints 5327½, 5328½, and 5329½ on line M44B Extension (approximately ¼ mile north-east of the Marlin No. 1 well) were filtered with a 5-100 cps digital filter and a 10-55 cps digital filter and displayed on individual paper records with an average trace deflection of ½ inch at a scale of 3.75 inches per second. The All-Multiple and Multiple-Free synthetic traces from Marlin No. 1 were similarly filtered and displayed for analytical comparison.

In the pie-slice process, each input data trace is passed through a separate velocity filter. The filters are so designed that all coherent events with a moveout from trace to trace within a specified range are uniformly preserved over a wide frequency range, and further, all coherent events with a moveout outside the specified range are uniformly attenuated about 20 db. During the pie-slice process each input trace from a common-depth-point is filtered, summed and output as a single stacked trace.

The pie-slice applied to the 3 depth-points, on Line M44B Extension had an aperature of 4 msecs., and a tilt of 0 msecs.

5. Experimental Velocity Filtering

On portions of several lines in the area a strong second bounce from the water bottom occurs at the same record time as primary events from horizons of interest. In an attempt to eliminate or attenuate the second bounce, Line M45A was reprocessed with pie-slice velocity filtering

The pie-slice had an aperture of 4 msecs, and a tilt of zero. Common-depth-point gathers were used as input to the routine. Time-varying deconvolution, time varying filtering, and display parameters were the same as for production line M45A. Comparison of the record section for line M45A Experimental with the standard production record section for line M45A shows that the experiment was unsuccessful. No significant attenuation of the second bounce is apparent.

6. Time Variant Gain Versus Time Invariant Gain.

The record section for line M27B Experimental (standard time-invariant gain) as compared with the normal production record section for line M27B (time-variant gain) shows the effectiveness of time-variant gain in attenuating the high amplitude shallow data and amplifying the relatively lower powered intermediate and deep data.

The time-variant gain applied is commonly referred to within GSI as medium digital AGC. The display program applies medium digital AGC to a record by first amplifying the entire record to a chosen average level within a specified gate. The entire record is then divided into 300 millisecond gates. Amplitudes within these gates are attenuated if they exceed the average amplitude within the originally specified gate.

7. Statics and Display of Portions of ESSO-BHP lines.

Those portions of ESSO-BHP lines EC-160, EC-161, EC-162, and EC-163 that fall within Magellan concession T/1P were processed with water replacement statics, and displayed with the scale and mode (12 traces per inch, 3.75 seconds per inch, variable area-wiggly trace) applied to the normal production processing.

8. Filter Analysis

Filter analyses were processed at 15 selected locations over three adjoining output records following the deconvolution stage of the normal single-fold, 6-fold dynamic correlations or 12-fold coverage processing. The 3 output records were displayed with 4 different digital filters (5-15, 10-20, 20-40, and 30-60 cps) on the normal production display mode and scale.

The following tabulation shows the location and fold of the filter analyses:

	Line #	Shotpoints	Type Coverage
	M1A	354-371	100%
M3A	M3A	739-756	100%
	M3A	739-756	1200%
	M42A	578-595	100%
	M5B	7-24	100%
	M9B	2181-2187, 2211-2223, 2253-2259	1200%
	M11B	1130-1145	100%
	M27B	935-952	100%
	M29B	1845-1862	600%

Line #	Shotpoints	Type Coverage
M44B	2075-2093	100%
M32T	3111-3123	600%
M35T	3549-3567	1200%
M39T	4871-4889	1200%
M40T	4407-4425	1200%
M40T	4555-4572	600%

These filter analyses provided the basis for designing the time-varying filters applied in final production processing.

E. SPECIAL PROCESSING FOR VELOCITY CONTROL

1. Moveout Scans.

A moveout scan is the application of negative time shifts approximating a normal moveout (NMO) correction curve to traces for one to 24/N consecutive common depth points and stacking of the traces. N is multiplicity of subsurface coverage. In the routine, 96 scans for 96 different NMO correction curves are performed for each group of common-depth-point (CDP) input traces, therefore outputting 96 stacked traces. Correlative reflections with NMO time equal to absolute values of time shifts for a scan are aligned, and the stacked reflection will be a maximum relative to corresponding stacked reflections on adjacent traces.

For each set of 96 scans, the following processes were performed:

a. Gathered a set of 24 CDP traces from input records.
b. Performed time variant deconvolution on CDP traces.
c. Applied time-variant zero-phase filtering to CDP traces.

d. Computed shot-to-group distances.
e. Zeroed early parts of CDP traces.
f. Output the processed CDP traces on output tape.
g. Applied time shifts for 96 different moveout scans to CDP traces and summed the CDP traces after each application.
h. Picked reflection maxima on stacked traces for the set of moveout scans and computed implied RMS velocities from time shifts corresponding to reflection maxima.

In order that early parts of CDP traces could be zeroed properly at deep water locations it was necessary generally, to introduce a fictitious water depth. The zeroing is applied as a function of submitted water depth and water velocity. Therefore,listings on the computer printout are correct only as regards RMS velocities relative to the surface. Water bottom velocities must be computed from the surface velocities.

Appendix E is a tabulation of the location of the 73 moveout scans processed during the project.

8. Dynamic Correlations.

Dynamic correlations are cross-correlations between two traces computed from a number of sequential short-time gates. For each time gate, the correlations from Common-depth-point traces with common geometry are space-averaged over a set of input records. The space-averaged dynamic correlations are then displayed in such a manner that moveout of any event within the time gate is essentially linear. As an additional aid, dynamic correlations are velocity filtered to resolve and identify specific velocities within each time gate. From an analysis of the displays and the associated computer printouts, the interpreter determines velocity as a function of time.

Dynamic correlations were processed from data over the following locations:

Line	Shotpoints
M29B	1840-1874
M44B EXT.	5317-5328
M32T	3106-3140
M40T	4550-4584

F. PRELIMINARY PROCESSING - (100% Coverage)

A complete flow diagram for preliminary processing (100% coverage) is shown onPlate 2.

The record section displays at this stage of processing were utilized for the following:

1. Residual normal moveout analysis for modification of velocity function change points.
2. Design of stack first-break suppression times.
3. Design of trace equalization gates.
4. Design of time varying deconvolution parameters.
5. Design of bandpass and change points ~~from~~ for time-varying filters in conjunction with filter analysis.

6. Design of final display gain gates

Input velocity functions for normal moveout corrections in preliminary processing were designed on the basis of interpretations of the moveout scans and dynamic correlations. Water top functions were plotted directly from the scan/dynamic interpretations and then converted to water bottom functions by the following formula:

$$\bar{V}_b = \frac{\bar{V}_{(t)}\ T_{v(t)} - \bar{V}_{(w)}\ T_{v(w)}}{T_{v(t)} - T_{v(w)}}$$

where:

$\bar{V}_{(b)}$ = Average velocity from bottom of water layer.

$\bar{V}_{(t)}$ = Average velocity from top of water layer.

$\bar{V}_{(w)}$ = Average velocity in water at 4850 ft. per second.

$T_{v(b)}$ = Vertical two-way time from bottom of water layer.

$T_{v(t)}$ = Vertical two-way time from top of water layer to reflector.

$T_{v(w)}$ = Vertical two-way time in water layer.

The resultant water bottom fuctions were input to the normal-moveout routine. In application the computer converted these water bottom functions to a unique water top function for every set of 12 sequential traces on the basis of the average water depth for this set of traces.

The tabulation following subsection G (final processing) of section VII of this report defines these velocity functions and shows where they were applied.

G. FINAL PROCESSING (1200% coverage)

A complete flow diagram for the final processing (1200% coverage) is shown on Plate 3.

The table on the next page shows the 8 separate sets of first-break suppression times (A through H) utilized during the 12-fold stack program.

The first channel and corresponding first time listed for any given First Break Suppression Function is the time at which traces 24 and 23 of the input records begin contributing to the stack. The second time (corresponding to channel 2) is the time at which traces 24 and 23 are contributing fully and is also the time at which traces 22 and 21 begin contributing. The third through twelfth times listed follow similarly for each set of two traces. The thirteenth time listed is the time at which traces 2 and 1 are fully contributing to the stack.

The following table shows the 6 separate sets of time varying deconvolution parameters applied. (Times given in seconds)

TIME VARYING DECONVOLUTION PARAMETERS

Code Number	I	II	III	IV	V	VI
Number of filter points	56	50	46	40	32	34
Length of operator	226	206	186	160	133	100
First gate start time	.400	.700	1.000	1.300	1.600	1.900
Second gate start time	1.534	1.734	1.934	2.100	2.267	2.400
First gate end time	2.666	2.766	2.866	2.900	2.933	2.900
Second gate end time	3.800	3.800	3.800	3.700	3.600	3.400

Time varying deconvolution filters were not normalized.

Appendix C shows a complete listing by line and shotpoint of the specific first break suppression, (ramp function) trace equalization, time varying deconvolution, (TVD) and time varying filter, (TVF) parameters applied in final processing.

FIRST BREAK SUPPRESSION RAMP FUNCTIONS

Times in Milliseconds

Channel	A	A-1	B	C	D	E	F	G	H
1	50	50	250	450	700	1000	1300	1000	800
2	200	200	350	550	800	1100	1400	1100	900
3	800	700	900	1000	1200	1400	1600	1200	1000
4	930	830	1030	1120	1290	1470	1660	1300	1100
5	1060	960	1160	1240	1380	1540	1720	1400	1200
6	1190	1090	1290	1360	1470	1610	1780	1500	1300
7	1320	1220	1420	1480	1560	1680	1840	2000	1800
8	1450	1350	1550	1600	1650	1750	1900	2600	2400
9	1580	1480	1680	1720	1740	1820	1960	2670	2470
10	1710	1610	1810	1840	1830	1890	2020	2740	2540
11	1840	1740	1940	1960	1920	1960	2080	2800	2600
12	1970	1870	2070	2080	2010	2030	2140	2850	2650
13	2100	2000	2200	2200	2100	2100	2200	2900	2700

Below the TVF heading in the listing, high and low-cut frequencies (in cycles per second) are shown for each time varying filter used for the particular line. For any given location, a time is listed, corresponding to each filter. These times were specific input parameters used to control the ramping of the filters in the following manner. The first time is the time at which the first filter begins to ramp off (fully on from time 0) and is also the time at which the second filter begins its taper on. The second time is the time at which the first filter is completely off, the second filter is fully on and begins its taper off. Other times and filter applications follow similarly. The last time is the time at which the next to last filter is completely off, and the last filter is fully on. The last filter remains fully on until end-of record time.

Appendix D lists all velocity functions used for normal moveout corrections and shows where these functions were applied during 100% and 1200% processing. These velocity functions start at water bottom and are the actual functions input to the computer. Before applying these functions to the data, the computer converts the functions to water top functions on the basis of specific water depths submitted.

The velocity functions applied in final 1200% processing were obtained by modifying the preliminary 100% functions on the basis of observed residual normal moveout (RNMO) on the 100% record sections. The steps in this modification are as follows:

1. For the shotpoint location where the RNMO is observed the water top function (that was input to the 100% processing) is plotted.

2. This water top function is then modified on the basis of the RNMO. The result is a final water top function.
3. This final water top function is then converted to a final water bottom function (see formula in section F) which is input for final 1200% processing.

PROCESSED DATA ANALYSIS

A. RECORD QUALITY

General Record Quality is good to fair throughout the survey area.

A high-amplitude event with good continuity occurs at intermediate record times throughout PEP63B and T/1P (see Plate 1). Within PEP63A the quality and continuity of this event deteriorates and is generally poor. This event is beleived to have originated from near the top of the Latrobe Complex.

At earlier record times (above the Latrobe Complex Event), reflection quality is generally fair throughout the survey area, however the line to line continuity of any single event is generally poor.

At later record times (below the Latrobe Complex Event), reflection quality is generally poor in PEP63A, generally fair in PEP63B and varies locally from fair to very poor within T/1P.

Deep water in itself does not appear to have had a serious adverse affect on record quality excepting on portions of lines (i.e. Line M46A) where a strong second bounce from the water bottom occurs at the same record time as primary events from horizons of interest.

Irregular water bottom conditions had an adverse effect on record quality on some lines (i.e. Line M41T). This deterioration in record quality can probably be associated with (1) the inadequacy of theoretical water replacement statics and (2) diffractions originating from sharp water bottom features.

Where character and continuity are questionable a symbol ("?") is shown on subsurface map data.

B. RECORD SECTION PICKING

Prints of the final processed 1200% record sections were picked continuously for each horizon mapped. The reflection picks were timed (for later conversion to depth and map posting) at every 5th shotpoint. Intermediate shotpoints were timed where necessary to define faults or dip changes.

C. MAPPING

One water depth map, three subsurface structural depth maps and two isopachs were prepared on a scale of 1:100,00. Two average velocity maps were prepared on a scale of 1:250,000.

Fathograms and water bottom reflection times (refer section VII) provided the source of data for the water depth map.

Final processed (1200%) record sections from the subject survey and from portions of ESSO-BHP lines EC-160, 161, 162 and 163 provided the source data for all subsurface maps.

Water depth contours and contours from horizons equivalent to Horizons B and C and Isopach B-C were traced from maps from previous seismic surveys to the north and west of the prospect area.

D. DEPTH CONVERSION

Sixty nine separate and distinct final velocity functions (starting from water-bottom) were designed and applied in final processing (refer Subsections E and G, Section VII). The reliability of these functions is generally good down through the Horizon B level. The reliability below Horizon B is generally poor.

On the basis of these velocity functions, average velocity (water-bottom to horizon) gradient interpretations were made for Horizons A and B (see enclosures 7 and 8). The velocity variations are substantial and have a significant effect on structural definition.

Steps in depth conversion of Horizon A and B were:

1. Reflection times from water-bottom to horizon were obtained for each data point by subtracting 2(water depth)/7000 ft. per sec. from the record section reflection times.
2. Average velocity (water-bottom to horizon) was interpolated from the velocity gradient contours.
3. Depth below water-bottom was obtained by applying the velocity from step 2 to the time of step 1.
4. Total depth was obtained by adding the water depth to the depth obtained in step 3.

For the depth conversion of Horizon C, the time interval from Horizon B to Horizon C was converted to thickness by applying the function $\overline{V}$ (average interval velocity) = 11000 ft. per sec. + 1000T (reflection time).

This function was established on the basis of the velocity data from Marlin No. 1 well and those seismically measured B-C interval velocities considered reliable. The B-C thicknesses were added to Horizon B depths to obtain Horizon C depths.

Respectfully submitted,
GEOPHYSICAL SERVICE INTERNATIONAL

Kenneth W. Graybill
Party Chief

069049

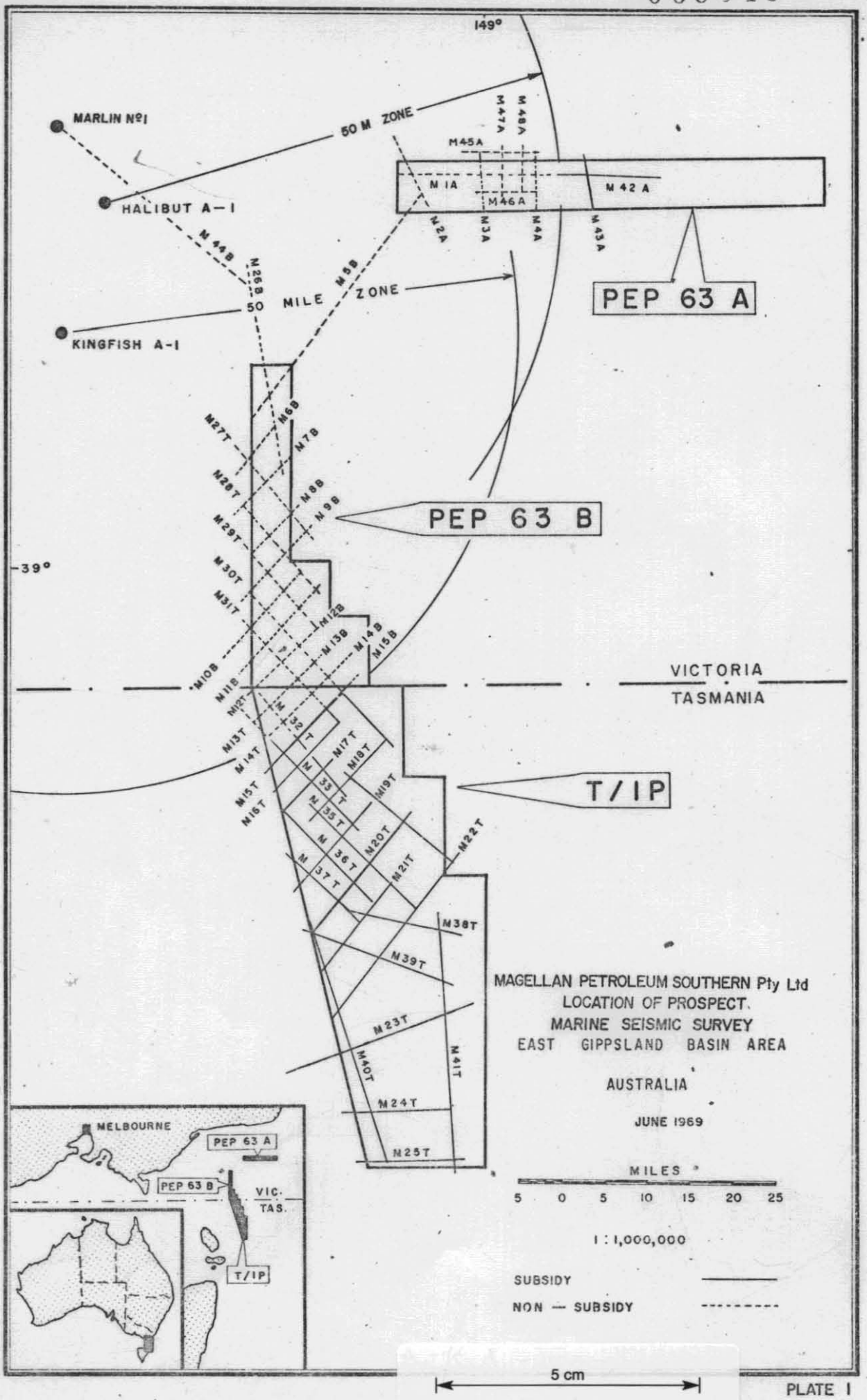
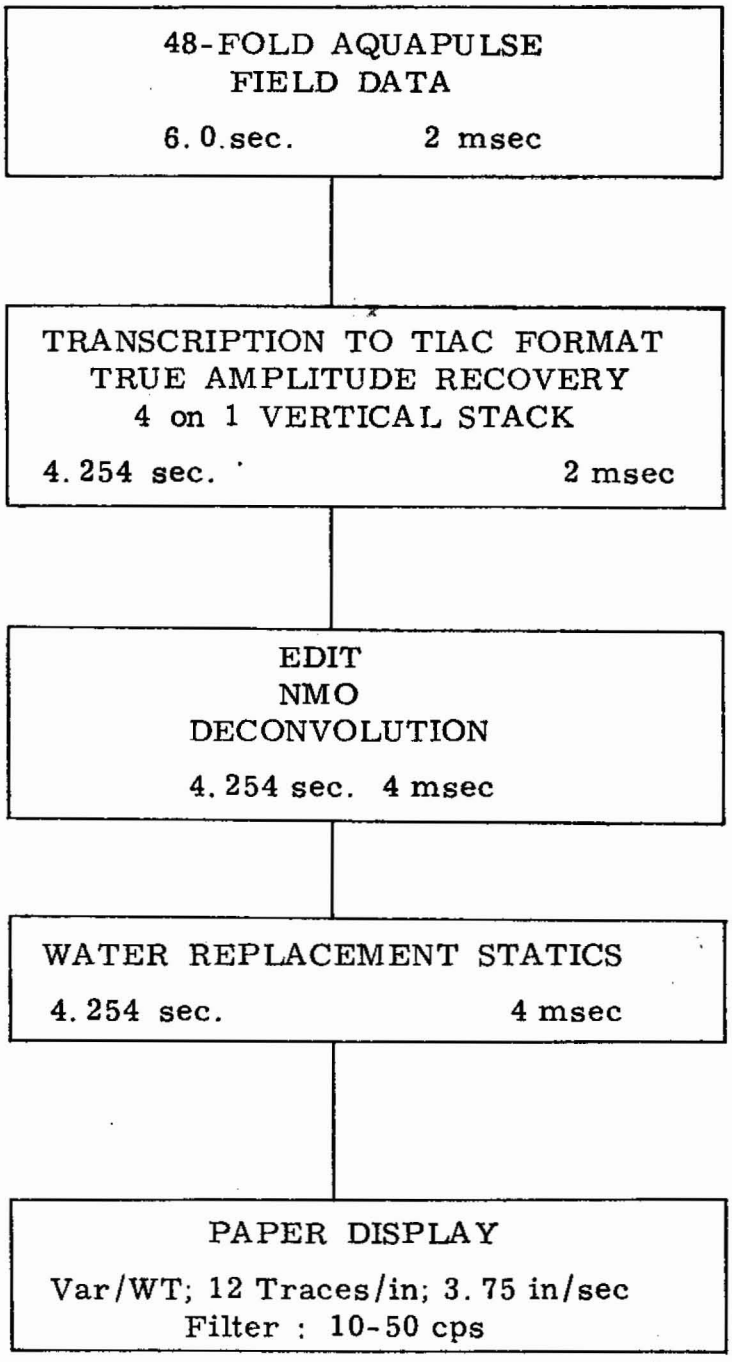


PLATE 1





MAGELLAN PETROLEUM SOUTHERN PTY. LTD.

FLOW DIAGRAM

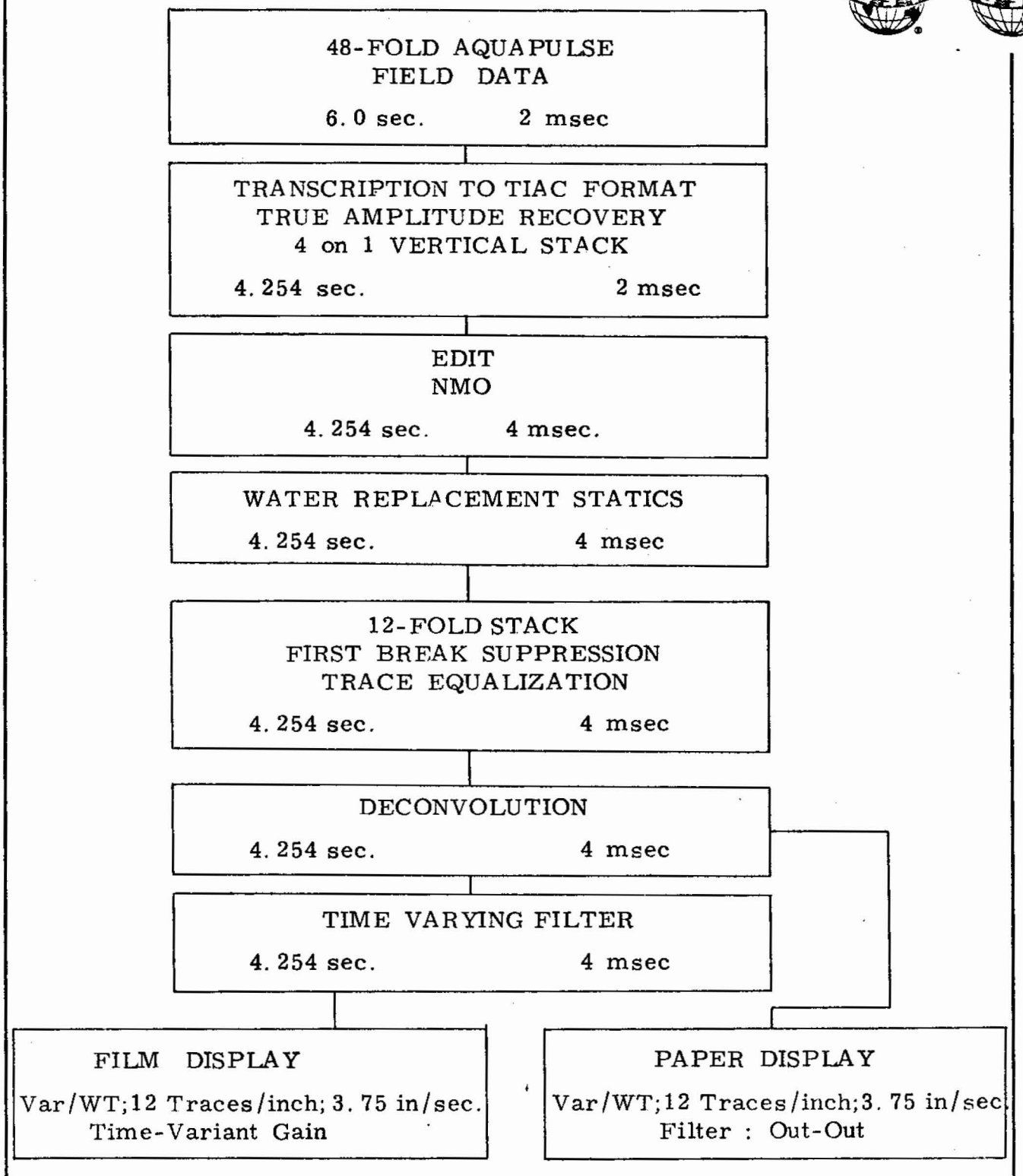
PRELIMINARY 100% PROCESSING

GEOPHYSICAL SERVICE INTERNATIONAL PARTY 852

GSI-709

PLATE 2





MAGELLAN PETROLEUM SOUTHERN PTY. LTD.

FLOW DIAGRAM

FINAL 1200% PROCESSING
GEOPHYSICAL SERVICE INTERNATIONAL PARTY 852

GSI-709

PLATE 3

069052

APPENDIX A

FINAL OPERATIONS REPORT

EAST GIPPSLAND MARINE SEISMIC SURVEY

P.E.P. 63A AND P.E.P. 63B T/1P

VICTORIA AND TASMANIA

FOR

MAGELLAN PETROLEUM SOUTHERN PTY. LTD.

BY

WESTERN GEOPHYSICAL COMPANY OF AMERICA

PARTY 64

DECEMBER - 1968

069053

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Instrument Specifications and Parameters
General Description and Specifications DFR-300
Binary Gain Seismic System

I. SUMMARY

A continuous reflection seismic survey using the AQUAPULSE system was conducted in the East Gippsland area immediately North East of the Island of Tasmania in Australia, operations commenced on December 4th, 1968, and were completed on December 20th, 1968. The areas surveyed were P.E.P. 63A and P.E.P. 63B T/1P.

II. GENERAL INFORMATION

A. Contractors

The survey was conducted by Western Geophysical Company of America, 933 North La Brea Avenue, Los Angeles, California, and 69 Berry Street, North Sydney, New South Wales, Australia. Positioning control was provided by Offshore Navigation, Incorporated, 5728 Jefferson Highway, New Orleans, Louisiana, and 413-417 New South Head Road, Double Bay, New South Wales, Australia.

B. Base of Operations

Devonport, Tasmania, was used as the base of operations for this project. Good harbour facilities and daily air service was available, and the town provided a good source of supply.

C. Weather

Only one complete day was lost due to bad weather. Some rough seas were encountered but

not to an extent necessitating suspension of operations.

D. Surveying Technique

The SHORAN direct ranging method was employed for positioning control. The equipment included track plotter and digital print out system. Three land based stations were used for the project. A description of the SHORAN System and the fixed base station sites is included in a separate report to be submitted by Offshore Navigation, Incorporated.

E. Chronolgy

December 5th, 1968 - Field test completed on ship board equipment.

December 6th, 1968 - Enroute to project area.

December 7th, 1968 - First day recording.

December 10th, 1968 - Rough seas, unable to bring in cable.

December 20th, 1968 - Project completed.

III. RECORDING OPERATIONS

A. Survey Vessel: M/V "Western Spruce" - 119 foot steel hull twin-screw vessel of American registry, powered by two General Motors V-16 Marine Diesel engines, capable of 11 knots cruising speed, and fitted with two Decca 202

Radar, Raytheon fathometer, and Apelco ship-to-shore radio.

B. Instrumentation

Digital Recorder - SDS 1010, 30-channel, 9-track, IBM compatible, EPRCO preferred, ½ inch gapless tape format, binary gain controlled amplifiers.

On-board Display - Raytheon Precision Depth Recorder, driven by output of trace 22, through TFA-1 amplifier and analog summing network.

Magnetometer - Varian Proton Marine Magnetometer - Model V-4937.

C. Detector Cable

A neutrally-buoyant oil-filled streamer cable equipped with four depth detectors, three special water break detectors, and 24 seismic detector groups was used throughout the survey. Each seismic detector group consisted of 32 crystal geophones in a tapered noise cancelling array, and were 230 feet in length. Dead sections 100 feet in length separated each "live" group, giving a group centre spacing of 330 feet. Refer to Plate II. The streamer cable buoyancy was adjusted to run at an average depth of 45 feet, and depth was maintained by eight CONDEP pressure cable depth

controllers, to plus or minus 7 feet.

D. Recording Technique

With the AQUAPULSE system, four "guns", in a rectangular array, were trailed at a depth of about 30 feet. The gun pulse monitoring system was used in conjunction with M.P.8 Geospace phones and 300 Hz galvonometers. Tests were made to ascertain the optimum gas pressure and fill time in order to obtain as near as possible a 3.1 gun pulse ratio of the first positive peak to the second. The pressures decided on were oxygen 50 lbs/sq.in., propane 20 lbs/sq.in. with a fill time of 1.5 seconds. Under continuous-tow operations, a metered oxygen/propane mixture was fired electrically at intervals such that four pulses per 330 feet, or approximately 64 pulses per mile were produced. This pulse density allows certain options in so-called vertical summing and horizontal stacking, such as, 4-sum 12-stack, or 8-sum 6-stack. Refer to Plate II for a detailed diagram of the streamer cable, AQUAPULSE gun array, and navigation antenna-gun array-cable relationship.

IV. DATA PRESENTATION

A. Field

A variable density section was made by recording

the output of group 22 on the Raytheon Precision Depth Recorder. Wiggly trace, read-after-write monitors were produced by a Dri-Write camera every 5 shotpoints or 3,300 feet. This monitor displayed data from the 24 seismic data channels, time break, individual gun pulse signatures, and direct water arrivals to the three water break detectors.

B. Processing

The digital tapes were air-shipped to Geophysical Services International for processing.

V. KEY FIELD PARTY PERSONNEL

A. Magellan Petroleum Southern Pty. Ltd.

Name	Position
A. Sabitay	Client Representative

B. Western Geophysical Company of America

Name	Position
V. Smith	Supervisor
V. Hearon	Operations Manager
P. Cooper	Co-ordinator
K. Dunwoody	Observer
R. Adams	Gun Captain
A. Shirley	Instrument Supervisor

C. Offshore Navigation, Incorporated

Name	Position
I. Easterbrook	Party Chief
D. Hackenbruch	Mobile Operator
H. Adams	Mobile Operator

VI. STATISTICAL SUMMARY

Line	Positions	Positions Occupied	Statute Miles
M5B	1-258	258	32.250
M2A	259-353	95	11.875
M1A	354-530	179	22.125
M42A	531-620	90	11.250
M43AP	621-683	63	7.875
M4A	684-738	55	6.875
M3A	739-792	54	6.750
M6B	793-856	64	8.000
M27B	857-977	121	15.125
M10B	978-1081	104	13.000
M11B	1082-1191	110	13.750
M28B	1192-1294	Re-shot - Too Noisy	
M34T	1295-1415	121	15.125
M31BT	1416-1541	126	15.750
M8B	1542-1606	65	8.125
M7B	1607-1684	78	9.750
M28B	1685-1787	103	12.875
M29B	1788-1875	88	11.000
M26B	1876-2050	175	21.875
M44B	2051-2175	125	15.625
M9B	2176-2260	85	10.625
M30BT	2261-2451	191	23.875
M18T	2452-2554	103	12.875
M17T	2555-2617	63	7.875
M16T	2618-2695	78	9.750
M15BT	2696-2809	114	14.250
M14BT	2810-2904	95	11.875
M13BT	2905-2987	83	10.375
M12BT	2988-3073	86	10.750
M32T	3074-3203	130	16.250
M33T	3204-3366	163	20.375
M36T	3367-3500	134	16.750
M35T	3501-3638	138	17.250
M19T	3639-3749	111	13.875
M20T	3750-3884	135	16.875
M21T	3885-3989	105	13.125

Line	Positions	Positions Occupied	Statute Miles
M22T	3990-4176	187	23.375
M41T	4177-4406	230	28-750
M40T	4407-4642	236	29.500
M37T	4643-4729	87	10.875
M38T	4730-4828	99	12.375
M39T	4829-4955	127	15.875
M23T	4956-5099	144	18.000
M24T	5100-5171	72	9.000
M25T	5172-5236	65	8.125
TOTAL FOR PROJECT:		5133	641.625

Number of tapes used: 972

Average mileage per tape: 1.52

069061

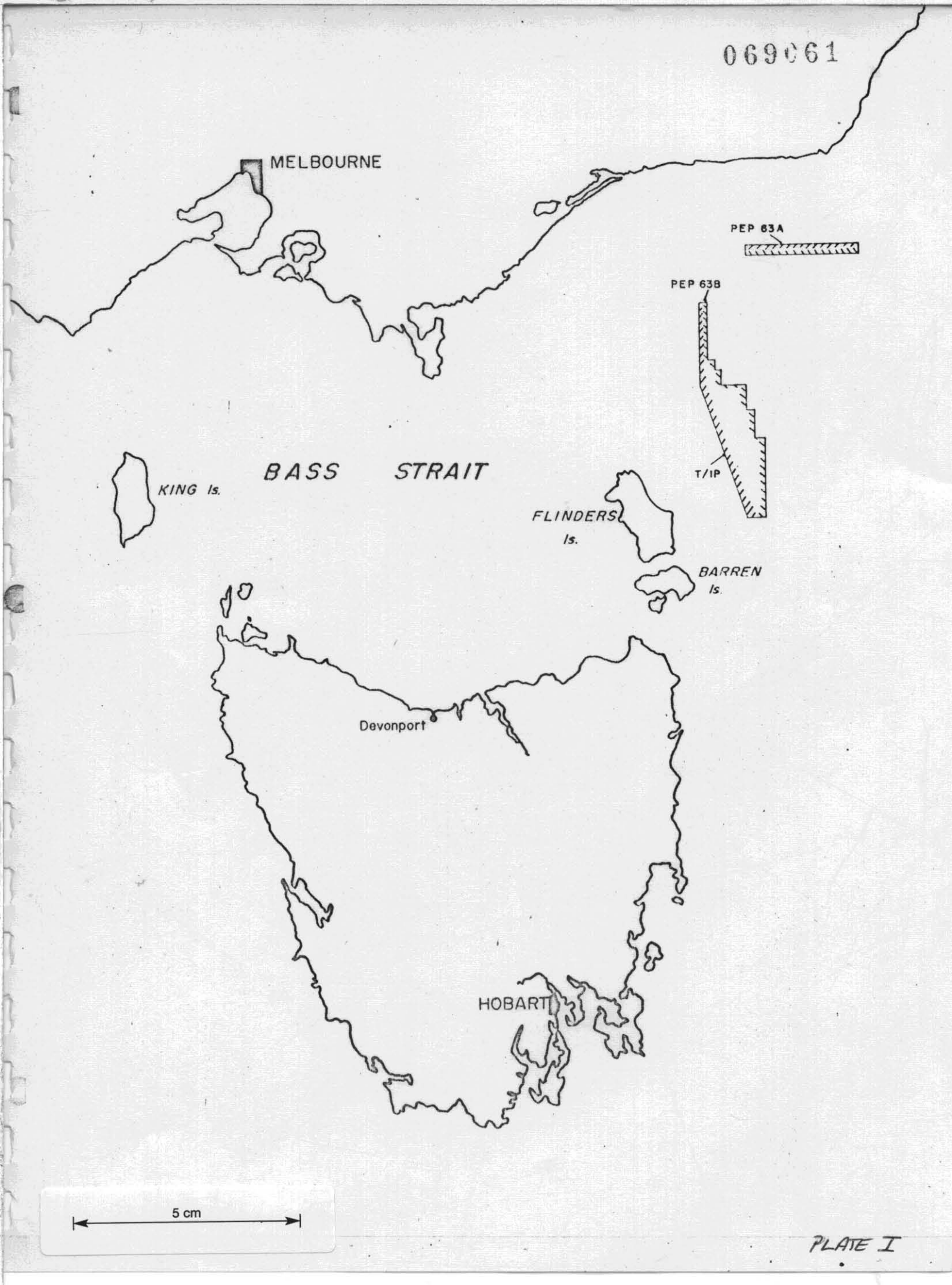
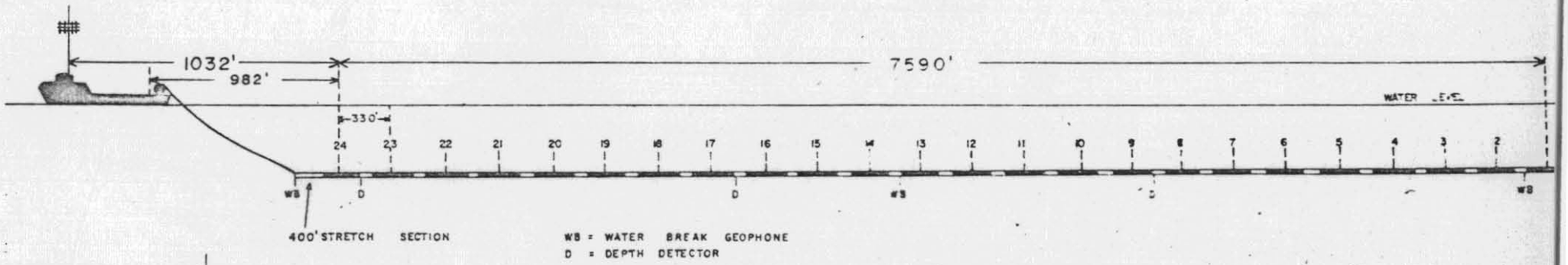


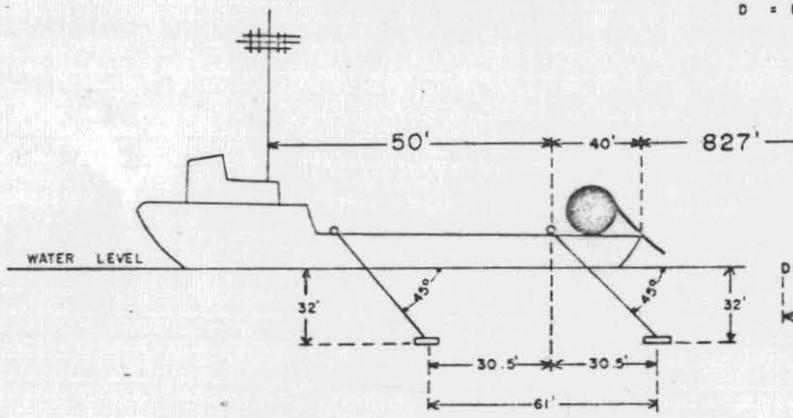
PLATE I

MAGELLAN
SEISMIC SURVEY
1968

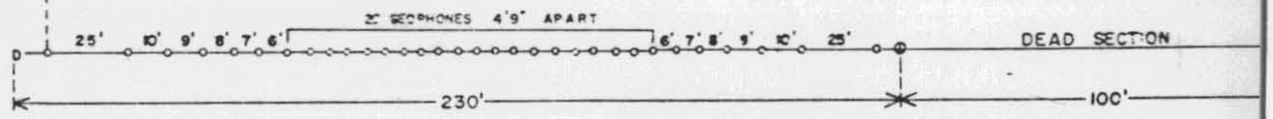
069062

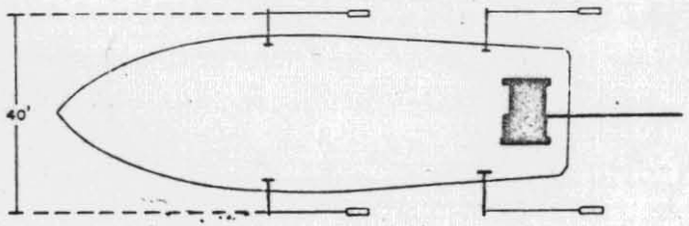
DIAGRAM OF 7590 Ft. STREAMER CABLE





DETAIL OF NOISE CANCELLING ARRAY





THE AQUAPULSE SYSTEM

WESTERN GEOPHYSICAL
DIVISION OF LITTON INDUS

5 cm

PLATE II

INSTRUMENT SPECIFICATIONS AND PARAMETERS

Digital Recorder System:	S.D.S. 1010
Amplifiers:	Preston, model GAU-72
Tape System:	Plotter tape deck DT-5 Tape transport, model PF-28
Tape Specifications:	Manufacturer - Memorex Bits per inch - 800 Length - 2,400 feet Width - $\frac{1}{2}$ inch Reel diameter - 10 inches
Section Plotter:	Raytheon Precision Depth Recorder model 193-4 Amplifier TFA-1 Filter - Cp AGC - Fast
Monitor Camera:	Western Geophysical Company W-1

Digital System Parameters:

Digital Channel assignment

Channel 1 -	24	Data channels
	25	Timing word
	26	Auxiliary - not used
	27	Auxiliary - not used
	28	Water breaks
	29	Time breaks
	30	Timing (100 Hz from Fork)

Sample rate	: 2 milliseconds
Release length	: Fast - 200 db/sec.
Record length	: 6 seconds
High cut filter	: High - 100 Hz
Low cut filter	: Low - 10 Hz
Early gain	: 60 db
Minimum gain	: 32 db
Gain range	: 90 db

Field Monitor Trace Identification:

Trace 1	100 c/s from fork
Trace 2	Time break, read-after-write
Trace 3 - 14	Data traces
Trace 15	Tape tachometer 106 c/s
Trace 16 - 27	Data traces
Trace 28	Time accumulator trace
Trace 29	Read-after-write time break 100 c/s
Trace 30	Water breaks
Trace 31	Not used
Trace 32 - 35	Gun pulse signatures, direct
Trace 36	Digital clock 100 c/s

I. ADDENDUM

Line M44B, the last of which was not completed due to hazardous conditions created by gas leakage of the Esso Marlin Platform, has now been completed together with the additional program which consisted of four lines.

II. EQUIPMENT

There was no change in the equipment or in the equipment setting to receive seismic data.
The following additional preliminary tests were conducted as requested by Mr. A. Sabitay, Client Representative.

1. The shipboard D-721 fathometer was calibrated using lead line measurement over a given known depth spot.

2. The PFR which produces the shipboard section from any of the 24 available groups was moved from accepting data from groups 22, as it had been done on the rest of the program, to group 24.

3. A daily check system was set up to assure that all clocks aboard the "Western Spruce" were set exactly according to GMT.

4. Positive identification of the time break on the PFR shipboard was established.

III. CHRONOLOGY

March 3, 1969 : Started line M44B at 1652 hours and completed at 1847 hours.

March 13, 1969 : Shot remaining four lines started shooting at 1050 hours and completed at 2004 hours. Program completed.

IV. STATISTICAL DATA

Line	Positions	Positions Occupied	Statute Miles
M44B	5243 - 5334	92	11.438
M46A	5335 - 5398	64	7.938
M48A	5399 - 5438	40	4.938
M54A	5439 - 5516	78	9.688
M47A	5517 - 5556	40	4.938
	Total Additions:	314	38.940
	Previous Totals:	5133	641.625
	Totals for Complete Project:	5447	680.565

069067

APPENDIX B

FINAL REPORT

OFFSHORE NAVIGATION, INC.

PROJECT 305

WESTERN GEOPHYSICAL COMPANY OF AMERICA

PARTY 64

FOR

MAGELLAN PETROLEUM SOUTHERN PTY. LTD.

BASS STRAIT, AUSTRALIA

DECEMBER 1968

069068

A B S T R A C T

Project 305 was a Shoran-controlled, marine seismic survey for potential mineral deposits in the Bass Strait area off the southeastern coast of Australia.

The principal involved was Magellan Petroleum Southern Pty. Ltd. (MAGELLAN).

Western Geophysical Company of America (WESTERN) was the prime contractor and operator.

Offshore Navigation, Inc. (ONI) employed a Shoran radiolocation system to provide horizontal control for the survey.

069069

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I. THE SHORAN RADIOPOSITIONING SYSTEM

The Shoran system is a radar transponder type of radio-positioning system. The Shoran mobile station equipment measures the distance from its location to those of two fixed ground beacon stations. The position of the mobile unit is thus fixed at the intersection of the two circular distance or range arcs so determined. The position of the ground beacon stations or base stations is normally accurately known, so that the corresponding position of the mobile station can be accurately computed or determined by graphical methods. Should the position coordinates of the base stations not be accurately known, the mobile station may still be positioned relative to the baseline determined by the base station locations.

The Shoran mobile unit measures the distances of the two base stations by measuring the time required for pulses of radio signals to travel from the mobile station to each base station and return. The time intervals so measured are related to the corresponding distances by using the highly constant velocity characteristic of radio waves in air through the simple relationship:

Total distance covered = Elapsed time x velocity

Because of this relationship, it is possible to graduate

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

the indicating dials in the mobile unit in terms of distance rather than elapsed time. For example, using radio waves which have a velocity of approximately 186,000 miles per second, the scale of the time-interval measuring system is graduated so that when the time interval required for a round trip of the signal is 1/1000 second, the scale reads 93 miles. (The total distance traveled by the radio signals in 1/1000 second is 186 miles. Since this is round trip distance, it must be halved to obtain the distance between mobile and base stations.) The Shoran dials are graduated in terms of statute miles rather than nautical miles.

The basic equipment units used to create the round trip signal paths originating and terminating at the mobile station are shown in Figure 1. This equipment consists of a signal source (labeled pulse generator in Figure 1), a transmitter, receiver and indicator unit comprising the mobile station, and a receiver coupled to a transmitter at each base station.

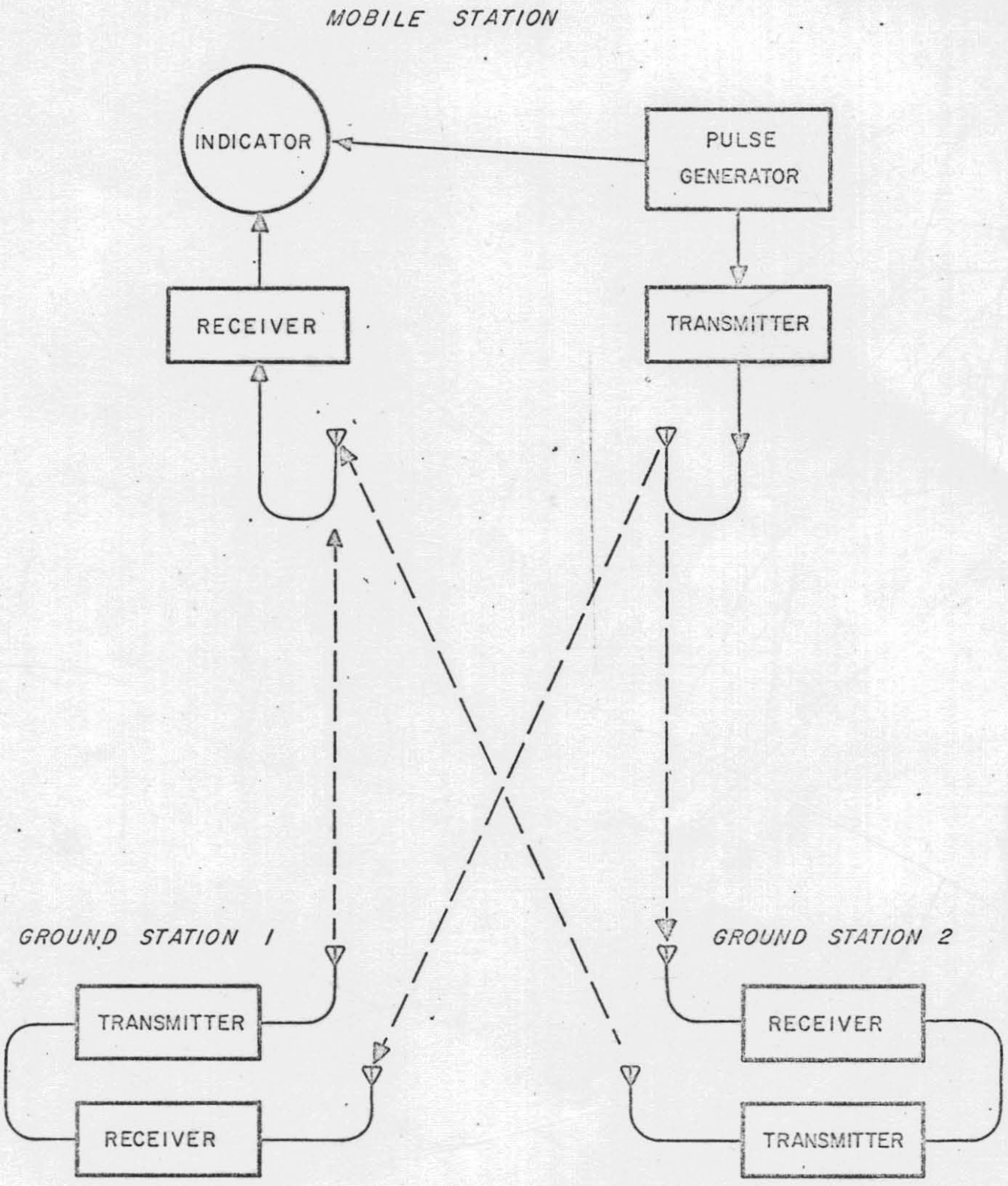


FIGURE 1
SIMPLIFIED BLOCK DIAGRAM OF BASIC RADIO EQUIPMENT OF A SHORAN SYSTEM

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

Pulse signals originating at the mobile station are radiated from the mobile transmitter and recieved by one of the base stations. At this base station, the pulse is sent from the output of the receiver to the input of the transmitter, and is then retransmitted back to the mobile station. After passing through the mobile receiver, the pulse is routed to an indicating circuit where its time lag, or lapse, with respect to the original outgoing pulse is determined, and indicated in terms of distance rather than units of time.

Other pulses are transmitted to the second base station, using a different radio frequency to permit their discrimination from those intended for the first base station. These pulses are received and retransmitted by the second base station, and on their return to the mobile station are similarly sent through the indicating circuits for measurement of the time required for their round trip and the indication of corresponding distance. Thus the equipment provides continuous, essentially simultaneous, indications of the distances to both base stations.

The Shoran system operates in the VHF/UHF portion of the radio spectrum. Normally, three separate frequencies are used. Two of these are transmitted alternately by the

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

mobile station to interrogate each base station in turn, as previously described. The third frequency is utilized by the base stations to retransmit the received pulses back to the mobile station. Both base stations transmit on the single frequency in order to utilize a single receiver at the mobile station.

The propagation characteristics of VHF/UHF radio signals is such that they tend to travel in straight lines. While they are refracted in the atmosphere to some small extent, they do not tend to follow the earth's curvature as do radio signals of considerable lower frequency. They lack the ability to "see" beyond the radio horizon. Thus the Shoran system is essentially a "line of sight" system, with the maximum range being limited, to a large extent, by the heights of the mobile and base station antennas.

The range of the system under particular conditions may be estimated from the relationship

$$d = k (\sqrt{h_1} + \sqrt{h_2})$$

where,

d = estimated maximum range, in miles
h_1 = height of mobile station antenna, in feet, above sea level
h_2 = height of base station antenna, in feet, above sea level
k = empirical range factor

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

The factor, k, depends upon several factors among which are included antenna gain, receiver sensitivity, transmitted power and atmospheric refractive index. It will vary in value from 1.5 to 2.5, under normally encountered conditions.

The range formula presumes no obstructions between mobile and base stations. The presence of intervening hills or other obstructions can reduce the otherwise obtainable range.

Under certain conditions, abnormally long Shoran ranges can be obtained by exploiting the existence of an atmospheric phenomenon known as a temperature inversion layer. This is a layer of high refractive index occurring within the first few thousand feet of the atmosphere. It has the effect of confining the radio waves near the earth's surface, and acts as a duct to bend radio waves around the curvature of the earth. Under these conditions the factor, k, may be several times greater than normal. In some marine areas of the world, this phenomenon occurs quite regularly during certain seasons.

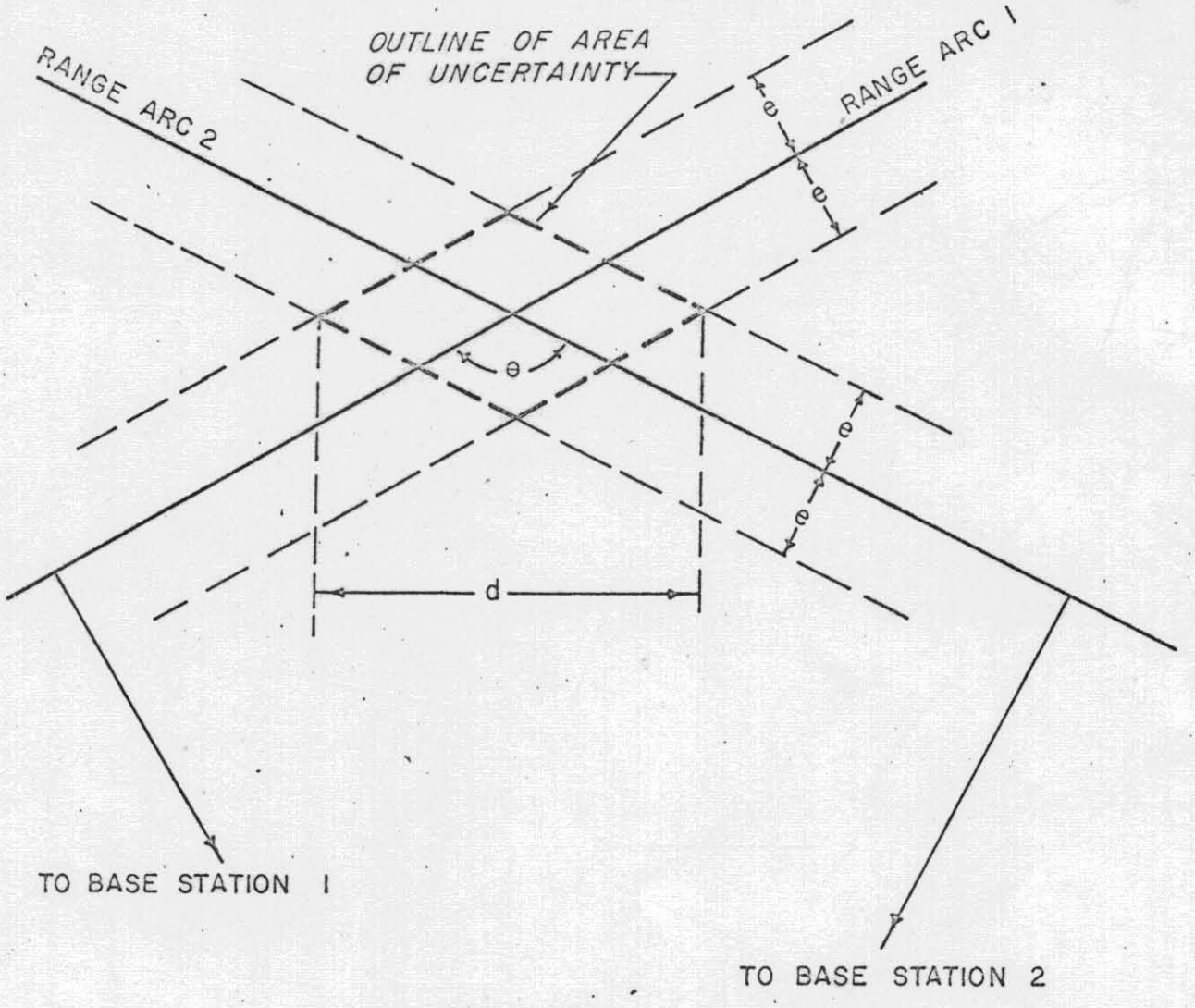
The instrumental accuracy of the Shoran equipment, when properly calibrated, is $\pm$ 50-75 feet on a single range. The overall position accuracy is related to the range accuracy by

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

the angle of intersection, at the mobile station, between the two Shoran range circles. This is illustrated in Figure 2. In normal geophysical operations, this angle of intersection is held between 30 and 150 degrees. Refer to Appendix A for examples of areas of coverage for different angles of intersection of the Shoran range circles.

The range accuracy of the Shoran system can be improved, possibly by a factor of 2, by correcting the propagation velocity slightly under varying meteorological conditions, and by the application of more rigid calibration and operating specifications. For most operations, this additional accuracy cannot be economically justified.

In computing (or determining graphically) the position from a pair of Shoran ranges, cognizance must be maintained that a position ambiguity may exist. Each pair of ranges (one to each base station) actually determines two independent positions, one on each side of the Shoran baseline, as illustrated in Figure 3. One position is the "mirror image," so to speak, of the other. Further, the Shoran mileage dials repeat every 100 miles of range. To eliminate this ambiguity one must know, from other means, the correct side of the baseline and the distance to each base station within the proper multiple of 100 miles.



$$d = \frac{2e}{\sin \frac{\theta}{2}}$$

e = RANGE ERROR

θ = ANGLE OF INTERSECTION OF RANGE CIRCLES

5 cm

FIGURE 2

AREA OF UNCERTAINTY OF POSITION
DUE TO ERROR IN RANGE MEASUREMENT

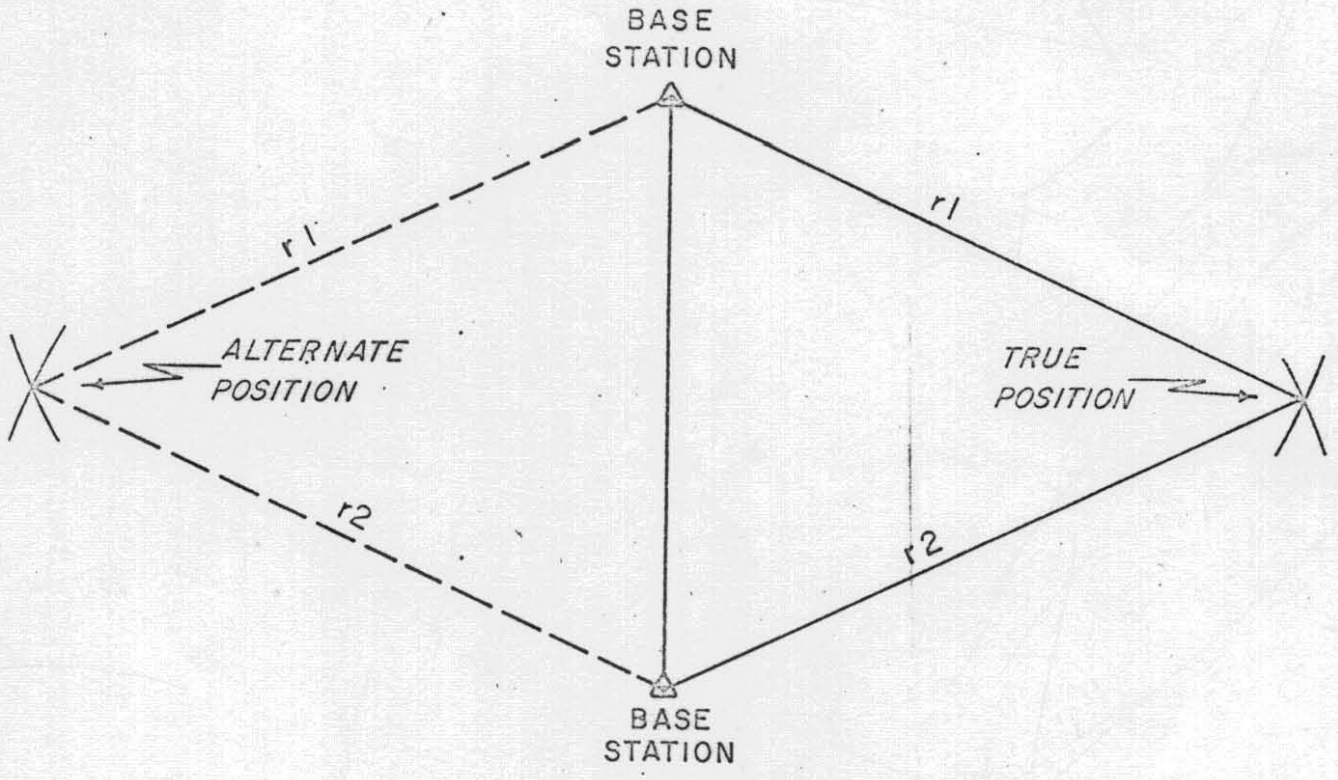
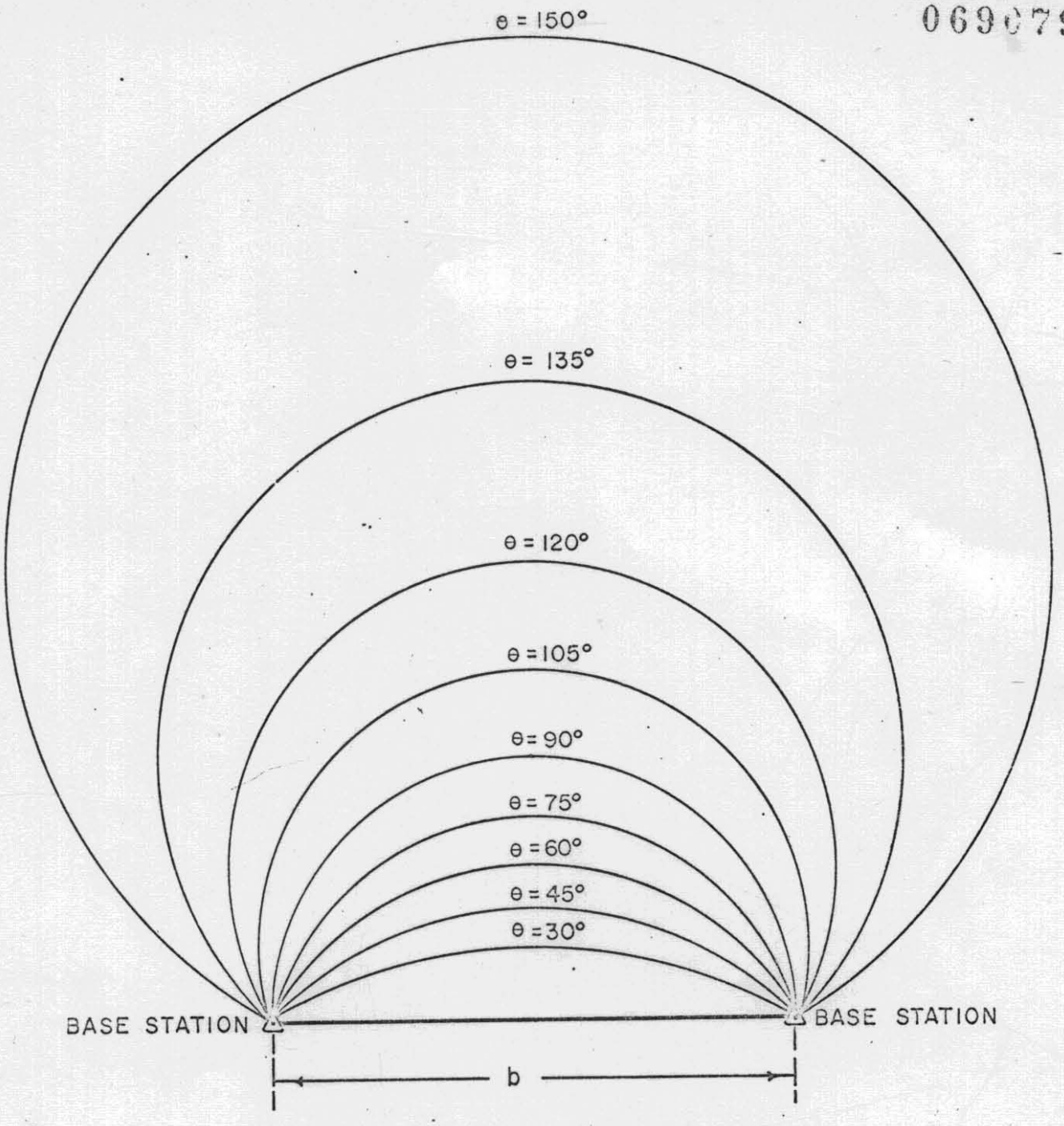


FIGURE 3

POSITION AMBIGUITY IN CIRCULAR RANGE SYSTEM



ALL ARCS ARE PORTIONS OF CIRCLES THROUGH BASE STATION POSITIONS OF RADIUS GIVEN BY:-

$$r = \frac{b}{2 \sin \theta}$$

WHERE θ IS ANGLE OF INTERSECTION BETWEEN RANGE CIRCLES

5 cm

APPENDIX A
RELATIVE AREA OF COVERAGE, CIRCULAR RANGING SYSTEM

II. AREA OF OPERATIONS

The program area covered a portion of the Bass Strait from southeast of Flinders Island to northeast of Deal Island.

ONI's base of operation was located in Devonport, Tasmania. From this office the activities of the field crew were directed and radiotelephone communications maintained.

III. FIELD OPERATIONS RECAP

On 27 November 1968, preparation for the survey commenced by shipping a Shoran base station from Port Albert, Victoria, to Deal Island. At the same time a base station was being flown from Melbourne to Flinders Island. Both stations were erected on 28 November 1968. The third base station was flown from Tasmania to Melbourne on 6 December and then trucked to Mt. Nowa Nowa and erected on 6 December.

Actual seismic operations commenced on 6 December 1968 when the M/V WESTERN SPRUCE, with Shoran indicating equipment installed and operational, entered the work area. Operations continued through 19 December 1968. During this time a total of 5,236 shotpoints were recorded.

The base of operation in Devonport remained open, and the Shoran base stations were left in position for the next prospect under WESTERN's control.

IV. GENERAL INFORMATION

A. Satisfactory radiotelephone communications between the Shoran installations and the base of operation was maintained on the frequency of 2398 kilocycles.

B. Equipment was periodically checked for proper calibration during the course of the survey.

C. The Shoran field survey notes were turned over to Mr. B. Sherman, a WESTERN representative, on 21 December 1968.

V. MAPPING

Prior to the start of field operations, ONI in New Orleans predetermined the Shoran ranges and grid coordinates for each recording boat location to be occupied during the course of the survey. These preplots were prepared in accordance with the program assignment chart furnished by MAGELLAN, and at the shotpoint interval specified by WESTERN.

Additional preplots were prepared by the IBM Data Service Center in Sydney, Australia.

For computing and mapping purposes, the Australian Transverse Mercator Projection, based on the Clarke 1858 Spheroid, Belt 7, Central Meridian 146° East, was employed. A False Northing of 1,000,000 yards was used.

VI. PERSONNEL

Name	Position
Easterbrook, I.	Party Chief
Adams, H.	Mobile Operator
Devlin, W.	Mobile Operator
Hackenbruck, D.	Mobile Operator
Killalea, I.	Mobile Operator
Bienz, W.	Base Operator
Binderman, B.	Base Operator
Kingsley, B.	Base Operator
Martin, K.	Base Operator

VII. DISTRIBUTION

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of America
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New Orleans, Louisiana 70123 — Two Copies

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413-417 New South Head Road
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069083

AUSTRALIA

LEGEND

① STA. MT. NOWA NOWA
② STA. DEAL ISLAND
③ STA. WALKERS LOOKOUT

① Orbost

Bairnsdale

Cape Conran

Cape Everard

38° 00'

(APPROX.) PROGRAM AREA

(APPROX.) PROGRAM AREA

148° 00'

39° 00'

149° 00'

150° 00'

TASMANIAN SEA

② Deal Island

FLINDERS IS

40° 00'

③ Whitemark

REFERENCE CHART, ONC R-3, ONC-S-11

5 cm

SCALE 1 : 1,000,000 OR-047

OFFSHORE NAVIGATION, INC.
NEW ORLEANS, LA.

SHORAN BASE STATION DESCRIPTIONS AND PLATES

STATION: MT. NOWA NOWA

LOCATED: Northeast of Bairnsdale in the state of Victoria.

ACCESS: Follow the Princes Highway to the township of Nowa Nowa. Travelling east through town, take the first left turn. Pass a forestry camp until the sign "Mt. Nowa Nowa" is seen on a tree. Follow this road to the top of the mountain. There is a fire tower on top.

GENERAL: Water is available at the site in wet season. This is a drive-on site.

ELEVATION: 388 yards.

SKETCH: See next page.

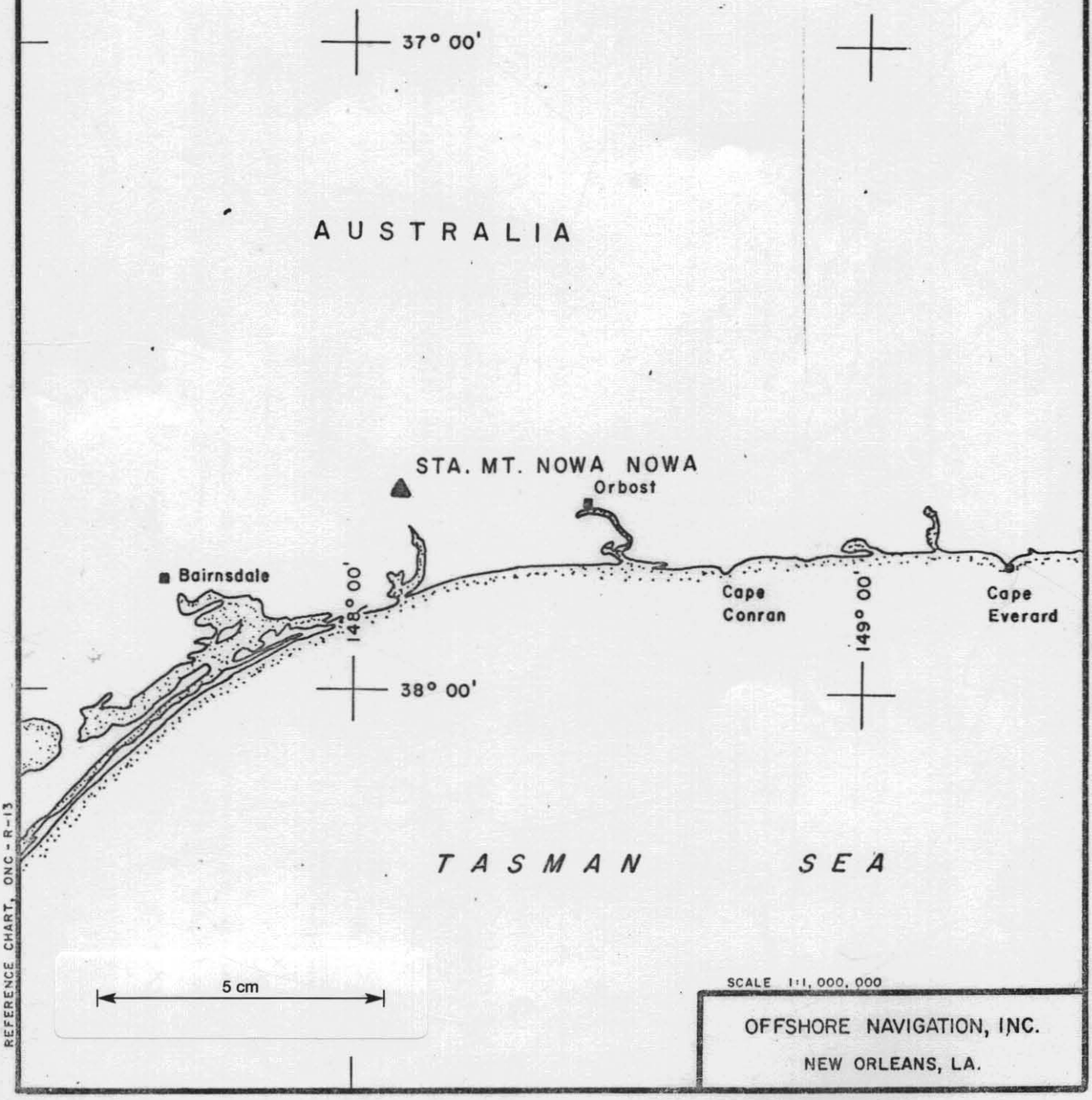
GEOGRAPHICAL COORDINATES		ATM PROJ., CLARKE 1858 SPHEROID Belt 7, C.M. 146°	
Latitude	Longitude	East	North
37°41'36".90 S	148°05'30".03 E	601,770 yards	1,349,561 yards

069085

STATION MT. NOWA NOWA — AUSTRALIA

LAT.	37° 41' 36."90 S	N	1,349,561 yards
LONG.	148° 05' 30."03 E	E	601,770 yards
ELEV.	388 yards		

AUSTRALIAN TRANSVERSE MERCATOR PROJECTION, CLARKE 1858 SPHEROID
BELT 7, C.M. 146° E, F.N. = 1,000,000 YARDS



SCALE 1:1,000,000

OFFSHORE NAVIGATION, INC.
NEW ORLEANS, LA.

REFERENCE CHART, ONC-R-13

STATION: DEAL ISLAND

LOCATED: On the southwest end of Deal Island.

ACCESS: Equipment and supplies must be carried from Port Albert, Victoria. This can be arranged by contacting Mr. Frank Gould at Port Albert, telephone 832343. Mr. Gould has a boat in which he makes regular supply runs to Bass Strait lighthouses. Equipment will be unloaded at Jetty which is 2 miles from the site. The Lightkeeper has a Land Rover which is available to transport equipment to within 125 yards of the site. From this point it must be packed up a bush track to the site. Water is available at the Lighthouse.

MARKER: A metal plate on highest point of hill between two large rocks.

GENERAL: To occupy site permission must be obtained from The Regional Lighthouse Engineer, Shipping and Transport Department, 497 Collins St., Melbourne. Phone 620151.

ELEVATION: 333 yards.

SKETCH: See next page.

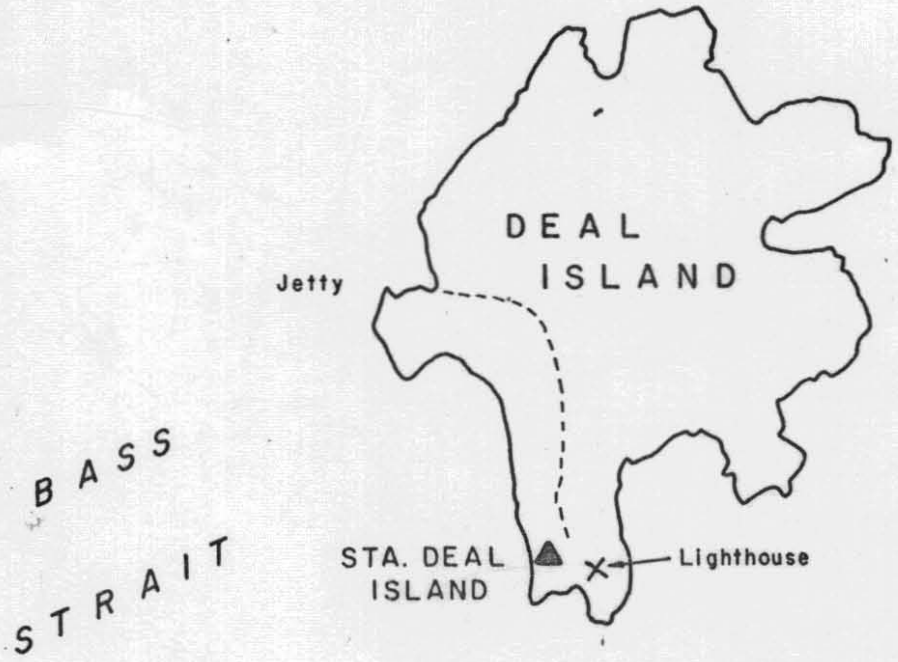
GEOGRAPHICAL COORDINATES		ATM PROJ., CLARKE 1858 SPHEROID Belt 7, C.M. 146° E	
Latitude	Longitude	East	North
39°29'41".36 S	147°19'09".23 E	524,112 yds.	1,132,236 yds.

069087

STATION DEAL ISLAND — TASMANIA

LAT.	39° 29' 41."36 S	N	1,132,236 yards
LONG.	147° 19' 09."23 E	E	524,112 yards
ELEV.	333 yards		

AUSTRALIAN TRANSVERSE MERCATOR PROJECTION, CLARKE 1858 SPHEROID
BELT 7, C.M. 146° E; F.N. = 1,000,000 YARDS





N.T.S.

OFFSHORE NAVIGATION, INC.
NEW ORLEANS, LA.

STATION: WALKERS LOOKOUT

LOCATED: In the central region of Flinders Island in the Bass Strait.

ACCESS: Equipment must be flown to Whitemark Airport from Victoria or Tasmania. Follow road from airport to Whitemark until Memana turnoff is reached. Follow the turnoff until a dirt road is seen on the right about two miles from turnoff. Follow this road to the top of the hill and trig. point, a distance of three miles.

MARKER: A wooden post with a four-gallon drum on top. There are two T.V. towers beside trig marker.

GENERAL: Mr. Walker, a contractor in Whitemark, is available to transport equipment. Water and supplies must be carried from Whitemark.

ELEVATION: 500 yards.

SKETCH: See next page.

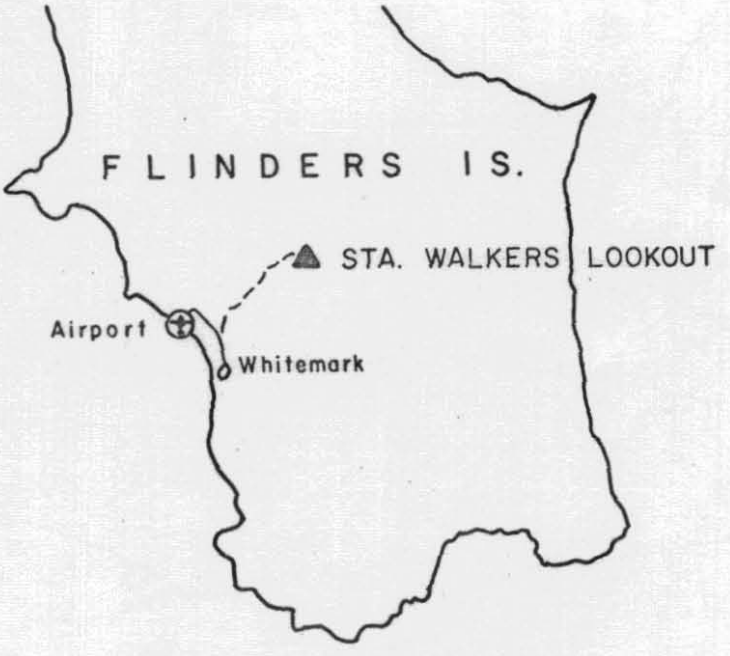
GEOGRAPHICAL COORDINATES		ATM PROJ., CLARKE 1858 SPHEROID Belt 7, C.M. 146°	
Latitude	Longitude	East	North
40°03'27".53 S	148°04'46".40 E	594,059 yards	1,062,537 yards

069089

STA. WALKERS LOOKOUT — TASMANIA

LAT.	40° 03' 27".53 S	N	1,062,537 yards
LONG.	148° 04' 46".40 E	E	594,059 yards
ELEV.	500 yards		

AUSTRALIAN TRANSVERSE MERCATOR PROJECTION, CLARKE 1858 SPHEROID
BELT 7, C.M. 146° E, F.N. = 1,000,000 YARDS



BASS

STRAIT

5 cm

OFFSHORE NAVIGATION, INC.
NEW ORLEANS, LA.

FINAL PROCESSING PARAMETERS

APPENDIX C

LINE M1A

SP to SP	Ramp Function	Equalization Gates	
354-480	B	Not Applied	
481-528	C	"	"

	TVD	TVF	
		20-60	8-40
354-390	III	1.700	2.100
391-480	III	1.800	2.200
481-528	III	1 900	2.300

LINE M2A

SP to SP	Ramp Function	Equalization Gates	
259-271	C	Not Applied	
272-307	B	"	"
308-353	A	"	"

	TVD	TVF	
		20-60	8-40
259-271	III	1.900	2.300
272-289	II	1.800	2.200
290-319	II	1.700	2.100
320-353	I	1.600	2.000

LINE M3A

SP to SP	Ramp Function	Equalization Gates
739-751	B	Not Applied
752-775	C	" "
776-787	D	" "

	TVD	TVF	
		20-60	8-40
739-751	III	1.700	2.100
752-787	V	1.800	2 200

LINE M4A

SP to SP	Ramp Function	Equalization Gates
684-696	E	Not Applied
697-702	D	" "
703-720	C	" "
721-738	B	" "

	TVD	TVF	
		20-60	8-40
684-690	IV	1.900	2.300
691-720	III	1.900	2.300
721-738	II	1.800	2.200

LINE M5B

SP to SP	Ramp Function	Equalization Gates
1- 55	B	.800-2.400
56- 67	C	1.100-2.700
68- 73	D	1.300-2.900
74- 85	E	1.500-3.000
86-109	F	1.900-3.400
110-211	F	2.300-3.800
212-223	F	1.900-3.400
224-235	E	1.500-3.000
236-241	D	1.300-2.900
242-257	C	1.100-2.700

SP to SP	TVD	TVF				
		20-60	15.55	10-50	8-40	8-30
1- 7	III	.800	1.700	2.000	2.400	2.800
8- 49	II	.800	1.700	2.000	2.400	2.800
50- 67	III	1.000	1.800	2.100	2.500	2.900
68- 73	IV	1.300	1.900	2.200	2.600	3.000
74- 91	V	1.600	2.100	2.400	2.800	3.200
92-103	VI	1.700	2.200	2.500	2.900	3.300
104-121	VII	1.900	2.300	2.600	3.000	3.400
122-187	VIII	2.100	2.400	2.700	3.100	3.500
188-217	VII	1.900	2.300	2.600	3.000	3.400
218-223	VI	1.600	2.200	2.500	2.900	3.300
224-235	V	1.400	2.100	2.400	2.800	3.200
236-241	IV	1.200	1.900	2.300	2.600	3.000
242-257	III	1.200	1.900	2.200	2.600	3.000

LINE M6B

SP to SP	Ramp Function	Equalization Gates
795-807	E	1.800-3.200
808-813	D	1.400-2.800
814-819	C	1.200-2.600
820-843	B	1.000-2.500
844-856	A	.800-2.300

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
795-807	VI	1.700	2.000	2.300	2.700	3.100
808-819	IV	1.200	1.800	2.100	2.500	2.900
820-825	III	.900	1.600	1.900	2.300	2.700
826-831	II	.900	1.600	1.900	2.300	2.700
832-856	II	.700	1.400	1.700	2.100	2.500

LINE M7B

SP to SP	Ramp Function	Equalization Gates
1607-1625	C	1.400-2.800
1626-1643	B	1.000-2.500
1644-1684	A	.700-2.200

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
1607-1613	IV	1.400	1.800	2.100	2.500	2.900
1614-1631	III	1.000	1.600	1.900	2.300	2.700
1632-1684	II	.700	1.400	1.700	2.100	2.500

LINE M8B

SP to SP	Ramp Function	Equalization Gates
1542-1572	A	.600-2.100
1573-1606	B	.900-2.400

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
1542-1572	I	.500	1.100	1.400	1.800	2.200
1573-1602	II	.800	1.300	1.600	2.000	2.400
1603-1606	III	.800	1.300	1.600	2.000	2.400

LINE M9B

SP to SP	Ramp Function	Equalization Gates
2176-2182	C	1.000-2.500
2183-2212	B	.750-2.250
2213-2260	A	.500-2.000

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
2176-2182	III	.900	1.400	1.700	2.100	2.500
2183-2212	II	.700	1.252	1.552	1.952	2.352
2213-2260	I	.500	1.100	1.400	1.800	2.200

LINE M10B

SP to SP	Ramp Function	Equalization Gates
978-1008	B	.700-2.200
1009-1081	A	.500-2.000

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
978- 996	II	.700	1.300	1.600	2.100	2.900
997-1014	II	.600	1.200	1.500	2.000	2.800
1015-1026	I	.500	1.100	1.400	1.900	2.700
1027-1044	I	.400	.900	1.200	1.700	2.500
1045-1081	I	.400	.800	1.100	1.600	2.400

LINE M11B

SP to SP	Ramp Function	Equalization Gates
1082-1178	A	.600-2.100
1179-1191	B	.800-2.300

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
1082-1124	I	.400	.800	1.100	1.600	2.400
1125-1136	I	.400	.900	1.200	1.700	2.500
1137-1172	I	.500	1.100	1.400	1.900	2.700
1173-1191	II	.700	1.300	1.600	2.100	2.900

LINE M12BT

SP to SP	Ramp Function	Equalization Gates
2988-3073	A	.500-2.000

	TVD	TVF			
		20-60	15-55	10-50	8-40	8-30
2988-2994	I	.500	1.100	1.400	1.900	2.700
2995-3012	I	.500	1.000	1.300	1.800	2.600
3013-3030	I	.400	.900	1.200	1.700	2.500
3031-3073	I	.400	.800	1.100	1.600	2.400

LINE 13BT

SP to SP	Ramp Function	Equalization Gates
2905-2987	A	.500-2.000

	TVD	TVF			
		20-60	15-55	10-50	8-40	8-30
2905-2917	I	.400	.700	1.000	1.500	2.300
2918-2959	I	.400	.800	1.100	1.600	2.400
2960-2977	I	.500	.900	1.200	1.700	2.500
2978-2987	II	.500	1.000	1.300	1.800	2.600

LINE M14BT

SP to SP	Ramp Function	Equalization Gates
2810-2834	B	.700-2.200
2835-2904	A	.500-2.000

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
2810-2840	II	.500	1.000	1.300	1.800	2.600
2841-2858	I	.400	.900	1.200	1.700	2.500
2859-2904	I	.400	.800	1.100	1.600	2.400

LINE M15BT

SP to SP	Ramp Function	Equalization Gates
2696-2786	A	.500-2.000
2787-2809	B	.700-2.200

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
2696-2726	I	.400	.700	1.000	1.500	2.300
2727-2744	I	.400	.800	1.100	1.600	2.400
2745-2774	I	.500	.900	1.200	1.700	2.500
2775-2786	II	.500	.900	1.200	1.700	2.500
2787-2809	II	.500	1.000	1.300	1.800	2.600

LINE M16T

SP to SP	Ramp Function	Equalization Gates
2618-2695	A	.600-2.100

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
2618-2630	II	.700	1.100	1.400	1.900	2.700
2631-2642	I	.500	.952	1.252	1.752	2.552
2643-2654	I	.400	.800	1.100	1.600	2.400
2655-2695	I	.400	.700	1.000	1.500	2.300

LINE M17T

SP to SP	Ramp Function	Equalization Gates
2555-2617	A	.500-2.000

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
2555-2597	I	.400	.700	1.000	1.500	2.300
2598-2617	I	.400	.800	1.100	1.600	2.400

LINE M18T

SP to SP	Ramp Function	Equalization Gates
2452-2470	C	1.000-2.500
2471-2494	B	.700-2.200
2495-2554	A	.500-2.000

	TVD			TVF		
		20-60	15-55	10-50	8-40	8-30
2452-2476	III	.900	1.152	1.400	1.900	2.700
2477-2500	II	.700	1.000	1.300	1.800	2.600
2501-2518	I	.500	.900	1.200	1.700	2.500
2519-2550	I	.400	.800	1.100	1.600	2.400

LINE M19T

SP to SP	Ramp Function	Equalization Gates
3639-3657	B	.700-2.200
3658-3729	A	.500-2.000
3730-3749	A-1	.500-2.000

	TVD			TVF		
		20-60	15-55	10-50	8-40	8-30
3639-3645	II	.700	1.100	1.400	1.900	2.700
3646-3663	II	.600	1.100	1.400	1.900	2.700
3664-3693	I	.500	1.000	1.300	1.800	2.600
3694-3749	I	.400	.900	1.200	1.700	2.500

LINE M20T

SP to SP	Ramp Function	Equalization Gates
3750-3834	A	.500-2.000
3835-3852	B	.700-2.200
3853-3870	B	1.000-2.500
3871-3884	C	1.000-2.500

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
3750-3792	I	.400	.800	1.100	1.600	2.400
3793-3816	I	.400	.900	1.200	1.700	2.500
3817-3834	I	.500	1.000	1.300	1.800	2.600
3835-3852	II	.600	1.100	1.400	1.900	2.700
3853-3864	II	.800	1.252	1.552	2.052	2.852
3865-3884	III	1.000	1.400	1.700	2.200	3.000

LINE M21T

SP to SP	Ramp Function	Equalization Gate
3885-3903	B	.700-2.200
3904-3989	A	.500-2.000

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
3885-3903	II	.600	1.200	1.500	2.000	2.800
3904-3921	I	.500	1.100	1.400	1.900	2.700
3922-3969	I	.500	1.000	1.300	1.800	2.600
3970-3989	I	.400	.900	1.200	1.700	2.500

LINE M22T

SP to SP	Ramp Function	Equalization Gates
3990-4038	A	.500-2.000
4039-4056	A	.600-2.100
4057-4068	B	.700-2.200
4069-4080	C	1.000-2.500
4081-4092	B	.700-2.200
4093-4104	B	.900-2.400
4105-4110	C	.900-2.400
4111-4122	C	1.100-2.600
4123-4140	D	1.400-2.900
4141-4146	E	1.700-2.900
4147-4152	F	1.700-2.900
4153-4176	G	1.700-2.900

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
3990-4002	I	.400	.900	1.200	1.700	2.500
4003-4020	I	.500	1.000	1.300	1.800	2.600
4021-4038	I	.500	1.100	1.400	1.900	2.700
4039-4056	II	.600	1.200	1.500	2.000	2.800
4057-4068	II	.700	1.300	1.600	2.100	2.900
4069-4080	III	.900	1.300	1.600	2.100	2.900
4081-4098	II	.800	1.300	1.600	2.100	2.900
4099-4110	III	.900	1.400	1.700	2.200	3.000
4111-4122	III	1.000	1.500	1.800	2.300	3.100
4123-4134	IV	1.200	1.652	1.952	2.452	3.252
4135-4146	V	1.400	1.800	2.100	2.600	3.400
4147-4158	VI	1.600	1.900	2.200	2.700	3.500
4159-4176	VI	1.700	2.000	2.300	2.800	3.600

LINE M23T

SP to SP	Ramp Function	Equalization Gates
4956-5022	A	.500-2.000
5023-5040	B	.700-2.200
5041-5052	C	1.000-2.400
5053-5070	D	1.300-2.600
5071-5099	G	1.500-2.800

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
4956-5010	I	.400	.900	1.200	1.700	2.500
5011-5028	II	.600	1.100	1.400	1.900	2.700
5029-5046	III	.800	1.300	1.600	2.100	2.900
5047-5058	III	1.000	1.500	1.800	2.300	3.100
5059-5070	IV	1.200	1.700	2.000	2.500	3.300
5071-5082	V	1.400	1.800	2.100	2.600	3.400
5083-5099	VI	1.600	1.800	2.100	2.600	3.400

LINE M24T

SP to SP	Ramp Function	Equalization Gates
5100-5106	D	1.100-2.600
5107-5118	C	.900-2.400
5119-5130	B	.800-2.300
5131-5154	B	.652-2.152
5155-5171	A	.500-2.000

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
5100-5106	IV	1.200	1.700	2.000	2.500	3.300
5107-5118	III	1.000	1.600	1.900	2.400	3.200
5119-5130	II	.852	1.452	1.752	2.250	3.052
5131-5142	II	.700	1.300	1.600	2.100	2.900
5143-5154	II	.550	1.152	1.452	1.952	2.752
5155-5171	II	.400	1.000	1.300	1.800	2.600

LINE M25T

SP to SP	Ramp Function	Equalization Gates
5172-5190	A	.500-2.000
5191-5208	B	.700-2.200
5209-5220	B	.900-2.400
5221-5236	C	1.100-2.600

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
5172-5190	I	.400	1.100	1.400	1.900	2.700
5191-5208	II	.600	1.252	1.552	2.052	2.852
5209-5220	II	.800	1.400	1.700	2.200	3.000
5221-5236	III	1.000	1.552	1.852	2.352	3.152

LINE M26B

SP to SP	Ramp Function	Equalization Gates
1876-1888	C	1.400-2.800
1889-1900	D	1.500-3.000
1901-1912	E	1.800-3.200
1913-1918	D	1.400-2.900
1919-1948	C	1.000-2.700
1949-2050	B	.700-2.400

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
1876-1882	III	1.000	1.600	1.900	2.300	2.700
1883-1888	III	1.300	1.800	2.100	2.500	2.900
1889-1900	IV	1.500	1.900	2.200	2.600	3.000
1901-1912	VI	1.700	2.000	2.300	2.700	3.100
1913-1918	V	1.300	1.900	2.200	2.600	3.000
1919-1924	IV	1.300	1.900	2.200	2.600	3.000
1925-1948	III	1.000	1.800	2.100	2.500	2.900
1949-1978	II	.800	1.700	2.000	2.400	2.800
1979-2050	II	.700	1.600	1.900	2.300	2.700

LINE M27B

SP to SP	Ramp Function	Equalization Gates
857- 875	C	1.200-2.700
876- 977	B	1.000-2.500

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
857- 875	III	1.000	1.600	1.900	2.300	2.700
876- 911	II	.700	1.400	1.700	2.100	2.500
912-953	II	.800	1.300	1.600	2.000	2.400
954- 971	II	.700	1.252	1.552	1.952	2.352
972- 977	III	.700	1.252	1.552	1.952	2.352

LINE M28B

SP to SP	Ramp Function	Equalization Gates
1685-1757	A	.700-2.200
1758-1787	B	.800-2.300

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
1685-1787	II	.700	1.300	1.600	2.000	2.400

LINE M29B

SP to SP	Ramp Function	Equalization Gates
1789-1875	A	.600-2.100

	TVD	TVF			
		20-60	15-55	10-50	8-40	8-30
1789-1875	I	.500	1.100	1.400	1.800	2.200

LINE M30BT

SP to SP	Ramp Function	Equalization Gates
2261-2375	A	.500-2.000
2376-2393	B	.700-2.200
2394-2451	C	1.000-2.500

	TVD	TVF			
		20-60	15-55	10-50	8-40	8-30
2261-2303	I	.500	1.100	1.400	1.900	2.700
2304-2351	I	.500	1.000	1.300	1.800	2.600
2352-2387	II	.500	1.000	1.300	1.800	2.600
2388-2393	III	.500	1.000	1.300	1.800	2.600
2394-2451	III	.900	1.100	1.400	1.900	2.700

LINE M31BT

SP to SP	Ramp Function	Equalization Gates
1416-1428	B	.700-2.200
1429-1541	A	.500-2.000

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
1416-1428	II	.600	1.000	1.300	1.800	2.600
1429-1446	I	.500	.900	1.200	1.700	2.500
1447-1541	I	.400	.800	1.100	1.600	2.400

LINE M32T

SP to SP	Ramp Function	Equalization Gates
3074-3203	A	.500-2.000

	TVF	TVF				
		20-60	15-55	10-50	8-40	8-30
3074-3158	I	.400	.900	1.100	1.600	2.400
3159-3170	II	.400	.900	1.100	1.600	2.400
3171-3203	I	.400	.900	1.100	1.600	2.400

LINE M33T

SP to SP	Ramp Function	Equalization Gates
3204-3366	A	.500-2.000

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
3204-3210	I	.400	1.000	1.300	1.800	2.600
3211-3228	I	.400	.900	1.200	1.700	2.500
3229-3252	I	.400	.800	1.100	1.600	2.400
3253-3258	I	.400	.700	1.000	1.500	2.300
3259-3264	II	.400	.700	1.000	1.500	2.300
3265-3366	I	.400	.700	1.000	1.500	2.300

LINE M34T

SP to SP	Ramp Function	Equalization Gates
1295-1307	G	1.700-2.900
1308-1325	E	1.600-2.800
1326-1337	D	1.300-2.500
1338-1361	C	1.000-2.200
1362-1391	B	.700-2.200
1392-1415	A	.500-2.000

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
1295-1301	VI	1.700	2.000	2.300	2.800	3.600
1302-1313	VI	1.600	1.852	2.152	2.652	3.452
1314-1325	V	1.400	1.700	2.000	2.500	3.300
1326-1337	IV	1.200	1.552	1.852	2.352	3.152
1338-1355	III	1.000	1.400	1.700	2.200	3.000
1356-1367	III	.800	1.252	1.552	2.052	2.852
1368-1391	II	.700	1.100	1.400	1.900	2.700
1392-1415	II	.700	1.000	1.300	1.800	2.600

LINE M35T

SP to SP	Ramp Function	Equalization Gates
3501-3513	C	.900-2.400
3514-3555	B	.700-2.200
3556-3638	A	.500-2.000

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
3501-3513	III	.900	1.400	1.700	2.200	3.000
3514-3531	II	.700	1.300	1.600	2.100	2.900
3532-3549	II	.600	1.200	1.500	2.000	2.800
3550-3561	II	.500	1.100	1.400	1.900	2.700
3562-3597	I	.500	1.000	1.300	1.800	2.600
3598-3615	I	.400	.900	1.200	1.700	2.500
3616-3638	I	.400	.800	1.100	1.600	2.400

LINE M36T

SP to SP	Ramp Function	Equalization Gates
3367-3500	A	.500-2.000

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
3367-3385	I	.400	.700	1.000	1.500	2.300
3386-3403	I	.400	.800	1.100	1.600	2.400
3404-3469	I	.400	.900	1.200	1.700	2.500
3470-3487	I	.500	1.000	1.300	1.800	2.600
3487-3500	II	.500	1.100	1.400	1.900	2.700

LINE M37T

SP to SP	Ramp Function	Equalization Gates
4643-4729	A	.500-2.000

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
4643-4729	I	.400	.900	1.200	1.700	2.500

LINE M38T

SP to SP	Ramp Function	Equalization Gates
4730-4760	A	.500-2.000
4761-4772	A	.650-2.150
4773-4784	B	.800-2.300
4785-4790	C	1.000-2.500
4791-4796	D	1.200-2.700
4797-4802	E	1.400-2.900
4803-4808	G	1.600-3.100
4809-4828	G	1.800-3.200

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
4730-4736	I	.400	.900	1.200	1.700	2.500
4737-4748	I	.500	1.000	1.300	1.800	2.600
4749-4760	I	.600	1.100	1.400	1.900	2.700
4761-4772	II	.700	1.252	1.552	2.052	2.852
4773-4784	II	.800	1.400	1.700	2.200	3.000
4785-4790	III	1.000	1.552	1.852	2.352	3.152
4791-4796	IV	1.200	1.700	2.000	2.500	3.300
4797-4808	V	1.400	1.800	2.100	2.600	3.400
4809-4828	VI	1.700	1.900	2.200	2.700	3.500

LINE M39T

SP to SP	Ramp Function	Equalization Gates
4829-4847	D	1.600-2.800
4847-4859	C	1.200-2.500
4860-4871	B	.900-2.200
4872-4913	B	.700-2.100
4914-4955	A	.500-2.000

	TVD	TVF			
		20-60	15-55	10-50	8-40	8-30
4829-4841	V	1.500	1.800	2.100	2.600	3.400
4842-4853	IV	1.300	1.600	1.900	2.400	3.200
4854-4865	III	1.000	1.500	1.800	2.300	3.100
4866-4889	II	.700	1.300	1.600	2.100	2.900
4890-4919	II	.600	1.100	1.400	1.900	2.700
4920-4937	I	.500	.952	1.252	1.752	2.552
4938-4955	I	.400	.800	1.100	1.600	2.400

LINE M40T

SP to SP	Ramp Function	Equalization Gates
4407-4642	A	.500-2.000

	TVD	TVF			
		20-60	15-55	10-50	8-40	8-30
4407-4449	I	.400	1.100	1.40	1.900	2.700
4450-4503	I	.400	1.000	1.300	1.800	2.600
4504-4587	I	.400	.900	1.200	1.700	2.500
4588-4641	I	.400	.800	1.100	1.600	2.400

LINE M41T

SP to SP	Ramp Function	Equalization Gates
4177-4267	G	1.500-3.000
4268-4333	H	1.400-2.900
4334-4351	C	1.300-2.800
4352-4406	C	1.200-2.700

	TVD	TVF			
		20-60	15-55	10-50	8-40	8-30
4177-4195	V	1.400	1.800	2.100	2.600	3.400
4196-4243	V	1.500	1.800	2.100	2.600	3.400
4244-4261	V	1.400	1.800	2.100	2.600	3.400
4262-4291	IV	1.400	1.800	2.100	2.600	3.400
4292-4309	IV	1.300	1.700	2.000	2.500	3.300
4310-4327	IV	1.200	1.700	2.000	2.500	3.300
4328-4339	IV	1.100	1.600	1.900	2.400	3.200
4340-4406	III	1.000	1.600	1.900	2.400	3.200

LINE M42A

SP to SP	Ramp Function	Equalization Gates
530- 572	C	Not Applied
573- 608	D	" "
609- 620	E	" "

	TVD	TVF	
		20-60	8-40
530- 542	III	1.800	2.200
543- 578	III	1.700	2.100
579- 620	V	1.600	2.000

LINE M43A

SP to SP	Ramp Function	Equalization Gates
621- 633	C	Not Applied
634- 651	D	" "
652- 651	E	" "
660- 681	F	" "

	TVD	TVF	
		20-60	8-40
621- 645	IV	1.600	2.000
646- 663	V	1.800	2.200
664- 681	V	2.000	2.400

LINE M44B

SP to SP	Ramp Function	Equalization Gates
2051-2057	B	.700-2.400
2058-2175	A	.700-2.400

	TVD	TVF				
		20-60	15-55	10-50	8-40	8-30
2051-2105	II	.700	1.600	1.900	2.300	2.700
2106-2175	I	.600	1.500	1.800	2.200	2.600

LINE M44B Ext.

SP to SP	Ramp Function	Equalization Gates
5237-5303	A	.700-2.400
5304-5334	A-1	.700-2.400

	TVD	TVF			
		20-60	15-55	10-50	8-40	8-30
5237-5261	I	.600	1.400	1.700	2.100	2.500
5262-5273	I	.600	1.300	1.600	2.000	2.400
5274-5285	I	.600	1.200	1.500	1.900	2.300
5286-5297	I	.600	1.100	1.400	1.800	2.200
5298-5334	I	.600	1.000	1.300	1.700	2.100

LINE M45A

SP to SP	Ramp Function	Equalization Gates
5439-5515	B	.800-2.200

	TVD	TVF	
		20-60	8-40
5439-5515	II	1.500	2.000

LINE M46A

SP to SP	Ramp Function	Equalization Gates	
5335-5395	C	1.000-2.400	
	TVD	TVF	
		20-60	8-40
5335-5395	II	1.500	2.000

LINE M47A

SP to SP	Ramp Function	Equalization Gates	
5517-5535	B	.800-2.200	
5536-5553	C	1.000-2.400	
	TVD	TVF	
		20-60	8-40
5517-5529	II	1.500	2.000
5530-5541	III	1.600	2.100
5542-5553	III	1.700	2.200

LINE M48A

SP to SP	Ramp Function	Equalization Gates	
5399-5417	C	1.000-2.400	
5418-5435	B	.800-2.200	
	TVD	TVF	
		20-60	8-40
5399-5411	III	1.600	2.200
5412-5423	III	1.600	2.100
5424-5435	II	1.500	2.000

APPENDIX D

VELOCITY FUNCTION A

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	100% Processing SP to SP	1200% Processing Line	1200% Processing SP to SP
0	7400	M1A	354- 389	M1A	354- 389
1.250	10900	M2A	281- 315	M2A	290- 313
1.850	11000				
2.500	11500				
4.254	14423				

VELOCITY FUNCTION AA

0	7000	M44B 5303X-5334 ext.	
.300	7546		
.530	8264		
.760	8804		
1.040	8853		
1.150	8949		
1.700	9730		
4.254	13612		

VELOCITY FUNCTION AA-1

0	7200		M44B 5303X-5334 ext.
.300	7800		
.530	8518		
.760	9058		
1.000	9099		
1.080	9181		
1.330	9891		
4.254	13985		

VELOCITY FUNCTION B

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	100% Processing SP to SP	1200% Processing Line	1200% Processing SP to SP
0	7400	M1A	390- 445	M1A	390- 456
1.500	10640	M3A	739- 755	M3A	739- 768
2.100	10960	M45A	5489-5516		
4.254	14406	M46A	5335-5365		
		M47A	5541-5556		

VELOCITY FUNCTION B-1

0	7100			M1A	457- 480
1.000	9350				
2.100	10700				
4.000	13900				

VELOCITY FUNCTION B-2

0	7400			M3A	769- 792
1.500	11000				
2.100	11300				
4.000	14000				

VELOCITY FUNCTION B-3

0	7200	M45A	5466-5488
1.000	9450	M46A	5366-5385
1.310	10014	M47A	5517-5540
1.730	10179	M47A	5399-5420
4.254	14418		

VELOCITY FUNCTION B-4

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6000			M47A	5530-5541
1.000	9320				
1.400	9480				
4.254	14332				

VELOCITY FUNCTION B-5

0	6600			M46A	5366-5383
.750	9105			M48A	5399-5417
1.050	9237				
4.254	14684				

VELOCITY FUNCTION B-6

0	7300			M47A	5536-5541
1.000	9460				
1.400	9572				
4.254	14424				

VELOCITY FUNCTION B-7

0	6600			M46A	5335-5365
.980	10030			M47A	5542-5556
1.540	10265				
4.254	14879				

VELOCITY FUNCTION BB

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6400	M44B ext.	5274-5303		
.350	7187				
.600	8080				
1.100	9600				
1.500	9704				
2.100	10394				
4.254	13668				

VELOCITY FUNCTION BB-1

0	6400			M44B ext.	5274-5303
.350	7205				
.600	8105				
1.100	9605				
1.500	9865				
2.100	10585				
4.254	13816				

VELOCITY FUNCTION C

0	6500	M1A	446- 492
.750	8000	M4A	716- 738
.900	8800		
1.300	8850		
1.850	9200		
4.254	13784		

APPENDIX D

VELOCITY FUNCTION D

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6800	M1A	493- 529	M1A	481- 529
.400	7500	M42A	530- 548	M4A	684- 738
.950	9060	M45A	5439-5465	M42A	530- 620
1.500	9220	M46A	5386-5398	M43A	621- 662
4.254	14375	M48A	5421-5438		

VELOCITY FUNCTION D-1

0	6400			M46A	5384-5398
.400	7500				
.820	9180				
1.750	10091				
4.254	14348				

VELOCITY FUNCTION D-2

0	6200			M45A	5439-5516
1.000	9240			M47A	5517-5529
1.500	9710			M48A	5418-5438
4.254	14392				

VELOCITY FUNCTION DD

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6800	M39T	4829-4865	M23T	5071-5082
.400	7480	M41T	4201-4270	M39T	4829-4841
.640	7811			M41T	4202-4249
.900	8066				
1.300	8730				
1.550	9393				
4.254	12962				

VELOCITY FUNCTION DD-1

0	6600			M39T	4842-4853
1.000	9000				
1.300	9495				
1.800	10030				
4.254	13318				

VELOCITY FUNCTION E

0	6200	M42A	549- 620
.400	7100	M43A	621- 683
.700	8060		
1.100	8240		
2.450	10200		
4.254	13515		

VELOCITY FUNCTION E-1

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6000			M43A	663- 683
.750	7400				
1.200	7700				
4.254	12390				

VELOCITY FUNCTION EE

0	7000	M23T	5066-5099	M24T	5100-5118
.415	7830	M24T	5100-5118	M41T	4250-4393
.600	8478	M25T	5215-5236		
.800	9078	M41T	4271-4406		
1.040	9668				
1.550	9964				
1.900	10307				
4.254	13414				

VELOCITY FUNCTION EE-1

0	6000			M23T	5083-5099
.600	7092				
1.100	7342				
2.300	10102				
4.254	12759				

VELOCITY FUNCTION F

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	7400	M2A	259- 280	M2A	259- 289
1.050	10380	M5B	236- 271	M5A	236- 271
1.560	10420				
4.254	14373				

VELOCITY FUNCTION FF

0	7600	M23T	5035-5065	M23T	5035-5070
.700	9980	M24T	5119-5148		
1.350	10052				
1.600	10509				
4.254	14039				

VELOCITY FUNCTION FF-1

0	6800			M24T	5119-5148
1.100	9792				
1.650	10001				
4.254	13438				

VELOCITY FUNCTION G

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	100% Processing SP to SP	1200% Processing Line	1200% Processing SP to SP
0	6800	M2A	332- 353	M2A	316- 353
1.000	9000				
1.300	9460				
1.550	9500				
1.700	9660				
1.900	10160				
4.254	14576				

VELOCITY FUNCTION G-1

0	7100			M2A	314- 331
1.300	10100				
1.850	10500				
4.254	14413				

VELOCITY FUNCTION GG

0	7000	M20T	3817-3858
1.150	9300	M22T	3990-4032
1.800	9736	M23T	4956-5034
4.254	13343	M40T	4516-4587

VELOCITY FUNCTION GG-1

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6500			M22T	3990-4032
.600	7790			M23T	4993-5034
1.150	9253			M40T	4510-4557
1.800	9689				
4.254	13296				

VELOCITY FUNCTION H

0	7400	M3A	756- 792		
1.100	10560				
1.900	10640				
4.254	14406				

VELOCITY FUNCTION HH

0	7000	M21T	3885-3989	M22T	4033-4050
1.000	9420	M22T	4033-4110	M22T	4081-4110
1.300	9780	M37T	4716-4729	M38T	4761-4784
1.800	9965	M38T	4730-4785	M40T	4462-4509
4.254	13499	M39T	4866-4931		
		M40T	4588-4611		

VELOCITY FUNCTION HH-1

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6700			M21T	3892-3957
1.200	9772			M36T	3494-3500
1.950	10057			M38T	4737-4760
4.254	12914			M39T	4908-4931

VELOCITY FUNCTION HH-2

0	6400			M22T	4051-4080
1.000	9760			M39T	4854-4907
1.500	9925				
4.254	13368				

VELOCITY FUNCTION I

0	7000	M4A	684- 715
.400	7600		
.950	8600		
1.200	8660		
1.850	9200		
2.500	9900		
4.254	13174		

VELOCITY FUNCTION J

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6000	M5B	1- 61	M5B	1- 61
.600	8800	M26B	1913-2008	M26B	1913-2008
1.250	11075	M44B	2051-2175	M44B	2051-2175
1.500	11463				
2.100	11565				
4.254	14796				

VELOCITY FUNCTION J-1

0	5800	M44B ext.	5237-5273	M26B	2039-2050
.400	6800			M44B ext.	5237-5273
.700	8042				
1.250	9967				
1.500	10355				
2.100	10456				
4.254	13687				

VELOCITY FUNCTION JJ

0	6800	M19T	3664-3687
.770	8594	M19T	3716-3749
1.100	9861	M24T	5149-5171
1.300	10491	M37T	4643-4697
1.800	11531		
4.254	14378		

VELOCITY FUNCTION K

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6200	M26B	2009-2050		
.600	8060				
1.250	10660				
1.450	10900				
2.300	10900				
4.254	13831				

VELOCITY FUNCTION K-1

0	6000			M26B	2009-2038
.400	7132				
.700	8470				
1.250	10395				
1.500	10707				
2.200	10826				
4.254	13907				

VELOCITY FUNCTION KK

0	6700	M20T	3750-3792
.550	8020	M37T	4698-4715
1.300	9325	M39T	4932-4955
2.000	11005	M40T	4612-4642
4.254	13710		

VELOCITY FUNCTION KK-1

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	7000			M20T	3750-3792
1.100	8485			M21T	3958-3989
1.600	9485			M23T	4956-4992
4.254	13068			M37T	4704-4715
				M39T	4932-4955
				M40T	4558-4642

VELOCITY FUNCTION L

0	5600	M27B	918- 953
1.680	9760		
2.240	10024		
4.254	13045		

VELOCITY FUNCTION LL

0	7000	M40T	4474-4515	M24T	5149-5171
1.200	10240			M25T	5214-5233
1.800	10498			M40T	4432-4461
4.254	13615			M41T	4394-4406

VELOCITY FUNCTION M

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	5600	M6B	793- 856	M6B	793- 813
1.350	8948	M26B	1901-1912	M26B	1907-1912
1.900	9130	M27B	857- 917		
4.254	12661	M27B	954- 977		

VELOCITY FUNCTION N

0	5600	M7B	1607-1625	M7B	1607-1631
.900	7535	M26B	1876-1900	M26B	1876-1906
1.600	8669				
2.200	8981				
4.254	12062				

VELOCITY FUNCTION O

0	7000	M8B	1567-1596
.800	8664	M10B	1014-1032
1.800	10591	M11B	1167-1191
4.254	13462	M14T	2810-2846
		M15T	2781-2809
		M18T	2452-2494
		M28B	1704-1733
		M28B	1764-1787
		M30B	2274-2291
		M30B	2346-2451

VELOCITY FUNCTION O-1

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6200			M28B	1764-1787
1.100	8906				
1.700	9344				
4.254	12766				

VELOCITY FUNCTION O-2

0	6500			M14T	2810-2834
1.000	8800			M15T	2764-2809
2.000	10400			M16T	2618-2642
4.254	13420			M17T	2580-2617
				M18T	2507-2554
				M30B	2364-2417
				M31B	1416-1436
				M32T	3159-3203
				M33T	3211-3270
				M36T	3367-3385

VELOCITY FUNCTION O-3

0	6700			M18T	2452-2506
.700	8436			M30B	2418-2451
2.000	10516			M33T	3204-3210
4.254	13536			M34T	1398-1415

VELOCITY FUNCTION P

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	7000	M10B	996-1014		
1.100	9585	M11B	1131-1148		
2.000	11178	M12B	2988-3006		
4.254	14018	M13T	2972-2987		
		M29B	1788-1801		
		M29B	1820-1837		
		M30B	2292-2309		
		M30B	2334-2345		

VELOCITY FUNCTION Q

0	6000	M7B	1626-1684
1.250	8900	M8B	1542-1566
1.850	9122	M8B	1597-1606
4.254	12367	M9B	2176-2260
		M10B	1032-1081
		M11B	1082-1118
		M12B	3049-3073
		M13T	2905-2941
		M14T	2883-2904
		M15T	2696-2744
		M16T	2649-2695
		M17T	2555-2585
		M28B	1685-1703
		M29B	1836-1875
		M31B	1513-1541
		M32T	3074-3152
		M33T	3271-3366

VELOCITY FUNCTION Q-1

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6000			M28B	1685-1715
1.250	9075				
1 800	9311				
4.254	12599				

VELOCITY FUNCTION Q-2

0	6000			M8B	1542-1590
1.100	8475			M9B	2189-2260
1.300	8827			M29B	1788-1875
1.800	8987				
4.254	12275				

VELOCITY FUNCTION Q-3

0	5600			M9B	2176-2188
.500	6400			M27B	942-977
1.300	8640				
1.800	8955				
4.254	12292				

VELOCITY FUNCTION Q-4

0	5600			M6B	814- 856
1.300	8824			M8B	1591-1606
1.800	9014			M27B	857- 887
4.254	12351			M27B	924- 941

VELOCITY FUNCTION Q-5

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6000			M7	1632-1684
.500	7410			M27	888- 923
1.200	8992				
1.850	9304				
4.254	12910				

VELOCITY FUNCTION Q-6

0	6000	M10B	1033-1081
.800	7504	M11B	1082-1118
1.200	8424	M31B	1507-1541
4.254	12333		

VELOCITY FUNCTION Q-7

0	6000	M12B	3037-3073
1.250	8900	M13T	2905-2923
4.254	13105	M14T	2835-2904
		M15T	2696-2763
		M16T	2643-2695
		M17T	2555-2579
		M30B	2346-2363
		M31B	1437-1470
		M32T	3093-3158
		M33T	3271-3318

VELOCITY FUNCTION R

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6000	M10B	978- 996	M10B	997-1032
1.300	8795	M11B	1149-1166	M11B	1119-1148
1.900	9581	M12B	3007-3018	M12B	2988-3036
2.700	10877	M28B	1734-1763	M13T	2924-2987
4.254	12990	M29B	1802-1819	M30B	2261-2345
		M30B	2261-2273	M31B	1471-1506
		M30B	2310-2333	M32T	3074-3092
				M33T	3319-3366

VELOCITY FUNCTION R-1

0	6000			M28B	1716-1763
.700	7722				
1.300	8712				
1.800	8947				
4.254	12235				

VELOCITY FUNCTION R-2

0	6000			M10B	978- 996
.900	8178				
2.700	10914				
4.254	13011				

VELOCITY FUNCTION R-3

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6000			M11B	1149-1191
.500	6975				
1.000	8015				
1.400	8935				
1.750	9323				
2.200	10372				
4.254	13001				

VELOCITY FUNCTION S

0	6000	M5B	62- 235		
.970	7552				
1.380	9098				
1.490	9378				
1.690	9554				
1.920	9959				
4.254	13460				

VELOCITY FUNCTION S-1

0	5600			M5B	98 - 181
.970	7520				
1.380	9066				
1.490	9347				
1.690	9523				
1.920	9928				
4.254	13428				

VELOCITY FUNCTION S-2

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	5800			M5B	62- 97
.780	7625				
1.340	9585				
1.550	9870				
2.150	10315				
4.254	13471				

VELOCITY FUNCTION S-3

0	6150			M5B	182- 199
.850	7969				
1.350	9569				
1.650	9773				
4.254	13679				

VELOCITY FUNCTION S-4

0	6560			M5B	200- 217
.750	8307				
1.250	9852				
1.600	9982				
4.254	13963				

VELOCITY FUNCTION S-5

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	7000			M5B	218- 235
.650	8638				
1.150	10098				
1.600	10210				
4.254	14191				

VELOCITY FUNCTION T

0	6800	M11B	1119-1130
1.000	9100	M12B	3019-3048
1.300	9406	M13T	2942-2971
1.900	9718	M14T	2847-2882
4.254	12731	M15T	2745-2780
		M16T	2618-2648
		M17T	2586-2617
		M18T	2495-2554
		M31B	1416-1512
		M32T	3153-3203
		M33T	3204-3270
		M34T	1398-1415
		M35T	3580-3638

VELOCITY FUNCTION U

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	7000	M35T	3501-3531		
.800	9736				
1.000	9850				
1.850	10080				
4.254	12652				

VELOCITY FUNCTION U-1

0	7000			M21T	3885-3891
.800	9688			M35T	3501-3537
1.300	9873				
2.500	11793				
4.254	13547				

VELOCITY FUNCTION V

0	7100	M35T	3532-3579
.800	10028		
1.600	10364		
4.254	13230		

VELOCITY FUNCTION V-1

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6800			M35T	3538-3579
1.000	10070				
1.750	10625				
4.254	13379				

VELOCITY FUNCTION W

0	7100	M25T	5170-5214	M25T	5191-5214
.800	10044	M40T	4407-4473		
1.100	10923				
1.750	11027				
4.254	13781				

VELOCITY FUNCTION W-1

0	7000			M25T	5170-5190
1.100	10454			M40T	4407-4473
1.800	10769				
4.254	13714				

VELOCITY FUNCTION X

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	8000	M22T	4136-4176	M34T	1326-1349
.600	9716	M34T	1295-1343		
1.200	9848				
2.200	12348				
4.254	14874				

VELOCITY FUNCTION X-1

0	5000			M22T	4147-4176
1.000	7000			M34T	1295-1325
2.750	11095			M35T	3580-3638
4.254	13231			M38T	4806-4828

VELOCITY FUNCTION X-2

0	7600			M22T	4135-4246
.400	8720				
1.000	8888				
4.254	13639				

VELOCITY FUNCTION Y

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	7600	M19T	3639-3663	M38T	4785-4805
.500	8575	M20T	3859-3884	M41T	4177-4201
.900	9735	M22T	4111-4135		
1.400	9735	M34T	1344-1397		
1.800	9863	M38T	4786-4828		
2.200	10179	M41T	4177-4200		
4.254	12890				

VELOCITY FUNCTION Y-1

0	7000			M19T	3639-3663
.500	8180			M20T	3823-3884
1.000	9640			M34T	1350-1397
1.600	9778				
4.254	13069				

VELOCITY FUNCTION Y-2

0	7000			M22T	4111-4134
.500	8350				
.900	9718				
1.600	9795				
4.254	13670				

VELOCITY FUNCTION Z

Time in Seconds	Average Velocity in Ft. Per Sec.	100% Processing Line	SP to SP	1200% Processing Line	SP to SP
0	6800	M19T	3688-3715		
.800	8688	M20T	3793-3816		
1.400	10458	M36T	3367-3500		
2.050	11524				
4.254	14081				

VELOCITY FUNCTION Z-1

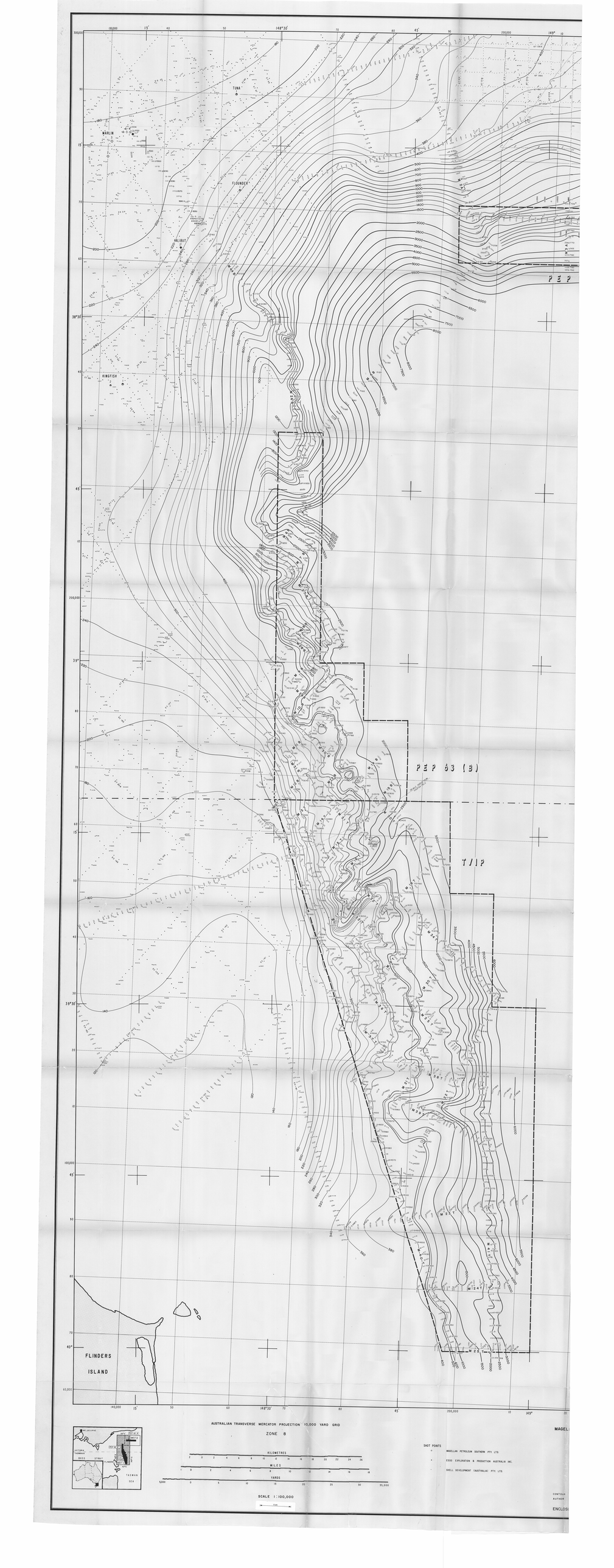
0	6600			M19T	3664-3749
.820	8552			M20T	3793-3822
1.300	9944			M36T	3386-3493
4.254	13577			M37T	4643-4703
				M37T	4716-4729
				M38T	4730-4736

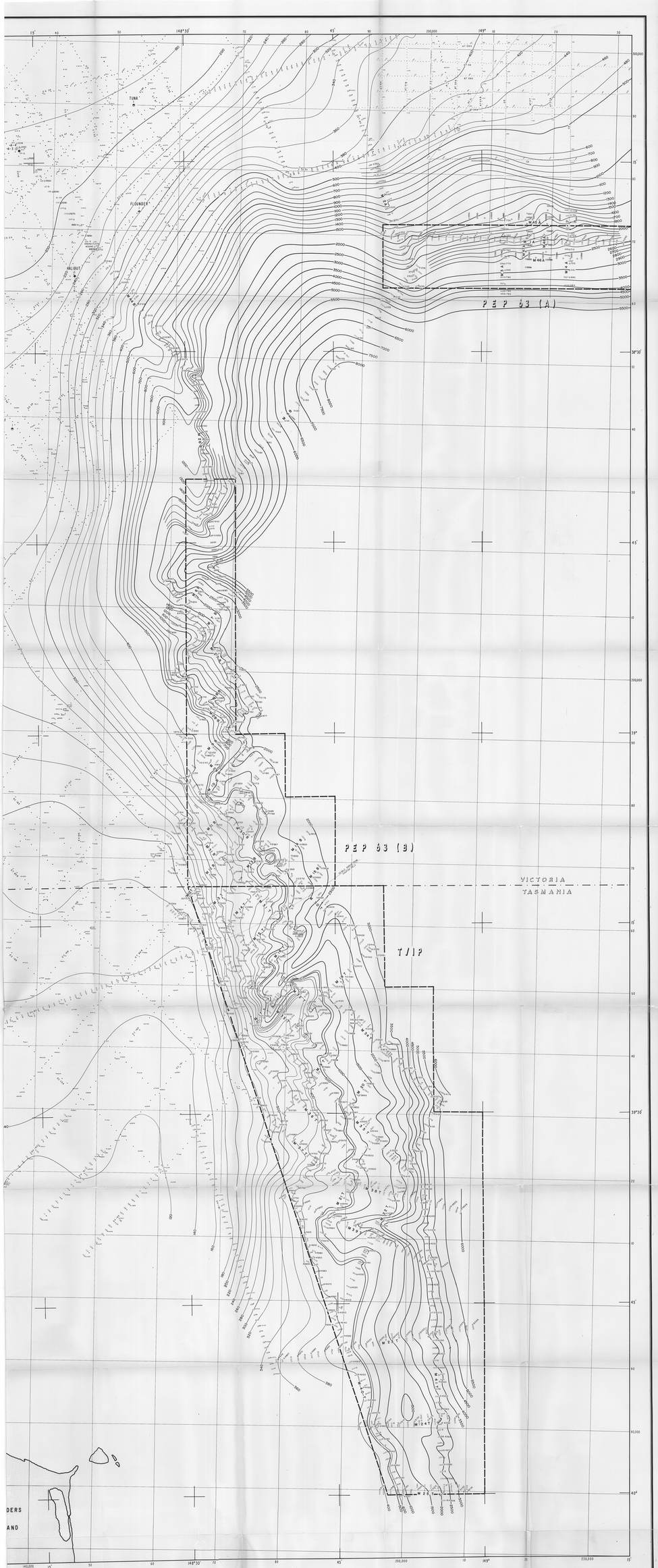
APPENDIX E

LOCATION OF MOVEOUT SCANS

Line No.	Shotpoint	Line No.	Shotpoint
M1A	367	M26B	2030
M1A	397	M27B	882
M1A	460	M27B	900
M2A	271	M27B	942
M2A	346	M27B	965
M3A	775	M28B	1691
M4A	700	M28B	1719
M42A	530	M28B	1753
M42A	583	M28B	1780
M5B	17	M29B	1793
M5B	152	M29B	1809
M6B	810	M29B	1828
M9B	2208	M29B	1850
M10B	1075	M29B	1869
M13B	2981	M30B	2267
M14B	2838	M30B	2281
M26B	1888	M30B	2300
M26B	1975	M30B	2323

Line No.	Shotpoint	Line No.	Shotpoint
M30B	2377	M33T	3239
M44B	2087	M33T	3291
M44B	2130	M33T	3360
M44B	2170	M34T	1330
M44B Ext.	5328	M34T	1376
M13T	2922	M35T	3561
M14T	2867	M35T	3595
M17T	2567	M35T	3631
M22T	4057	M36T	3390
M22T	4115	M36T	3404
M23T	4960	M37T	4669
M23T	5003	M38T	4742
M23T	5060	M39T	4946
M24T	5128	M40T	4419
M30T	2445	M40T	4490
M32T	3133	M40T	4591
M32T	3189	M41T	4241
M33T	3206	M41T	4320
		M41T	4375


MARLIN
TUNA
FLOUNDER
HALIBUT
KINGFISH
PEP
PEP 63 (B)
T/1P
FLINDERS
ISLAND
AUSTRALIAN TRANSVERSE MERCATOR PROJECTION 10,000 YARD GRID
ZONE 8
KILOMETRES
MILES
YARDS
SCALE 1:100,000
SHOT POINTS
MAGELLAN PETROLEUM SOUTHERN PTY. LTD.
ESSO EXPLORATION & PRODUCTION AUSTRALIA INC.
SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
MAGEL
CONTOUR
AUTHOR
ENCLOS





AUSTRALIAN TRANSVERSE MERCATOR PROJECTION 10,000 YARD GRID

ZONE 8

KILOMETRES

MILES

YARDS

SCALE 1:100,000

SHOT POINTS

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MARINE SEISMIC SURVEY

EAST GIPPSLAND BASIN AREA

069545

WATER DEPTHS

CONTOUR INTERVAL 20, 100, 500 FEET

AUTHOR K. GRAHAM, GEOPHYSICAL SERVICE INTERNATIONAL

DATUM SEA LEVEL

DATE JUNE 1969

ENCLOSURE 1

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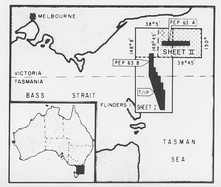

AUSTRALIAN TRANSVERSE MERCATOR PROJECTION 10,000 YARD GRID

ZONE 8

SHOT POINTS

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MARINE SEISMIC SURVEY

EAST GIPPSLAND BASIN AREA

WATER DEPTHS

CONTOUR INTERVAL 20, 100, 500 FEET — DATUM SEA LEVEL

AUTHOR K. GRAYBILL, GEOPHYSICAL SERVICE INTERNATIONAL — DATE JUNE 1969

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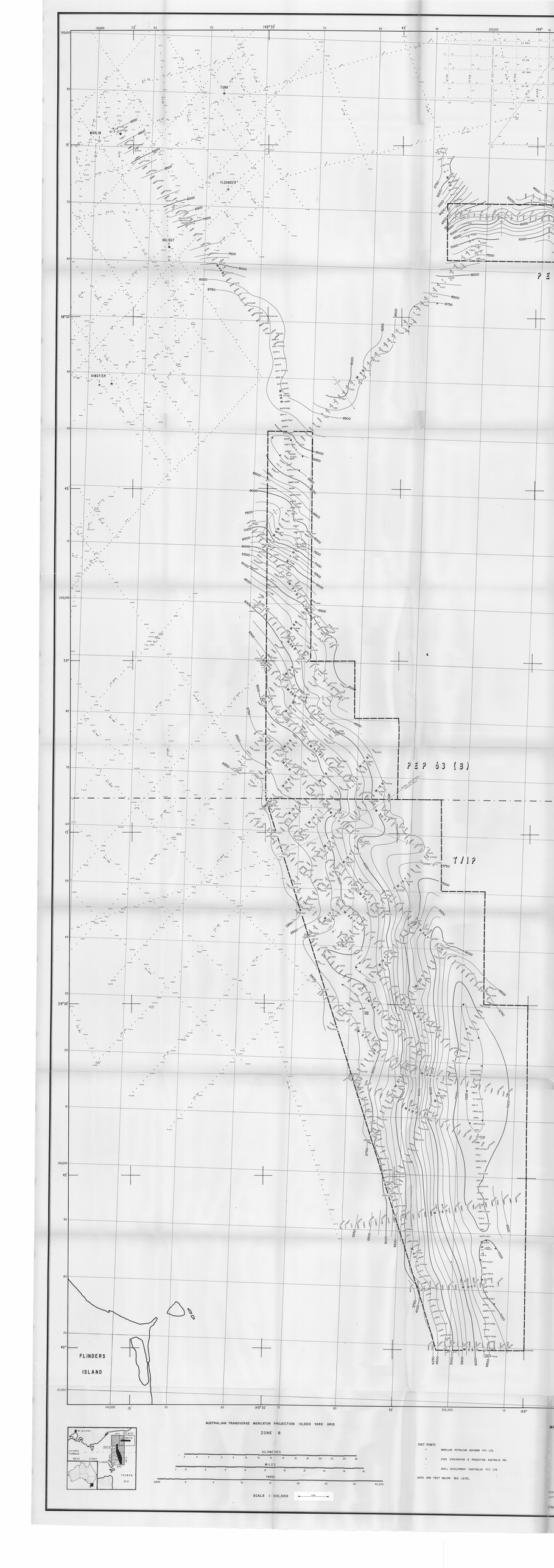
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MARLIN
FLOUNDER
HALIBUT
KINGFISH
PEP 63 (B)
T/1P
FLINDERS
ISLAND
AUSTRALIAN TRANSVERSE MERCATOR PROJECTION 10,000 YARD GRID
ZONE 8
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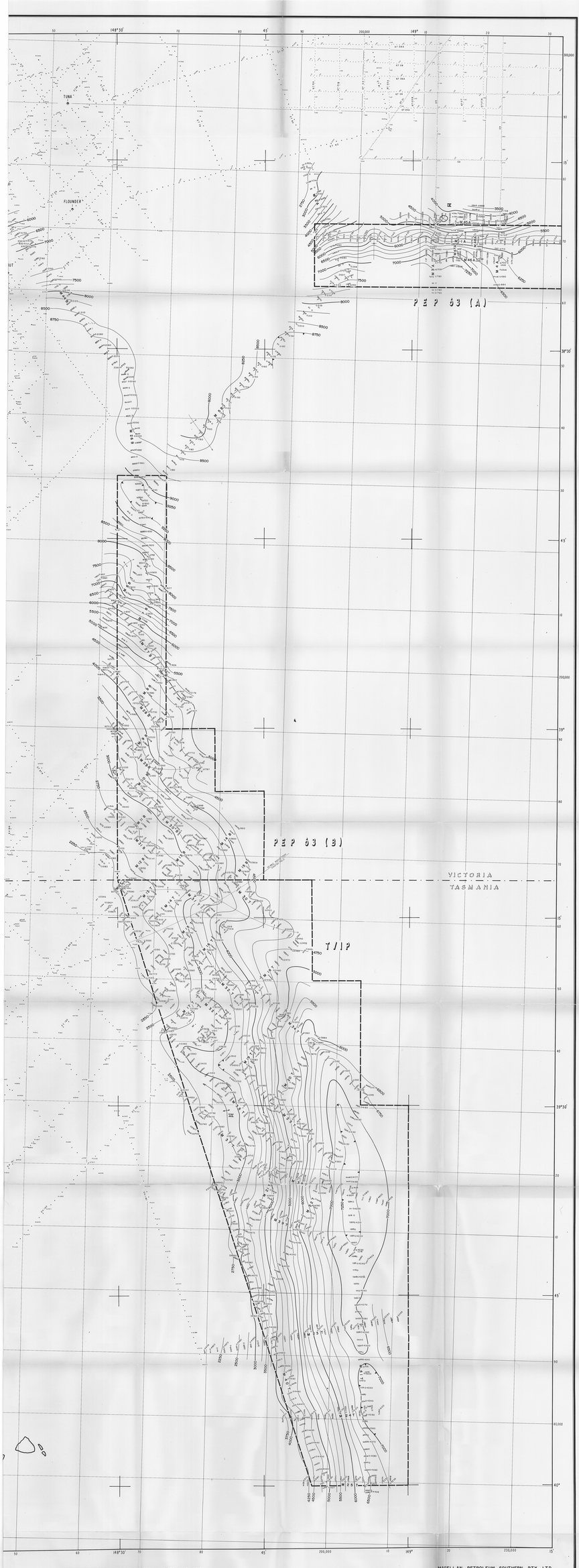

AUSTRALIAN TRANSVERSE MERCATOR PROJECTION 10,000 YARD GRID

ZONE 8

KILOMETRES

MILES

YARDS

SCALE 1:100,000

SHOT POINTS

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MARINE SEISMIC SURVEY

EAST GIPPSLAND BASIN AREA

HORIZON A

(WITHIN MIOCENE)

CONTOUR INTERVAL 250 FEET — DATUM SEA LEVEL

AUTHOR K. GRAFBILL, GEOPHYSICAL SERVICE INTERNATIONAL — DATE JUNE 1969

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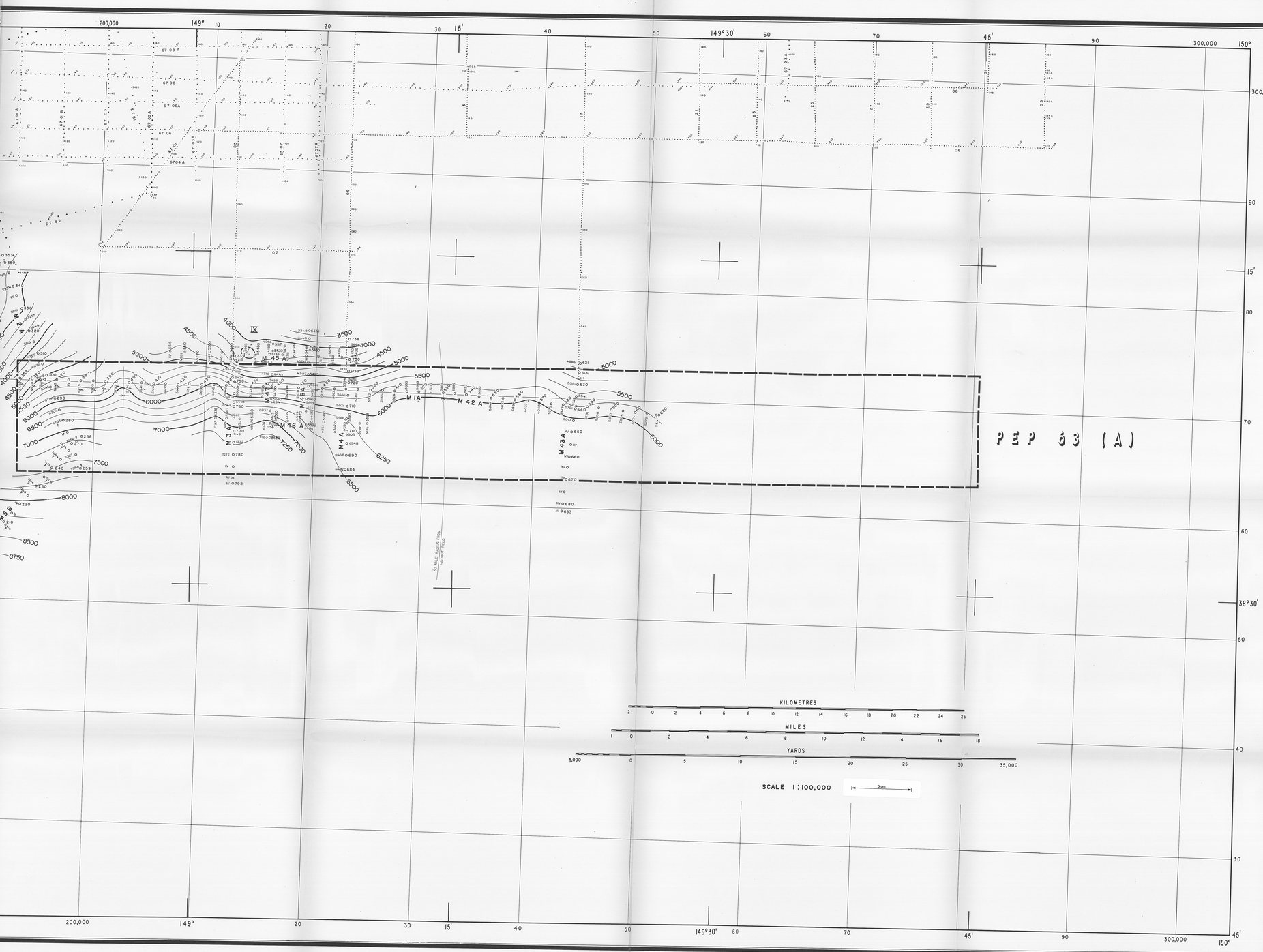

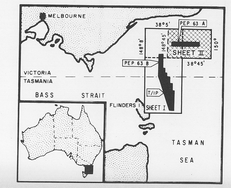

AUSTRALIAN TRANSVERSE MERCATOR PROJECTION 10,000 YARD GRID

ZONE 8

SHOT POINTS

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MARINE SEISMIC SURVEY

EAST GIPPSLAND BASIN AREA

HORIZON A

(WITHIN MIOCENE)

069151

CONTOUR INTERVAL 250 FEET

DATUM SEA LEVEL

AUTHOR K. GRAYBILL
GEOPHYSICAL SERVICE INTERNATIONAL

DATE JUNE 1969

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SHEET II

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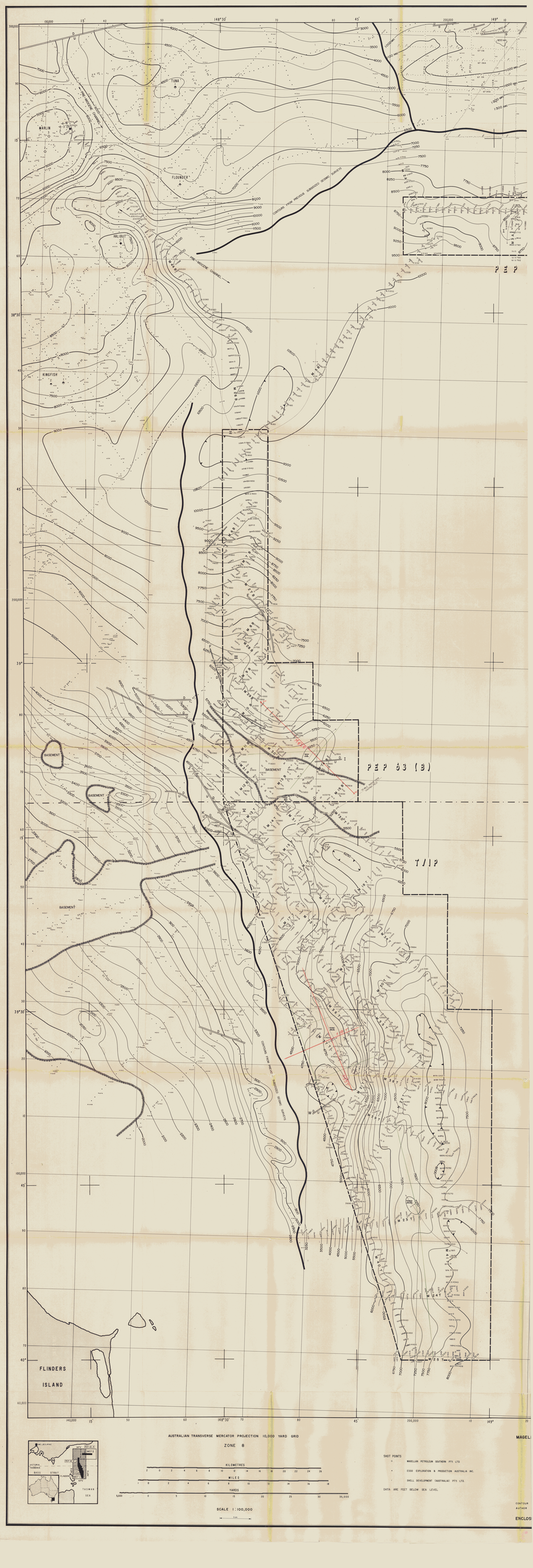
MARLIN
TUNA
FLOUNDER
HALIBUT
KINGFISH
PEP
PEP 63 (B)
T/1P
BASEMENT
FLINDERS
ISLAND
AUSTRALIAN TRANSVERSE MERCATOR PROJECTION 10,000 YARD GRID
ZONE 8
KILOMETRES
MILES
YARDS
SCALE 1:100,000
SHOT POINTS
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ESSO EXPLORATION & PRODUCTION AUSTRALIA INC.
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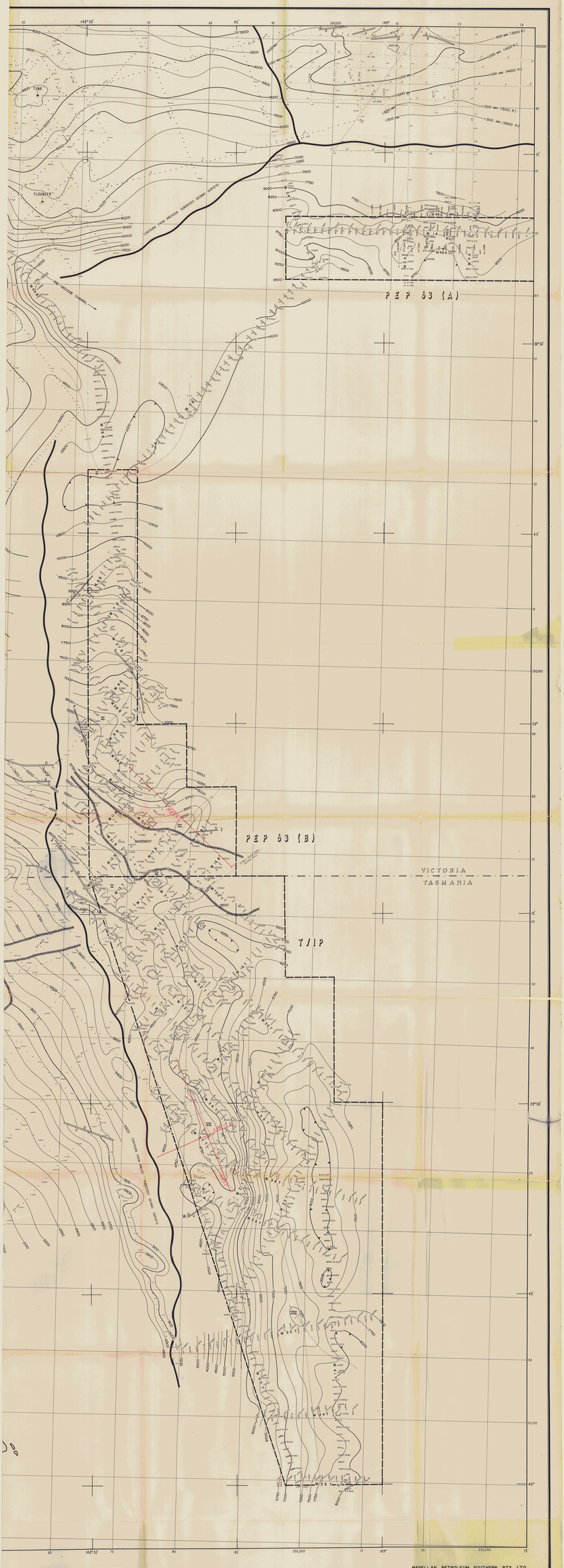

AUSTRALIAN TRANSVERSE MERCATOR PROJECTION 10,000 YARD GRID

ZONE 8

KILOMETRES

MILES

YARDS

SCALE 1:100,000

SHOT POINTS

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MARINE SEISMIC SURVEY

EAST GIPPSLAND BASIN AREA

HORIZON B

(TOP LATROBE COMPLEX)

CONTOUR INTERVAL 250 FEET DATUM SEA LEVEL

AUTHOR K. GRIBBELL DATE JUNE 1989

GEOPHYSICAL SERVICE INTERNATIONAL

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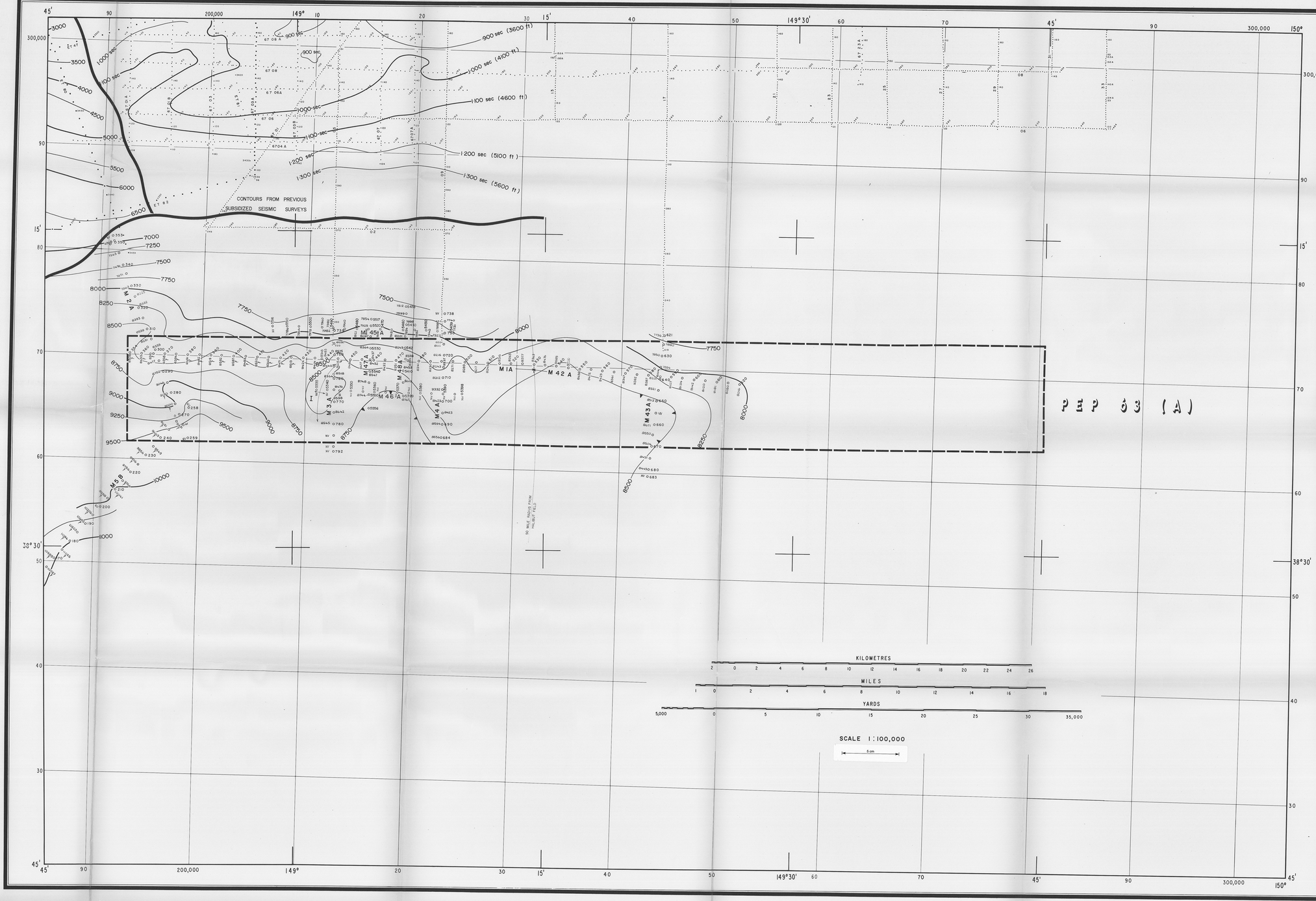

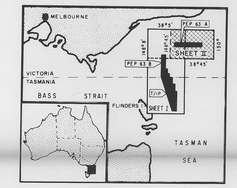

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