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Offshore Area part-III*

MAGELLAN PETROLEUM SOUTHERN PROPRIETARY LIMITED

AIRBORNE MAGNETOMETER SURVEY

EASTERN AND WESTERN BASS STRAIT

PART I

OPERATIONAL REPORT

AERO SERVICE LIMITED

PART II

INTERPRETATION

GEOPHYSICAL ASSOCIATES PTY. LTD.

JANUARY 1968

038002

PART I

OPERATIONAL REPORT

AIRBORNE MAGNETOMETER SURVEY

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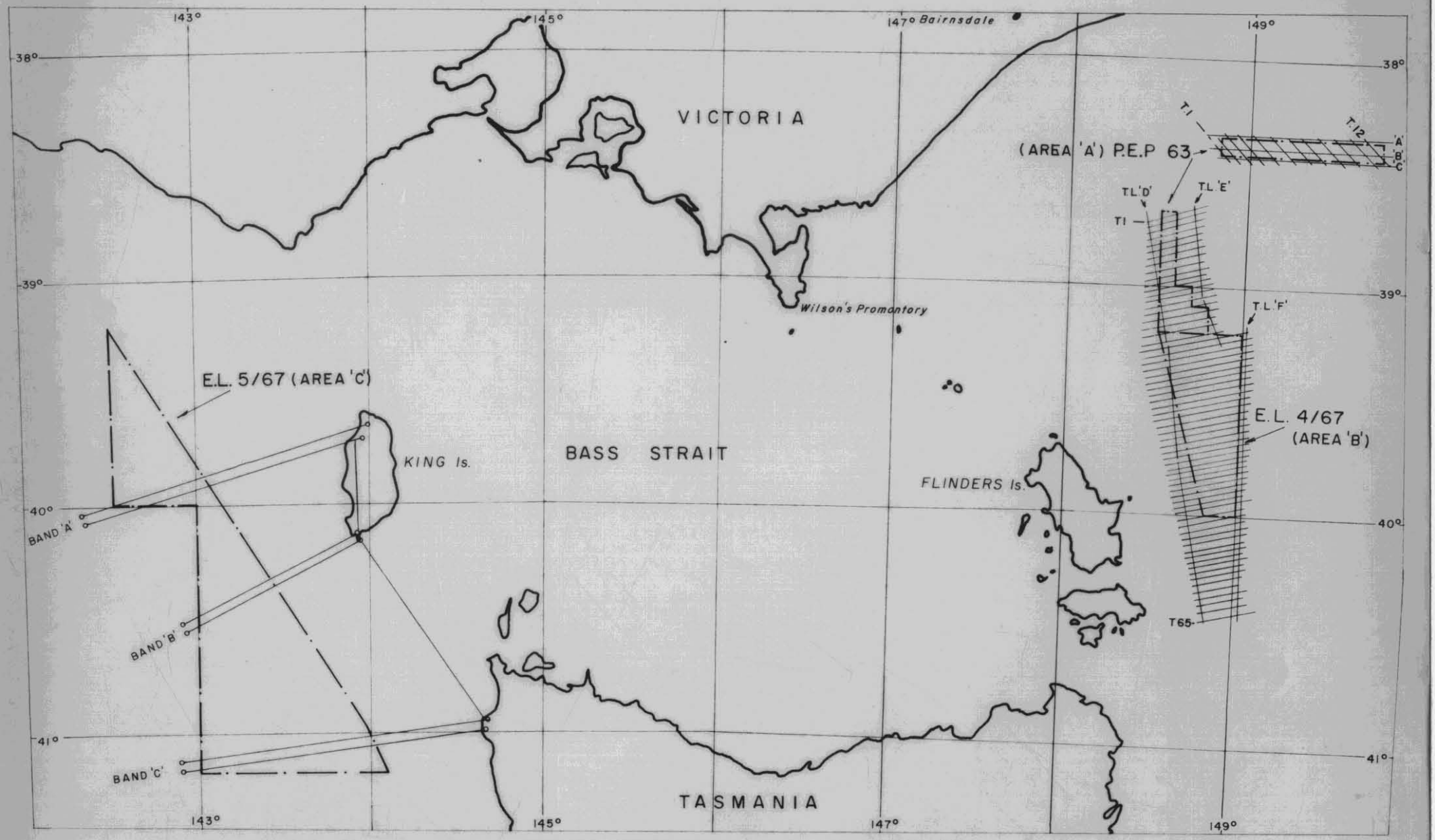

-FLIGHT LINE INDEX MAP-

038004

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I STATISTICS

CLIENT:	Magellan Petroleum Southern Proprietary Limited
CONTRACTOR:	Aero Service Limited
COMMENCEMENT OF FLYING:	31st August 1967
COMPLETION OF FLYING:	23rd October 1967
AIRCRAFT:	Aero Commander Model 680F Registration VH-MJJ
AIRCRAFT BASES:	King Island Bairnsdale Flinders Island
DAYS ON PROJECT:	33 (Flying operation days only - not including Raydist mob and demob time)
PRODUCTION DAYS:	13
TIME LOST:	
WEATHER	1
DIURNAL	2
INSTRUMENT MAINTENANCE	10 (Includes fitment of Raydist and erection of stations)
AIRCRAFT MAINTENANCE	3
FERRY	4
FLIGHT ALTITUDE:	1000 feet above sea level
MAGNETOMETER:	Gulf Mark 111 continuous recording Total Field Flux-gate magnetometer
RECORDER:	Gulf 7-1 ten (10) inch
CAMERA:	Aeropath AS-5 continuous strip 35mm camera

TERRAIN CLEARANCE CONTROL:	APN-1 radio altimeter
NAVIGATION AIDS:	Area A and B - Transistorised miniaturised Raydist type DR. Area C - GPL Doppler and Kearfott N-1 compass
MILEAGE FLOWN:	2070
CREW:	Pilot - Captain A.E. McKenzie Electronics Engineer - Mr. W. Clark Geophysical Data Technician - Mr. J. Boyd Raydist Operator/Technicians - Mr. C. Simpson, Mr. R. McFadyen, Mr. D. Vaughn Field Party - Mr. W. Shields - Manager; - Mr. B. Izard - Assistant

II FIELD CREW

Project Manager/Pilot: Captain A.E. McKenzie

Captain A.E. McKenzie was responsible for the co-ordination of all operations necessary to complete the project. In addition to his responsibilities as Project Manager the Aero Commander VH-MJJ was in his command along with the entire flying phase of the project. An ex RAAF pilot Captain McKenzie has approximately 9,500 flying hours and has spent the last eleven years continuously engaged in airborne survey.

Electronics Engineer: Mr. W. Clark

Mr. W. Clark was responsible for operation and maintenance of the electronic instrumentation in the aircraft and on the ground necessary for production of the magnetic data.

Data Control: Mr. J. Boyd

Mr. J. Boyd was responsible for the quality and assembly of the data recorded.

In addition to the above Mr. Boyd's duties included checking of the magnetic storm monitor to ensure that production was not being attempted during periods of magnetic disturbance in excess of the specified limitations.

Raydist Operator Technicians: Mr. C. Simpson
Mr. R. McFadyen
Mr. D. Vaughn

The duties of these personnel included supervision of the erection of the Raydist ground stations and maintenance of all Raydist equipment. They also flew in the aircraft and were responsible for the operations of the airborne equipment and for passing to the pilot at appropriate time, fixes based on the equipment lane count.

Field Party:

Mr. W. Shields was in charge of field operations on Flinders Island. He personally carried out the erection of the Raydist stations at the selected locations.

III SURVEY PROCEDURES AND EQUIPMENT

In September of 1967 agreement was reached between Magellan Petroleum Southern Proprietary Limited, with registered offices at 276 Edward Street, Brisbane, Queensland and Aero Service Limited, with registered offices at 31 Park Road, Ramsgate, New South Wales.

The purpose of this agreement was the conduct of an airborne magnetometer survey over three areas located offshore in the eastern and western approaches to Bass Strait. Three areas were involved and are shown on the sketch map accompanying this report (See Frontispiece). Area C, west of King Island and northwest Tasmania was to be flown using Doppler control only. The remainder, areas A, South of eastern Victoria, and B east of Flinders Island were to be subject to control by Raydist. Flight line directions in each case are shown on the sketch map. Flight line spacing was nominally two miles and a total of some 2070 line miles was to be flown.

1. Operations

The bases used for survey purposes, accommodation and fuelling were King Island, (Currie), Bairnsdale and Flinders Island (Whitemark).

Prior to commencement of flight operations, the Doppler was calibrated over a known distance and reciprocal heading checks were established. Compensation of the magnetometer was effected and checks were made on the correlation of all three records, viz. magnetometer, altimeter and 35mm tracking film.

The survey aircraft, Aero

Commander registered no. VH-MJJ carried a Gulf Mark III magnetometer with the detector head housed in a tail cone installation. In flight, the magnetometer continuously measures the earth's total magnetic field thereby indicating any variations in this field as the aircraft proceeds along predetermined flight lines. Using a recording potentiometer coupled with the detector head, the magnetic information is automatically recorded on a graph chart. The aircraft's altitude is also graphically recorded on a chart which shows the terrain clearance. In order to validate the flight path as flown by the aircraft an Aeropath AS-5 continuous strip 35mm camera photographs the terrain.

The aforementioned three records, viz. magnetometer, altimeter and 35mm film are correlated by a Doppler driven timing or fiducial system which imposes serially numbered marks at one nautical mile intervals on each of the records simultaneously.

On the ground, a Gulf Fluxgate magnetic storm monitor was continuously maintained over a twenty-four hour basis so that no aeromagnetic data would be accepted if obtained during period of abnormal magnetic disturbance.

2. Doppler Techniques

The three pairs of lines reconnoitering Area C were controlled solely by the Doppler Navigator. A description of this instrument may be found under "Technical Specifications" in this report.

The technique of Doppler navigation over the sea relies on the establishment of a correction for water movement, and the application of this correction to the selected track for the runs. This is done initially by flying a dummy run and correcting for the landfall error found. This correction is then updated according to the landfall error as each pair of survey lines is completed.

A close check on landfalls

was maintained and all questionable lines were reflown. In addition to the survey lines shown in the sketch map tie lines joining the landward end of the three pairs of lines were flown, to provide control of the magnetics.

3. Raydist Techniques

In order to provide control for Areas, A and B, the aircraft was fitted with Raydist, and Raydist ground stations were established at positions as listed below:

Victoria

	Lat.	Long.
Marlo (Red Station)	37°47'54"	148°32'12"
Cape Everard (Green Station)	37°48'17"	149°16'30"

Flinders Island

North East River (Red Station)	39°44'06"	147°57'12"
Patriarch Inlet (Green Station)	39°56'54"	148°11'24"
Lady Barron (Red Station)	40°13'30"	148°17'40"

The Stations at Marlo and Cape Everard were used for Area A. The stations at North East River and Patriarch Inlet covered lines 21 - 50 and the station from North East River then was transferred to the Lady Barron position and with the Patriarch Inlet station was used to finalise coverage of Area B. A brief description of the Raydist equipment is included under "Technical Specifications" in this report.

In the actual flying of these two areas, maps were prepared showing the location of the stations, outline of the area and the flight lines. Arcs were drawn over the area to be surveyed, spaced each twenty (20) lanes from the respective ground stations. Suitable intersections of these areas with the flight lines were then chosen and tabulated as fixes for the control of the flight lines.

After calibration of the equipment and establishment of the base line lane count

a suitable start point was chosen and its lane count checked to both stations. This start point was crossed before each sortie and the Raydist counters were started. On completion of each sortie the start point was again crossed and the Raydist count checked to ensure constancy of the lane count throughout the sortie.

4. Data Reduction

Two methods of flight path recovery and magnetic control were used in the data reduction of this survey.

Areas A and B. Flight path was recovered on the original base maps showing the lane arcs of each station. Fiducials were identified with lane crossovers on the Raydist record and plotted onto the base map.

Tie lines forming a closure around the area were used to correct for any drift within the closure. An arbitary base line was used on the first side of the closure and intersection values read in a clockwise direction. A base line was applied to each side of the closure determined from the intersection value of the adjoining side. The difference between readings of the last intersection and the first was then applied as the correction factor back around the closure in an anti-clockwise direction, establishing a common value for each intersection.

Regional correction was applied, from the BMR Isomagnetic Maps of Australia for the Epoch 1957.5, Plate G96 - 23, to the values of the intersections, and the corrected values marked onto the aeromagnetic record. These points were joined to form a base map. The transcribed values were contoured at 5 gamma contour interval.

Area C. Flight path was recovered onto base maps by using Doppler and the magnetic drift was controlled by a tie line intersecting each flight line on the landward side. Regional gradient correction was applied and profiles were constructed using the flight

lines as magnetic base lines.

IV TECHNICAL SPECIFICATIONS

1. Operations

The magnetic survey operations were conducted under licence from the Gulf Research and Development Corporation.

2. Method of Navigation

a) The survey aircraft was navigated over areas A and B using the miniaturised, transistorised type DR Raydist. Area C was controlled with the GPL Doppler navigation system and computer integrated Kearfott N-1 compass.

b) Description of Navigation Aids:

(i) Type DR Raydist. This small, highly portable fixing equipment operates on a principle of measuring the direct range between the aircraft and each of two ground stations simultaneously. This is done by using a system of "lane" counting, "lanes" being the transmission signal from each station and each lane having a finite width of 148.63 feet. The presentation of this information in the aircraft is in two forms:
a) Digital counters which show the actual lane count between the aircraft and each station. Stations are identified as Red and Green.
b) A sawtooth record which shows the simultaneous range in lanes of the aircraft from each station. This record is synchronised with magnetometer and altimeter records by a system of fiducials. Additionally the record is endorsed manually with the lane count as shown by the digital presentation. Every tenth lane is presented as a modified sawtooth to assist in the counting and checking of lanes.

In executing the survey, maps are drawn up showing the position of the ground stations, the survey area and the flight lines. Lanes at an appropriate scale are drawn on the map and the

lane numbers at their intersection with selected positions on each line are tabulated. Thus a series of fixes is available to assist in guiding the aircraft along the required line.

(ii) Kearfott N-1 Compass. This compass unit is integrated into the Doppler computer system and is a navigational aid using the output of sensitive elements suitably amplified to monitor an electrically driven directional gyro. This system provides accurate compass indication in which turning, accelerating and gyro wander errors are almost eliminated. Heading information in the form of a synchronous output is provided at the amplifier to feed a synchronous repeater of any of the following equipment:
radio compass,
electro-mechanical flight computer,
automatic reckoning system,
The following units are used in this compass:
detector,
gyro,
amplifier,
resolver,
slave unit,
indicator and master indicator.

(iii) Automatic Pilot. The conventional Lear L3 three axis automatic pilot was used.

(iv) Doppler. The GPL Doppler navigation system is a self contained long range navigation aid that gives the pilot:
1. ground speed
2. drift angle
3. distance to go to destination
4. distance right or left of selected course.

The output information is obtained by sending to the ground four beams of continuous wave energy and measuring the change in frequency of the energy return from the ground to the aircraft. This change in frequency commonly known as "Doppler Shift" is proportional to the aircraft speed in the direction that the beam is pointing. By checking the speed in the

four directions in which the beams are pointing, the system derives ground speed and drift angle data and presents it on the Doppler indicator on the instrument panel. This drift angle information is then combined with the aircraft heading data and is fed along with ground speed information to the navigation computer. The computer accepts this information and computes automatically and continuously the aircraft's ground position relative to the selected course and point of origin. The Doppler unit is guaranteed to an accuracy of ± 1% of the distance flown by the survey aircraft.

3. Magnetometer

a) The magnetometer used on this survey was a Gulf Research and Development Corporation total magnetic field saturable core magnetometer Mark III recording through a Gulf 7-1 recording potentiometer. The sensing or detecting head was mounted on the tail stinger of the Aero Commander.

b) Technical Data:

(i) Sensitivity: The instrument was set to record a full scale deflection of 300 gamma for a complete excursion of a Leeds and Northrup ten inch chart and the recorder was run at a speed proportion to ground speed as determined by the Doppler output.

(ii) Noise level: The noise level as recorded at no time exceeded two gamma.

(iii) Instrument Drift: During the course of this survey, the instrument did not drift at any rate greater than four gamma per hour.

4. Radio Altimeter

An APN-1 radio altimeter was used for recording the height of the aircraft above terrain. An Esterline Angus recording potentiometer running at 3" per minute continuously recorded the terrain clearance.

5. Recording 35mm Camera

a) An Aeropath AS-5 continuously recording positioning camera was used to record the actual flight path of the aircraft over the terrain.

b) Technical Data:

Lens:	A2 Cook. Speed Panchro, ANGENIEUX 18.5mm
Focal Length:	0.75 ins.
Shutter Speed:	Variable
Magazines:	400 feet.

c) Control:

The recording 35mm camera was driven by an electric motor at a constant speed and is pre-set for a given mean ground speed and altitude above the ground.

6. Storm Monitor

a) Magnetic field variations were monitored by a Gulf Research and Development Corporation single fluxgate saturable core magnetometer recording on to a 5 inch curvi-linear chart using an Esterline Angus recorder, running a 1.5 inches per minute during sorties and 1.5 inches per hour at all other times.

b) Control:

The instrument was constantly attended whilst the survey aircraft was operating and time intervals of approximately ten minutes duration were noted on the chart by the operator.

7. Synchronisation of Records

Synchronisation of all records taken during the survey was achieved by the use of Veeder counters and fiducial system.

An electrical pulse from the intervalometer operated the fiducial flag of the camera and at the same time moved the camera Veeder

counter up one unit. The magnetometer recorder and the radio altimeter recorder are each fitted with the fiducial marking pen which is also operated by signals from the intervalometer. The magnetometer operator annotated each record by reference to the counters at the beginning and end of each profile, regularly throughout the survey for alignment of numbers. Using this technique the numbers appearing on the edge of the 35mm tracking film were also identified by interpolation on both the magnetometer and radio altimeter records. Thus the ground position of any anomaly and the height of the aircraft above the ground at that point may be easily ascertained.

The storm monitor and airborne magnetometer record were related by reference to time only, and were synchronised by time check prior to and at the end of each sortie.

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V TRAVERSE AND TIE LINE INDEX

Area "A" - Bairnsdale

Traverse	Direction	Flight	Fiducial Start	Fiducial End	From To
Northern Project					
1	E	3	314	320	N.Bdy.-S.Bdy.
2	W	3	328	342	S.Bdy.-N.Bdy.
3	E	3	343	365	N.Bdy.-S.Bdy.
4	W	3	366	385	S.Bdy.-N.Bdy.
5	E	3	386	404	N.Bdy.-S.Bdy.
6	W	3	410	430	S.Bdy.-N.Bdy.
7	E	3	431	449	N.Bdy.-S.Bdy.
8	W	3	450	469	S.Bdy.-N.Bdy.
9	E	3	470	489	N.Bdy.-S.Bdy.
10	W	3	490	510	S.Bdy.-N.Bdy.
11	E	3	511	529	N.Bdy.-S.Bdy.
12	W	3	530	543	S.Bdy.-N.Bdy.
TL A	E	2	047	092	W.Bdy.-E.Bdy.
B	W	2	093	147	E.Bdy.-W.Bdy.
C	W	3	558	621	E.Bdy.-W.Bdy.
Southern Project					
1	SW	4	710	732	E.Bdy.-W.Bdy.
2	NE	4	733	752	W.Bdy.-E.Bdy.
3	SW	4	753	773	E.Bdy.-W.Bdy.
4	NE	4	774	796	W.Bdy.-E.Bdy.
5	SW	4	797	816	E.Bdy.-W.Bdy.
6	NE	4	817	836	W.Bdy.-E.Bdy.
7	SW	4	837	856	E.Bdy.-W.Bdy.
8	NE	4	857	876	W.Bdy.-E.Bdy.
9	SW	4	877	895	E.Bdy.-W.Bdy.
10	NE	4	896	918	W.Bdy.-E.Bdy.
11	SW	4	920	938	E.Bdy.-W.Bdy.
12	NE	4	939	960	W.Bdy.-E.Bdy.
13	SW	4	961	979	E.Bdy.-W.Bdy.
14	NE	4	980	999	W.Bdy.-E.Bdy.
15	SW	4	000	018	E.Bdy.-W.Bdy.
16	NE	4	019	038	W.Bdy.-E.Bdy.
17	SW	4	174	195	E.Bdy.-W.Bdy.
18	NE	4	154	173	W.Bdy.-E.Bdy.
19	SW	4	129	153	E.Bdy.-W.Bdy.

Traverse	Direction	Flight	Fiducial Start	Fiducial End	From	To
Southern Project (contd.)						
20	NE	4	112	128	W.Bdy.	-E.Bdy.
TL D	S	4	075	111	N.Bdy.	-S.Bdy.
TL E	N	4	039	074	S.Bdy.	-N.Bdy.
Area "B" - Flinders Island						
21	NE	1	066	092	W.Bdy.	-E.Bdy.
22	SW	1	093	127	E.Bdy.	-W.Bdy.
23	NE	3	053	078	W.Bdy.	-E.Bdy.
24	SW	1	158	191	E.Bdy.	-W.Bdy.
25	NE	1	192	220	W.Bdy.	-E.Bdy.
26	SW	1	221	253	E.Bdy.	-W.Bdy.
27	NE	1	254	281	W.Bdy.	-E.Bdy.
28	SW	1	282	314	E.Bdy.	-W.Bdy.
29	NE	1	315	342	W.Bdy.	-E.Bdy.
30	SW	1	343	373	E.Bdy.	-W.Bdy.
31	NE	1	374	400	W.Bdy.	-E.Bdy.
32	SW	3	106	133	E.Bdy.	-W.Bdy.
33	NE	1	432	456	W.Bdy.	-E.Bdy.
34	SW	1	457	486	E.Bdy.	-W.Bdy.
35	NE	1	487	511	W.Bdy.	-E.Bdy.
36	NE	3	134	153	W.Bdy.	-E.Bdy.
37	NE	1	541	563	W.Bdy.	-E.Bdy.
38	SW	1	564	591	E.Bdy.	-W.Bdy.
39	NE	2	594	614	W.Bdy.	-E.Bdy.
40	SW	2	615	639	E.Bdy.	-W.Bdy.
41	NE	2	640	658	W.Bdy.	-E.Bdy.
42	SW	2	659	683	E.Bdy.	-W.Bdy.
43	SW	3	154	175	E.Bdy.	-W.Bdy.
44	SW	2	703	726	E.Bdy.	-W.Bdy.
45	SW	2	000	023	E.Bdy.	-W.Bdy.
46	SW	2	746	767	E.Bdy.	-W.Bdy.
47	NE	2	768	785	W.Bdy.	-W.Bdy.
48	SW	2	786	807	E.Bdy.	-W.Bdy.
49	NE	2	808	825	W.Bdy.	-E.Bdy.
50	SW	2	826	849	E.Bdy.	-W.Bdy.
51	NE	4	207	225	TL D	- TL G
52	SW	4	226	245	G	- D
53	NE	4	246	265	D	- G
54	SW	4	266	285	G	- D
55	NE	4	294	314	D	- G
56	NE	5	554	574	D	- G

Traverse	Direction	Flight	Fiducial Start	Fiducial End	From To
57	SW	5	534	553	TL G-TL D.
58	NE	5	513	533	D- G.
59	SW	5	493	512	G- D.
60	NE	5	472	492	D- G.
61	SW	5	452	471	G- D.
62	SW	6	866	887	G- D.
63	NE	6	778	800	D- G.
64	NE	5	388	409	D- G.
65	SW	5	368	387	G- D.
TL D	N	2	873	928	S.Bdy.-N.Bdy.
D	N	5	638	682	T.65 -S.Bdy.
E	S	2	929	947	T.13 -T.23.
F	S	2	948	999	N.Bdy.-S.Bdy.
F	S	5	588	637	S.Bdy.-T.65.
G	S	5	683	741	S.Bdy.-T.65.

Area "C" - King Island

Band A

1	NE	1	312	391	W.Bdy.-King Is.
2	SW	1	237	311	King Is.-W.Bdy.

Band B

1	NE	1	481	540	W.Bdy.-King Is.
2	SW	1	425	480	King Is.-W.Bdy.

Band C

1	NE	3	147	231	W.Bdy.-Tasmania.
2	SW	3	066	146	Tasmania-W.Bdy.

038020

PART II

INTERPRETATION

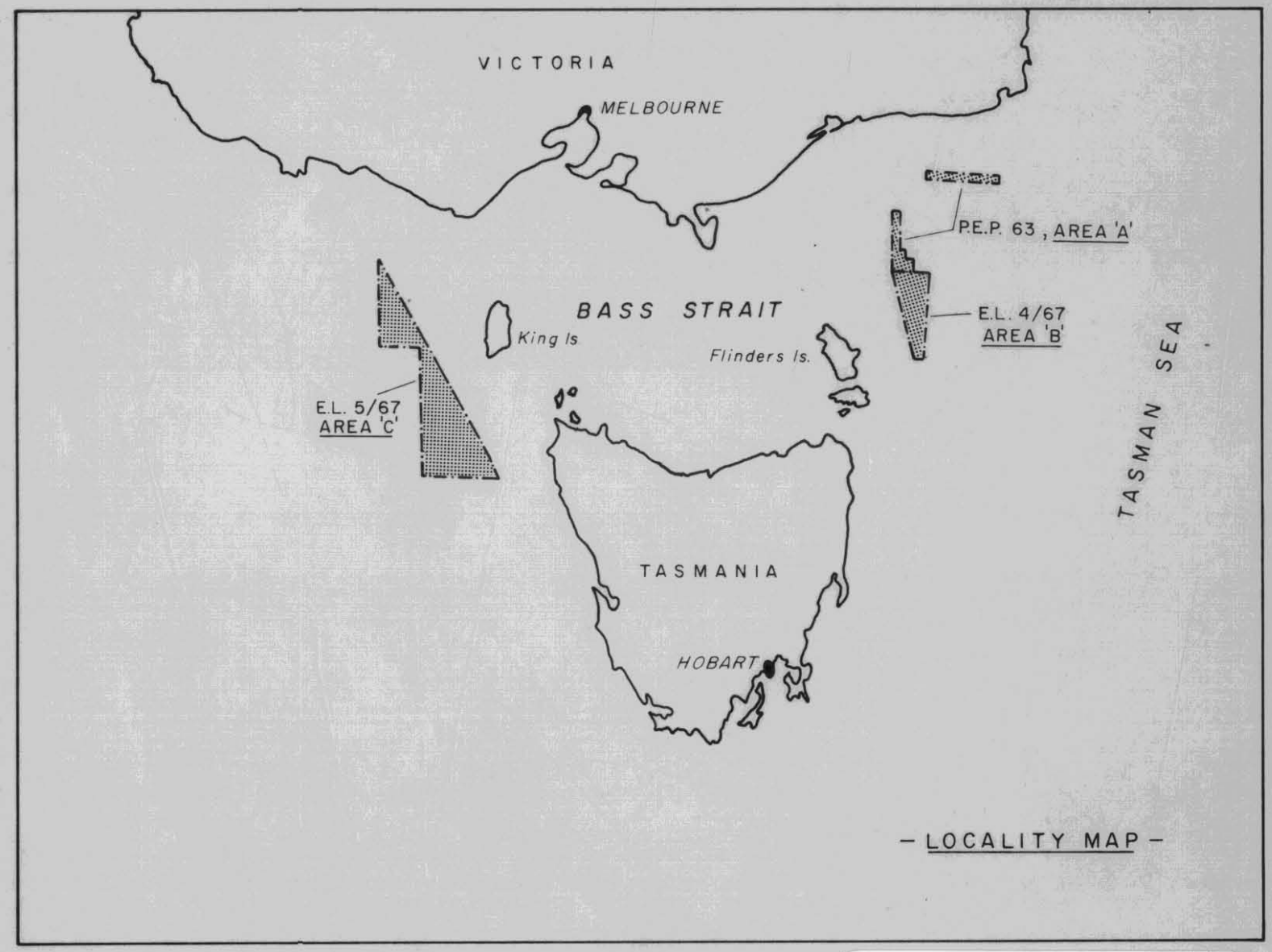
AEROMAGNETIC SURVEY

EASTERN AND WESTERN BASS STRAIT

MAGELLAN PETROLEUM SOUTHERN PROPRIETARY LIMITED

GEOPHYSICAL ASSOCIATES PTY. LTD.

JANUARY 1968.



– LOCALITY MAP –

SUMMARY

Reconnaissance surveys of two areas in the eastern approaches to Bass Strait and of reconnaissance doublets on the western approaches were flown and mapped by Aero Service Limited and interpreted by Geophysical Associates Pty. Ltd. The two eastern areas are labelled A (P.E.P. 63) and B (E/L 4/67). Northern Area A is rectangular with its long axis east-west. Southern Area A also rectangular has its long axis north-south. Area B approximates an inverted triangle with its northern border common with the southern border of Area A. They total 1693 square miles in area. Area C (E/L 5/67) includes three doublets west of King Island and northwestern Tasmania, comprising 475 miles. Most of the eastern areas are in deep water defined as greater than 600 ft, but the doublets are about half over shallow water.

The surveys are made 1000ft above sea level. The analysis of these data is based upon a method of model comparison developed by the parent company of GAPL, GMX. It includes both intrabasement and suprabasement models, representing thick prisms and thin plates of magnetic rock. Such rocks, igneous or metamorphic, ordinarily are the foundation of the sedimentary section. Therefore, the interpretation attempts to show the thickness of sediments within an area that may be potentially productive by mapping this basement-sedimentary interface.

The results are shown on contoured magnetic basement map having an interval of 1000ft. Basement depths in Area A range from -8,000 to -21,000ft, those in Area B from -1400 to -22,000ft, and those on the western approaches from about sea level to -24,000ft.

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MAPS

Total Magnetic Intensity: Areas A and B; 1":100,000, contour interval - 5 gamma;

Area C 1":250,000 stacked profiles, vertical scale 1" = 200 gamma. These maps were compiled by Geodrafting Services, Melbourne, Victoria.

Magnetic Basement: Areas A and B, 1":100,000 contour interval - 1000'; Area C, 1":250,000 contour interval - 1000', prepared by Geophysical Associates Pty. Ltd., Brisbane, Queensland.

I INTRODUCTION

This is the final report on the interpretation of offshore aeromagnetic surveys in the eastern and western approaches to Bass Strait over Areas A, B and C as delineated on the Locality Map. Area A (P.E.P. 63) is comprised of two small rectangular blocks separated by approximately twenty five miles. Northern Area A is due east of the center of the Gippsland basin which has an estimated section of 14,000ft under the continental shelf. This small area of about 285 square miles, is a narrow east-west strip thought to be on line with the basinal axis but in deep water, between 1000 and 6000 ft. In other words it is entirely south and east of the continental shelf. Southern Area A and adjoining Area B (E/L 4/67) lie southwest of northern Area A and contain about 1113 square miles of which half is east of the continental shelf in water depths that are as great as 4000 ft. It approximates a rectangular area, trending slightly west of north and situated east of Flinders Island. Area C(E/L 5/67) consists of reconnaissance doublets west of a line between northwest Tasmania and King Island. These doublets cover about equal areas on and off the continental shelf. The flight lines are perpendicular to the coast except for northern Area A where they are oriented west northwest in order to attain some length. Flight lines are approximately two miles apart throughout the area, and they are flown at 1000ft asl.

The aeromagnetic data were recorded and compiled by Aero Service Limited. The operation of the survey and the compilation of the data are described in Part I of this report.

II QUALIFICATIONS AND EXPERIENCE OF STAFF

The magnetic basement interpretation was preliminarily prepared by F.L. Hickey, geophysicist in GAPL's Brisbane office. Mr. Hickey has been engaged in geophysical exploration for seventeen years, the last three years with GAPL.

The final interpretational report was prepared by GAPL's parent company in Houston, GMX by R.H. Hammons and Nelson C. Steenland.

Mr. Hammons has been with GMX since 1954 and has been engaged in aeromagnetic interpretation since 1957.

Dr. Steenland has been with GMX since 1949 and has been in charge of aeromagnetic interpretation since that time.

III DESCRIPTION OF THE SURVEY

As indicated above, the three areas are flown in different styles but all with flight lines spaced at two miles at 1000ft asl. Northern Area A is so narrow, about five and one-half miles, that the primary control was tilted in a west-northwest direction in order to attain some length to the individual lines. They averaged about fifteen miles in length and are connected by three east-west tie-lines.

Southern Area A and Area B lines were slightly north of east and connected by tie lines along their extremities.

The doublets of Area C were flown south of west, and it is quite remarkable that the relationship between the lines was maintained by Doppler control over very long distances. The observed data along the reconnaissance lines were not mapped but are shown by Aero Service Limited in profile form along the flight tracks. It is quite remarkable also that almost every magnetic event may be found on each line of a pair. The data in Areas A and B are mapped with a contour interval of five gamma.

The magnetic data were recorded with a fluxgate magnetometer in analog fashion with a full-scale range of 300 gamma. The horizontal scales of these magnetograms vary between 0.65 and 0.85 miles per inch. The data quality ranges from fair to good.

The principal facts of the Earth's normal magnetic field are:

Declination	13°E
Inclination	-70°
Total Intensity	61,500 gamma.

IV OBJECTIVE OF THE SURVEY

The purpose of the survey was to map the magnetic field which in turn was to be interpreted to indicate the thickness of sediments in the area. Additionally, any magnetic materials in that sedimentary section and isolated above the magnetic basement were to be mapped should observed anomalies indicate their presence.

The magnetic basement surface is that horizon at which materials become sufficiently magnetic to produce observable anomalies. Ordinarily this interface marks the boundary between relatively nonmagnetic sedimentary rocks and ferromagnetic igneous/metamorphic rocks, usually called "basement". However, "basement" is identified by petroleum geologists as that surface below which there is no productive potential. Therefore the usefulness of the method is dependent upon the correlation of the magnetic basement of the geophysicist with the economic basement of the petroleum geologist.

V REGIONAL GEOLOGY

For the purpose of this survey, the areas of investigation have been separated into three blocks. Area A and Area B are in the offshore eastern portion of the Gippsland basin and Area C is in or near the southern offshore part of the Otway basin.

Gippsland Basin The Gippsland basin is located in the southeastern part of Victoria and the adjacent eastern portion of Bass Strait. It is situated within the southern part of the Tasman geosyncline, a Paleozoic feature which extended through eastern Australia some 2500 miles from New Guinea in the north to Tasmania in the south.

Great thicknesses of Paleozoic sediments were deposited in the Tasman geosyncline along with intrusive and extrusive igneous rocks, and it appears that rocks of that age underlie all 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 Permian rocks have been reported as having possible source and reservoir potential.

The Paleozoic formations are overlain by a sequence of Mesozoic strata which probably attained a thickness of more than 20,000ft in the deeper part of the Gippsland basin. The rock types are largely of terrestrial origin and include sandstone, mudstone, shale and coal.

Orogenic movement occurred near the close of the Early Cretaceous which folded and eroded the Lower Cretaceous rocks. This was followed by deposition of sediments in Late Cretaceous time and throughout most of the Tertiary. Deltaic deposits, which may interfinger with more marine beds in the east, were laid down in the western and central portions of the basin from Late Cretaceous throughout most of the Eocene. Epeirogenic movement occurred near the close of the Eocene and in the Pliocene. However, several thousand feet of Oligocene, Miocene, and Pliocene marine sands, muds, marls, and limes were deposited in the basin. The sea regressed to approximately its present position near the middle of the Pliocene, and terrestrial deposits ranging in age from Upper Pliocene to Recent were laid down in the coastal area on the mainland.

Structural movements, which were oriented mostly northwesterly in the Paleozoic, were predominantly directed along east-northeast axes after the Mesozoic; and the Gippsland basin attained its general present configuration by Early Tertiary time.

Commercial hydrocarbon deposits have been found in the Gippsland basin in the

region west of Areas A and B. It is expected that the proposed survey will yield information on the thickness of the sedimentary section and or basement configuration in the potentially prospective eastern margin of the basin.

Otway Basin The Otway basin is a Mesozoic-Tertiary feature which occupies southwestern Victoria, southeastern South Australia, and the adjacent part of the continental shelf. The northern onshore margin has been established by outcrop and well control. The eastern margin of the basin, based largely on magnetic anomalies is formed by the Selwyn Fault - King Island structural trend. The southern offshore limit of the basin is unknown. It is stated in the Bureau of Mineral Resources Record 1966/170, "A Preliminary Review of the Otway Basin", p. 9, that marine seismic data show a continuous section, mainly Cretaceous, extending well south of the 100 fathom limit of the continental shelf. The same report says that the morphology of the slope development in the area of the marine seismic survey actually suggests pinch-out of offshore sedimentation rather than any structural control.

Sedimentation started in Late Jurassic or Early Cretacious time in the Otway Basin and continued throughout the remainder of the Mesozic and much of the Tertiary. The depositional trends were transverse to the earlier northerly aligned depositional trends in the Paleozoic Tasman geosyncline, reflecting east-west faulting in the southern part of the Tasman geosyncline. Some 25,000ft of sediments were deposited in the deeper portions of the basin. The section, comprised primarily of sandstone, shale, and siltstone, is considered to have both source rock and reservoir potential.

Tectonic activity in the Otway basin is indicated by faulting and associated folding with dominant structural trends northeasterly in the northeastern part of the basin and northwesterly in the northwestern portion.

It is believed that the reconnaissance lines proposed for Area C will give information pertaining to the southern margin of the prospective

Otway basin, especially insofar as the thickness of the sedimentary section and basement configuration are concerned.

VI PREVIOUS GEOPHYSICAL SURVEYS

The most relevant geophysical control available is from aeromagnetic surveys conducted over parts of Bass Strait and Tasmania by the Bureau of Mineral Resources and from aeromagnetic and marine seismic surveys performed by private industry in the offshore exploration permits adjacent to the Areas of Investigation. Included among these are: Gippsland Basin Airborne Magnetic Surveys, Victoria 1951-1952 and 1956, by the BMR; Bass Strait and Encounter Bay Aeromagnetic Survey, 1960-1961, by Haematite Exploration; Offshore Gippsland Seismic Survey, 1966, by Shell Development; Eastern Bass Strait Marine Seismic Survey, 1967, by Esso Exploration; Tasmania Aeromagnetic Survey in 1966, by the BMR; and Cape Grim to Cape Jaffa Marine Seismic Survey, 1965 by Haematite Exploration.

In the northern part of the Gippsland basin, magnetic trends generally coincide with the southward trending Paleozoic axes. Farther south, however, they reflect the east-west axes along which the primary movement in Mesozoic and later times was directed. Magnetic control shows a deep trough extending eastward offshore from Lake Wellington containing a thickness of sediments on the order of 15,000ft. A shallowing of the magnetic basement is indicated southward from the trough. To the southeast, the magnetic control stops a short distance west of the western boundary of Area B. In the area of last control, a considerable thickness of sediments is indicated west of the northern part of Area B with the magnetic basement shallowing southward.

The most important geophysical information relevant to Area A and Area B are the two following offshore marine seismic surveys in adjacent waters.

1) Offshore Gippsland Seismic Survey, Gippsland Basin, Victoria, by Shell Development (Australia) Proprietary Limited, 1966.

2) Eastern Bass Strait Marine Seismic

Survey by Esso Exploration
and Production Australia Inc., 1967.

The Shell survey was conducted in Petroleum Exploration Permit 57, which abuts the northern boundary of Area A, to define the northern limits of the eastern Gippsland basin and to investigate the sedimentary thickness and structure within the permit. In general, it shows the regional dip to be southward with the strike more or less parallel to the coast. The sedimentary section, considered to be mostly Tertiary, thickens southward. Approximately 7000ft of section is indicated a short distance north of Area A. It is probable that Area A is covered by substantial thickness of sedimentary rocks.

The Esso-Eastern Bass Strait Seismic data indicate that the eastern limits of distribution of the Latrobe Valley Coal Measures and the Lakes Entrance formation are near the western boundary of Area B and the Strezlecki Group is further restricted to the northwest. Hence, the basement appears to be overlain by Post-Lakes Entrance beds in Area B. Significantly, a uniform northeast dip component is indicated for the basement, and a considerable thickness of marine post-Lakes Entrance beds could be present in Area B.

An airborne magnetic survey was flown by the BMR over Tasmania in 1966, the lines of which extended about 100 miles off the west and east coasts. The western extremities of the northernmost lines extended into the southeastern corner of Area C, thereby affording the only geophysical coverage in that block. The survey was flown at a high altitude. According to Finney and Shelley (Record No. 1966/139, p. 13), the basement is very shallow in the northwest offshore and possibly reflects Cambrian sedimentation similar to that east of the Precambrian block in northwestern Tasmania.

The Cape Grim to Cape Jaffa marine seismic survey was done by Haematite Exploration in 1965 to investigate the continental shelf from northwestern Tasmania to southeastern South Australia. Generally the results indicate a pronounced angular unconformity between Tertiary and Mesozoic formations. South of

Victoria, Tertiary sediments dip southward and appear to pinch out due to nondeposition on the continental slope. A mainly Cretaceous section is indicated, however, extending well south of the 100 fathom limit of the continental shelf. The area west of King Island is depicted as a shallow positive area covered by a thin Tertiary sequence. About thirty miles west of King Island, seismic information suggest a thick wedge of unmetamorphosed sediments of uncertain age underlying the Tertiary beds.

On the basis of the above-mentioned geophysical evidence, the possibility exists that substantial sediments may underlie at least part of Area C.

VII RESULTS

The observed results are presented on observed total magnetic intensity maps and profiles compiled by Aero Service Limited. The interpreted results are shown on magnetic basement maps prepared by GAPL. Both are submitted with this report on 3 sheets for Areas A and B at 1:100,000 and one sheet for Area C at 1:250,000.

1. Observed Aeromagnetic Map

The observed field is contoured with an interval of five gamma, and its anomalies everywhere seem to result from induced magnetization by the Earth's normal magnetic field. For intrabasement anomalies reference can be made to Figures A64 through A76 in Geological Society of America, Memoir 47. These models, for infinitely thick prisms at inclination 75°, show that the negative components of anomalies, which in this hemisphere are south of the southerly edges of the causative bodies, commonly have amplitudes of only 5% of the positive amplitude. Unpublished anomalies of thin plates, which can represent local structure, show that smaller anomalies in the range of ten to fifty gamma have negative components of approximately one-third the value of the positive component.

Northern Area A The field decreases eastward toward a minimal axis of northwest strike before terminating on the northern margin of a large positive closure in the southeast. There is nothing of especial interest in the field except that it would indicate that the section is shoaling eastward.

Southern Area A and Area B The magnetic field shows at once that there should be thick section in the flat magnetic zone north of 39°15' and that the central shallow zone will terminate approximately southward at 39°45'S. In this central anomalous zone anomalies remain intense eastward to the continental shelf, suggesting that there is simply no section there. A negative system, parallel to and east of the shelf edge, suggests a tight syncline east of which the section again thins toward the negative-positive system approximately at 39°25'S. The southern flat zone over possibly moderately thick section consists primarily of a southeastward increasing gradient which culminates on a positve anomaly at about 40°10'S. Finally, the anomalous situation in the extreme southwest indicates another zone of thin section. This area also shows some sharp anomalies indicative of shallow magnetic material, quite possibly intrusive igneous bodies.

Again, there is no trend habit to the anomalies. Most, big, and little, seem to be subcircular in shape.

Area C The doublet west from the northern part of King Island has anomalies up to 300 gamma using the vertical scale of 200 gamma per inch on the profile rendition of the magnetic field. The large anomalies terminate abruptly approximately sixteen miles offshore. West from there the field is very flat with only widely spaced negatives appearing once in awhile, and these do not extend across the doublet.

The doublet west of the southwestern corner of King Island likewise is very anomalous offshore for a distance of about twenty miles at which point the field assumes the flat nature of the northern doublet except that the conspicuous, isolated negatives are absent.

Finally, the third doublet west of northwestern Tasmania is distinctly anomalous for an even larger distance, approximately forty-two miles, at which point the field resumes the flat characteristic indicative of a deep magnetic basement.

2. Magnetic Basement Maps

Northern Area A The computed basement depths which are shown in hundreds of feet develop a synclinal axis at -21,000ft in the western part of the area. From here the section thins rather abruptly, culminating in a dome in the far east at -15,000 ft and in a possible dome in the far west a -18,400ft. Note that the water depth in the west is 1000ft, and on the dome in the east it is between 4000 and 5000ft. The synclinal area has about 2000ft, leaving a net thickness of section of about 19,000ft. However, just south of the southwestern corner of the area there is a single water depth of 6100ft.

There seems to be little of local structural interest. Some indications of shallow magnetic material over the eastern dome suggest that it might be a younger intrusive.

Recall that the magnetic basement is probably Precambrian in age and that there is a distinct possibility of a substantial thickness of Lower Paleozoic sediments of the Tasman geosyncline which probably have been intensely folded and become slightly metamorphic as discussed in the section on regional geology. Also reference can be made to Wallis' report in the Proceedings of the World Petroleum Congress in Mexico City, 1967, where he shows about 14,000ft down to the magnetic basement on strike in the Gippsland basin center just west of this area. His work also suggests west dip on the eastern edge of the basin which is along the edge of the continental shelf. This would have to be a shelf anticline from the results just described in northern Area A.

Southern Area A and Area B An area of essentially no section appears on the shelf in the central part of this

prospect.

North of here the basement is downfolded into -20,000ft and -22,000ft of section which essentially marks the depth of the northern basin except for isolated structures at -15,000ft in the southern part of the northern basin and at -13,400ft in the extreme north. These three shoal areas together with the intermediate one at -16,400ft are good prospects for local structure.

Water depths in the extreme northeast are from 4000 to 6000ft, but the other areas of interest have water depths from 400 to 800 ft.

The central shelf terminates against a strike syncline of north-northwest strike with 19,000ft of section estimated. This in turn terminates against a shallow terrane of essentially no sediments under the ocean floor in the extreme east. However, the synclinal system itself is interrupted by a dome at approximately 39°10'S, 148°40'E which may be the best local structural indication of the analysis. Here the basement is about at -14,200ft where water depths are anticipated to be around 1000ft.

If good structure with little section in shallow water are desired, there is one on the shelf at approximately 39°20'S, 148°35'E at -3900ft where the water depth is probably 200ft.

The southern basin of Area B has a floor at about -17,000ft which is interrupted by several local structures but more conspicuously by a down-to-the-northwest fault in the northern part of this basin. A good half-block of northeasterly attitude is mapped but not recommended because the strike anticline southwest at 40°10'S, 148°45'E is considered a better prospect. Notice a similar strike anticline due east of it where there is some unsatisfactory evidence in the form of shallow magnetic material at -2400ft. Finally there is a dome at -10,000ft on the western boundary of the concession near 40°15'S which is a fair prospect and also the bigger dome east of it at -14,200ft which is

crossed by a possible narrow dike system of shallow magnetic material.

The magnetic results suggest that the best prospects in southern Area A and Area B are situated in the northern basin where those in the area of shallow water would quite logically be inspected first.

Area C The magnetic basement on the doublets gives more information than might be expected from the paucity of data because the magnetic signature is essentially the same on each of the six traverses. It shows that most of the shelf on the western approaches to the Bass Strait has little or no section out to a distance increasing from sixteen miles off northern King Island to forty miles off northwestern Tasmania. It is expected that the edge of the buried shelf is downfaulted to the west because the section increases dramatically by approximately 15,000ft on the northern two doublets. This should be the Selwyn fault mentioned by Leslie, for example, in preprint No 109, "Petroleum Exploration in the Otway Basin," Com. Min. Met. Cong., Australia and New Zealand 1965, except that the basement fault is west of the projection of the fault trace in his fig.1. Secondly, each of the doublets shows a possible synclinal axis not too far west of the faulted edge of the basin, approximately fifteen miles. Along this synclinal trend, the magnetic basement is mapped at -22,000ft in the north, -24,000 in the center and south. However, along the northern doublet the depth of the magnetic basement again increases to a depth of -23,800ft where the water depths are approaching 10,000ft. Therefore, the isopach is really thinning as the water depths along the previously mentioned syncline are only around 300ft. The substantial thickness of section developed on the northern doublets between the edge of the shelf and the buried faulted eastern edge of the basin make a distinct zone of interest. Possibly the best indication of local structure is the suggested southward plunging nose at -13,000ft just west of the concession boundary on the central doublet, "B". The doublets are labelled A, B, and C from north to south.

Finally, in passing it is

noted that the sharp negatives on the northern doublet in the areas of thick section or flat observed magnetic field are very isolated and might very well represent intrusives. In that case, the depths computed from them would be uniquely applicable to them, and it is incorrect to have contoured the basement as though these anomalies were generated from the normal basement surface. Note also that the negative on the northern line of doublet A is north of a positive anomaly on the southern line which is an inverse relationship. This relationship does suggest, for what it is worth, that there might be an intrusive of inverse polarization in the subsurface. Reference is made by Leslie (op. cit., p. 34) to Jurassic dolerites along the northern coast of Tasmania.

3. CONCLUSION

The area of magnetic data over the eastern and western approaches to Bass Strait define the magnetic basement to a degree that might not have been anticipated from the reconnaissance nature of Area C and the small areas of A and B. The eastern areas are distinctly anomalous as though over routine continental stable basement so that events for basement depth computations are readily available. Not only that but the observed magnetic field itself shows the gross differences in depth to the magnetic basement. As far as the reconnaissance doublets in the west are concerned they exhibit a very definite break between little or no section just west of King Island and northwest Tasmania and basins with more than 20,000ft of section developed abruptly as though by large scale faulting.

Local structural prospects would appear to be best in the basin of southern Area A, where structures with up to 5000ft of relief interrupt the basinal floor which is about at -20,000ft. Moreover, one or two of these structures can be found on the shelf in relatively shallow water.

GEOPHYSICAL ASSOCIATES PTY. LTD.

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VIII ELEMENTS OF AEROMAGNETIC INTERPRETATION

In general, the earth is a uniformly magnetized sphere with a generally uniform external magnetic field. This phenomenon has been known since the beginnings of civilization as attested by such primitive practices as navigation by the magnetic compass.

There are local distortions to this magnetic field, and man has long been aware of these also. Several centuries ago, even in 1640, the so-called distortions or anomalies were employed for the search of iron ores; so magnetic exploration is one of the earliest geophysical methods.

The local distortion suggested by Figure 1 is occasioned by a mass of more easily magnetized material, soft iron for example, than the surrounding space where the magnetic susceptibility is zero. It is more convenient for the magnetic lines of force to travel through the material than through space so they are crowded together in the vicinity of the material. In other words, the magnetic intensity is increased and a positive distortion or anomaly is created above and below the mass.

A geologic explanation of a magnetic anomaly must translate the disturbing mass into a geologic entity of some sort. Where to begin? Fortunately there is a magnetic classification that follows a geologic classification. For the most part, sedimentary rocks have little, if any, magnetic susceptibility, whereas igneous and metamorphic rocks, the basement rocks, have susceptibilities that range from 100 to 10,000 times that of sedimentary rocks. Therefore, rock masses of variable susceptibilities will, in the main, be confined to basement rocks.

Can the distorting basement masses be further defined by examining their possible configuration? First of all, what is the nature of these common local distortions to the normal field? Commonly, anomalies of several hundred gamma, normal intensity of tens of thousands of gamma, are observed over several tens of square miles. Such anomalies cannot originate in thin sheets of highly magnetized rocks because the opposing polarity of

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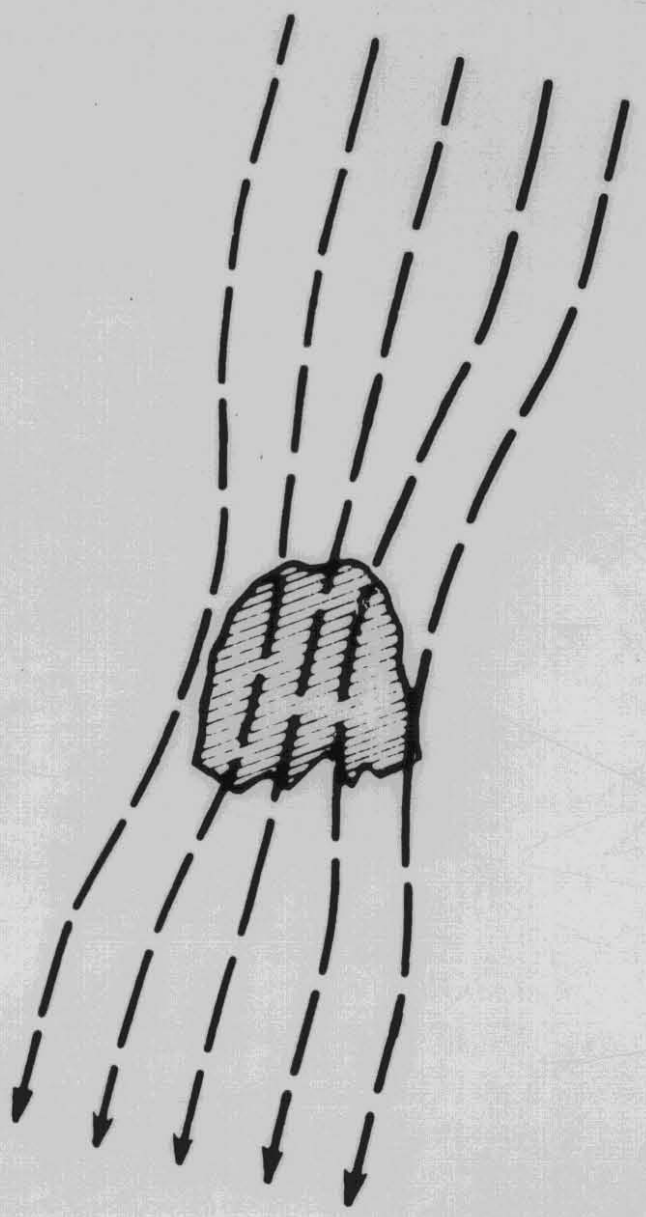

AEROMAGNETIC ANOMALY

FIGURE 1

the top and bottom layers would essentially obliterate the magnetic effect. Therefore, the anomalous rock mass must have great depth extent.

Secondly, the rock mass must be uniformly magnetized as dissimilar internal magnetization would also tend to reduce the net magnetic effect.

The third limitation is more or less inferred from the definiteness of the observed anomalies. It consists simply of assuming that the basement magnetic units are bounded by vertical sides and that their upper surfaces are approximately coincident with the basement's surface.

So the nebulous mass of Figure 1 can be translated into a geologic entity, the intrabasement unit of Figure 2.

Figure 2 also shows the increased magnetic intensity over an intrabasement rock unit, the primary source of anomalies observed on magnetic maps. Their existence has been known throughout the years of magnetic prospecting, and they are in no sense a discovery of the airborne magnetometer. The anomalies are actually of sufficient amplitude and area to have been mapped rather accurately by earlier magnetic instruments, most of which measured the vertical magnetic intensity to an accuracy of five gamma with careful surveying practices.

In theory, the airborne magnetometer, which measures total intensity, can yield no more information than the ground instruments. If even the same locations were read with the land-type instrument and the airborne magnetometer, the only advantage would be an increase in accuracy as the probable error of an aeromagnetic value can easily be less than two gamma. The fact that total intensity is measured instead of vertical intensity is of no import. The one can be computed from the other and vice versa. True enough, the aeromagnetic data can be obtained at several higher levels. This is likewise of no import. Higher levels can be computed from lower levels to as great an accuracy as they can be flown and at much less cost, too. So no new information is provided by an aeromagnetic survey that essentially repeats a

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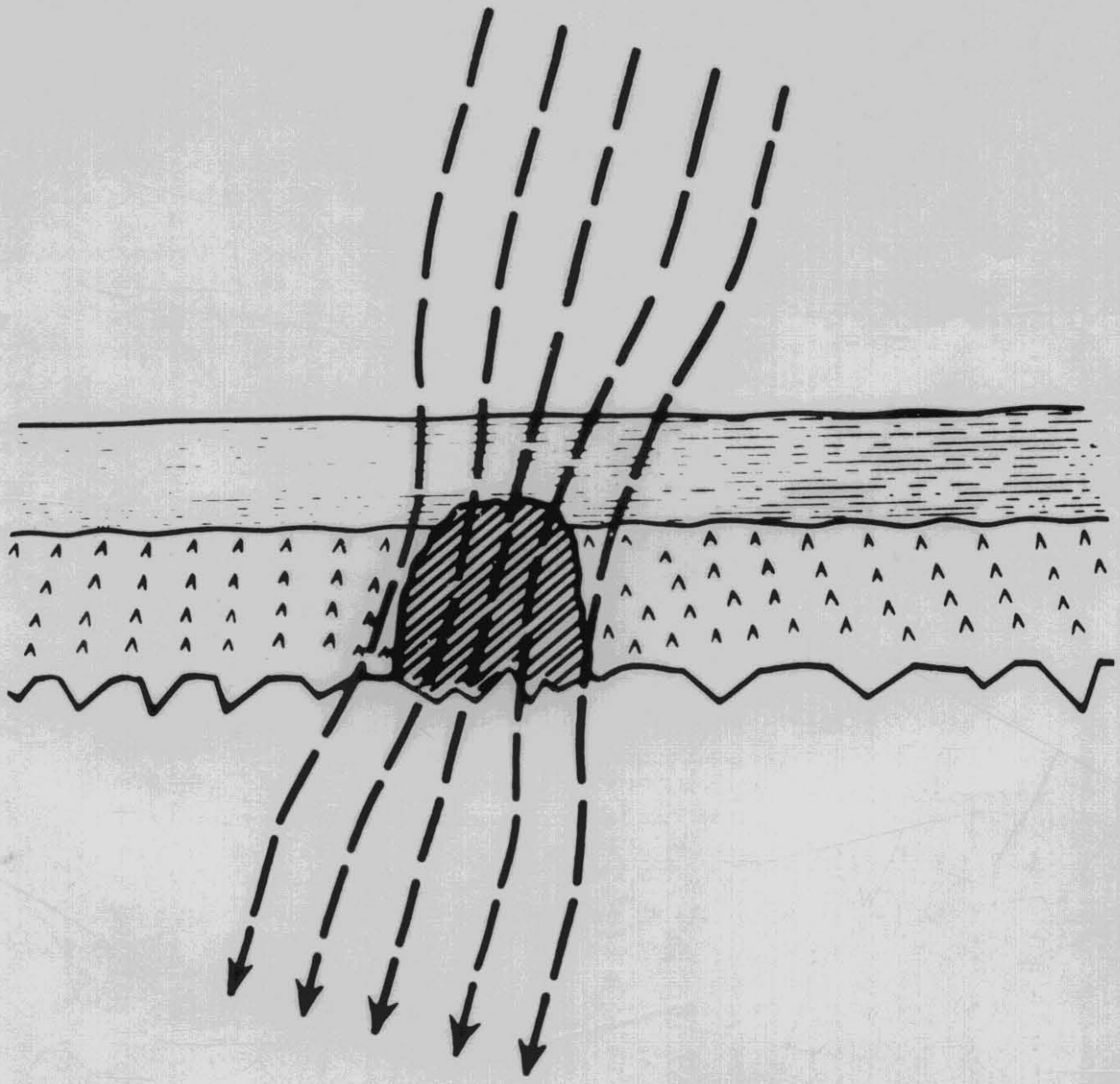


BASEMENT EFFECT

FIGURE 2

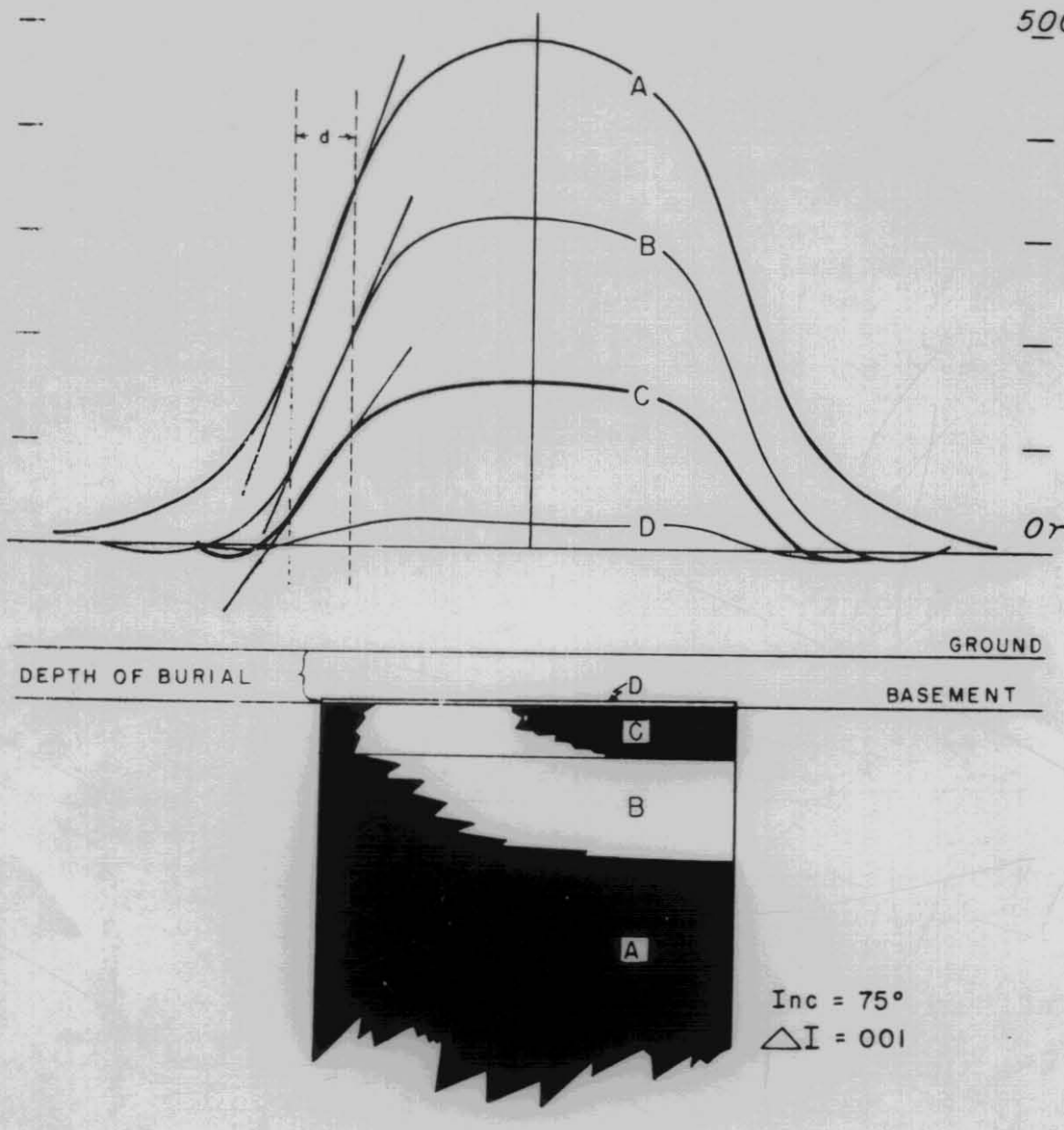
ground survey.

There is this distinction, however. The airborne magnetometer is able to obtain so much more data so much more rapidly and accurately that it is really an entirely new tool of exploration. The great increase in data is primarily the result of the continuous recording of the magnetic field by the airborne magnetometer, one of the few geophysical instruments that make a continuous record. Secondarily it is the result of the ability of the airborne instrument to fly as many lines as desired over territory that simply cannot be inaccessible to it.

Returning to Figure 2, the intrabasement unit, the primary source of magnetic anomalies, can serve as the fundamental basis of interpretation. For example, theoretical aeromagnetic anomalies can be computed for a large assortment of intrabasement blocks.

Figure 3 illustrates a series of east-west profiles computed for an intrabasement block which has a surface eight units of length on a side, with a unit of length equal to the depth of burial. This series illustrates the change in amplitude as the thickness of the intrabasement block is changed. For example, the uppermost profile, with a maximum amplitude of 500 gamma, corresponds to the block which is infinitely thick. The essential shape of the profile is determined by the depth of burial of the block because the amplitude of the anomaly can be drastically changed by assigning different magnetization contrasts to the block. Such changes can be compensated by altering the vertical scale of the profiles so that the profile maintains its original shape. An example of a function of the curve which varies with the depth of burial of the block is, for example, the horizontal length of the constant gradient. Such a property of an anomaly is derived from its shape and not its amplitude and can, therefore, be used to compute the depth of burial of an intrabasement block.

The second profile from the top is similar to the upper one except that the thickness of the intrabasement block is reduced to three units. This limitation essentially only affects the amplitude of the anomaly. The horizontal length of the linear gradient



INTRABASEMENT AND SUPRABASEMENT EFFECTS

FIGURE 3

has practically remained constant. The same conclusions are reached from a block only one unit thick as shown in the next profile. This profile, although considerably reduced in amplitude, has depth indices which are only reduced by approximately 10%.

Therefore, it can be concluded that the assumption that intrabasement blocks are infinitely thick is a practicably useful assumption.

The assumption which is most suspect is that these intrabasement magnetic units are bounded by vertical sides. This problem has been investigated along with the other assumptions by the empirical test of calculating from the magnetic anomalies the depths to the basement's surface where they actually are known. These investigations have altogether supported the assumption of vertical sides. Preliminary results of such tests were the basis of the first publication on this method of interpretation, Geological Society of America Memoir No.47, 1951.

The fourth or lowermost curve of Figure 3 is derived from a thin sheet of magnetic or basement material which is located on the basement's surface as shown on top of the basement block. This sheet has the top and bottom layers of the disturbing mass in close proximity, thereby decreasing the amplitude of the anomaly to a maximum of 21 gamma. Moreover, the depth indices are also significantly decreased substantially. This type of anomaly is called the suprabasement anomaly and is applicable to sheets with thicknesses up to approximately 20 percent of the depth at burial. The sheet shown in Figure 3 is actually 10 percent of the depth to burial. This second category of anomalies has an obviously useful role in magnetic prospecting for it represents relief of the basement's surface. Sufficient data are accumulated from actual surveys over known surfaces to demonstrate that these anomalies do exist and that their representation by a thin sheet is a valid one.

The two fundamental types of magnetic anomalies have been developed at this point and are called "intrabasement" and "suprabasement" according to their geneses. An interpretation starts with the intrabasement anomalies which afford computations of the depth

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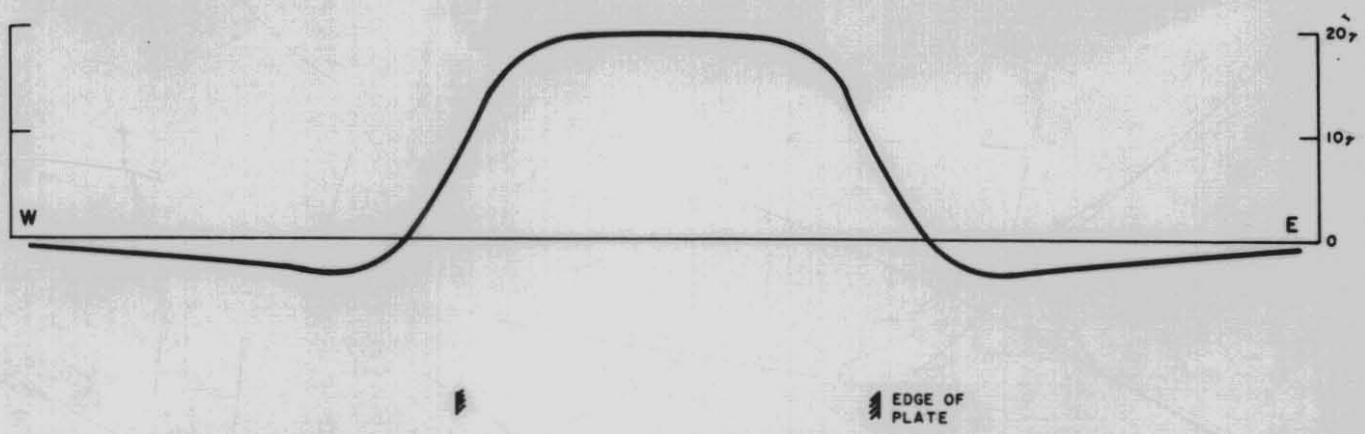


TYPICAL AEROMAGNETIC PROFILE FOR THIN PLATE
NORMAL MAGNETIZATION AT INCLINATION 75°

FIGURE 4

to the basement's surface. Two internal methods are available with which to evaluate the results of the depth computations. First, the estimates made from various measurements on one anomaly must agree among themselves. Second, the depth which is finally assigned to that anomaly must conform to the regional basement configuration which is being developed by the depth computations from all of the intrabasement anomalies. Naturally, the degree of conformity is arbitrary. The regional structure of the basement's surface is that which the interpreter is assigning to the area.

After the intrabasement anomalies have been examined for depths, anomalies remain which are too small or too sharp to originate from the intrabasement block. These are residual anomalies which may, because of their shape, be assumed to originate from the basement's surface. If that is correct, these are the suprabasement anomalies which may be of direct and local importance for petroleum exploration when the superimposed sediments have related structure.

Figure 4 illustrates a typical suprabasement anomaly by way of an east-west profile. The profile is relatively large in order to show the details of an anomaly. Of interest are the flanking negatives, the sharpness of the positive gradients, and the broad, flat nature of the apex of the anomaly. Of course, if the edges of the plate become even more separated so that the distance between them is considerably great compared to the depth of burial of the plate, the apex of the anomaly can easily degenerate into two apexes, each occurring near the edge of the plate with a lower intensity between them over the center part of the plate.

Some mention should be made of the preponderance of the occurrence of this type of anomaly in association with ovbious intrabasement anomalies. The association may be classified as follows :

(a) Superposition or congruency with an intrabasement anomaly,

(b) occurring adjacent to or as noses from intrabasement anomalies, and

(c) occurrence along an obvious intrabasement trend but not otherwise connected with any assumed intrabasement anomalies.

The reason for introducing these categories may be apparent from their clarification. The first instance attempts to describe the case where large anomalies with amplitudes of hundreds of gamma yield depth estimates which are much too shallow from the point of view of the regional configuration. It then becomes necessary to introduce a residual anomaly, along with the intrabasement anomaly and usually on its crest, in order to use suprabasement coefficients which must, if these assumptions are correct, place the basement at a deeper and correct depth. Translated into geologic terms, this means that a lithologic unit of relatively high magnetic polarization would either (1) have sufficient relief on the basement's surface to cause a concomitant suprabasement effect or (2) have a phenomenal layer of mineralization at and immediately under the basement's surface in order to create the suprabasement effect. The latter interpretation is favored in spite of its perhaps more difficult manifestation because too many instances of this first category (a) occur in the interpretation.

The second category is considered to mean, geologically, that the more highly magnetically polarized intrabasement units flare out either on or immediately under the basement's surface rather than having a sharp vertical contact extending completely to the basement's surface. This is suggested by the fact that many large anomalies nose, especially along their strike, with such magnitude that the presence of additional thin plates of material at or near the basement's surface must be assumed. In this second case, as in the first case, the observed anomaly is not completely accounted for by either a suprabasement or intrabasement type but by a combination of these.

In the third category, the anomaly

is completely accounted for by a suprabasement residual, but the occurrence of the anomaly along a previously recognized or assumed intrabasement trend suggests strongly that the anomaly is caused by an intrabasement slab of relatively highly polarized material rather than by relief of the basement's surface.

Of course, these considerations are a matter of interpretation because the distinctions are made not from the anomalies themselves but from assumptions regarding their origins.

GRAVITY METER EXPLORATION COMPANY

Nelson C. Steenland

APPENDIX I

Data Resumé

NAME OF SURVEY	Eastern and Western Bass Strait
CONTRACTOR	Aero Service Ltd.

FLYING	
INITIATION	31 August 1967
COMPLETION	23 October 1967
SURVEY MILEAGE	
LINEAR	(Area A & B) 1600 (Area C) 475
SQUARE	(Areas A & B) 1693
AIRCRAFT	Aero Commander
LOCATION SYSTEM	Doppler and Raydist
FLIGHT DIRECTION	Variable
FLIGHT ALTITUDE	1000' asl
TRAVERSE INTERVAL	2 mi
MAGNETOMETER	Gulf Fluxgate Mark III

ORIGINAL RECORDING

	Type	Vertical Scale	Horizontal Scale	Quality
ANALOG	Rectlinear	30 gamma/ in	0.65-0.85mi/ in	Fair - Good

PRINCIPAL FACTS OF EARTH'S NORMAL FIELD

INCLINATION	-70°
DECLINATION	13°E
INTENSITY	61500 gamma

OBSERVED MAPS

BASE	Transverse Mercator
SCALE	Areas A and B 1:100,000; Area C 1:250,000
NUMBER OF SHEETS	Area A and B - 3, Area C - 1
CONTOUR INTERVAL	Area A and B 5 gamma, Area C 1"=200 gamma

MAGNETIC BASEMENT MAPS

BASE	Overlay
SCALE	Areas A and B 1:100,000 Area C 1:250,000
NUMBER OF SHEETS	Area A and B - 3, Area C - 1
CONTOUR INTERVAL	1000ft

SHEET 1

148°30'

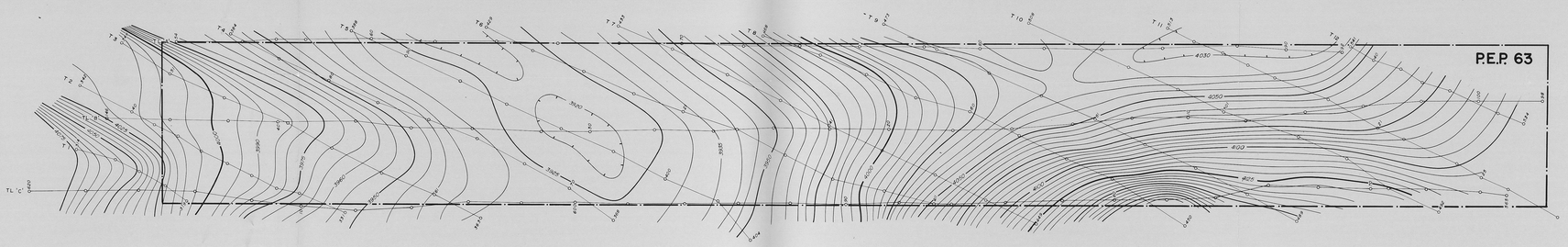
149°00'

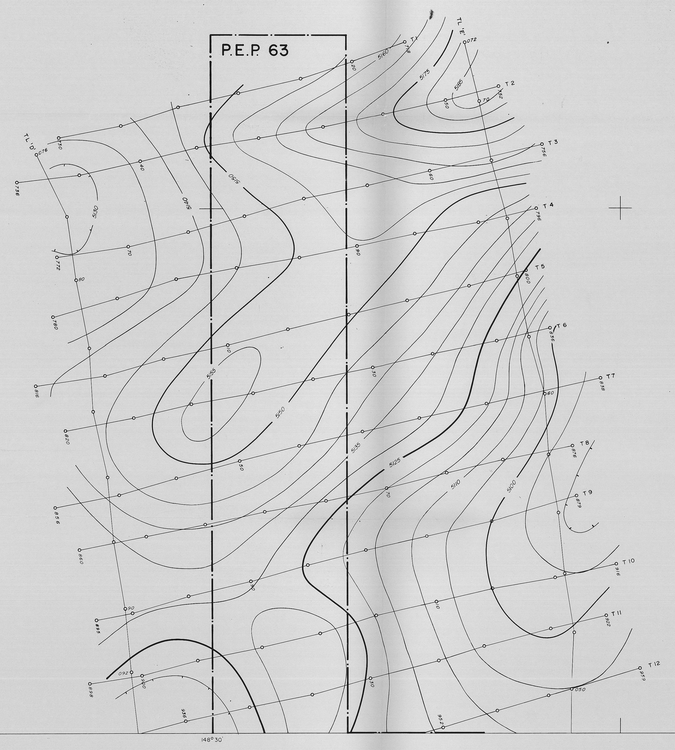
149°30'

149°50'

38°50'

38°50'





39°00'

148°30'

149°00'

149°30'

39°00'

LINE SPACING — 2 STATUTE MILES
CONTOUR INTERVAL — 5 GAMMAS
BASE INTENSITY — ARBITRARY
ALTITUDE — 1,000' A.S.L.

REGIONAL VARIATION CORRECTION APPLIED
TRANSVERSE MERCATOR PROJECTION

SHEET INDEX

1
2
3

5 cm

038051

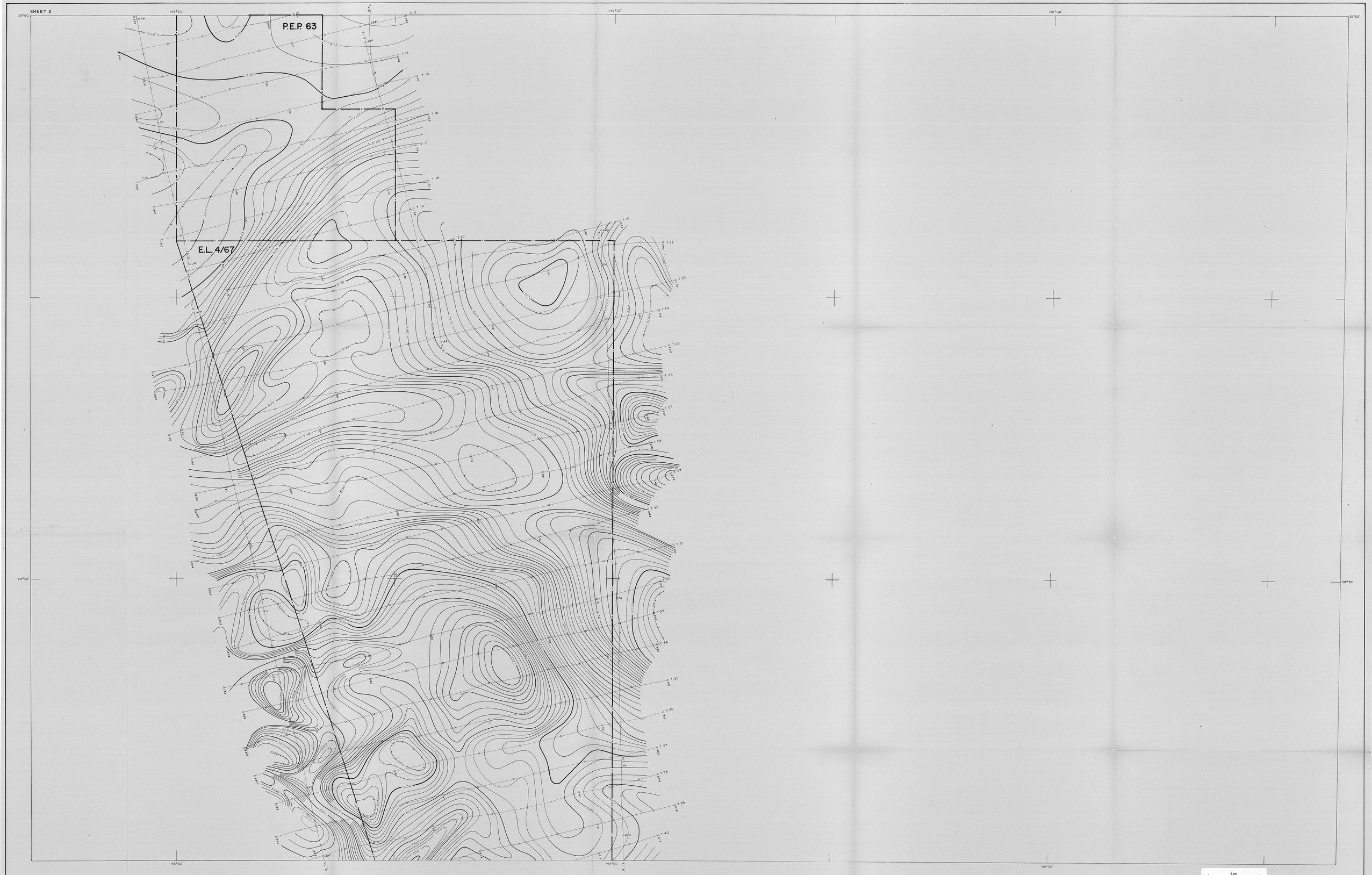
TOTAL MAGNETIC INTENSITY
AEROMAGNETIC SURVEY EASTERN AND WESTERN BASS STRAIT AREA A
MAGELLAN PETROLEUM SOUTHERN PTY. LTD.

—SCALE—
Miles 2 1 0 2 4 6 8

COMPILED AND DRAWN BY
GEODRAFTING SERVICES
PROPRIETARY LIMITED

AERO SERVICE LIMITED

Offshore Airmag part-III* SHEET: 1



LINE SPACING —— 2 STATUTE MILES
CONTOUR INTERVAL —— 5 GAMMAS
BASE INTENSITY —— ARBITRARY
ALTITUDE —— 1,000' A.S.L.

REGIONAL VARIATION CORRECTION APPLIED
TRANSVERSE MERCATOR PROJECTION

SHEET INDEX

1
2
3

5 cm

038052

TOTAL MAGNETIC INTENSITY
AEROMAGNETIC SURVEY EASTERN AND WESTERN BASS STRAIT
AREA A-B
MAGELLAN PETROLEUM SOUTHERN PTY. LTD.

—SCALE—
Miles 2 1 0 2 4 6 8

COMPILED AND DRAWN BY
GEODRAFTING SERVICES
PROPRIETARY LIMITED

AERO SERVICE
LIMITED

OR-084

Offshore Array part-III*

SHEET 2

SHEET 3

E.L. 4/67

148°30'

149°00'

149°30'

40°00'

40°30'

LINE SPACING — 2 STATUTE MILES
CONTOUR INTERVAL — 5 GAMMAS
BASE INTENSITY — ARBITRARY
ALTITUDE — 1,000' A.S.L.

REGIONAL VARIATION CORRECTION APPLIED
TRANSVERSE MERCATOR PROJECTION

SHEET INDEX

1
2
3

5 cm

038653

TOTAL MAGNETIC INTENSITY
AEROMAGNETIC SURVEY EASTERN AND WESTERN BASS STRAIT AREA B
MAGELLAN PETROLEUM SOUTHERN PTY. LTD.

SCALE
Miles 2 1 0 2 4 6 8

COMPILED AND DRAWN BY
GEODRAFTING SERVICES PROPRIETARY LIMITED

AERO SERVICE LIMITED

CR-084

Offshore Airmag part-III* SHEET 3

E.L. 5/67

BASS STRAIT

KING ISLAND

NORTH WEST TASMANIA

BAND 'A' R-1 NE R-2 SW

BAND 'B' R-1 NE R-2 SW

BAND 'C' R-1 NE R-2 SW

40°00'

40°30'

41°00'

144°00'

144°30'

145°00'

LINE SPACING — 2 STATUTE MILES
VERTICAL SCALE (PROFILES) — 1" = 200 GAMMAS
BASE INTENSITY — ARBITRARY
ALTITUDE — 1,000' A.S.L.

REGIONAL VARIATION CORRECTION APPLIED
TRANSVERSE MERCATOR PROJECTION

LOCATION DIAGRAM



5 cm

TOTAL MAGNETIC INTENSITY
AEROMAGNETIC SURVEY EASTERN AND WESTERN BASS STRAIT
E.L. 5/67
MAGELLAN PETROLEUM SOUTHERN PTY. LTD.
AREA C

5 0 5 10 15 20 Miles

COMPILED AND DRAWN BY
GEODRAFTING SERVICES
PROPRIETARY LIMITED

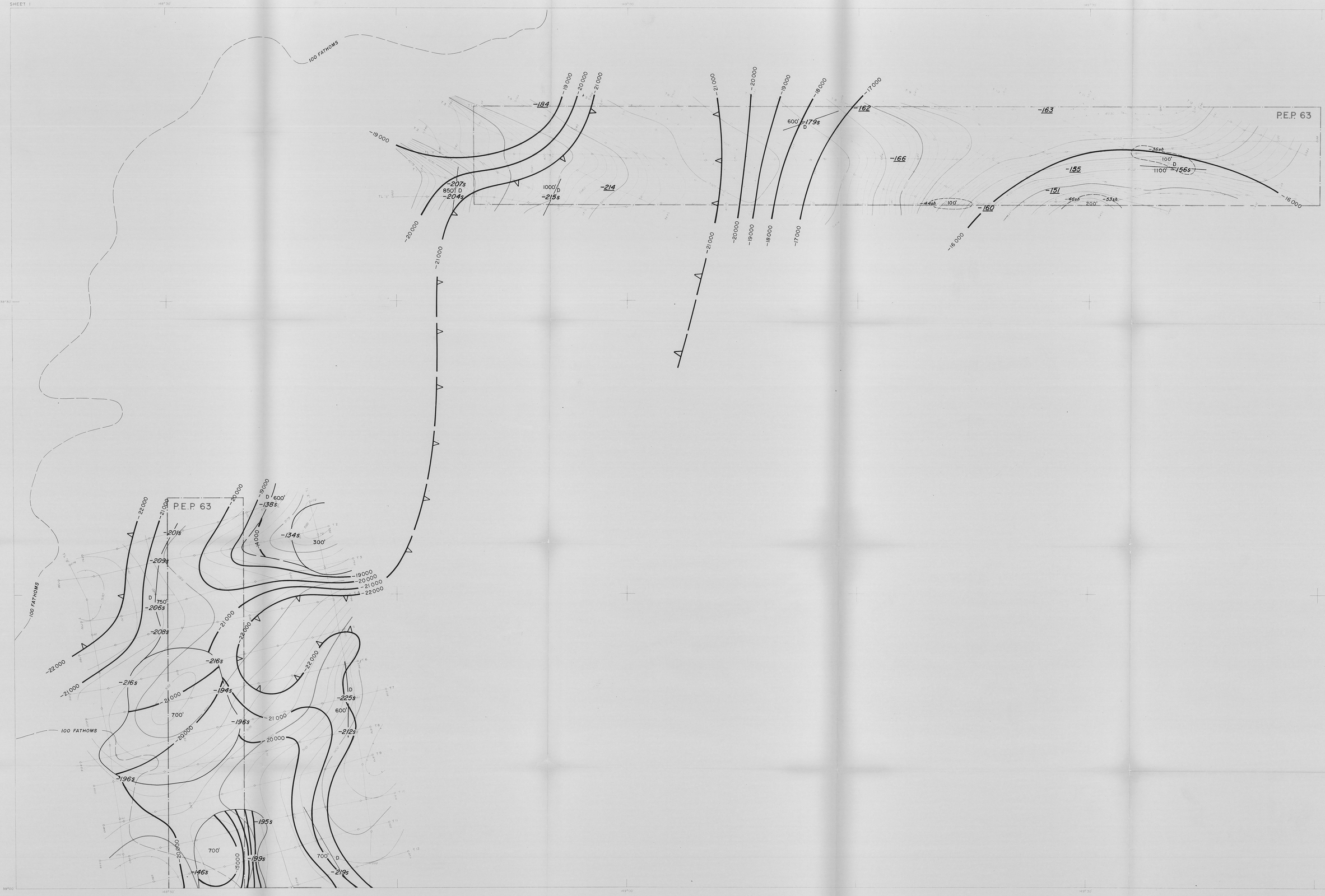
AERO SERVICE
LIMITED

038654

OR 084

Offshore Airmag part-III*

4



LINE SPACING — 2 STATUTE MILES
CONTOUR INTERVAL — 5 GAMMAS
BASE INTENSITY — ARBITRARY
ALTITUDE — 1,000' A.S.L.

REGIONAL VARIATION CORRECTION APPLIED
TRANSVERSE MERCATOR PROJECTION

SHEET INDEX

1
2
3

MAGNETIC BASEMENT ESTIMATES FT/100 SEA LEVEL DATUM

-72 FROM INTRABASEMENT ANOMALY
GOOD FAIR POOR

-72s FROM SUPRABASEMENT ANOMALY

OUTLINES AND EDGES OF PLATES FROM SUPRABASEMENT ANOMALIES WITH MAXIMUM THICKNESSES IN FEET ESTIMATED WITH 0·001 POLARIZATION CONTRAST

1500 MAXIMUM THICKNESS IN FEET
800 VERTICAL THICKNESS IN FEET

MAGNETIC MATERIAL WITHIN SEDIMENTARY SECTION

150 MAXIMUM THICKNESS IN FEET
4·9 sh DEPTH ESTIMATE IN FT/100

FEBRUARY 1968
GEOPHYSICAL ASSOCIATES PTY. LTD.

5 cm

MAGNETIC BASEMENT

(CONTOUR INTERVAL: 1000 FEET)
TOTAL MAGNETIC INTENSITY

AEROMAGNETIC SURVEY EASTERN AND WESTERN BASS STRAIT
AREA A

MAGELLAN PETROLEUM SOUTHERN PTY. LTD.

038055

-SCALE-

Miles 2 1 0 2 4 6 8

COMPILED AND DRAWN BY
GEODRAFTING SERVICES
PROPRIETARY LIMITED

AERO SERVICE
LIMITED

CR-C84

Offshore Airmag part-III*

SHEET 1 5



LINE SPACING —— 2 STATUTE MILES
CONTOUR INTERVAL —— 5 GAMMAS
BASE INTENSITY —— ARBITRARY
ALTITUDE —— 1,000' A.S.L.

REGIONAL VARIATION CORRECTION APPLIED
TRANSVERSE MERCATOR PROJECTION

SHEET INDEX

1
2
3

MAGNETIC BASEMENT ESTIMATES FT/100 SEA LEVEL DATUM

-72 FROM INTRABASEMENT ANOMALY
▨ GOOD ▭ FAIR — POOR

-72s FROM SUPRABASEMENT ANOMALY

OUTLINES AND EDGES OF PLATES FROM SUPRABASEMENT ANOMALIES WITH MAXIMUM THICKNESSES IN FEET ESTIMATED WITH 0.001 POLARIZATION CONTRAST

1500 MAXIMUM THICKNESS IN FEET
800 VERTICAL THICKNESS IN FEET

MAGNETIC MATERIAL WITHIN SEDIMENTARY SECTION

150 MAXIMUM THICKNESS IN FEET
+9 DEPTH ESTIMATE IN FT/100

FEBRUARY 1968
GEOPHYSICAL ASSOCIATES PTY. LTD.

5 cm

MAGNETIC BASEMENT

(CONTOUR INTERVAL: 1000 FEET)

TOTAL MAGNETIC INTENSITY

038056

AEROMAGNETIC SURVEY EASTERN AND WESTERN BASS STRAIT
AREA A-B

MAGELLAN PETROLEUM SOUTHERN PTY. LTD.

-SCALE-

Miles 2 1 0 2 4 6 8

COMPILED AND DRAWN BY
GEODRAFTING SERVICES
PROPRIETARY LIMITED

AERO SERVICE
LIMITED

OR.084

Offshore Airmag part-III*

SHEET 2 6



LINE SPACING — 2 STATUTE MILES
CONTOUR INTERVAL — 5 GAMMAS
BASE INTENSITY — ARBITRARY
ALTITUDE — 1,000' A.S.L.

REGIONAL VARIATION CORRECTION APPLIED
TRANSVERSE MERCATOR PROJECTION

SHEET INDEX

1
2
3

MAGNETIC BASEMENT ESTIMATES FT/100 SEA LEVEL DATUM
FROM INTRABASEMENT ANOMALY
(G) GOOD (F) FAIR ... POOR
-7Z
-7Zs FROM SUPRABASEMENT ANOMALY

OUTLINES AND EDGES OF PLATES FROM SUPRABASEMENT ANOMALIES WITH MAXIMUM THICKNESSES IN FEET ESTIMATED WITH 0·001 POLARIZATION CONTRAST
1500 MAXIMUM THICKNESS IN FEET
800 VERTICAL THICKNESS IN FEET

MAGNETIC MATERIAL WITHIN SEDIMENTARY SECTION
150 MAXIMUM THICKNESS IN FEET
DEPTH ESTIMATE IN FT/100

FEBRUARY 1968
GEOPHYSICAL ASSOCIATES PTY. LTD.

MAGNETIC BASEMENT

038057

(CONTOUR INTERVAL: 1000 FEET)

TOTAL MAGNETIC INTENSITY

AEROMAGNETIC SURVEY EASTERN AND WESTERN BASS STRAIT AREA B

MAGELLAN PETROLEUM SOUTHERN PTY. LTD.

5 cm

~SCALE~

Miles 2 1 0 2 4 6 8

COMPILED AND DRAWN BY
GEODRAFTING SERVICES
PROPRIETARY LIMITED

AERO SERVICE
L I M I T E D

68-084

Offshore Airmag part-III*



LINE SPACING — 2 STATUTE MILES
VERTICAL SCALE (PROFILES) — 1" = 200 GAMMAS
BASE INTENSITY — ARBITRARY
ALTITUDE — 1,000' A.S.L.

REGIONAL VARIATION CORRECTION APPLIED
TRANSVERSE MERCATOR PROJECTION

LOCATION DIAGRAM



MAGNETIC BASEMENT ESTIMATES FT/100 SEA LEVEL DATUM

-72 FROM INTRABASEMENT ANOMALY
GOOD FAIR POOR

-72s FROM SUPRABASEMENT ANOMALY

OUTLINES AND EDGES OF PLATES FROM SUPRABASEMENT ANOMALIES WITH MAXIMUM THICKNESSES IN FEET ESTIMATED WITH 0·001 POLARIZATION CONTRAST

500 1500 MAXIMUM THICKNESS IN FEET
800 800 VERTICAL THICKNESS IN FEET

MAGNETIC MATERIAL WITHIN SEDIMENTARY SECTION

150 150 MAXIMUM THICKNESS IN FEET
+9 sh DEPTH ESTIMATE IN FT/100

FEBRUARY 1968
GEOPHYSICAL ASSOCIATES PTY. LTD.

MAGNETIC BASEMENT

(CONTOUR INTERVAL: 1000 FEET)
TOTAL MAGNETIC INTENSITY

AEROMAGNETIC SURVEY EASTERN AND WESTERN BASS STRAIT
E.L. 5/67

MAGELLAN PETROLEUM SOUTHERN PTY. LTD.
AREA C

5 0 5 10 15 20 Miles

5 cm

COMPILED AND DRAWN BY
GEODRAFTING SERVICES
PROPRIETARY LIMITED

AERO SERVICE
LIMITED

Offshore Airmag part-III*

OR-084