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OEL 33

EUCLA BASIN

1965 EUCLA BASIN GRAVITY SURVEY. PROGRESS AND FINAL REPORTS FOR THE PERIOD 8/11/65 TO FEBRUARY 1966

Submitted by

Outback Oil Co. NL
1966

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PRIMARY INDUSTRIES AND RESOURCES SA

OUTBACK OIL COMPANY N.L.

Registered Office:
DEVON COURT • 6-7 DEQUETTEVILLE TERRACE
KENT TOWN • SOUTH AUSTRALIA
Telephone: 63 4563

Telegrams & Cables: "DEVCRED" Adelaide   Telex: AA 82159

25th November, 1965.

Dear Sir,

Eucla Basin Gravity Survey,
O.E.L. 33, SOUTH AUSTRALIA.
HALF-MONTHLY PROGRESS REPORT FOR PERIOD ENDED 15TH NOVEMBER 1965

Enclosed herewith please find a report on the progress being made in the Eucla Basin by our Company.

It is anticipated that the helicopter gravity survey field work will be completed within two weeks and the contractor has undertaken to render final report for the end of January. A further interim report will be made during the early days of December.

Yours faithfully,
OUTBACK OIL COMPANY N.L.

L.G. ADAM
Secretary

The Director,
South Australian Mines Department,
169, Rundle Street,
ADELAIDE. S.A.

Enclosure

→ Env 537

NOTED
Director of Mines

B.M.R. Reference 65/4819

EUCLA BASIN GRAVITY SURVEY

O.E.L. 33 SOUTH AUSTRALIA

HALF-MONTHLY PROGRESS REPORT

for

PERIOD ENDED 15TH NOVEMBER, 1965

OPERATOR

OUTBACK OIL COMPANY N.L.
Devon Court,
6-7 Dequetteville Terrace,
Kent Town.
South Australia.

CONTRACTOR

GEOSURVEYS OF AUSTRALIA PTY. LTD.
68 Grenfell Street,
Adelaide.
South Australia.

1. DESCRIPTION OF TRAVERSES SURVEYED:

Progress map attached.

2. NUMBER OF NEW STATIONS ESTABLISHED:

268 field stations
3 cell centre stations
13 tie point stations

284 helicopter stations

6 base stations
52 field stations

58 vehicle stations

3. CHANGE IN PERSONNEL EMPLOYED OR EQUIPMENT USED:

(a) Personnel

H. Reith and S. Wood left Adelaide on 29th October, 1965, to commence positioning fuel on cell centres.

R. Hoogenraad, J. Radus, C. Thomson and A. Andre, left Adelaide on 3rd November, 1965.

(b) Equipment

Gravity meter World Wide No. 32 is being used for this survey. It was calibrated on the Adelaide Calibration Range on 27th October, 1965. The meter factor is 0.10055 milligals per scale division.

4. COPIES OF FIELD SHEETS AND LOOP CLOSURE CHARTS:

Field sheets will be made available on completion of field work. Progress Loop Closure Chart is attached.

5. STATEMENT OF HOURS WORKED AND MILES TRAVERSED:

Surveying	Hours worked	3/4
	Miles traversed	3/4

Metering	Helicopter hours	67
	No. of miles not applicable	
	Vehicle stations hours	8

6. TIME LOST DUE TO BAD WEATHER, INSTRUMENT BREAKDOWN OR OTHER CAUSES:

Surveying	Nil
Metering	½ hour (helicopter adjustments)

7. BRIEF DESCRIPTION OF OPERATIONS:

Operations commenced on Monday, 8th November, 1965, with the running of Bases M/L/K/J/H/G. These form a "backbone" of base control for the survey and are tied to the B.M.R. Isogal station 6491-9099 at Cook (value 979,320.91 milligals).

The survey was commenced at the western extreme of the prospect. Cell centres are being used for drift control, while gravity values are being carried forward via the tie points. A loop closure chart is attached.

It was found impossible to recover bench marks of the Commonwealth Transcontinental Railway, so rail elevations are being used. These are available at ½ mile and mile posts. The rails were lifted recently so 1.25 ft. has to be added to the heights as supplied by the Commonwealth Railways. Datum is Mean Sea Level, Port Augusta.

Due to the unfavourable meteorological conditions it is expected that elevation control will be only fair. Gusty winds of 30 knots plus, are prevalent and very few days are calm. Furthermore, it has not been found convenient to position the base barometers on the cell centre being operated. Base barometers are being read at the nearest base station on the railway line, where elevations are available.

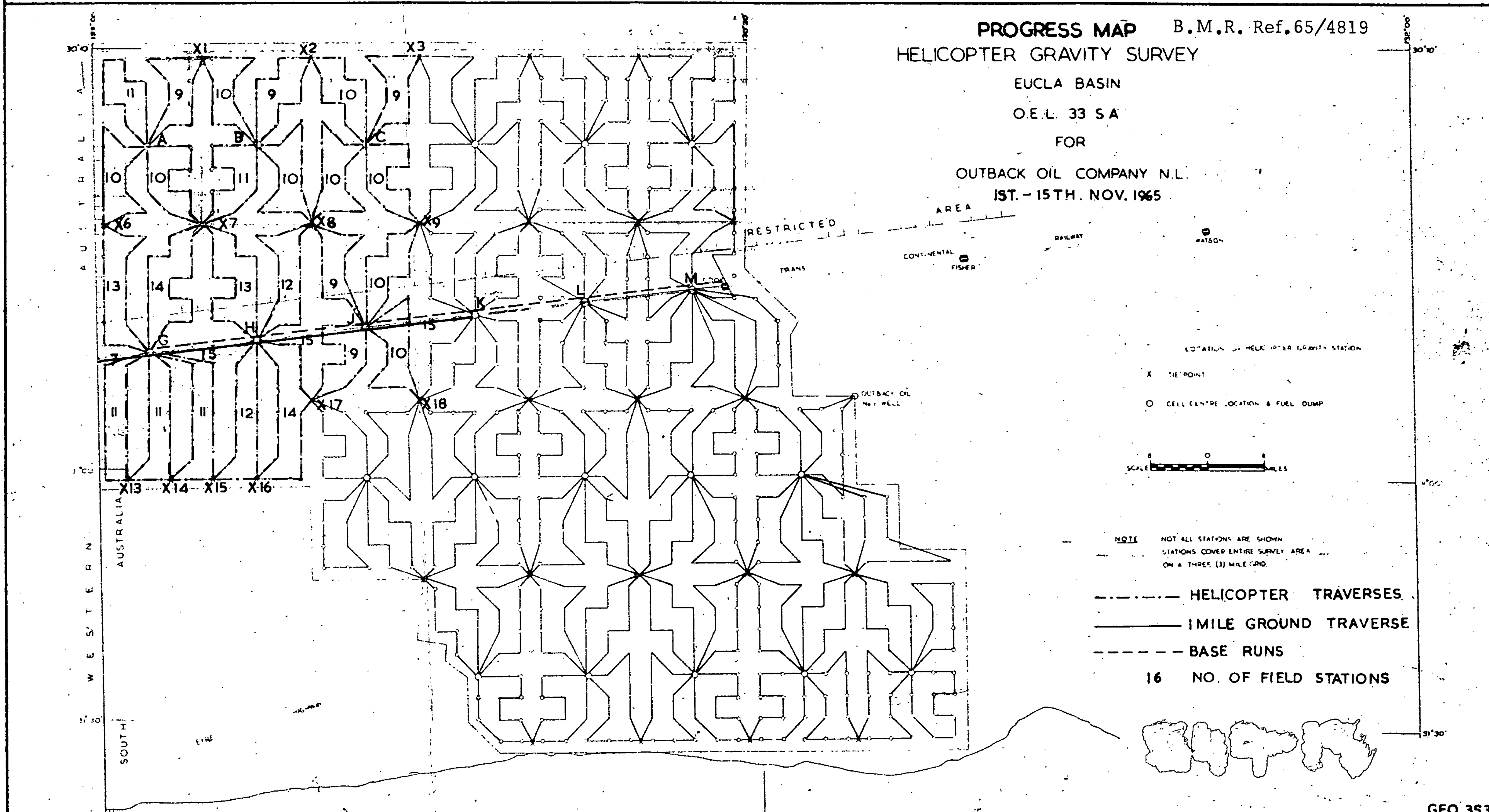
8. PROGRESS BOUGUER ANOMALY MAP:

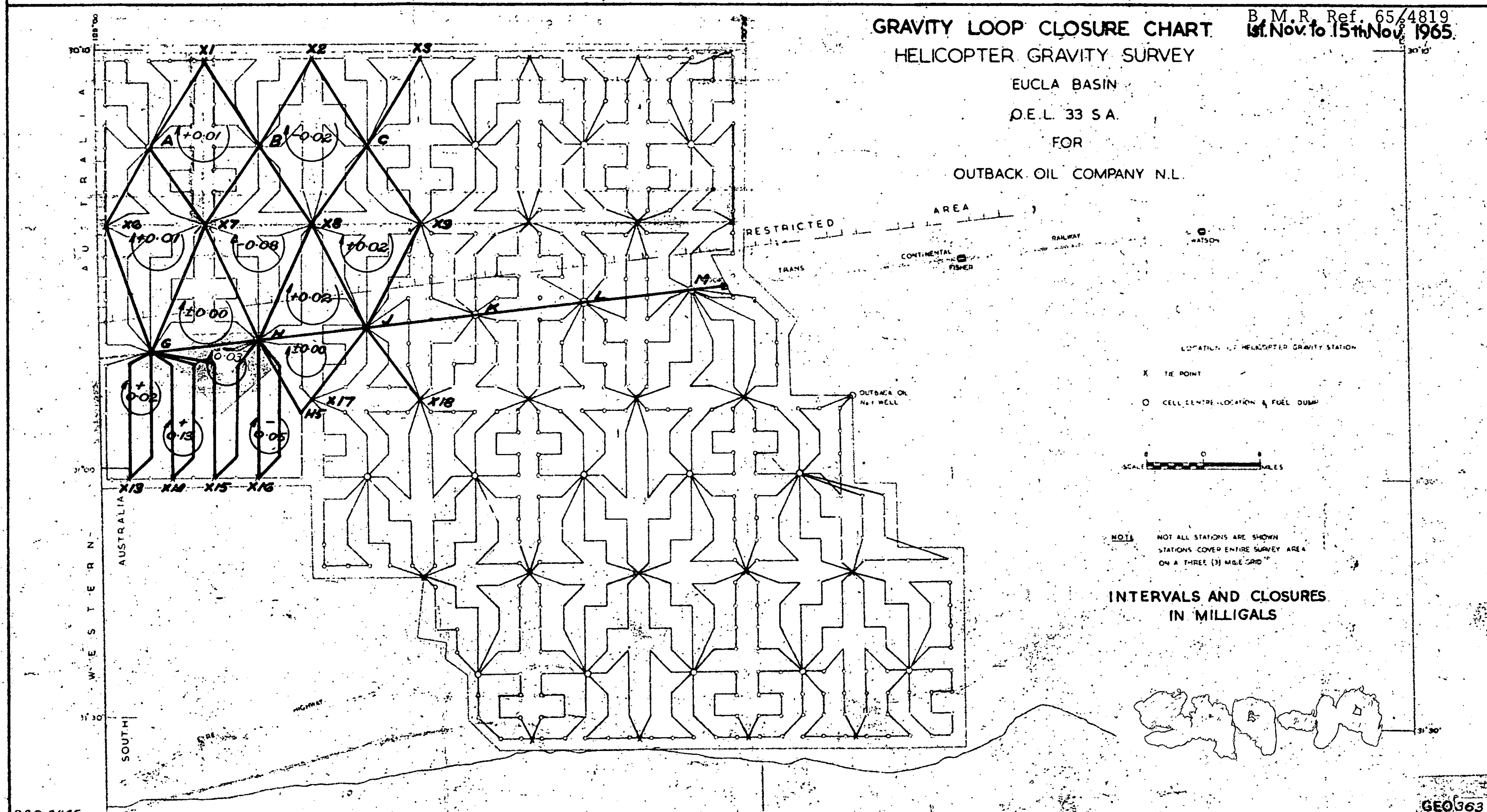
A Progress Bouguer Anomaly Map is attached. Station Location maps and all computations are up to date, but all values and adjustments have still to be checked and, therefore, the Progress Bouguer Anomaly Map is preliminary only.

GEOSURVEYS OF AUSTRALIA PTY. LTD.

W.F. Stackler
W.F. Stackler
Chief Gravity Geophysicist

for W.F. Stackler
Robert M. Hoogenraad
Party Chief


PROGRESS MAP
B.M.R. Ref.65/4819
HELICOPTER GRAVITY SURVEY
EUCLA BASIN
O.E.L. 33 S.A
FOR
OUTBACK OIL COMPANY N.L.
1ST. - 15TH. NOV. 1965
RESTRICTED AREA
TRANS CONTINENTAL RAILWAY
FISHER
WATSON
OUTBACK OIL No 1 WELL
X TIE POINT
HELICOPTER TRAVERSES
1 MILE GROUND TRAVERSE
BASE RUNS
16 NO. OF FIELD STATIONS
NOTE NOT ALL STATIONS ARE SHOWN STATIONS COVER ENTIRE SURVEY AREA ON A THREE (3) MILE GRID.
WESTERN AUSTRALIA
SOUTH AUSTRALIA
X1
X2
X3
X6
X7
X8
X9
X13
X14
X15
X16
X17
X18
30°10'
31°00'
31°30'
GEO 353



B.M.R. Ref. 65/4819
GRAVITY LOOP CLOSURE CHART
1st. Nov. to 15th Nov. 1965.
HELICOPTER GRAVITY SURVEY
EUCLA BASIN
O.E.L. 33 S.A.
FOR
OUTBACK OIL COMPANY N.L.
RESTRICTED AREA
TRANS CONTINENTAL RAILWAY
FISHER
WATSON
OUTBACK OIL No.1 WELL
X TIE POINT
O CELL CENTRE LOCATION & FUEL DUMP
SCALE MILES
NOTE NOT ALL STATIONS ARE SHOWN
STATIONS COVER ENTIRE SURVEY AREA
ON A THREE (3) MILE GRID
INTERVALS AND CLOSURES
IN MILLIGALS
X1
X2
X3
A
B
C
+0.01
-0.02
X6
X7
X8
X9
+0.01
-0.08
+0.02
+0.02
±0.00
G
H
J
K
L
M
-0.03
±0.00
X17
X18
H5
+0.02
+0.13
-0.05
X13
X14
X15
X16
WESTERN AUSTRALIA
SOUTH AUSTRALIA
HIGHWAY
30°10'
31°00'
31°30'
GEO 363
D.R.O. 2/11/65.

B.M.R. Reference 65/4819

EUCLA BASIN GRAVITY SURVEY

O.E.L. 33 SOUTH AUSTRALIA

HALF-MONTHLY PROGRESS REPORT

for

PERIOD ENDED 30TH NOVEMBER, 1965

OPERATOR	OUTBACK OIL COMPANY N.L. Devon Court, 6-7 Dequetteville Terrace, Kent Town. South Australia.
CONTRACTOR	GEOSURVEYS OF AUSTRALIA PTY. LTD. 68 Grenfell Street, Adelaide. South Australia.

1. DESCRIPTION OF TRAVERSES SURVEYED:

Progress map attached.

2. NUMBER OF NEW STATIONS ESTABLISHED:

490 field stations		
7 cell centre stations		
15 tie point stations		
3 base stations		
515 helicopter stations	Progress total	805
65 vehicle stations	Progress total	117
	Progress total to 30th Nov. 1965.	922

(Base stations were erroneously shown as vehicle stations in the last report).

3. CHANGE IN PERSONNEL EMPLOYED OR EQUIPMENT USED:

(a) Personnel

S. Wood, left the field party on Wednesday 24th November, 1965, to commence work on the Murray Basin Gravity Survey.

A. André has taken his place as base barometer observer.

(b) Equipment

The micro-altimeter (Paulin MM-1) became unserviceable on the evening of 29th November, 1965. A set of three altimeters are now in the field, while a set of two are used as base barometers.

4. COPIES OF FIELD SHEETS AND LOOP CLOSURE CHARTS:

Field sheets and a provisional Loop Closure Chart are attached. (Gravity).

5. STATEMENT OF HOURS WORKED AND MILES TRAVERSED:

Surveying	Hours worked	3/4	
	Miles traversed	3/4	
Metering	Helicopter hours	$105\frac{1}{4}$	- Progress Total $172\frac{1}{4}$
	Vehicle station hours	9	- Progress Total 17

6. TIME LOST DUE TO BAD WEATHER, INSTRUMENT BREAKDOWN OR OTHER CAUSES:

Metering	-	4 hours	(servicing helicopter. Vehicle stations were observed in the interim - 20/11/65).
		6 hours	(helicopter breakdown - 21/11/65.)
Elevation control	-	7 hours	(re-run Cell E for elevations - with additional gravity readings at tie points only. 25/11/65).

7. BRIEF DESCRIPTION OF OPERATIONS

Meteorological conditions have improved somewhat during the last fortnight, with strong winds becoming less frequent. However, 22nd November, 1965, was marked by thunderstorms to the north of the prospect area, while temperature inversions in the area of operations necessitated the re-running of Cell E for elevation control.

Ties have been run from Cell centres M to S to W, primarily to give stronger elevation control along the Eyre Highway.

Dr. W.F. Stackler visited the field crew on 20th and 21st November, 1965.

Mr. D. von Sanden visited the field crew on 24th November, 1965.

8. PROGRESS BOUGUER ANOMALY MAP:

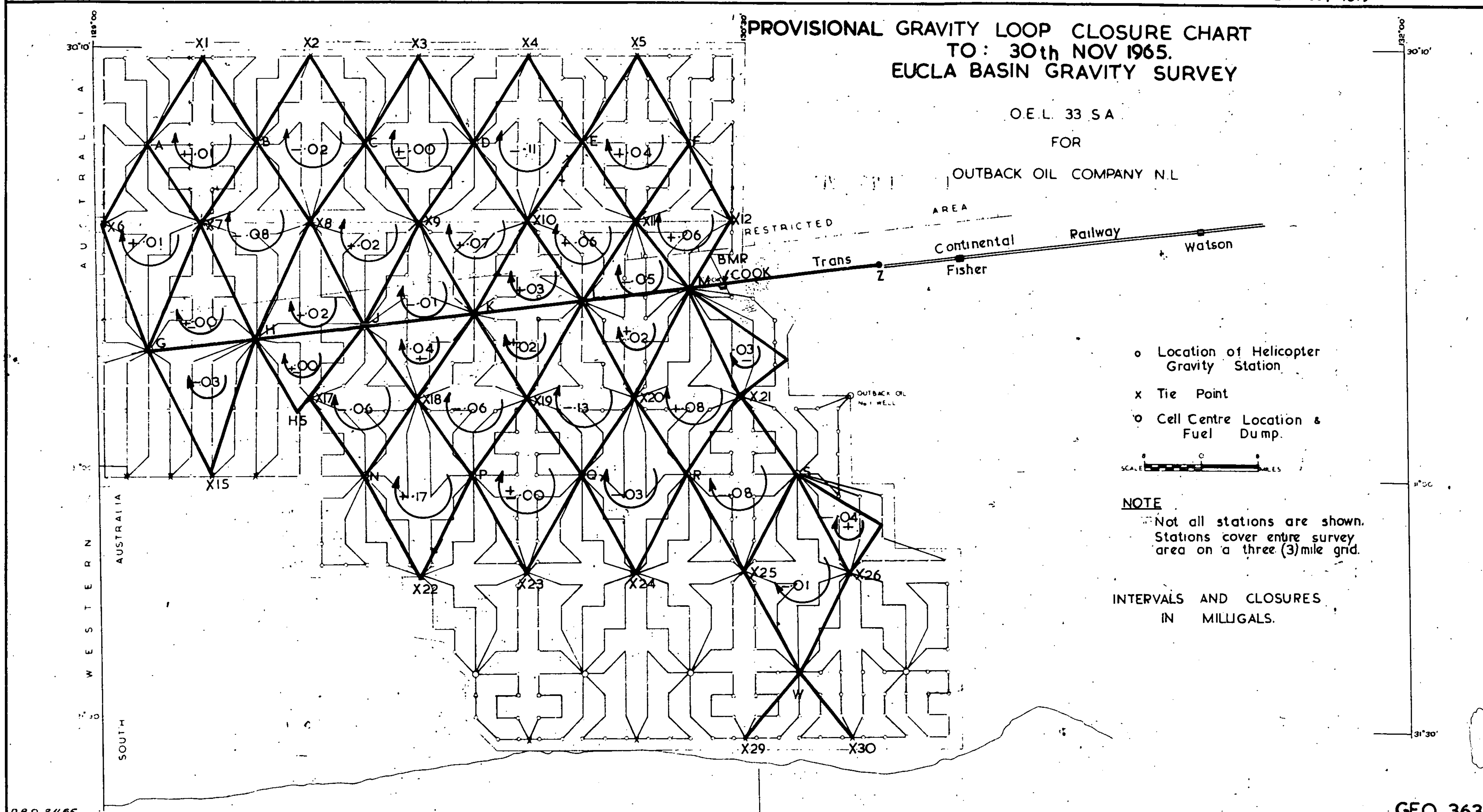
A Progress Bouguer Anomaly Map, incorporating all work up to 25th November, 1965, is attached. This is provisional only.

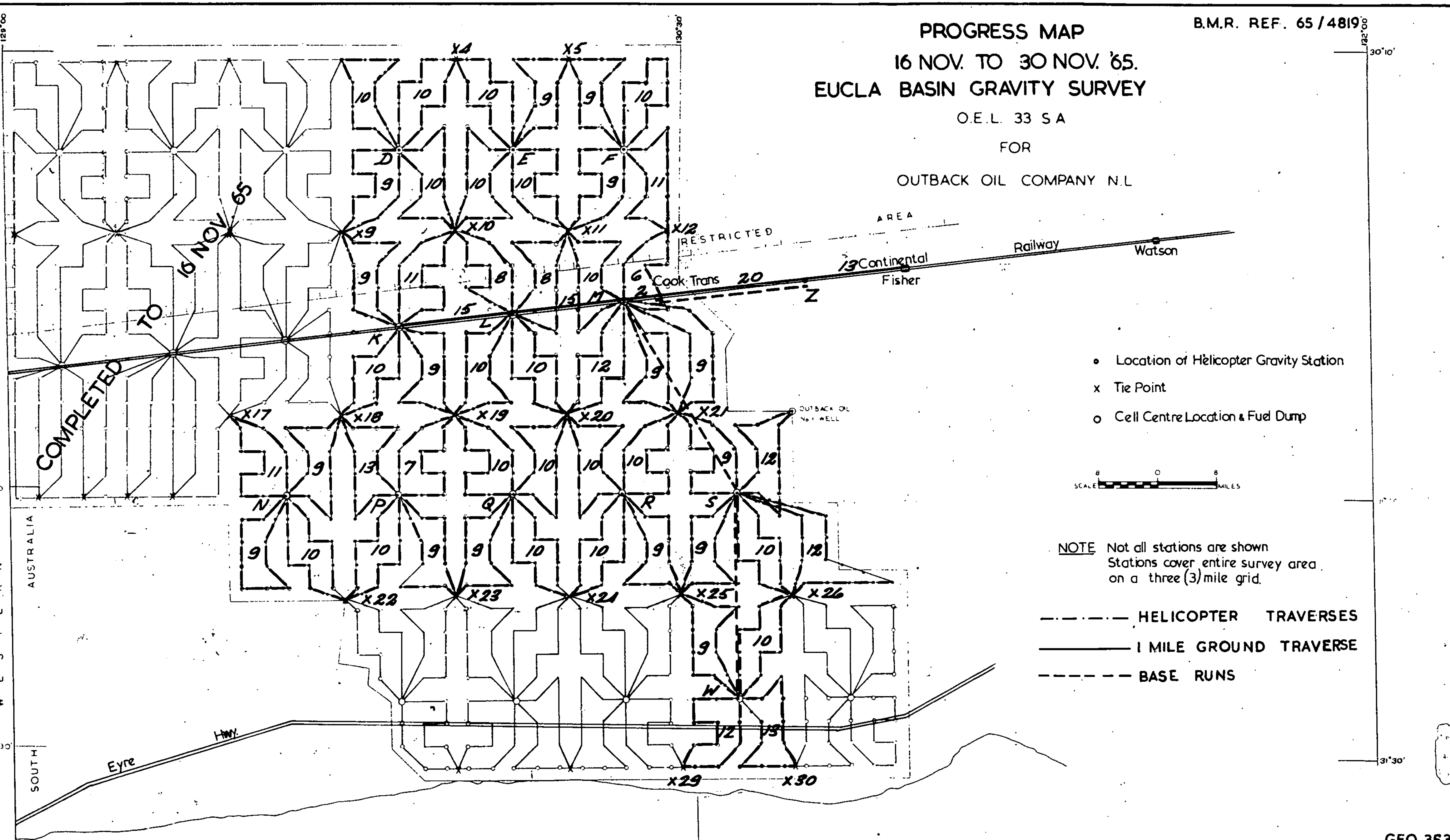
GEOSURVEYS OF AUSTRALIA PTY. LTD.

Robert M. Hoogenraad
Party Chief.

W.F. Stackler
Chief Gravity Geophysicist.

B.M.R. REF. 65/4819





PROGRESS MAP
16 NOV. TO 30 NOV. '65.
EUCLA BASIN GRAVITY SURVEY
O.E.L. 33 S A
FOR
OUTBACK OIL COMPANY N.L
B.M.R. REF. 65 / 4819
COMPLETED TO 16 NOV 65
RESTRICTED AREA
Railway
Watson
Continental
Fisher
Cook Trans
Eyre Hwy.
OUTBACK OIL No 1 WELL
WESTERN AUSTRALIA
SOUTH AUSTRALIA
Location of Helicopter Gravity Station
Tie Point
Cell Centre Location & Fuel Dump
SCALE MILES
NOTE Not all stations are shown
Stations cover entire survey area on a three (3) mile grid.
HELICOPTER TRAVERSES
1 MILE GROUND TRAVERSE
BASE RUNS
D.R.O. 2/11/65.
GEO 353

OUTBACK OIL COMPANY N.L.

EUCLA BASIN GRAVITY SURVEY

O.E.L. 33 SOUTH AUSTRALIA

(FINAL REPORT)

by

R.M. Hoogenraad, W.F. Stackler and R.B. Wilson
Geosurveys of Australia Pty. Limited

February, 1966

1966/1

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ABSTRACT

A gravity survey, involving both helicopter and vehicle operations, was carried out for Outback Oil Co. N.L., by Geosurveys of Australia Pty. Ltd., over approximately 8,500 square miles of O.E.L. 33 (South Australia) in the Eucla Basin.

A 3 mile grid of stations was established, using the helicopter "cell flying" method, covering those portions of the lease that were considered of interest in oil exploration.

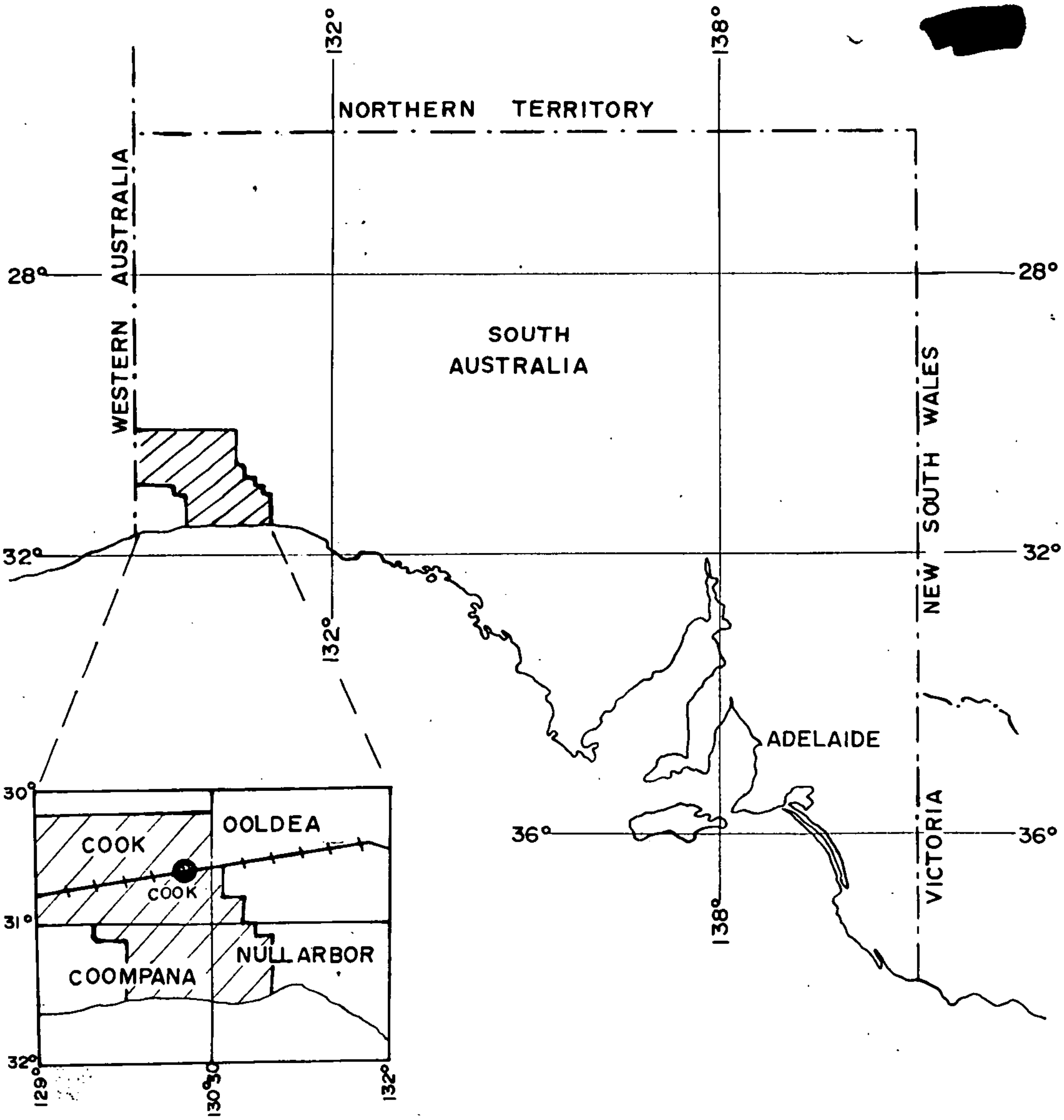
Barometers were used to establish vertical control, while rail heights along the Commonwealth Transcontinental Railway, were used to give a "backbone" of rigid vertical control. Aerial photographs were used to establish station locations and National Mapping Compilation sheets at 1:100,000 provided the basic map.

A traverse of one mile stations at rail height, opposite mile posts on the Transcontinental Railway, was established to aid detailed interpretation.

Observed gravity values are tied into the National Network via the Isogal Stations at Cook and Nullarbor Homestead.

The survey has delineated a broad Bouguer gravity minimum, straddling the Transcontinental Railway. This minimal trend may continue northward from the survey area. A narrow northeast trending minima south of Cook has been outlined.

From borehole and geophysical evidence, the nature of the geological controls reflected by the northeast trending minimum across the Eyre Highway, remains conjectural.



SCALE

MILES 100 0 100 200 300 MILES

LOCATION MAP

EUCLA BASIN GRAVITY SURVEY

OEL. 33 S.A.

FOR

OUTBACK OIL COMPANY N. L.

BY

GEOSURVEYS OF AUST. PTY. LTD.

1966/1

OB 28

I. INTRODUCTION

A gravity survey, involving both helicopter and vehicle operations, was carried out for Outback Oil Co. N.L., by Geosurveys of Australia Pty. Ltd. The survey covers approximately 8,500 square miles of O.E.L. 33 (South Australia). Field work commenced on the 8th of November, 1965, and was completed on the 5th of December, 1965. Survey statistics are detailed in Appendix I, while the Locality Plan, O.B. 28, shows the location of the survey area.

Previous geological and geophysical work had indicated that a more comprehensive gravity survey of the prospect area could reveal areas of interest for more detailed exploration work, particularly in the north-western portion of the area. To this end the present survey was initiated. A 3 mile matrix (grid) of stations was established, using the helicopter cell-flying method, modified after the Bureau of Mineral Resources (Hastie and Walker, 1962; Vale, 1962). Only those portions of the lease that were considered of potential interest in oil exploration were covered.

Barometers were used to establish vertical control, while rail heights along the Commonwealth Transcontinental Railway provided a "backbone" of rigid vertical control. Aerial photographs were marked in the field to establish station locations and National Mapping Compilation sheets at 1:100,000 were used as a basis for the basic map of the area.

A traverse of one mile stations at rail height opposite mile posts on the Commonwealth Transcontinental Railway was established to aid detailed interpretation.

Observed gravity values were tied into the National Network by means of the Isogal Stations at Cook and Nullarbor Homestead.

The survey area covers portion of the Nullarbor Plains, which

[redacted]

consists of a gently undulating limestone plain, sloping downward to the southeast. The total range in elevations is less than 500 feet. Extensive caves underly the plain and are marked by occasional sink-holes, evidence of the development of a karst topography. Cliffs 200 feet or more in height form the coastline of the Great Australian Bight.

A treeless plain commences just north of the Eyre Highway and extends to the northern margin of the survey area, where a sparse tree-cover commences. The area south of the highway has a sparse tree cover. The area is accessible throughout, but kunkar outcrops make travelling rough. The Commonwealth Transcontinental Railway traverses the centre of the area from east to west.

Landmarks are sparse and ambiguous. Navigation from the air using air photographs proved difficult, especially on the treeless plain, while on land the only landmarks are often tracks. As the latter are prone to change, navigation on land must often be by speedometer and magnetic compass.

The climate of the Nullarbor plains, is characterised by strong winds and a large range of temperatures. Daytime temperatures ranged between 45°F and 110°F while 20-30 knot winds were prevalent throughout most of the survey period.

The Maralinga Long Range Weapons Establishment Restricted area, extends northward from a line parallel to, and 5 miles north of the Transcontinental Railway. Permission must be obtained from the Range Commander, Maralinga, prior to entering the restricted area.

II. OBJECTIVE OF SURVEY

That part of the Eucla Basin which lies within South Australia, consists of a relatively thin sequence of marine and paralic Tertiary and Mesozoic sediments, together with possible Palaeozoic sediments, overlying Pre-Cambrian sedimentary and igneous rocks.

Due to the blanketting effect of the ubiquitous flat lying Tertiary Nullarbor Limestone, little is known of the depth and nature of sediments within the basin margins. The records of sparsely scattered bores and the interpretation of the results of a number of geophysical surveys comprises virtually all the known geological information.

The known basement rocks include (?)Archaean granite and gneiss and Proterozoic shales and sandstones. The latter are unmetamorphosed, and uncertainty exists in certain of the bores as to whether they bottomed in Proterozoic or younger (?Lower Cambrian and ?Permian) sediments.

Ludbrook (1965) has placed a tentative Lower Cambrian age on almost 400 feet of interbedded sandstone and oolitic limestone, intersected below 525 feet in Outback Oil Co. N.L's Cook No. 1 Stratigraphic Test Well. Drilling was abandoned at 915 feet, while still in this sequence. Overlying the (?)Lower Cambrian sediments, 55 feet of rapidly deposited pyritic quartz sands were intersected. No age has yet been assigned to the sands, although Ludbrook has suggested certain similarities to Permian sands of the Great Artesian Basin.

The recent re-examination of bore samples from the Nullarbor Plains has established a Permian age for the sequence of the shales intersected from 1132 to 1387 feet in Yangoonabie (Nullarbor No. 8) Bore (N. Ludbrook and W.K. Harris, South Australian Department of Mines).

The Mesozoic consists of Cretaceous shallow marine and paralic basal conglomerate and sandstone, overlain by siltstones and laminated shales. Tertiary sediments nowhere exceed 1,000 feet in thickness within the permit area, and consist of Eocene carbonaceous sands and clays and the Upper Eocene Wilson Bluff Limestone, the latter probably conformable with the overlying Nullarbor Limestone of Lower Miocene age.

Local outliers of Eocene-Tertiary sediments have been reported to rest directly on basement rocks near Maralinga and Tietkins Well to the northeast of the Eucla Basin proper.

Pleistocene calcareous sandstones and aeolianite dunes overly the Tertiary to the south along the Great Australian Bight, to the west along the Western Australian border, and along the western margin of the basin.

Little is known structurally about the basin, the surface outcrop being almost ubiquitously the flat lying Nullarbor Limestone. The sediments slope regionally seaward from the north although the coastal cliffs show them to be monotonously flat in an east-west direction, with dips rarely exceeding one degree.

Photogeological studies have revealed a series of faint northwest-southeast lineaments and also gentle warp-structures, which may relate to underlying structural developments.

An east-west seismic refraction survey along the Eyre Highway from near the Western Australian border to the vicinity of basement outcrops in the east, was conducted by the South Australian Department of Mines. A north-south traverse was run from Cook to the Eyre Highway, with subsidiary traverses in the vicinity of Cook No. 1 Well (Kendall, 1965).

Confirmation of known shallow granitic basement near the Western Australian border was obtained, but the refraction seismic also outlined a steep buried escarpment structure, forming the western edge of a possible "buried trough", some 50 miles east of the border. Bedrock velocities in this vicinity are of the order of 19,000 to 20,000 feet/sec., which in the "buried trough" are overlain by thicknesses of 3,000 to 4,000 feet of rocks with refractor velocities of 14,000 to 16,000 feet/sec.

As stated above, thin developments of sediments, with comparable velocities, have been intersected previously in bores, where they overlie metamorphic basement. In Cook No. 1 Well these sediments have been regarded to be possibly of Lower Cambrian age.

A previous reconnaissance gravity traverse (Gunson and Van der Linden, 1956) along the Eyre Highway, demonstrated a close correspondence of Bouguer anomaly minima with the suspected "buried trough" or sub-basin and the present survey was projected in order to gain a fuller understanding of this northwesterly alligned subsurface feature.

A number of aeromagnetic traverses by the Bureau of Mineral Resources (1956) had indicated that a greater depth to crystalline basement was to be expected in the north of the basin. This was also suggested by comparison of the Bureau of Mineral Resources gravity traverse along the Eyre Highway and along the Transcontinental Railway to the north.

The possible presence of (?)Upper Proterozoic to (?)Lower Palaeozoic sub-basins within the generally thinly sedimented and formerly unprospective Eucla Basin, has substantially upgraded its possible petroleum potential.

III. RESULTS OF THE SURVEY

1. Operational Procedure

a. General

A 3 mile grid of helicopter stations was established using a modification of the "cell flying" method developed by officers of the Bureau of Mineral Resources (Hastie and Walker, 1962). The survey area was divided into 22 cells, usually of circa 40 stations. Each cell consists of a number of flight loops (usually 4, of about 10 field stations each), commencing and ending at the node point at the centre of the cell. The cell is named after its node point. Tie points form a link between adjacent cells and allow both observed gravity and barometric elevations to be carried forward from cell to cell. The tie points and node points form a grid of ties which, when presented on a closure chart, give an indication of the reliability of the basic data (elevations and observed gravity).

Base camps were established at each of the node points on the railway line and also at node points S, U and W. Direct elevation and gravity ties were made between node points M-S-W-V-U-P-K, primarily to strengthen the elevation control.

Cells A to Q, north and south of the railway line, were operated from base camps along the railway line. Cells R to S were operated from a base camp at S, while cells T to Y along the Eyre Highway were operated from base camps at U and W, close to the highway. In this way, flying time between node points and base camp was kept to a minimum, while also vastly simplifying the problems of supply, communication and fuel positioning.

Stations S47, W34 and W37, were placed near cave openings or blow holes in order to ascertain the effect of caves on the final Bouguer value. This is further discussed under Interpretation and Discussion of Results.

One mile traverse stations along the Transcontinental Railway were observed at rail level opposite the mile posts.

b. Gravity Observations

Gravity meter World Wide No. 32 was used for the survey. The meter was calibrated at the beginning and end of the survey on the Bureau of Mineral Resources calibration range in Adelaide (Kensington Gardens to Norton Summit 62.61 milligals).

Date	Scale Factor (milligals/scale division)
27/10/65	0.10055
13/12/65	0.10058

A scale factor of 0.10055 milligals/scale division was used in reduction of the field readings.

Node points M, L, K, J, H and G and base Z, on the Trans-continental Railway were tied to Bureau of Mineral Resources Isogal Station 6491.9099 at Cook, with a number of runs. They form a backbone of base control for the survey.

Node point "Y" is tied to Bureau of Mineral Resources Isogal Station 6491.9120 at Nullarbor Homestead with a number of runs. Mistie with the adjusted value of Y was 0.04 milligals.

Drift control was obtained by re-occupying the node point of the cell being operated. The time lapse was generally less than 2 hours for each loop.

Time Lapse	No. of Loops	% of Total
76 - 80 (minutes)	2	2
81 - 100	37	39
101 - 120	36	38
121 - 140	12	13
141 - 160	5	5
161 - 176	3	3
Total	95	100

The mode lies in the range 80 to 120 minutes.

The one mile traverse stations are tied to the node points on the railway line and to vehicle base Z between Cook and Forrest. Drift control for these stations was always within 2 hours.

c. Elevation Control

Node points on the Transcontinental Railway were tied to rail heights opposite $\frac{1}{2}$ mile posts by short theodolite ties. Rail heights supplied by the Commonwealth Railways were corrected to datum, which is Mean Sea Level, Port Augusta. They are correct to $\pm$ 0.5 feet; however, as the original bench marks are lost or destroyed, rail heights constitute the highest order of elevation control available in the area.

Elevation control for helicopter stations was by altimeter (see Appendix II for specifications). Three altimeters were read in the field, while a set of three altimeters, read at 10 minute intervals, and an automatically recording "barograph", were used for base control.

Field altimeter drift control was obtained by re-occupying the node point of the cell being operated. (For time interval between drift control readings, see "b. Gravity Observations".)

Base altimeters were read at the base camp (at G, H, J, K, L and M and at S, W and U). Thus the northernmost stations of cells A to F and the southernmost stations of cells N to Q were up to 45 miles from base control, while the node points were up to 18 miles from base control. The most easterly stations of cell Y and the most westerly stations of cells R, V and T were up to 21 miles from base control and the node points up to 15 miles from base control.

Loop closures and index adjustments (see "Reduction of Data") [redacted] 050

indicate that the most satisfactory results were obtained when the stations being operated were sensibly north or south from base control. This is no doubt related to the easterly movement of pressure patterns across the Nullarbor plains.

While the terrain on the Nullarbor plains is favourable for altimetry, with few sudden rises and a small range of elevations (under 500 feet in total), weather conditions are generally most unfavourable. Temperatures commonly ranged between $50^{\circ}F$ and $100^{\circ}F$, while the altimeters are calibrated for $50^{\circ}F$. Gusty winds up to 30 knots occur quite generally and this caused some erratic instrument behaviour. As the weather was generally unfavourable, operations were carried on even when this would not normally have been considered good practice. However, one cell, cell E, was re-run for elevation control when thunderstorms localised in the area of operation caused unacceptably large misties, presumably due to rapid pressure and temperature fluctuations.

d. <u>Station Location</u>

Land stations were established opposite mile posts on the Transcontinental Railway.

Helicopter stations were identified and pricked on air photos supplied by the Department of National Mapping. The photos were flown at 25,000 feet and are controlled on photo-compilation sheets at a scale of 1:100,000. Stations were transferred to compilation sheets using normal photogrammetric techniques.

Navigation (using air photographs and magnetic compass), proved difficult on the treeless plain portion of the Nullarbor.

However, photo-identification of the stations is generally better than ± 150 feet where stations were placed in claypans or small subcircular internal drainage depressions (known locally as "dongas") which are the most outstanding features in the area, but this was not always possible. Doubt exists as to the precise location of the following stations; L14 (± 300 yards), L26, S9, S30, S50, W12 (± 400 feet). However, none of these stations give rise to unsubstantiated local anomalies so that the position assigned to them would appear to be satisfactory.

Transferring of the stations from photographs to compilation sheets is correct to ± 150 feet, so that the final position of the stations has a minimum standard error of ± 200 feet.

2. Reduction of Data

a. Observed Gravity

Observed gravity is tied into the National Network via the Isogal Station 6491.9099 at Cook (Observed Gravity = 979,320.91 milligals).

The survey is also tied to Isogal Station 6491.9120 at Nullarbor Homestead (Observed Gravity = 979,405.75 milligals).

The node points and tie points form a grid of gravity ties (see Gravity Loop Closure Chart, O.B. 15). This grid was adjusted to zero misclosure using standard adjusting techniques. The adjustment was distributed proportionally among the stations on each flight loop.

Greatest loop misclose	0.17 milligals
Mean loop misclose	0.05 "

Greatest limb adjustment	0.09 milligals
Mean limb adjustment	0.03 "

The standard error is estimated as 0.03 milligals.

This estimate is based on the mean limb adjustment. Reliability in any particular portion of the area is best ascertained from the Gravity Loop Closure Chart.

b. <u>Elevations</u>

Elevation datum is Mean Sea Level, Port Augusta. Basic survey control is rail level opposite mile and half mile posts on the Transcontinental Railway (error, as supplied by Commonwealth Railways is $\pm$ 0.5 feet).

The Paulin barograph was used only as a check on the base altimeters. The altimeters are calibrated to read in feet at 50°F. The isothermal atmosphere formula was used for reduction of the altimeter readings (e.g. see Clark "Plane and Geodetic Surveying").

$$\triangle z = (Ro - Rb - I)\left(1 + \frac{To + Tb - 100}{K}\right)$$

where:-

$\triangle z$	is the height of the station with respect to the node point of the cell being operated.
Ro	is the observed field reading.
Rb	is the simultaneous base reading (interpolated if necessary).
To, Tb	are the field and base temperatures.
K	is a constant, which was taken as 1,000 to sufficient accuracy.
I	is the index adjustment.

At the node point I = Ro - Rb. The change in index adjustment was assumed to be linear between subsequent re-occupations of the node point.

As it was not economically or logistically plausible to always operate the base altimeters at the node point of the cell being operated, it was assumed that the pressure difference between the node point of the cell and the base altimeter control was constant.

Where this was not in actual fact so, the change in index adjustment, beside being compounded of normal and erratic instrument drift will also contain the variation in this pressure difference. Since the change in index adjustment was normally random for the three field instruments, it can be deduced that the pressure difference between the node point and base control normally varied only slowly.

The rapid changes in altitude inherent in helicopter operations caused a significant incidence of erratic instrument behaviour and where one instrument was found to differ widely from the others, its reading was discarded. This was not necessary for the base altimeters.

Tie points and node points form a grid which was subsequently adjusted (Elevation Loop Closure Map, O.B. 14). The direct tie M-S-W-V-U-P-K was adjusted initially. The large total mistie of the region south of the railway line is thought to relate principally to the section close to the cliffs, where large temperature gradients were encountered, and large and erratic pressure gradients are to be expected.

Largest loop mistie is	43 feet
Mean loop mistie is	12 "
Large limb adjustment is	30 "
Mean limb adjustment is	6 "

The standard error in the elevations will increase away from the basic control on the railway line. An elevation reliability diagram on the Bouguer Anomaly Map (O.B. 12) shows the estimated errors. It increases from 0.5 feet (.03 milligals) on the railway line to 8 feet along the northern margin of the survey and 18 feet along the southern margin. The estimates are based on the mean limb adjustment at various distances from the railway.

Ties were made to 2 barometrically levelled National Mapping markers. NME 205 (M33) 15 miles south of Cook, mistied by -14 feet. NME 92, on the Great Australian Bight, mistied by -20 feet. No ties to the barometrically levelled Bureau of Mineral Resources traverse along the Eyre Highway were made, but indications are that the elevations of the present survey differ with these elevations by up to 20 feet.

c. Latitude Correction

Lines of equal latitude correction (isogals of latitude correction) were drawn on the work maps and the latitude correction scaled off.

Minimum standard error in the station location is ± 200 feet, corresponding to approximately 0.04 milligals. Error in scaling off the latitude correction is ± 0.01 milligals. Total standard error in latitude correction is ± 0.05 milligals.

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d. Elevation Correction

An elevation correction factor of 0.06344 milligals/foot was used, corresponding to a density of 2.4 gm/cm^3. This is in accord with the blanketting cover of kunkarised limestone on the Nullarbor plains.

Standard error in the elevation correction is estimated to vary from 0.03 milligals in the vicinity of the railway line to approximately 0.50 milligals at the northern margin of the survey area and approximately 1.10 milligals on the Great Australian Bight.

e. Terrain Correction

Terrain corrections were necessary only for stations close to the cliff. However, as they were all less than 0.04 milligals they were disregarded, except in the case of NME 92. This is within 20 feet of the cliff and has a terrain correction of approximately 2.64 milligals.

f. Accuracy of Data

It must be stressed that the following are merely estimates of the standard error (in milligals).

Error in	Railway Line	Northern Margin	Southern Margin
Observed Gravity (OG)	0.02	0.04	0.06
Latitude Correction (LC)	0.05	0.05	0.05
Elevation Correction (EC)	0.03	0.50	1.10
Terrain Correction (TC)	0.00	0.00	0.03
$\sqrt{OG^2+LC^2+EC^2+TC^2}$	.06	0.50	1.10

[redacted]

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3. Maps and Profiles

National Mapping photo-compilation sheets at 1:100,000 provide the basis for the basic work maps of this survey. Stations were plotted on these maps and an Elevation Map and a Contoured Bouguer Anomaly Map prepared at 1:100,000. These were photographically reduced to 1:250,000.

Elevation and Gravity Loop Closure Maps were prepared at 1:250,000. A chart of selected Bouguer anomaly profiles at 1:250,000 was prepared. The Bureau of Mineral Resources profiles (Gunson and Van der Linden, 1956) along the railway line and the Eyre Highway, are shown for comparison. This chart also shows the results of the South Australian Department of Mines Refraction Seismic Survey and the Bureau of Mineral Resources Aeromagnetic Profiles for comparison.

The following maps were prepared for this project:-

a. Work Maps

O.B. 25 : A,B & C.	1:100,000	Bouguer Anomaly Maps
O.B. 26 : A,B & C.	"	"
O.B. 27 : B & C.	"	"
O.B. 22 : A,B & C.	1:100,000	Elevation and Station Location Maps.
O.B. 23 : A,B & C.	"	"
O.B. 24 : B & C.	"	"

b. Maps and Charts

O.B. 12	1:250,000	Bouguer Anomaly Map (contoured at 1 milligal intervals).
O.B. 11	"	Elevation & Station Location Map.
O.B. 15	"	Gravity Loop Closure Map.
O.B. 14	"	Elevation Loop Closure Map.
O.B. 21	"	Geophysical Profiles.

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IV. DISCUSSIONS AND INTERPRETATION OF RESULTS

1. General

The following points were kept in mind in assessment of the results of this survey.

i. The survey is a regional one, so that only the broader Bouguer anomalies are outlined.

ii. The reliability of the basic data decreases away from the Transcontinental Railway. Estimated standard error ranges up to 1.1 milligals along the southern margin of the survey. Comparison with the Bureau of Mineral Resources gravity profile along the Eyre Highway shows that values of the present survey vary randomly by up to 3 milligals from values of that traverse (see Geophysical Profiles O.B. 15). However, this could be due to poor station locations for the 1954-55 Bureau of Mineral Resources survey, for which no rigidly controlled maps were available.

iii. The Nullarbor plain is underlain by extensive caves. Test stations placed over known caves indicate that these could give rise to local anomalies of perhaps -1.5 milligals where the cave is large and close to the surface.

Geological and geophysical data in the prospect area is sparse. Photogeological interpretation outlining lineaments and structural trends gives the only comprehensive coverage. Under "Discussion of Results and Correlation with Photogeological Features" the relationship of Bouguer anomaly trends and photogeological trends is discussed. Under "Summary and Interpretation" the relationship and implications of all geological and geophysical data is discussed.

2. <u>Discussion of Results and Comparison with Photogeological Features.</u>

The main Bouguer anomaly trends and features as discussed in this chapter are represented by the letters A to I. Their locations are shown on the Bouguer Anomaly Map (O.B. 12A). The principal photogeological features, numbered 1 to 12, are shown on map (O.B. 20).

It should be mentioned here, that the photogeological evaluation was conducted for C.C. Winn by the Photogravity Company Inc., Houston, Texas. Some of the photogeological features have been investigated in the field. Some lineaments have topographic expression, while others were found to have no significant expression in the field. Many of the interpreted fold structures could not be confirmed in the field. (N. Papalia, Geosurveys of Australia Ltd., Weekly Report No. 3, 26/6/64 to Outback Oil Co. N.L.). However, the photogeological features, as delineated by Photogravity Company Inc., have been used to correlate with the gravity features in this report and no discussion is entered into upon their relative merits.

In a broadly regional sense, two major gravity trends are discernible. A northwesterly trend intersected by a northeasterly trend of anomalies gives rise to circular and elongate maxima and minima. The elongate anomalies are aligned along northeasterly or northwesterly axes.

In the central portion of the prospect area the dominant trend of anomalies is northwesterly but this trend is intersected in the northwestern and southeastern portions of the survey area by strongly transverse (northeasterly) trends.

a. <u>Feature A</u>

An elongated northwest trending maximum, with a contour

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"closure" of approximately 6 milligals, situated some 20 miles northwest of Cook, has been designated Feature A.

The maximum is narrow and bounded by gradients of between 1 and 2 milligals per mile. It is intersected at its southeastern extreme by a southwesterly-nosing maximum, some 6 miles east of Cook.

Photogeological Feature 1, a north to northwest trending anticline axis, is situated in the general vicinity of gravity Feature A, although its axis does not correspond exactly with the axis of the maximum.

b. Feature B

Gravity Feature B consists of three gravity minima, centred on a northwest trending axis through the central portion of the prospect area. Together they form a broad elongated zone of gravity minimum, the axis of which passes almost through Denman Railway Siding.

This broad minimum is cut-off to the southeast by the southwest nosing maximum, which also intersects Feature A. A circular minimum anomaly, southeast of this intersecting maximum, is situated at the intersection of the major northwestern (B) and northeastern (C) trends of minimum gravity.

Minimum B is broadest at its northwestern extreme to the north of Hughes Railway Siding, and narrows to the southeast.

Photogeological Feature 2, a northwest-trending synclinal axis, approximates the axis of gravity Feature B, to the southeast of Denman.

Strong northwest trending lineaments (photogeological features 4, 5, 6, 7 and 8) throughout the area, are remarkably parallel to this major northwest trending development of minima forming Feature B.

c. <u>Feature C</u>

Feature C consists of a number of connected minima extending from south of Yangoonabie Bore on the Eyre Highway to a point southwest of Cook No. 1 Stratigraphic Well.

The feature comprises two minima, of some 4 milligals of closure, centred on the Eyre Highway, connected by a narrow "saddle" to a narrow minimum of some 6 milligals closure, elongated in a northeast direction. At a point some 10 miles south of Cook No.1 Well, this minimum intersects a northwesterly trending minimum which lies on the same axis as Feature B.

The most outstanding unit of Feature C is the northeasterly trending elongated minimum, which is centred on the main road linking Cook to the Eyre Highway.

Bouguer values increase east and southeast from Feature C, which is bounded to the immediate east by a tortuous zone of gradients of approximately 2 milligals per mile.

Photogeological Feature 9, a distinct northeasterly trend, is parallel with the northeast trending gravity Feature C.

Photogeological Feature 3, an interpreted syncline axis trending south to southwest, corresponds approximately to minor embayments in the isogals south of Cook, and also to the above described minimum, south of Cook No. 1 Well.

d. Feature D

Gravity Feature C, is bounded to the southeast by a large maximum, Feature D, which noses in a general northwest direction.

A distinct minimal embayment trends southeasterly from Feature C into positive Feature D, in the vicinity of Nullarbor Homestead.

Minor northeast trending nosings of isogals, north of the highway appear to align with photogeological Feature 9.

e. Features E, F and G

A broad gravity maximum, delineated by an earlier survey (Gunson and Van der Linden, 1956), extends across the Western Australia border into the southwestern corner of the prospect area. This portion of the area was not covered by the present survey, as it was known to be an area of shallow granitic basement with little or no potential in oil exploration. Features E, F and G delineate the extremes of this maximum.

Feature E, a bunching of isogals across the Eyre Highway in the vicinity of Koonalda Homestead, shows an easterly directed gradient of between 2 and 3 milligals per mile, the strongest gradient in the prospect area.

Features F and G are broad northeasterly nosings of the above described maximum into the survey area, the latter cutting across the Transcontinental Railway west of Hughes.

Photogeological Feature 12, an interpreted fault, corresponds broadly with the northeastern boundary of the nosing maximum G.

Farther to the northwest, photogeological lineaments 5 and 6 correspond approximately with the gradient zone between Features G and B. However, photogeological lineaments 7 and 8 do not follow any known gravity trends and appear to cut across a number of features and trends.

f. <u>Feature H</u>

Feature H consists of a number of minor anomalies forming a northwesterly trend, intersected by some southwesterly nosing of isogals. The major unit of Feature H, a northwesterly aligned maximum shows an approximate correspondence with photogeological Feature 10, an interpreted northwest trending anticline. Trends of isogals associated with Feature H, align with photogeological lineaments 5 and 6.

g. <u>Feature J</u>

Feature J, although not a particular anomaly or series of anomalies, is designated as such to illustrate a zone of northeasterly trending isogals which tends to interupt the northwest trending major gravity Features A and B in the northwestern corner of the survey area.

Northeast trending photogeological lineaments (number 11), some 27 miles northwest from Hughes Railway Siding, are coincident with the northeast trending Bouguer anomaly contours in their vicinity.

3. <u>Summary and Interpretation</u>

The main gravity features and their relation to certain photogeological elements, has been described under the previous heading.

The greatest density of geological and geophysical control is found along the Eyre Highway. Map No. O.B. 21, reproduces this information in the form of profiles.

From the western margin of the prospect area, shallow granitic basement is indicated by aeromagnetic and geological (water-bores) evidence, extending from across the Western Australian border to the vicinity of Koonalda Homestead. This region is also the locus of a general gravity "high", which, however, was not covered by the present survey.

A refraction seismic survey (South Australian Department of Mines), has delineated a 19,700 feet/sec. refractor at a depth of 4,800 feet below sea level, in the vicinity of Yangoonabie Bore. This refractor has been correlated with the granitic basement intersected at 960 feet below sea level in Guinewarra Bore, some 4 to 5 miles east of Koonalda Homestead.

The aeromagnetic profile (see Map O.B. 21) indicates that the depth to magnetic basement increases considerably in the region between Guinewarra and Yangoonabie Bores. As stated above a positive gravity anomaly coincides with the shallow granitic basement and the gravity gradients to the east of Koonalda Homestead (Feature E) confirm the presence of an east facing buried escarpment.

The gravity maximum feature west of Koonalda extends northward across the Transcontinental Railway (Feature F). The aeromagnetic profile along the railway indicates shallow magnetic basement corresponding with the gravity maximum and it seems certain that they relate to the same structure encountered along the Eyre Highway.

To the east of gravity Feature E, along the Eyre Highway, the gravitational minimum, Feature C, corresponds well with the sub-basin or "buried escarpment" structure outlined by refraction seismic probes. This minimum Feature C extends further eastward to approximately the junction of the Cook Road with the Eyre Highway. At this point an increase in the Bouguer anomaly, a sharp peak in the aeromagnetic profile and the recording of a gently east-dipping 15,900 feet/sec. refractor horizon, indicate a marked change in the nature of the basin. The 19,500 feet/sec. refractor continues with only minor fluctuations in depth until it rises gently to the east of Nullarbor Homestead. However, the Bouguer anomaly appears to be a composite of a large maximum with a considerable minimum embaying into it along the Eyre Highway. The implications of this are open to question, but it seems that the general gravity pattern in this area reflects a change within the basin rather than a change in depth to basement. The sharp aeromagnetic high points to a change in basement composition. Banded iron formations of early Precambrian age are known to occur in many localities in outcrop within the general Gawler Nucleus and could account for such an aeromagnetic anomaly. Alternatively, the wide-spacing of the refraction seismic probes (approximately 12 mile intervals), would allow a sharp peak in the basement floor of the presumed sub-basin if located midway between 2 such probes.

The second seismic line southward from Cook, shows a 19,500 to 20,300 feet/sec. refractor which gently shelves to the north. A minor "high" in the Bouguer anomaly some 12 miles north of the Eyre Highway, corresponds to a rise in the high speed refraction surface. The gravity minimum which obliquely crosses the road some 35 miles south of Cook, seems to be related to an interpreted "wedge" of a lower speed (16,000 - 16,500 feet/sec.) refracting interface, encountered on the seismic traverse. This could be related to a possible synclinal trough of (?)Cambrian sediments which were encountered below 525 feet in Cook No. 1 Well (Outback Oil Co. N.L.).

The general rise in Bouguer anomaly from minimum Feature C, northwards toward Cook, corresponds with the gentle shallowing of the high speed seismic refractor in this direction.

Thus there is certainly a close agreement between the three geophysical methods along the profiles for which all information is available.

The inference, particularly from the refraction seismic profiles, but also supported by gravity and aeromagnetic results, is that there is a marked trough in the crystalline basement surface. The western slope of this "buried trough" appears from aeromagnetic and Bouguer gradients to be steeper than its eastern or northern slopes. The information from seismic probes at Guinewarra and Yangoonabie Bores is not sufficiently close-spaced to obtain a reliable dip on the east-sloping basement surface.

More detailed traversing would be required to show whether the western margin of the "buried trough" is a fault (or monocline) or whether it is a more gently sloping erosional surface.

Shallow refractors with velocities varying from 11,000 to 16,000 feet/sec. have been traced throughout the two refraction seismic profiles and suggest the possible presence of Upper Proterozoic to Lower Palaeozoic sediments with thicknesses reaching up to 4,000 feet. Purple and grey shales of possible Upper Proterozoic age, have been intersected beneath Cretaceous sediments in some bores, while interbedded sandstone and oolitic limestone penetrated in the lower 390' of the Cook No. 1 Well (Outback Oil Co. N.L.) have been regarded as possibly

Cambrian in age.

Thus it seems probable that the postulated "buried trough" in the basement, is infilled with Upper Proterozoic to Lower Palaeozoic sediments. An intersection of feldspar porphyry shown from a depth of 1387 feet to total depth (1500 feet) in the Yangoonabie Bore is a puzzling feature which corresponds in depth to the 16,000 feet/sec. seismic refractor. The porphyry has been petrographically correlated with the Moonabie and Gawler Range porphyries. These latter extensive porphyry masses are thought to be partly intrusive and partly extrusive although their age of emplacement is not known.

It seems then, until further more detailed work is done, leading up to the drilling of a stratigraphic well, the possibility that the postulated "buried trough", at least in its southern extensions, may be infilled with an extensive outpouring of porphyry lavas, must be kept in mind. If such were the case, the low velocity factor and the corresponding density contrast with basement required to produce the Bouguer gradient (Feature E) would seem surprisingly low for an igneous rock.

A third alternative that this porphyry may occur as intrusive sills within Upper Proterozoic to Lower Palaeozoic sediments, is also possible.

The interpretation of the high-speed refractor layer by the South Australian Department of Mines (G.W. Kendall, 1965) has shown the trend of the suspected basement trough to be aligned in a northwesterly direction. From the present survey, the two main gravity troughs, Features B and C, suggest the trough to be trending at first northeastward from the coast across the Eyre Highway, and to swing to the northwest, to correspond with the gravity trough, Feature B. The geological controls for such a configuration would appear to be related to northeasterly and northwest trending major basement lineaments. A similar pattern of such fundamental lineaments is postulated to form the Gawler Cratonic Nucleus, to the immediate east of the Eucla Basin. Major northwest trending lineaments are the Eyre and Gardiner lineaments while the Pidinga and Lincoln Lineaments outline the respective northwestern and southeastern margins of the Gawler Nucleus. (Dickinson S.B., and Sprigg, R.C., 1953).

The existence of refractor velocities of 11,000 feet/sec. suggests the possible presence of thin wedges of Permian sediments preserved beneath the Cretaceous - Tertiary cover of the Nullarbor plains area. A possible Permian age has been suggested for 50 feet of un-named probably pre-Cretaceous and post (?)Cambrian sandstone, intersected in the Cook No. 1 Well.

A thickness of 255 feet of blue shale penetrated from 1132 feet to 1387 feet in the Yangoonabie Bore (Nullarbor No. 8) has recently been demonstrated to be of Permian age.

The Bureau of Mineral Resources aeromagnetic profile along the Transcontinental Railway, shows a general correlation with the Bouguer profile, with shallow basement predicted near the Western Australian border.

To summarize, the major Bouguer anomaly feature in the prospect area is the broad northwest trending series of minima (Feature B) the axis of which passes through Denman. This suggests the presence of a broad elongated basin trending northwesterly, with greatest depths to basement (possibly 5,000 to 6,000 feet or more) being attained to the northeast of Hughes. On this basis, Feature A would be interpreted as an anticlinal structure, striking northwest, either within the basin delineated by B or forming its northeastern margin. In either case such a structure would probably be influenced by shallowing crystalline basement.

Depth interpretations from aeromagnetic surveys to the north of O.E.L. 33, carried out by Brown Geophysical Co., indicate deepening basement in this direction, although the reliability of depth estimations based wholly on aeromagnetics, is open to question.

V. CONCLUSIONS AND RECOMMENDATIONS

The possibility of the existence of basement troughs, particularly the one trending northwest to correspond to Gravity Feature B, within O.E.L. 33 has been demonstrated by this reconnaissance gravity survey.

The nature of the infilling of such interpreted troughs is still open to conjecture, although the current stratigraphic drilling programme may solve some of these problems.

Now that the possible troughs have been broadly delineated, further more detailed gravity and refraction seismic work would be necessary in order to select targets for exploratory wells.

The detailed programming of such additional work in the suspected trough areas would best be delayed until the results of the current stratigraphic shallow drilling programme are available.

R.M. Hoogenraad Robert Hoogenraad

W.F. Stackler W.F. Stackler

R.B. Wilson R.B. Wilson per R.M.H.

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VI. REFERENCES

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HASTIE, L.M., and WALKER, D.G., 1962. "Two methods of Gravity Traversing with Helicopters". B.M.R. Record 1962/134.

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VALE, K.R., 1962. "Reconnaissance Gravity Surveys, using Helicopters, for Oil Search in Australia". B.M.R. Record 1962/130.

Maps for Reference

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By Brown Geophysical Co. for C.C. Winn.

"Photogeologic Evaluation of part of the Eucla Basin, Australia". Scale 1" = 2 miles.
By Photogravity Co. Inc. for C.C. Winn.

"Refraction Seismic Survey - Eucla Basin", 1964. South Australian Department of Mines - G.W. Kendall.

(a) Cross Section - Albala Karoo Bore to Nullarbor No. 7 Bore 1" = 4 miles (L65-39).

(b) High Speed Refractor - Contour Plan (65-73) 1" = 8 miles.

(c) Cross Section D14 to Cook Township Bore 1" = 4 miles (65-74).

APPENDIX I

SURVEY STATISTICS

Operator

Outback Oil Co. N.L.,
Devon Court,
6-7 Dequetteville Terrace,
Kent Town.
South Australia.

Contractor

Geosurveys of Australia Pty. Limited,
Da Costa Building,
68 Grenfell Street,
Adelaide.
South Australia.

Locality of Survey

South Australian section of Nullarbor Plains (Portion of O.E.L. 33, South Australia). See Locality Plan, O.B. 28.
Area : 8,500 square miles.

Timing of Survey

Fuel Positioning commenced	1st November, 1965
Survey commenced	8th November, 1965
Survey completed	5th December, 1965
No. of days worked	28 days
Hours worked	Helicopter Station hours - $208\frac{1}{2}$ hours Vehicle Station hours - $36\frac{1}{2}$ hours

Time Lost

11/11/65	$\frac{1}{2}$ hour - Helicopter adjustments.
20/11/65	4 hours - Servicing Helicopter. (vehicle stations observed in interim).

21/11/65 — 6 hours - Helicopter breakdown.

25/11/65 — 7 hours - re-running cell "E" for elevations (due to thunderstorms on 22/11/65).

Equipment Breakdown

29/11/65 — Paulin Micro Altimeter became unserviceable.

No. of New Stations Established

Helicopter Stations

No. of Node Points (= No. of Cells) (6 of these are 3rd order base stations)	22
Tie points	30
Field Stations	933
TOTAL	985

Vehicle Stations

3rd Order Base	1
Field Stations	117
TOTAL	118

Total No. of New Stations = 1103

Accuracy of data is discussed in the report, under "Reduction of Data", while the Gravity Loop Closure Map (O.B. 15) and the Elevation Loop Closure Map (O.B. 14) detail the actual miscloses.

APPENDIX II

[redacted]

EQUIPMENT

Gravity Meter

1 only — World Wide No. 32.

Altimeters

1 only — Micro Altimeter Model MM-1 Paulin.
1 only — Precision Microbarograph Model SMB-J Paulin.
5 only — Aneroid type micro-altimeters, compensated model, Mechanism Ltd.

Murcury dry bulb thermometers

Calibrated in Fahrenheit degrees.

Level

1 only — Cook Troughton & Sims and staff.

Helicopter

1 only — Hughes 300 (supplied by Helicopter S.A. Ltd.)

Vehicles

3 only — 4 x 4 Toyota Land Cruisers.

Office Caravan

1 only

Caravan

1 only — to accomodate 4.

Tent

1 only

Cessna 182 Aircraft

1 only — Used to transport supervising personnel.

APPENDIX III

PERSONNEL

Supervising Personnel

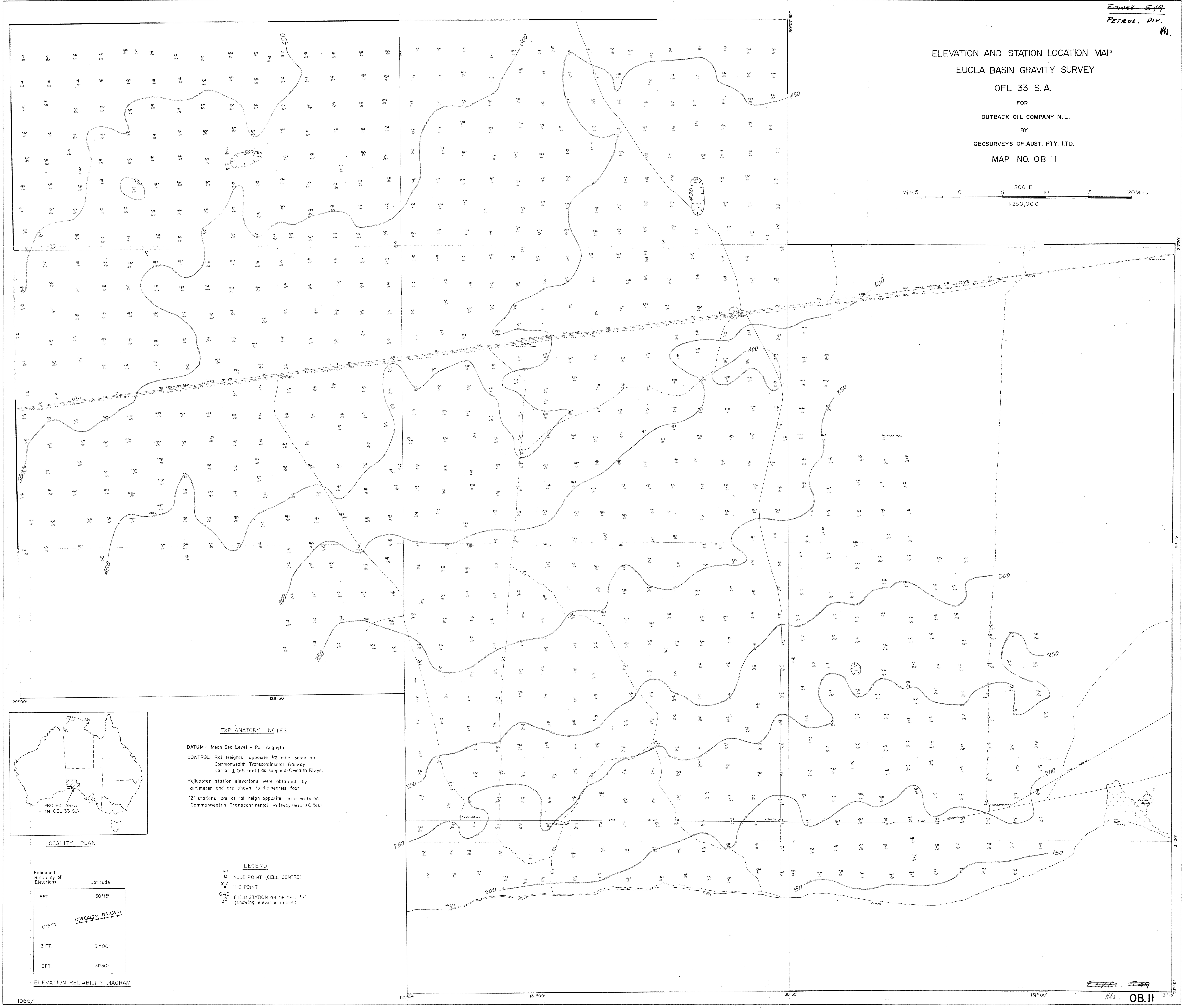
Dr. W.F. Stackler	Chief Geophysicist
D. von Sanden	Operations Manager

Field Personnel

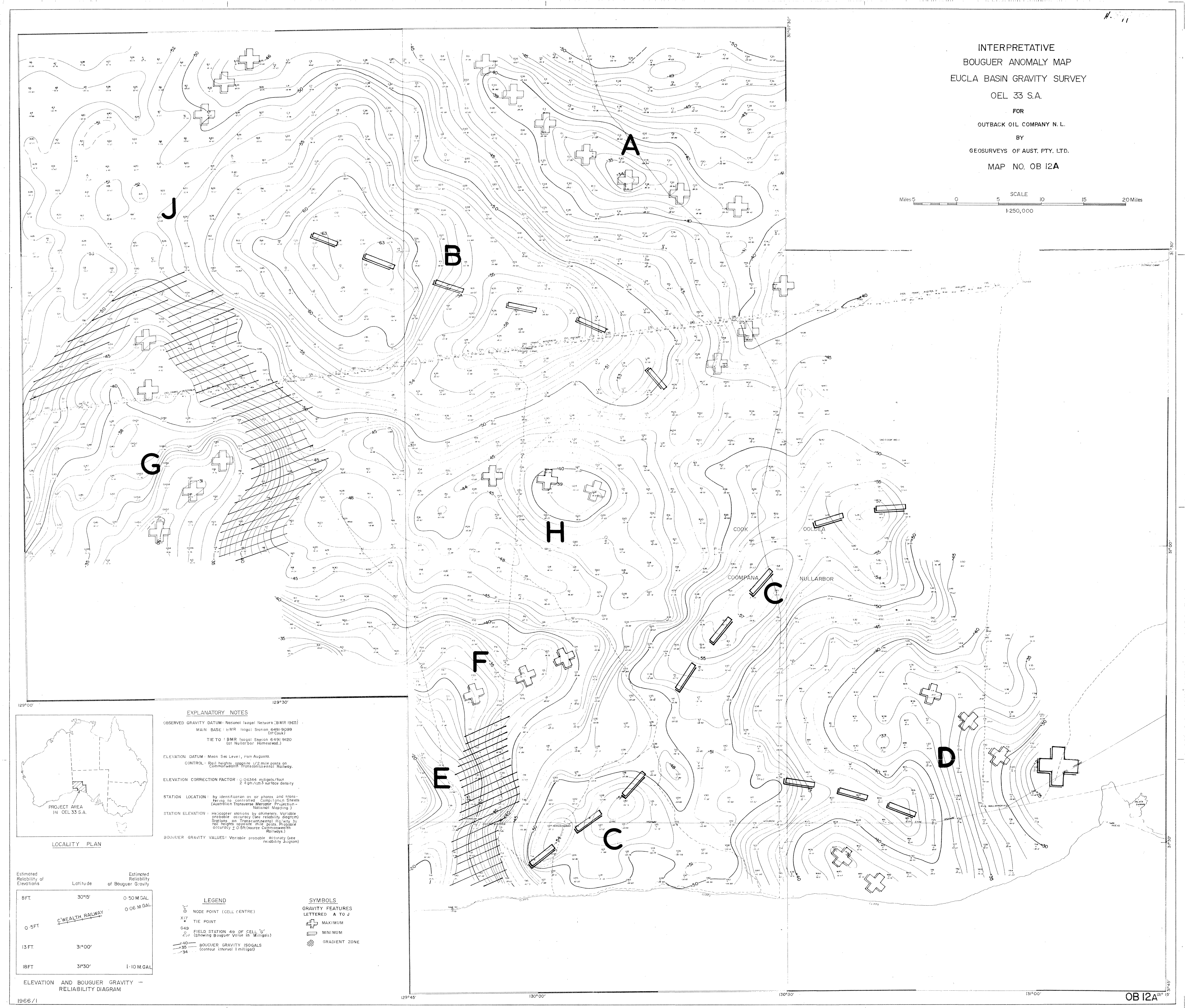
R.M. Hoogenraad	Party Chief, Geophysicist
H. Reith	Meter Operator and Photo Identification of stations.
J. Radus	Computer
C. Thomson	Photogrammetry and Preparation of base maps.
S. Wood	Base Barometer operator
A. Andre	Cook, handyman, driver

Additional Personnel

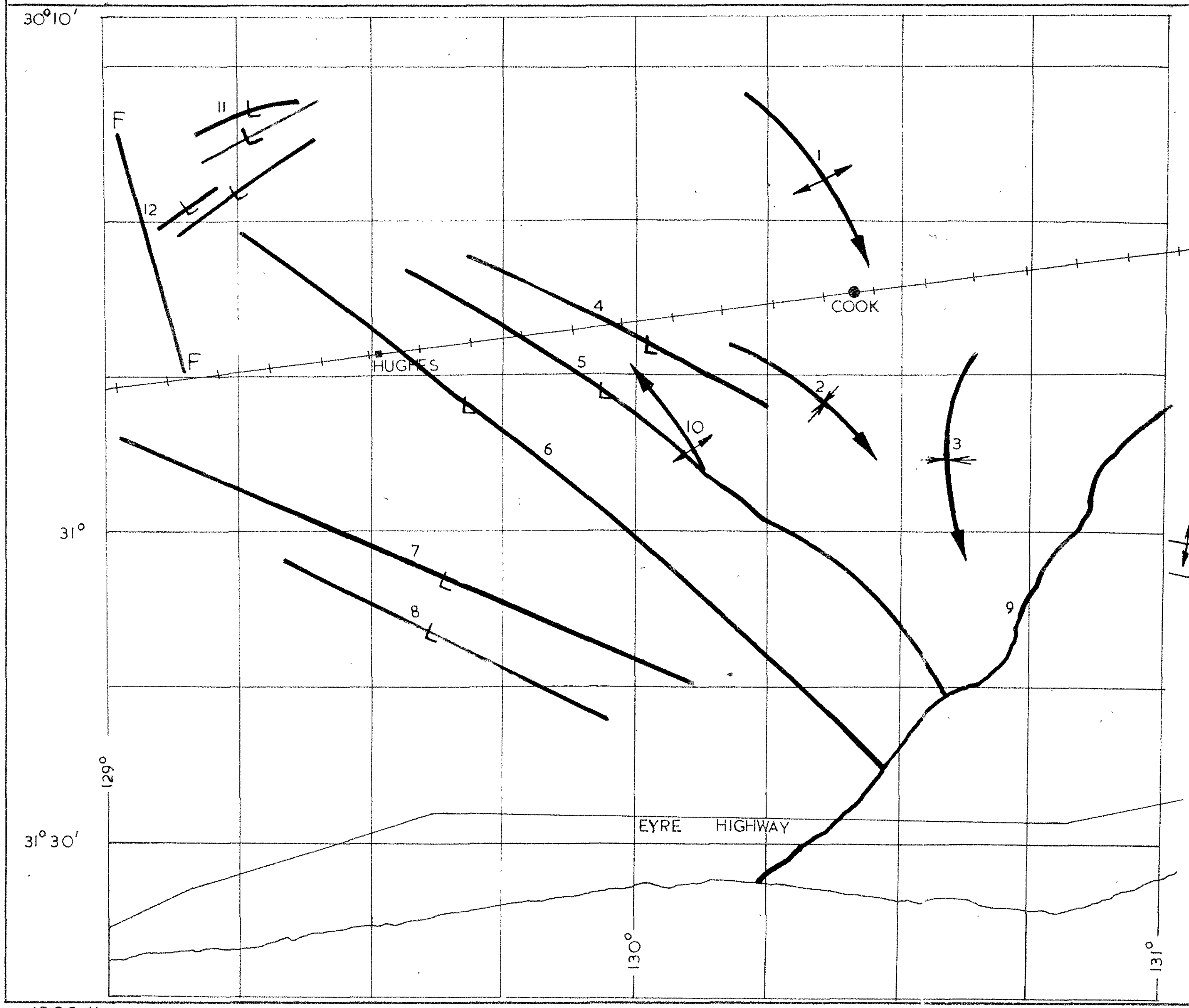
P. Spicer	Helicopter Pilot (Helicopter S.A. Ltd.)
C. Semmler	Pilot, Cessna Aircraft



Envel. 549
PETROL. DIV.
ELEVATION AND STATION LOCATION MAP
EUCLA BASIN GRAVITY SURVEY
OEL 33 S.A.
FOR
OUTBACK OIL COMPANY N.L.
BY
GEOSURVEYS OF AUST. PTY. LTD.
MAP NO. OB 11
SCALE
Miles 5 0 5 10 15 20 Miles
1:250,000
550
500
450
400
350
300
250
200
150
TRANS AUSTRALIAN RAILWAY
CLIFFS
129°00′
129°30′
129°45′
130°00′
130°30′
131°00′
131°15′
30°07′30″
30°30′
31°00′
31°30′
31°45′
LOCALITY PLAN
PROJECT AREA IN OEL 33 S.A.
EXPLANATORY NOTES
DATUM: Mean Sea Level – Port Augusta
CONTROL: Rail Heights opposite ½ mile posts on Commonwealth Transcontinental Railway (error ± 0·5 feet) as supplied: C'wealth Rlwys.
Helicopter station elevations were obtained by altimeter and are shown to the nearest foot.
'Z' stations are at rail heigh opposite mile posts on Commonwealth Transcontinental Railway (error ±0·5ft.)
LEGEND
'C' NODE POINT (CELL CENTRE)
X17 TIE POINT
G49 511 FIELD STATION 49 OF CELL 'G' (showing elevation in feet.)
Estimated Reliability of Elevations
Latitude
8FT. 30°15′
0·5FT. C'WEALTH RAILWAY
13 FT. 31°00′
18FT. 31°30′
ELEVATION RELIABILITY DIAGRAM
1966/1
Envel. 549
OB.11


INTERPRETATIVE
BOUGUER ANOMALY MAP
EUCLA BASIN GRAVITY SURVEY
OEL 33 S.A.
FOR
OUTBACK OIL COMPANY N.L.
BY
GEOSURVEYS OF AUST. PTY. LTD.
MAP NO. OB 12A
SCALE
Miles 5 0 5 10 15 20 Miles
1:250,000
A
B
C
D
E
F
G
H
J
COOK
OOLDEA
COOMPANA
NULLARBOR
129°00'
129°30'
129°45'
130°00'
130°30'
131°00'
31°00'
31°30'
EXPLANATORY NOTES
OBSERVED GRAVITY DATUM: National Isogal Network (BMR 1965)
MAIN BASE: BMR Isogal Station 6491·9099 (at Cook)
TIE TO: BMR Isogal Station 6491·9120 (at Nullarbor Homestead.)
ELEVATION DATUM: Mean Sea Level, Port Augusta.
CONTROL: Rail heights opposite 1/2 mile posts on Commonwealth Transcontinental Railway.
ELEVATION CORRECTION FACTOR: 0·06344 milligals/foot. 2·4 gm/cm3 surface density
STATION LOCATION: by identification on air photos and transfering to controlled Compilation Sheets (Australian Transverse Mercator Projection - National Mapping.)
STATION ELEVATION: Helicopter stations by altimeters. Variable probable accuracy (see reliability diagram) Stations on Transcontinental Railway by rail heights opposite mile posts. Probable accuracy ± 0·5ft. (source Commonwealth Railways.)
BOUGUER GRAVITY VALUES: Variable probable accuracy (see reliability diagram)
PROJECT AREA IN OEL 33 S.A.
LOCALITY PLAN
Estimated Reliability of Elevations
Latitude
Estimated Reliability of Bouguer Gravity
8FT. 30°15' 0·50 M.GAL
0·06 M.GAL
C'WEALTH RAILWAY
0·5FT
13 FT. 31°00'
18FT 31°30' 1·10 M.GAL
ELEVATION AND BOUGUER GRAVITY — RELIABILITY DIAGRAM
LEGEND
NODE POINT (CELL CENTRE)
TIE POINT
FIELD STATION 49 OF CELL 'G' (Showing Bouguer Value in Milligals)
BOUCUER GRAVITY ISOGALS (contour interval 1 milligal)
SYMBOLS
GRAVITY FEATURES LETTERED A TO J
MAXIMUM
MINIMUM
GRADIENT ZONE
1966/1
OB 12A

ENV 549



PRINCIPAL PHOTOGEOLOGICAL FEATURES.

(After Photogravity Company Inc.)

EUCLA BASIN GRAVITY SURVEY

O.E.L. 33 S.A.

FOR

OUTBACK OIL N.L.

BY

GEOSURVEYS OF AUST. PTY. LTD.

LEGEND

ANTICLINE AXIS

SYNCLINE AXIS

PHOTOGEOLOGICAL LINEAMENT

PHOTO-INTERPRETED FAULT

SCALE

MILES 10 0 10 20 30 MILES

1 : 1,000,000

549-3

O.B. 20

1966/1


WEST TRANSCONTINENTAL RAILWAY PROFILES EAST
GAMMAS
AEROMAGNETIC PROFILE
B.M.R. 1956
W.A. - S.A. BORDER
HUGHES
DENMAN RLY CAMP
COOK
EYRE COOK PROFILES
FISHER
ZERO
BOUGUER GRAVITY PROFILE
GEOSURVEYS 1965
MILLIGALS
129°45'
130°30'
WEST EYRE HIGHWAY PROFILES EAST
ALBALA KAROO NULLARBOR No. 3 BORE
GUINEWARRA NULLARBOR No. 4 BORE
YANGOONABIE NULLARBOR No. 8 BORE
ROBERTS' NULLARBOR No. 1 BORE
NULLARBOR No. 6 BORE
Surface Elev.
Sea Level
FEET
Limestone
Carbonaceous Clays and Sands (Tertiary)
Shales (Cretaceous)
1084 Granite
Limestone and Sands (Tertiary)
Shale (Cretaceous)
Decomposed Purple and grey Shales (? Marinoan)
1277 Granite
Limestone Clay and Sand (Tertiary)
Shales (Cretaceous)
Blue Shale (Permian)
1500' Feldspar Porphyry
Limestone Carbonaceous Clays and Sands (Tertiary)
Shales (Cretaceous)
Decomposed Purple and Grey Shales (? Marinoan)
19,000'/s
18,600'/s
16,500'/s
16,200'/s
15,700'/s
16,100'/s
14,400'/s
15,900'/s
14,800'/s
19,700'/s
18,500'/s
19,800'/s
19,500'/s
19,300'/s
19,600'/s
S.A. DEPT OF MINES
REFRACTION SEISMIC SURVEY
1965
AEROMAGNETIC PROFILE
B.M.R. 1956
BEND IN HIGHWAY
KOONALDA HOMESTEAD
COOK TURNOFF EYRE COOK PROFILES
NULLARBOR HOMESTEAD
BOUGUER GRAVITY PROFILES
GEOSURVEYS 1965
B.M.R. 1956
LOCALITY MAP
TRANS CONTINENTAL RAILWAY PROFILES
DEAKIN
HUGHES
COOK
FISHER
COOK No. 1
OUTBACK OIL
EYRE HIGHWAY TO COOK PROFILES
KOONALDA H.S.
NULLARBOR H.S.
EYRE HIGHWAY PROFILES
GREAT AUSTRALIAN BIGHT
EUCLA
Western Australia
South Australia
129°00'
130°00'
131°00'
30°00'
31°00'
32°00'
SOUTH EYRE HIGHWAY TO COOK PROFILES NORTH
COOK TOWNSHIP BORE
Tertiary Limestone, Sands
Cretaceous Shales
Red & Grey Shales (? Marinoan)
15,700'/s
15,300'/s
11,200'/s
14,800'/s
16,500'/s
15,100'/s
16,000'/s
16,300'/s
19,500'/s
20,300'/s
19,800'/s
20,000'/s
S.A. DEPT. OF MINES
REFRACTION SEISMIC SURVEY
1965
EYRE HIGHWAY
BEND IN HIGHWAY
COOK
BOUGUER GRAVITY PROFILE
GEOSURVEYS 1965
GEOPHYSICAL PROFILES
EUCLA BASIN GRAVITY SURVEY
OEL 33 S.A.
FOR
OUTBACK OIL COMPANY N.L.
BY
GEOSURVEYS OF AUST. PTY. LTD.
MAP NO. O.B. 21
VERTICAL SCALE AS SHOWN
HORIZONTAL SCALE
Miles 5 0 5 10 15 20 Miles
1:250,000
ENV. 549
5494
OB 21
1966/1