FINAL REPORT OF THE THREE CORNERS SEISMIC AND GRAVITY SURVEY O.P. 177 NORTHERN TERRITORY

1971

for
BEACH PETROLEUM NO LIABILITY

by
GEOSURVEYS OF AUSTRALIA PTY. LIMITED

FINAL REPORT
OF THE
THREE CORNERS
SEISMIC AND GRAVITY SURVEY
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(FORMERLY O.P. 57, N.T.)

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TEXT

FIGURES

PLATES

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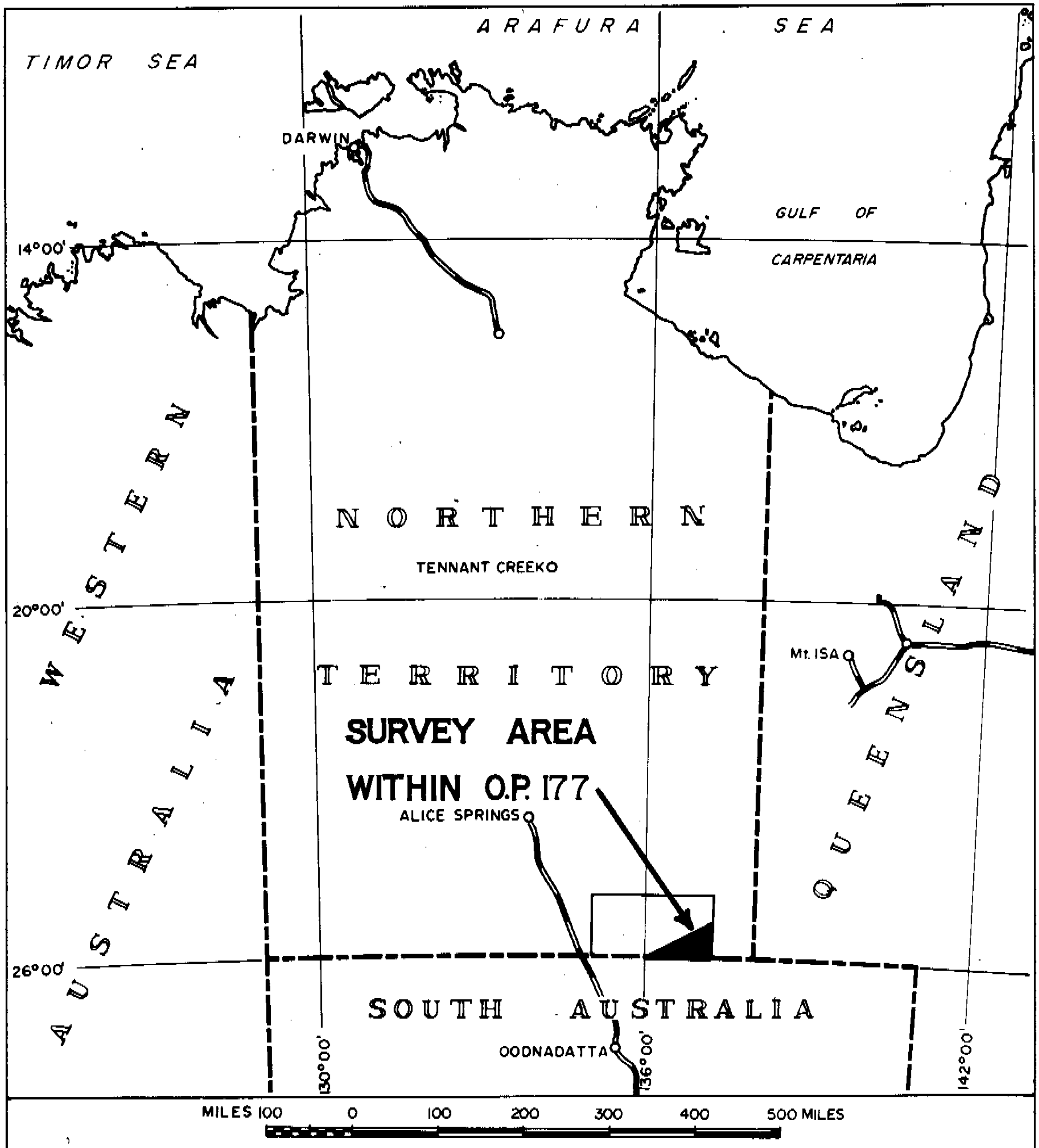
ABSTRACT

The intent of the Three Corners Survey was to obtain an accurate seismic and gravity interpretation of Permian stratigraphy and structure in the south-east corner of O.P. 177 N.T., and in particular to locate areas of structural closure in the Permian where upper beds have been preserved.

The survey has shown that the structural trends are directed north-south, and that, proceeding eastwards, there is addition of section to the top of the Permian and probable concomitant loss of section from the base of the Permian.

One structure, the Colson Anticline, has Permian structural closure of approximately 200 feet over 15 square miles and contains a younger Permian sequence than at Mokari No. 1.

A second large anticlinal trend, the East Border Anticline, has been indicated by the survey but is not yet accurately defined.



BEACH PETROLEUM NL.

OP177 NT

THREE CORNERS SEISMIC AND GRAVITY SURVEY

LOCALITY MAP

GEOSURVEYS OF AUSTRALIA PTY. LTD. November 1971

Map Ref. G-53-7, 8, 11, 12 Report N° 1971/34 Figure N° 1 Drawing N° BP 790

INTRODUCTION

A detailed seismic and gravity survey was made in the southeast corner of O.P. 177, Northern Territory (Fig. 1) for Beach Petroleum N.L. by Geosurveys of Australia Pty. Limited between August 17th and October 20th, 1971.

The initial programme, as specified in the Application for Subsidy, was for 140 line miles (Fig. 2). Of this, 110 miles (B-1, B-3, B-5, B-7, B-9, B-11, B-2) were programmed to complement the Amerada survey of 1966 and to tie the Amerada work with the Pedirka and Poolowanna surveys of French Petroleum Company in South Australia. Thirty miles were reserved for definition of promising structures.

The reserve mileage was used on B-4 west after completion of the first three lines (B-1, B-3, B-5). A second subsidy application was made to extend B-4 to the eastern border of the prospect in order to investigate an anomaly in that area.

Gravity observations were made on all seismic lines and three additional gravity traverses totalling 16 miles were run north of Amerada line 2E (B9 extension, B-13, B-15).

A total of 160 seismic line miles of continuous single-fold reflection cover and 176 gravity line miles (552 stations) was surveyed. Two continuous refraction profiles, each of approximately 6 miles, were recorded. A statistical summary of the survey together with crew personnel and equipment lists are given in Appendices I, II, III, and IV.

Before the survey commenced Beach Petroleum and Geosurveys decided that detonating cord would be used as the seismic source. Good data had been recorded with a cord source in the Cooper Basin in geological conditions similar to those of the Simpson Desert Infra-Basin. The method proved to be satisfactory for the Three Corners area and a considerable logistics effort was avoided by dispensing with the drill rigs and water trucks which would have been needed for a conventional operation.

PHYSIOGRAPHY

O.P. 177 lies in the central Simpson Desert, N.T. (Plate 1). Rainfall over the region varies from about 4 to 10 inches per year and is extremely irregular.

Ranges and hills border the desert on the north and west. In the north the Macdonnell Ranges consist mainly of steeply-dipping Upper Proterozoic and Lower Palaeozoic formations. The ranges are commonly east-west strike ridges with peaks rising 200 to 300 feet above the level of the plain.

Sand plains with seif dunes cover a large portion of the Simpson Desert. The dunes trend north-northwest and may be many miles long, some reaching a height of 100 feet or more. Drainage is generally poorly defined. Mesas and buttes occur locally where flat-lying Mesozoic sandstones crop out. The mesas attain 200 feet in height, and in many areas appear to represent the remnants of an old peneplain.

EXISTING GEOLOGICAL AND GEOPHYSICAL INFORMATION

Geology and Tectonic Setting

O.P. 177 N.T., lying in the central Simpson Desert, N.T. (Plate 1), straddles the margins of two major sedimentary basins - the AMADEUS BASIN to the north and west, containing over 18,000 feet of Upper Proterozoic to Middle Palaeozoic shallow-marine, glacial and fluvial sediments, and the GREAT ARTESIAN BASIN to the east and south, containing up to 8,000 feet of Mesozoic fluvial sandstones and shallow-water marine shales. Sandwiched between the accumulations of these two major basins are Permian strata of the ERINGA-PEDIRKA and SIMPSON DESERT INFRA-BASINS, comprising in stratigraphic order: (1) glacigene boulder-clays, (2) shallow marine? dark shales, and (3) freshwater sandstones and siltstones with some shale and coal interbeds. The Permian rocks are up to 2,000 feet thick. The geology of the Simpson Desert region is reviewed by Williams (1971).

The Amadeus Basin, which extends across the southern part of the Northern Territory, is bounded on the north and south by areas of granite-gneiss and schist - the Arunta and Musgrave complexes respectively. The northern margin of the basin is structurally complex; both the metamorphic basement and part of the sedimentary cover having been involved in recumbent folds. Upper Proterozoic (Adelaide System) strata overlie the crystalline basement with a strong angular unconformity. More than 18,000 feet of sediments, comprising quartzite, sandstone, siltstone, shale, limestone, dolomite and boulder-beds, are preserved in the northeastern part of the basin. The southern and eastern margins are concealed beneath overlapping Permian and Mesozoic sediments.

The Australian Great Artesian Basin is essentially a Mesozoic intracratonic basin which originated by epeirogenic downwarping in Early to Middle Jurassic time. The Early Jurassic saw the initiation of sedimentation in the Great Artesian Basin of central Australia on an erosion surface cut across Upper Triassic and older formations. Deposition continued into the Cretaceous period during which the basin reached its greatest areal extent.

Several Permian sub-basins occur within the Simpson Desert region. The Pedirka Infra-basin is a restricted Devonian? to Permian downwarp controlled in part by bordering positive areas, viz., a shallow basement platform between the Pedirka Infra-basin and the Amadeus Basin to the northwest, and the arcuate Mt. Etingambra-McDills structure to the east. The Permian section thickens towards the axis of the Pedirka Infra-basin by addition of section to the upper part of the sequence. The Simpson Desert Infra-basin is a restricted local downwarp similar to the Pedirka Infra-basin. It is limited on the northeast by the Arunta Block and on the northwest by the McDills Structure. The "Birdsville High" probably marks its southeastern border. The Eringa Infra-basin, containing Palaeozoic and Mesozoic rocks, extends into the southwest corner of O.P. 177. Aeromagnetic evidence suggests that the Eringa Infra-basin is the tectonic link between the Amadeus and Officer Basins.

Potential source beds, reservoir rocks and cap rocks ranging in age from Upper Proterozoic to Mesozoic, are sufficient to make the Simpson Desert region a potential petroleum province. The Permian sediments, which are draped over "basement" anticlinal highs, are the most prospective. Thinner Permian sequences over the crests of such anticlines comprise mainly porous sandstones, passing away from the anticlines into thicker sequences containing sandstones, carbonaceous shales, and coals. Such structural and facies relationships compare with those of the Permian sediments of the Cooper Basin (Gidgealpa and Moomba fields).

The two exploratory wells drilled within O.P. 177 N.T. (McDills No. 1 and Hale River No. 1), and the four wells drilled by the French Petroleum Company Ltd. in P.E.L. 5 and 6 S.A. (Mt. Crispe No. 1, Witcherrie No. 1, Purni No. 1 and Mokari No. 1) have not adequately tested the hydrocarbon potential of the Simpson Desert region. Well locations and stratigraphic sections are shown in Plate 1. Present exploration is being conducted by Beach Petroleum N.L. in the southeastern part of O.P. 177, where potential source rocks of carbonaceous Permian strata are probably best developed, and where Lower Triassic cap-rock may be present. Several potential anticlinal drilling targets have been revealed by gravity and seismic surveys in this part of the lease.

Previous Geophysics

Previous geophysical surveys in O.P. 177 and in the immediately adjacent portions of P.E.L. 5 and 6, S.A., and O.P. 172, N.T. are listed in Appendix V. Of these, the surveys of principal interest for evaluating the Three Corners area are:-

(i) Simpson Desert "A" survey 1966, O.P. 177, of Amerada;
(ii) Pedirka and Poolowanna surveys 1963-5, P.E.L. 5 and 6, of F.P.C.;
and (iii) Simpson Desert Gravity survey 1967, O.P. 177, of Beach Petroleum.

Seismic sections from these surveys were reviewed by Geosurveys in May-June 1971. The principal reflections, "C" Lower Cretaceous Transition Beds, and "P" top of Permian, were tied from Mokari No. 1 via the F.P.C. and Amerada surveys to Hale River No. 1. An attempt was made to follow a third reflection, "P_1", appearing some 0.100 seconds below reflection "P"; "P_1" was identified by F.P.C. as related to the top of the sandstone facies of the Permian Middle Purni Member. No reflection associated with the base of the Permian could be followed.

The review indicated a thickening of the Jurassic ("C" - "P") section down dip from Mokari No. 1 towards the southeast corner of O.P. 177 and also an eastward thickening within the upper ("P" - "P_1") section of Permian. Several structurally high areas were mapped over which local thinning above the Permian occurred. (Refer Application for Subsidy, O.P. 57 N.T., Beach Petroleum N.L.).

Due to the north-south alignment of the dune system, all seismic surveys made in the desert have produced a preponderance of north-south directed lines. In the southeast portion of O.P. 177 particularly, the existence of one only east-west tie line, coupled with the gently varying relief, did not allow a confident interpretation of the structural trends to be made.

The Simpson Desert Gravity Survey, 1967, was operated over seismic traverses of the Amerada Simpson Desert "A" Seismic Survey, 1965-6. Several areas of gravity maxima were mapped, generally coincident with the seismic structures. However, gravity station spacing did not allow accurate definition of these anomalies particularly where amplitudes of the order of only 2 milligals were encountered and narrower anomalies might be expected.

OBJECTIVES OF THE SURVEY

The objectives of the survey were:-

(i) To obtain a more accurate seismic interpretation of Permian structure in the Three Corners area and to locate areas of structural closure in the Permian where the upper beds have been preserved.

(ii) To obtain a semi-detailed gravity interpretation; stripping methods would be used to assist interpretation of structure below the Permian.

FIELD OPERATIONS

Access and Logistics

The north-south alignment of continuous sand dunes makes operations in the Simpson Desert difficult and expensive. It is not possible to move heavy wheeled vehicles east-west without great expenditure in bulldozing. This overriding characteristic of the desert governs every consideration of access and supply.

Access to the area was gained from Finke via Andado Homestead to the Hale River Escarpment where a supply dump was established. From the dump an interdune supply road was bulldozed to Amerada line 2E in the region of the westernmost lines of the programme. First basecamp was established at the intersection of this road with 2E; 2E was reopened as a lateral access road and the prospect was worked from west to east (Fig. 2). After completion of the western programme, base camp was moved to intersection 2E/2K and a second supply road was dozed eastward from the escarpment dump and thence down the interdune corridor to the second base camp. The central prospect area and the eastern lines were worked from this camp. Line units fly-camped during the working of B-11 and B-4 east.

Supplies were transported by a Mack 6 x 6 with trailer and a Bedford 4 x 4; a Leyland 6 x 6 was contracted locally for fuel deliveries. Bulk supplies were hauled from Finke; water was hauled from Andado Homestead. Total round trip from the base camps to Finke and return was 580 miles. Two to three light aircraft flights per week from Adelaide serviced the camps with light supplies and personnel.

Bulldozing

Initially, one D-6 bulldozer was used to cut both seismic lines and access roads. In September a TD-14 bulldozer was contracted to cut the second access road and assist with the eastern seismic lines.

Cord was laid by a TD-9 bulldozer.

In the final analysis, dozer time was accounted as follows:

Access route	34½%
Seismic and gravity line	26 %
Cord laying	28½%
Standby	11 %

Approximately 280 miles of access route were cut, compared with a total of 176 miles of geophysical traverse.

Camp

Camp consisted of 14 two-man tents, mess tent, workshop/supply tent, 3 billy-hut offices and one kitchen caravan. Five Eilco radios on the O.P.R. Alice Springs frequencies were used for communication between camp and line units and between camp and Alice Springs.

Surveying

(a) Vertical Control

The vertical control of all gravity stations and seismic shot points was determined by optical levelling using theodolites. Elevations are tied to adjusted values used for the 1967 Simpson Desert Gravity Survey, which were tied to elevations of the 1963 Anacoora Bore and 1964 Dakota Bore Gravity Surveys, which were in turn tied to Department of Interior Bench Mark NM 69/46. This bench mark is on the Department of Interior Datum, Queensland.

The accuracy of vertical control was maintained by loop closure or double run method (Vertical Loop Closure Map, Plate 2).

A total of 23 loops was closed. The average loop misclosure was ± 0.4 feet and the maximum misclosure 1.6 feet for a loop of 44 miles.

It is estimated that the accuracy for single stations, after adjustment, is better than ± 0.5 feet.

(b) Horizontal Control

The horizontal control of all gravity stations and seismic shot points was determined by latitude and departure methods, using chained distances and bearings carried by theodolite with magnetic compass attachment. Sun azimuth observations at base camps were used to set and check the compass.

Accuracy was maintained by using loop closure or double run methods (Horizontal Loop Closure Map, Plate 3).

A total of 21 loops was closed. The average loop closure was ± 58 feet in eastings and ± 51 feet in northings. The maximum misclosure was + 260 feet in eastings and + 108 feet in northings for a loop of 24 miles.

Plotting of horizontal position was controlled by an Astronomical Fix at Base Q (intersection 2K/2E) and by photo identifications. Weight was given to those identifications falling on photos of the Poolowanna 1:250,000 map-sheet as it is controlled by a Geodetic traverse along the S.A.-N.T. border. The photo identifications are considered to be above average because detail in the survey area is better than the norm for the region. Stations of the 1967 Simpson Desert Gravity Survey which have been included in the Bouguer Anomaly Map of the present survey have been adjusted for position where necessary.

It is estimated that plotting accuracy of single stations, after adjustment, is better than ± 300 feet.

Cord laying

The D-6 and TD-9 bulldozers were each equipped with two tynes for cord laying. Spool brackets above the tynes allowed two strings to be laid simultaneously, three feet apart, one string per furrow. Normal shotpoint loading was 4 strings each of 250 feet laid in two runs at a depth of approximately 18 inches. Because of the general prevalence of spinifex it was necessary, before laying, to cut two 250 feet strips adjacent to the line, one blade width each, in which to lay the cord. Back-blading the shot-strip after laying greatly decreased the air blast from the shot.

On cross-dune lines many spreads were shortened to avoid shot-strips falling on or near the crests of dunes.

Throughout the prospect the lithology encountered at the ripping depth of 18 inches was predominantly sand, with some clay in the occasional claypans, and no ripping problems were experienced. One TD-9, cutting shot-strips, laying and back-blading, could keep well ahead of the recording crew.

Recording - Instruments

The recording equipment comprised a set of Geospace III amplifiers, a Geospace FM300 tape recorder and a S.I.E. VRO-6D camera mounted on a Toyota 4 x 4 landcruiser. HSJ-20 c.p.s. geophones were used for reflection recording and HSI-4½ c.p.s. geophones for the weathering profiles. A squirter was used for rapid handling of the cable. A complete list of recording equipment is given in Appendix IV.

Recording - Experimentation

The principal reflections expected were those from the Lower Cretaceous Transition Beds, "C", at approximately 1.35 seconds, and the Top of Permian, "P", at approximately 1.70 seconds. It was hoped to record reflections from within the Permian, "P_1", and from the base of the Permian.

Experimental cord layouts to determine a satisfactory cord pattern were laid on B-1 and B-5 as follows.

For split spreads, 1725-0-1725 feet.
250 ft x 2, centre detonated and detonated at alternate ends
250 ft x 4, " " " " "
500 ft x 2, " "
330 ft x 2, " " " " "
330 ft x 4, " " " " "
250 ft x 4, in two furrows, centre detonated.

For on-end spreads, 0-75-3525 feet.
250 ft x 1, detonated into the spread
250 ft x 2, " " "
250 ft x 3, " " "
330 ft x 4, " " "

Records shot with various cord patterns are reproduced on Plate 4.

A noise test was made on B-1 to determine recording filters and geophone pattern (Plate 4).

The results of the experimental work and the experience gained during the initial production recording on B-1, B-3, B-4 west and B-5 were as follows:

1. For split spreads there was little apparent difference between centre detonation and alternate-end detonation of the cord. Centre detonation was adopted because of the easier priming.
2. Records with satisfactory reflections "C", "P" and "P_1" were obtained on split spreads from patterns 330 x 2 (line B-1), 330 x 4 (lines B-3 and B-5) and 250 x 4 (B-4 west). There was no recognisable reflection from the base of the Permian.
3. The on-end spreads gave satisfactory records from 250 ft. x 3 and 330 ft. x 4 patterns.

4. The noise test showed ground roll across the record, at the time of the "C" reflection, of wave length approximately 100-140 feet and frequency approximately 10 c.p.s.
5. To avoid air blast on the record it was essential that the cord be completely covered and the detonators well buried. Raising the tynes momentarily at the shotpoint marker in order to expose the cord for rapid priming was not satisfactory since the exposed cord and detonators were never afterwards buried deeply enough to avoid air blast. The procedure adopted was to lay cord continuously at full tyne depth and then back-blade over the shot-strip; the strip was primed by the shooter digging for the buried cord.
6. Air blast was greatly reduced when the shot-strip was graded before cord laying. The bulldozer could then lay cord at the full tyne depth and emergence of cord when the bulldozer mounted spinifex clumps was avoided.
7. Two cord lengths laid in one furrow at the ripping depth of 18 inches tended to blow and cause air blast even when the pattern was back-bladed.

<u>Recording - Reflection Production Parameters</u>

Parameters adopted on the basis of the tests were:-

Spread	1725-75-0-75-1725 feet	
Trace interval	150 feet	
Geophone group	10 at 15 feet spacing in line	
Recording filters	13 c.p.s. (single stage) - out	
A.G.C.	Fast	
Charge	2 x 330, on B-1 4 x 330, on B-3 and B-5 4 x 250, on all subsequent lines	one cord per furrow, centre detonated

The split spread was chosen to allow a field interpretation of Permian structure to be made from paper playbacks. Field playback filters were 20-60 c.p.s. Towards the end of the survey increasing wind noise was apparent on the records and the high cut recording filter was changed to 110 c.p.s. (two stage). This setting was used on B-4 east and B-11.

Geophones were grouped on the eastern faces of steep dunes.

Recording - Weathering Profiles

No useable first breaks were recorded on the production records, neither was it possible to obtain useable breaks by shooting 2 lb. weathering charges into the production spread. Static correction control was obtained from weathering profiles recorded on paper only at every third shotpoint (every one mile). Two 12-trace spreads with trace interval of 30 feet and two grouped $4\frac{1}{2}$ c.p.s. geophones per trace were laid at right angles to the line as follows.

0 - 30 - 360 feet, charge approximately 1 lb. at 2 feet depth
0 - 360 - 690 feet, charge approximately 2 lb. at 2 feet depth

Recording - Refraction

Two single-ended continuous refraction profiles were shot to enable an estimate of Permian thickness to be made by calibration of the refraction arrivals from the base of Permian with the reflection record section. The refraction profiles were recorded concurrently with the reflection profiles using the reflection geophone spread. One profile was recorded on B-3 over a continuous length of 6 miles with 9 shots, and the other on B-9 over a length of 4-2/3 miles with 7 shots. Ammonium nitrate was used as source; details of charges are given in Appendix VI.

Computation - Seismic

Static corrections were calculated at each control point using the refraction plots of the weathering profiles and time intercept equations (Fig. 5). Corrections for the intervening traces were interpolated with attention to varying surface elevation and thickness and velocity of the subsurface layers.

Field playbacks were computed using the above procedure, the records were picked and a time section made for each line. The section was then examined for abrupt changes in dip of the principal horizons between control points with consideration for coincident changes in elevation and apparent subsurface velocity. The initial computations of the interpolated centre trace corrections were then accepted or smoothed before final static corrections were listed.

Velocities and thicknesses of the near surface layers in the prospect appear to fall within the following broad classification:

V_0 1500 - 2500 ft./sec.; Z_0 5 - 100 ft.)
V_1 3300 - 4700 ft./sec.; Z_1 50 - 110 ft.) Dw 75 - 170 ft.
V_2 5600 - 7500 ft./sec.

V_0 and V_1 generally plotted at approximately 2200 and 3500 ft./sec. respectively. A seismic datum of 300 feet above sea level and a datum correction velocity of 6000 ft./sec. were used.

Interdune lines gave no problem in computation. However, cross-dune lines required special attention; as many as seven dunes per mile can be encountered, with elevation changes of 40 feet between corridor and dune crest. The bulk of a dune was found to be predominantly of V_0 material, the tops of the V_1 and V_2 layers continuing apparently at sensibly constant grade under the dune (Fig. 6). Elevation changes across the dunes were corrected at velocity V_0 with reference to the elevation profile and to abrupt changes in static moveout on the record.

FIELD OPERATIONS - GRAVITY

Tie to National Network

Observed gravity values of the present survey are based on a value of 978,914.99 milligals for Base E2. This is based on a tie to B.M.R. gravity station 1827 at Finke (N.T.).

Base Network

No new bases were established during the present survey. All new stations are tied to bases established during the 1967 Simpson Desert Gravity Survey.

Calibration of the Meter

The meter was run over the official calibration range in Adelaide between B.M.R. 6091.0108 (A.C.S.1, Kensington Gardens) and 6091.0208 (A.C.S.2, Norton Summit). The valid difference of the calibration range (May 1965) is 62.61 milligals.

The LaCoste and Romberg Gravimeter (G215) has a meter factor, dependent on the counter readings (in principle a function of the latitude), which is supplied in the Manufacturer's Manual. By using the factor table the following differences over the calibration range were obtained:-

5th July, 1971	62.63 milligals
26th October, 1971	62.62 milligals

In consequence the calibration factors supplied by the factory were accepted and have been used for the present survey.

Accuracy

The small instrumental drift of LaCoste and Romberg gravimeter G215 was rigidly controlled. All field readings were corrected for tidal effect by using tidal drift curves from Tables of Tidal Gravity Corrections for 1971, prepared by Service Hydrographique de la Marine. It was not possible to maintain loop times within 5 hours in all instances. In most cases the excess time interval was due to holdups travelling westwards over the sand dunes.

Elapsed Time	No. of Loops	Average Mistie
less than 5 hours	20	0.06 milligals
5 hours to 5 hours 50 minutes	5	0.04 milligals

As a check on accuracy, repeat readings were observed at 136 stations with an average mistie from the mean value of ± 0.025 milligals. It is estimated that the accuracy for single stations is better than ± 0.03 milligals.

Corrections Applied to Observed Gravity

(i) Latitude Corrections

Latitude correction lines were drawn for every 5 milligals on the work maps using Lambert, W.D. and Darling, F.W. (1931) "Tables for Values of Theoretical Gravity on the International Ellipsoid". The latitude correction for each station was then scaled off.

(ii) Elevation Corrections

A combined elevation correction factor (Free Air and Bouguer) of 0.06992 milligals/foot was used. This factor is equivalent to a density of 1.9 gm/cc. between the surface and Mean Sea Level.

(iii) Terrain Corrections

No stations were observed at locations which required terrain corrections.

Accuracy of Bouguer Anomaly Values

As previously indicated, the accuracy is:-

Vertical control (± 0.5 feet) = ± 0.035 milligals
Horizontal control (± 300 feet) = ± 0.06 milligals
Gravity Control = ± 0.03 milligals

Therefore the summary error is:-

$$(0.035^2 + 0.06^2 + 0.03^2)^{\frac{1}{2}} = \pm 0.075 \text{ milligals}$$

These values are strictly estimates and indicate the magnitude of anticipated errors.

SEISMIC DATA PROCESSING

Field tapes were processed digitally by Geophysical Service International of Sydney. The following processes and parameters were used.

1. Analogue to digital conversion

   Field tapes were transcribed to digital format at 0.002 seconds sample rate. The processes which follow were performed at 0.004 seconds sample rate.

2. Deconvolution

   Deconvolution was applied primarily to attentuate short-period ringing in the Permian section. The preliminary analysis showed short-period ringing of period 0.080 - 0.100 seconds; a 0.100 second operator was therefore used (26 points at 0.004 sample rate). Time-variant deconvolution over the record time 0.250 - 2.75 seconds was applied with 4 separate gates per trace and 50% overlap per gate.

3. Normal moveout correction

   This was based on a function derived from the sonic log of Mokari No. 1 (Appendix VII). After analysis of the preliminary results on line B-1 the original function was modified slightly to that shown in Appendix VIII. This modified function was used unchanged on all lines.

4. Static correction

   Static corrections computed by the field crew were applied. Some irregularities in the reflection horizons due to inaccurate static correction are apparent on cross-dune line B-4. These are not sufficient to cause misinterpretation of the section and have been left unaltered.

5. Time-variant scaling

   A time-variant scaling process was used to balance the modulation level of the record and enhance the appearance of the deeper reflections.

6. Playback filters

Zero-phase digital filtering with 20-60 c.p.s. pass-band was applied.

7. Trace edit

Wild and dead traces were edited by the field crew and replaced in processing by interpolation.

8. Playback mode

All sections were played in variable area/wiggle trace mode with horizontal scale 12 traces per inch and vertical scale 6 inches per second. At the time of the Permian reflection these scales give a ratio approximately one-to-one for horizontal and vertical distance.

Profiles of surface elevation, elevation of weathering (base of V_1 layer) and Bouguer anomaly are posted on the record section header together with the computed time ground-to-datum (Tg).

INTERPRETATION - SEISMIC

Three horizon maps, one isochron map and two refraction profiles are presented with this report:-

Horizon "C", Lower Cretaceous Transition Beds (Plate 5 and Figure 8).
Horizon "P", top of Permian (Plate 6 and Figure 9).
Horizon "P_1", Permian unit in upper section of Permian (Plate 7 and Figure 10).
Isochron "C-P" (Plate 8 and Figure 11).
Refraction profiles B-3-123 and B-9-136 (Plates 9 and 10).

In addition to the data acquired by the Three Corners Survey the maps incorporate approximately 500 line miles of reviewed data from the following previous seismic surveys:-

F.P.C. Pedirka Seismic Survey 1963.
F.P.C. Poolowanna Seismic Survey 1964-5.
Aquitaine Kilpattha Seismic Survey 1964.
Amerada Simpson Desert "A" Seismic Survey 1965-6.

Horizons are mapped in two-way reflection time corrected to datum 300 feet above sea level. Time adjustments used to reduce the various record section reflection times to a common base are given in Appendix IX. Depth estimates for the "C" and "P" horizons are calculated from velocities derived from sonic logs of Purni No. 1 and Mokari No. 1 (Appendix X); time allowances are incorporated for casing and datum and for cycle initiation lag. Thickness estimates for the "C-P" interval are based on the "C-P" interval velocity calculated from the Mokari sonic log. Horizons "C" and "P" are tied geologically to Mokari No. 1 and Hale River No. 1 by use of the sonic log of Mokari and the well velocity survey of Hale River.

Horizon "C"

The Lower Cretaceous Transition Beds produce a remarkably consistent reflection signal, usually of two strong cycles. It is recorded throughout the prospect and can be identified readily without ambiguity. For this interpretation the horizon was followed in the first trough of the reflection cycle; hence it corresponds with the "C" horizon of F.P.C. but is one cycle lower (approximately 0.025 seconds) than that of Amerada.

Horizon "C" is the most reliable of the horizons presented.

Horizon "P"

This horizon represents the surface of unconformity between the base of Mesozoic and top of Permian. The reflection is less consistent in character and weaker than reflection "C". On several record sections (for example F.P.C. line B and Amerada line 2C) the slight angularity of the unconformity can be seen to truncate the upper sections of Permian. Thus the velocity contrasts across the Mesozoic/Permian interface can be expected to change locally and produce changes in character of the "P" reflection.

For this interpretation the horizon was followed on the following hypotheses:

(i) Since the horizon represents an unconformity, not a stratigraphic unit, it is necessary on occasion to jump a reflection cycle (e.g. lines B, 2C, 20)

(ii) Because of the generally gentle relief of the Mesozoic and slight angularity of the unconformity the "C-P" interval will not change abruptly.

Horizon "P", as mapped for this report, generally coincides with the "P_1" of F.P.C. and the "P" of Amerada in the central area; in the east it is higher than the Amerada "P".

The horizon can be followed throughout the prospect but with less certainty than the "C". The map is reliable in the central area where there is close control; north-west of fault I, east of faults II and III, and on hanging lines uncertainties in correlation make the map less reliable.

Horizon "P_1"

This horizon follows a reflection appearing in the south-west area of the prospect, some 0.060-0.180 seconds below horizon "P". It is a strong reflection having the appearance of one produced by a continuous stratigraphic unit. It cannot be tied exactly to Mokari No. 1 since in that area it follows too closely the reflection cycles from the top of Permian.

Generally the horizon coincides with the "P_2" horizon of F.P.C. which was described by F.P.C. as "related to the top of the sandstone facies of the middle Purni member" (Final Report, Poolowanna and Emery Seismic and Gravity Surveys). Our opinion is that the horizon is higher than the middle Purni member in Mokari No. 1.

The reflection can be followed with confidence in an area extending from a position slightly down dip from Mokari to the southern portions of lines 2G and 2K; further east the reflection becomes weak and disappears. Correlations to the north-west across fault I are tenuous; the stratigraphic unit followed on the upthrown side might be different from that on the downthrown side.

Refraction Profiles

The refraction profiles were recorded to calibrate the high velocity pre-Permian sediments ("Z") to the reflection record section. Marker horizon "Z" is defined arbitrarily as a horizon having a velocity of the order of 18,000 feet per second or more. Approximate reflection time, To, of the marker horizon is given by

$$To = \frac{T}{\cos i}$$

where T = intercept

$i = \sin^{-1} \frac{Va}{Vz}$

Va = average vertical velocity to marker

Vz = refraction velocity of marker

The calibration technique is not accurate but gives useful comparisons.

Discussion of results

(i) Structure of the top of Permian

The three horizons and the "C-P" isochron show similar structure; the major trends run approximately north-south. Structure at the Permian level is reflected to a lesser degree by the structure of the Cretaceous Transition Beds and the discussion which follows relates principally to Horizon "P", top of Permian.

The Three Corners area lies between two fault-controlled anticlines some 50 miles apart. The western anticline is designated the Border Anticline, and the eastern anticline the East Border Anticline.

In the region of Mokari, fault I has a throw of approximately 1,000 feet, down to the east, at Permian level. Throw diminishes to the north and terminates between lines 20 and 2D. Throw on fault II is approximately 900 feet, down to the east; throw on fault III is some 400 feet, down to east, and diminishes northwards. No fault is seen on 2J south or on K2 west; however, steep dip is evident on 2J south and it is probable that the East Border Structure extends along the permit border between lines 3E and B.

The area between the two anticlines is one of varying relief with narrow north-south directed structural trends. The centre of the Mesozoic Basin appears to lie near intersection 2G/B. It is probable that the centre of the Permian structural basin lies to the west of this.

The anticline situated near intersection B-4/2M is designated the Colson Anticline. At Permian level there is structural closure of approximately 200 feet over 15 square miles; depth of Permian at the highest point of the structure is approximately 6250 feet, 250 feet lower than at Mokari No. 1. East of the Colson Anticline and separated from it by a syncline is a minor anticline of limited "closure" some 200 feet lower than the Colson Anticline.

The eastern flank of the minor anticline is controlled by a small fault (fault IV), down to the east. Fault IV is most evident at AA-1608 where it has a throw of approximately 200 feet on Horizon "P"; throw on Horizon "P_1" is slightly greater. The fault probably diminishes northwards.

On the record sections, faults V and VI appear as minor breaks in continuity of reflection "P_1" rather than as steep dip (Plate 7). Throw of both faults on Horizon "P_1", is approximately 100 feet or less; quality of the "P" reflection is not sufficient to determine whether faults V and VI cut Horizon "P".

No significant structural closure is evident on the high trend near B-9.

The increased seismic control given by the survey has reduced the previously interpreted"closure"of the structure near intersection 3E/2H.

(ii) Permian thickness: structure of the base of Permian

No continuous reflection from base of Permian or below it can be recognised. Interpretation of Permian thickness must be made from the "P_1" horizon and from the refraction profiles.

"P_1" is first recognised as a separate reflection at locations AA-1270 and B-270, where it is approximately 0.070 seconds (± 450 feet) below the top of Permian and at a depth of some 6850 feet (Fig. 7). From here it can be followed eastward to lines 2G and 2K and northward to line 2E. West of AA-1270 and B-270 "P_1" probably becomes the top of Permian, due to the angularity of the Permian unconformity.

There is continual eastward thickening of the "$P-P_1$" interval on lines AA and B. Maximum interval is attained near intersection 2G/B where it is approximately 0.180 seconds (± 1150 feet). Thus, relative to location AA1270, the upper section of Permian thickens by some 700 feet; relative to Mokari the thickening is probably greater. At the high point of the Colson Anticline the "$P-P_1$" interval shows a thickening of some 250 feet relative to AA-1270.

Immediately east of intersection 2G/B the "P_1" reflection disappears. At location B-4-157 it again disappears; further eastward near intersection 2G/B4 a deeper reflection, possibly pre-Permian, rises to the east. "P_1" is present on B-7 north, disappearing at B-7-137; a deeper reflection rises southward below it.

It is probable that the "P_1" horizon onlaps lower sediments east of line K (Plate 7), although the disappearance of the reflection might be due to a facies change. The former view was held by F.P.C. who put the eastern limit of the "P_1" horizon (i.e. F.P.C. "P_2" horizon) near intersection B/AS.

The reflection profiles indicate that the "P-Z" interval on line B-9 is thinner than on line B-3. "P-Z" at B-3-123 is 0.280 seconds (1800 feet?) very approximately, and at B-9-136 is 0.090 seconds (600 feet?) very approximately. More refraction profiles are necessary to establish whether this result indicates a general eastward thinning of the "P-Z" interval. However, the disappearance of the "P_1" reflection on lines B and B-4 coupled with the refraction results do suggest an eastward loss of section from the base of the Permian.

(iii) Isochron "C-P"

Isochron map "C-P" is broadly indicative of Jurassic thickness. At Mokari No. 1 the "C-P" interval is 0.340 seconds, equivalent to 2004 feet. In the deepest portion of the Mesozoic basin (area 2G/B) the "C-P" interval is approximately 0.400 seconds, showing a thickening of some 360-400 feet relative to Mokari. Over the Colson Anticline the interval and thickness are approximately 0.310 seconds and 1820 feet respectively.

The narrow elongated trends interpreted on the seismic maps give cause to doubt the legitimacy of connecting possibly isolated anomalies which might owe their origin to inaccurate weathering correction rather than to geologic structure. The doubt is valid, since in the Simpson Desert area the weathering component of total static correction can vary as much as 0.040 seconds (two-way) in one mile. The "C-P" isochron is valuable in assessing this matter. The main anticlinal trends are accompanied by thinning of the "C-P" interval, and we believe the interpretation of the trends is valid.

Summary

(i) The general structural trend at Permian level is north-south.

(ii) Local thinning of the "C-P" interval occurs over structural highs. Maximum increase in thickness of the "C-P" interval relative to Mokari No. 1 is approximately 400 feet.

(iii) Proceeding eastwards, there is stratigraphic addition of section to the top of the Permian and probable concomitant loss of section from the base of the Permian.

(iv) Permian structural closure on the Colson Anticline is approximately 200 feet over 15 square miles. Depth of the Permian on the structure is approximately 6250 feet, 250 feet lower than at Mokari. Thickness of Permian in the area of the Colson Anticline cannot accurately be ascertained, but is probably 1500-1800 feet; there is stratigraphic addition to the top of the Permian sequence of at least 300 feet relative to Mokari No. 1.

(v) The East Border Anticline is not yet accurately defined. It appears to be the northern extremity of an anticlinal trend more than 30 miles in length located on the eastern border of the permit. Depth to the high point of the Permian is some 6000 feet. Probably the Permian here is thinner but at a higher stratigraphic level than at Mokari No. 1.

DISCUSSION AND INTERPRETATION - GRAVITY

General

Gravity results are presented in the form of a Bouguer Anomaly Map (Plate 11) and Compensated Bouguer Anomaly Map (Plate 12) at a scale of 1:100,000. In addition, a Bouguer Anomaly Map (Plate 13) at a scale of 1:250,000 and a Gravity Interpretation Map (Fig. 14) are shown.

The results of the 1967 Simpson Desert Gravity Survey (Hoogenraad, 1968) and Dakota Bore Gravity Survey (Stackler, 1965) which fall within the map boundaries are included.

On the southern and eastern boundaries, gravity contour data of helicopter gravity surveys (Dalhousie Gravity Survey, 1963 and Gravity Survey of O.P. 36, N.T., 1961) have been used as an aid for extrapolation of major gravity trends across the boundaries.

The line spacing in the Three Corners survey area of approximately 2 miles is generally sufficient to define local gravity anomalies which are distinguished by narrow, elongated shapes. Outside of the area proper, the spacing of approximately 5 miles allows definition of regional contours only. Thus, a careful examination of the basic gravity data has to be made during interpretation of the Bouguer Anomaly Map.

Regional Gravity

The Three Corners survey area occupies the southern portion of an irregular plateau-like area of relatively low Bouguer values. This broad area of low ridge-like culminations extends generally northeastwards from the vicinity of the Mokari and Border structures.

The "plateau" is framed to the northwest and to the east by two narrow zones of steepened gravity gradients, directed southeast and west respectively. The gradients in these zones have values of up to 2 milligals per mile, except in the extreme southeast where the steepest gradients surpass it.

The "plateau" terminates to the south against a sub-regional gravity low which has its deepest point south of the lease boundary.

Culminations within the "plateau" appear to be influenced by secondary trends directed approximately north-northwest. In the immediate vicinity of the foregoing zone of steepened gradients, however, these latter trends swing more northerly and/or northeasterly. The most prominent gravity culminations are those coincident with the known Colson Anticline and the east-border line of anticlinal structures.

Local Detailed Gravity

The survey area is bounded on the west and east by major gravity maxima coincident with previously defined seismic anticlines. Respectively these are known as the Border and East Border structures. Although the latter is not fully defined either seismically or gravimetrically, the new gravity data have emphasized the general persistence of the "ridge" and the need for subdivision along its length. It is now evident that the culmination at about latitude 25° 50' S and longitude 137° 15' E is one of the most marked in the region, and is separated from the more northern seismic "East Border Anticline". This new culmination is here named the "Crocker Gravity Maximum" in honour of geologist-biologist, the late Professor L. Crocker, a member of Dr. C.T. Madigan's 1936 Simpson Desert Expedition. Contour closure is of the order of 2 milligals.

The prominent Colson Gravity Maximum, which is coincident with the Colson seismic anticline, reveals two culminations located immediately north of latitude 26° S. Elsewhere, gravity culminations are centred on about latitude 25° 36', longitude 136° 53', and latitude 25° 47', longitude 136° 55' respectively. The former is 12 x 8 miles in dimensions and the latter 8 x 2 miles. Contour closure is of the order of 1.0 and 0.5 milligals respectively. These latter are referred to as the Bejah anomalies in honour of Mr. Jack Bejah, camelier of Madigan's 1936 party.

The Crocker anomaly is strongly asymmetrical with steepened gradients to the east. Maximum dimensions within contour "closure" exceed 12 x 25 miles. To the north the anomaly links via a saddle into the southern extension of the incompletely defined East Border Gravity Maximum.

Between the principal Colson and Crocker anomalies a number of re-entrant low gravity features link into the southern "Simpson Desert" minimum which represents the major depression of the Simpson Desert Infra-basin immediately south of the N.T.-S.A. border. From the central ridge zone of more positive anomalies, gravity values decline by more than 7 milligals at the border, and continue this decline to the south.

Between the Bejah and East Border maxima is a somewhat rectilinear gravimetric low which also borders the Crocker maximum.

To the east of the East Border-Crocker trend of anomalies, gravity values generally decline relatively sharply. Unfortunately, data are sketchy in this direction (helicopter gravity spot values only), but assuming the general meridional lineation of the area, a decline in values from -10 to -25 milligals may occur in a zone only 6 to 8 miles wide.

Interpretation

The principal gravity maxima defined within the Three Corners area all accord closely with previously or newly defined seismic anticlinal structure. Relatively steep gradients in association with the Colson and Crocker anomalies accord with meridional faults, each with eastward downthrow.

Values increase slightly in an easterly direction, which could be indicative of rising basement there. This is also suggested from the seismic records.

The Madigan and Colson troughs form "natural" boundaries to the north and west of the survey area. Deposition of Finke Group sediments and possibly Upper Proterozoic sediments are considered to cause these gravity features. It is suggested that these sediments, if present, are greatly reduced in thickness in the survey area and compare with known developments further west.

In general, the anomalies are narrow northward trending features 4 miles wide and more than 10 miles in length. They can usually be subdivided by north-south "faults" into further sub-anomalies. The similarity of gravity anomalies and seismic results varies with the sub-anomalies of maxima zones. This is most likely due to pre-Permian gravity effects, where seismic records exhibit no reliable reflections for comparison with the gravity results.

Geological and seismic evidence indicates that the principal development of the Simpson Desert Permian Infra-basin lies on and south of the S.A.-N.T. border, and tends to overlap to the north across the ENE-WSW zone of structural and gravity maxima further defined in this survey. Permian sedimentary section blankets all the known structure in this area.

The Colson anticline itself is the dominating and persistent sub-feature within the maximum zone, although its amplitude is approximately 0.5 milligals only. If this effect can be interpreted as merely the result of Cretaceous/Permian structure, a (maximum) structural "closure" at a horizon intermediate between Cretaceous and Permian would be $\frac{0.5 \times 78}{0.25}$ feet = 150 feet (if a density contrast of 0.25 gm/cc. is used). This value is comparable to the seismically derived "closure" of 200 feet at the "P" horizon and in fact illustrates that effects from basement can be neglected here. The area of structural closure is approximately 14 square miles.

Line spacing in the area of the Crocker Gravity Maximum does not allow an accurate delineation of the anomaly. For the same reason small differences between seismic and gravity interpretations must be expected. However, the non-coincidence between the seismic and gravity locations of the East Border anticlinal trend (latitude 25° 35') is significant, since sufficient control is provided by lines 3E and B4. It suggests that gravity anomalies are influenced by a basement ridge which in general is situated west of the Cretaceous/Permian anticline. The width of the gravity maxima zone in its southern part supports this suggestion. Several strong fault-lines occur to the east with downthrows of more than 1,000 feet.

Three special gravity profiles, which originally were designed to check closure of structure on the B-9 line, defined the Bejah maximum zone extending to the north-northeast across the 3H line (see Gravity Interpretation Map, Fig. 14). 2E line separates the maxima zone into two distinct maxima, with gravity "closure" of approximately 0.65 milligals each.

The southern part, situated on line B9, is shown on seismic records as an anticline with only minimum closure to the north. No seismic shooting was conducted over the northern section. There are indications from the 3H and 2E seismic lines that the general shallowing of horizon towards the north may be interrupted by a structure.

The Compensated Bouguer Anomaly Map

Procedure

The concept of compensating the Bouguer Anomaly for the gravitational effect of blanketing sediments for which the density distribution and thickness is known, was introduced by Hammer (1963). Hoogenraad (1968) applied this method to the 1967 Simpson Desert Gravity Survey. To obtain anomalies of structures below the top of Permian, he stripped the sedimentary cover above the Permian in two steps. Firstly, he stripped to the "C" horizon (Lower Cretaceous to Upper Jurassic Transition Beds, density 2.1 gm/cc.) and secondly to the "P" horizon (Top of Permian, density 2.2 gm/cc.).

For the present survey the seismic "P" horizon was used as the stripping horizon. Seismic time/depth relationship was used to calculate the required depths.

It is considered that the density variations of the pre-Permian sediments from existing well information (Hoogenraad, 1968) is not known accurately enough to justify the effort of splitting the sediments into two distinct density zones. An average density of 2.1 gm/cc.was used for "stripping" and the compensation density of 2.4 gm/cc. as used by Hoogenraad accepted.

The Bouguer Slab Correction was used to strip the gravitational effect of the "Mean Sea Level to P horizon" from the Bouguer Anomaly and to correct for topography of the "P" horizon, by filling to M.S.L.

$$\begin{aligned}\Delta go''(P) &= \Delta go' - K\sigma sp\,(S-P) + K\sigma\,pP \\ &= \Delta go' + K\;(\sigma p-\sigma sp)P \\ &= \Delta go' + 0.003828P\end{aligned}$$

where $\Delta go''(P)$ mgls = the Bouguer Anomaly "stripped" to the "P" horizon and compensated to M.S.L.

$\Delta go'$ mgls = the Bouguer anomaly

= 0.01276 is the Bouguer Slab Correction constant

σsp = 2.1 gm/cc. is the M.S.L. to "P" horizon stripping density

σp = 2.4 gm/cc. is the compensating density

S feet = Mean Sea Level

P feet = the depth to the "P" horizon below M.S.L.

The difference of 0.3 gm/cc. between stripping and compensating densities appears to be a little on the high side of the range of possible values. However, test results in the area show that gravity anomalies have not been "over-compensated", which indicates that a large proportion of the anomalies of structures arise from below the Permian.

Results

Comparison between the Bouguer Anomaly Map (Plate 11) and the Compensated Bouguer Map (Plate 12) shows that in general anomaly trends of the Bouguer Map appear also in the compensated map, but are weakened to varying degrees within the area. These differences are the effect of varying pre-Permian rock conditions, in particular older basement structures and faults. No distinction can be made in this report between Ordovician-Upper Proterozoic "bedrock" and the "true" Lower Proterozoic crystalline basement. However, it may be assumed that an average density contrast of 0.2 gm/cc. exists between Ordovician and Permian rocks, so that the Ordovician might act as gravity basement (if not too thick sequences of clean sandstones are present within Ordovician and Upper Proterozoic successions).

Of the major gravity maxima in the area, the maxima of the Border Anticline and the Colson Anticline are considerably weakened, whereas the Crocker maximum still remains as a major anomaly in the Compensated Bouguer Map. This indicates that the basement is shallower there than in the west, and the effective density contrast is therefore closer to the surface.

A comparison between Colson and Border maxima in the Bouguer Map shows that both exhibit secondary maxima on their eastern flanks, trending in the same direction of the maxima trends. These secondary maxima are separated by geological faults from the major maxima. In particular, the fault I of the seismic map limits the Border Anticline to the east. The compensation procedure emphasizes the secondary maxima east of the Border and Colson maxima and thus may indicate that pre-Permian anticlines possibly are centred at the locations of the secondary maxima.

Smaller Bouguer Gravity anomalies have become rather irregular features in the Compensation procedure. This may be explained by the small amplitude of the Bouguer anomalies with decreasing relative accuracy after compensation.

On the eastern extremity of line B4 large changes of compensated Bouguer values are due to sharp seismic fault relief at the top of Permian, which creates unwanted side effects in the compensation procedures. Results have to be ignored here.

GEOLOGICAL CONCLUSIONS

The present survey has yielded valuable information on the stratigraphy and structure of the Permian and Mesozoic sediments within the Three Corners area of O.P. 177 N.T.

Although the exact thickness of the Permian section in the Three Corners area cannot be determined from the seismic records, it appears likely that eastwards and northeastwards from Mokari No. 1 into the Three Corners area the Permian section thickens by addition of the "$P-P_1$" interval to the top. This continues the overall eastwards thickening of the Permian section in P.E.L. 5 & 6 S.A. (see Plate 1).

The Permian sediments near the top of the Mokari No. 1 sequence are Artinskian in age (Evans, 1966). The "$P-P_1$" interval at Mokari has not been resolved, but probably is less than 400 ft. thick. In the area of the Colson Anticline the "$P-P_1$" interval is 700 ft. thick, indicating a stratigraphic addition of at least 300 ft. to the top of the sequence relative to that at Mokari No. 1. Between the Colson Anticline and line 2K the "$P-P_1$" interval may be as much as 900 feet. There may thus be post-Artinskian Permian sediments preserved in the Three Corners area.

The lowermost Mesozoic sediments at Mokari No. 1 belong to the J1 Unit of the lower Jurassic (Evans, 1966), the only known occurrence of rocks of this age in the Western Great Artesian Basin. If the thickening in "C-P" interval, eastwards from Mokari, represents addition of section to the base of the Jurassic, it is possible that Triassic strata occur within the Three Corners Area.

The overall northerly trend of the Permian and Mesozoic fold structure within the Three Corners area appears valid, as it fits the regional fold pattern for the Western Great Artesian Basin (Wopfner, 1960; Sprigg, 1961). Closed structures within the Three Corners area have now been determined.

In summary, prediction of thicker Permian and Mesozoic sections, and, more important, minimal stratigraphic break between Permian and Mesozoic, are confirmed for the Three Corners area. The closed structures now determined in this area thus appear to be potential drilling targets.

OBSERVATIONS

1. A detonating cord source is well suited to the Three Corners area. Data acquired during this survey is comparable in quality to data obtained in previous surveys with conventional dynamite sources. Surface lithology is such that cord laying is simple; a high production rate can be achieved. The extra cost of detonating cord - probably $9,000 for the survey - compared to the cost of conventional dynamite for a similar survey was more than offset by the saving of the expense of operating drill rigs, water trucks and attendant bulldozers.

2. Quality of the "C" and "P" reflections is sufficient to justify an increase in recording spread length from one-third mile splits to one-half mile splits.

3. Whilst the "C" and "P" reflections are sufficient for mapping the top of Permian, the problem of mapping the base of Permian remains unsolved. Neither this survey nor previous single-cover surveys have succeeded in recording a continuous pre-Premian reflection. A trial of multiple-cover methods should be made. (For example:- six-fold cover from one-half mile splits and 2 x 250 feet cord source.)

4. The continuous refraction profiles recorded on the reflection spreads provide spot comparisons of Permian thickness. More are needed; the next survey in the area should attempt to record a higher density of refraction profiles.

5. Multiple-cover recording and a higher density of refraction profiles would entail additional work load on the recording crew. The load could be reduced by employing a separate field unit operating a shallow refraction recorder for the weathering profiles.

6. The east-west traverse, B-4, greatly aided interpretation of the north-south structural trends. Whilst cross-dune traverses entail additional problems for all crew units, the cross-dune recording rate for this survey was only 12% lower than the rate in corridors.

7. A cross-dune multiple-cover line will require strict attention to static correction. The field corrections should be augmented by a digital process of automated static correction.

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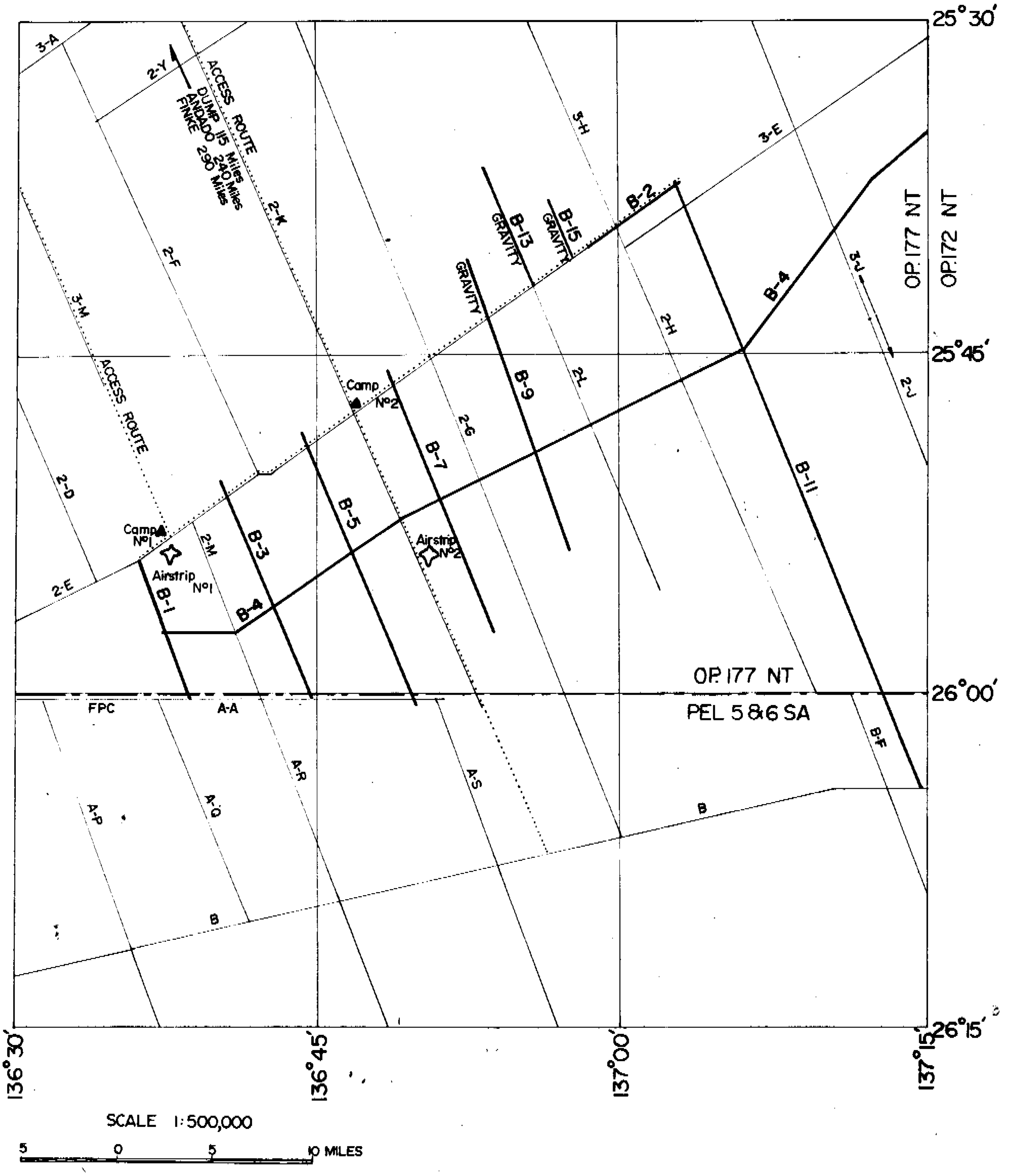

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O.P. 177 N.T.

THREE CORNERS
SEISMIC AND GRAVITY SURVEY
1971

PROGRAMME

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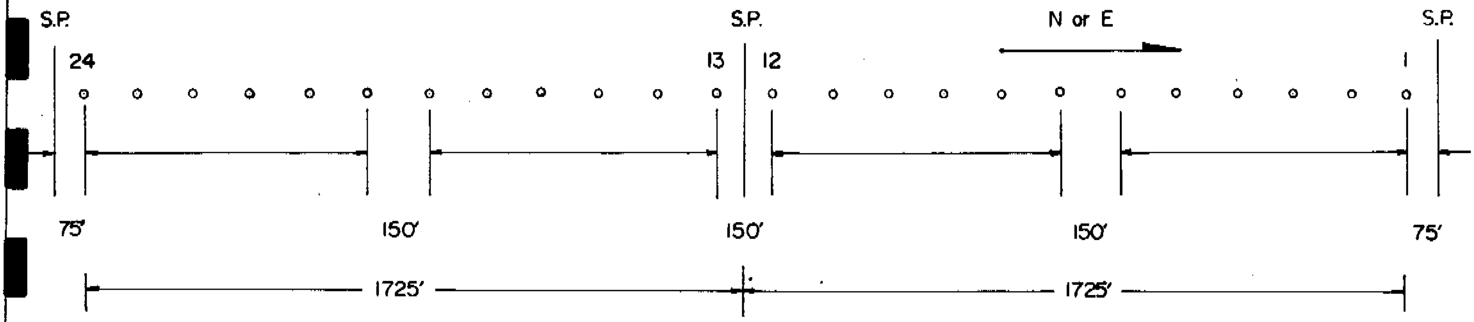
Fig.2

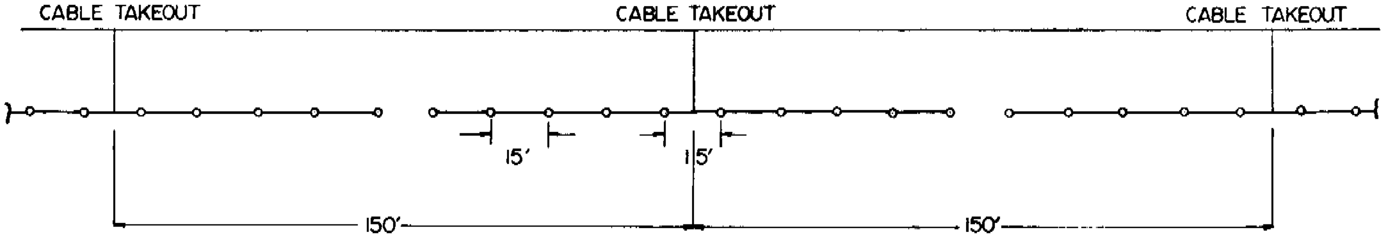
REFLECTION SPREAD LAYOUT .

1725-75-0-75-1725ft.



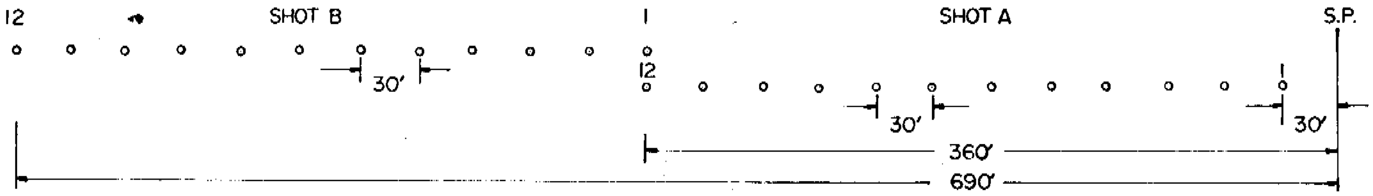
GEOPHONE GROUP LAYOUT

10 HSJ-20 AT 15ft SPACING



WEATHERING CONTROL LAYOUT

690-360-0 and 360-30-0ft



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RECORDING LAYOUT

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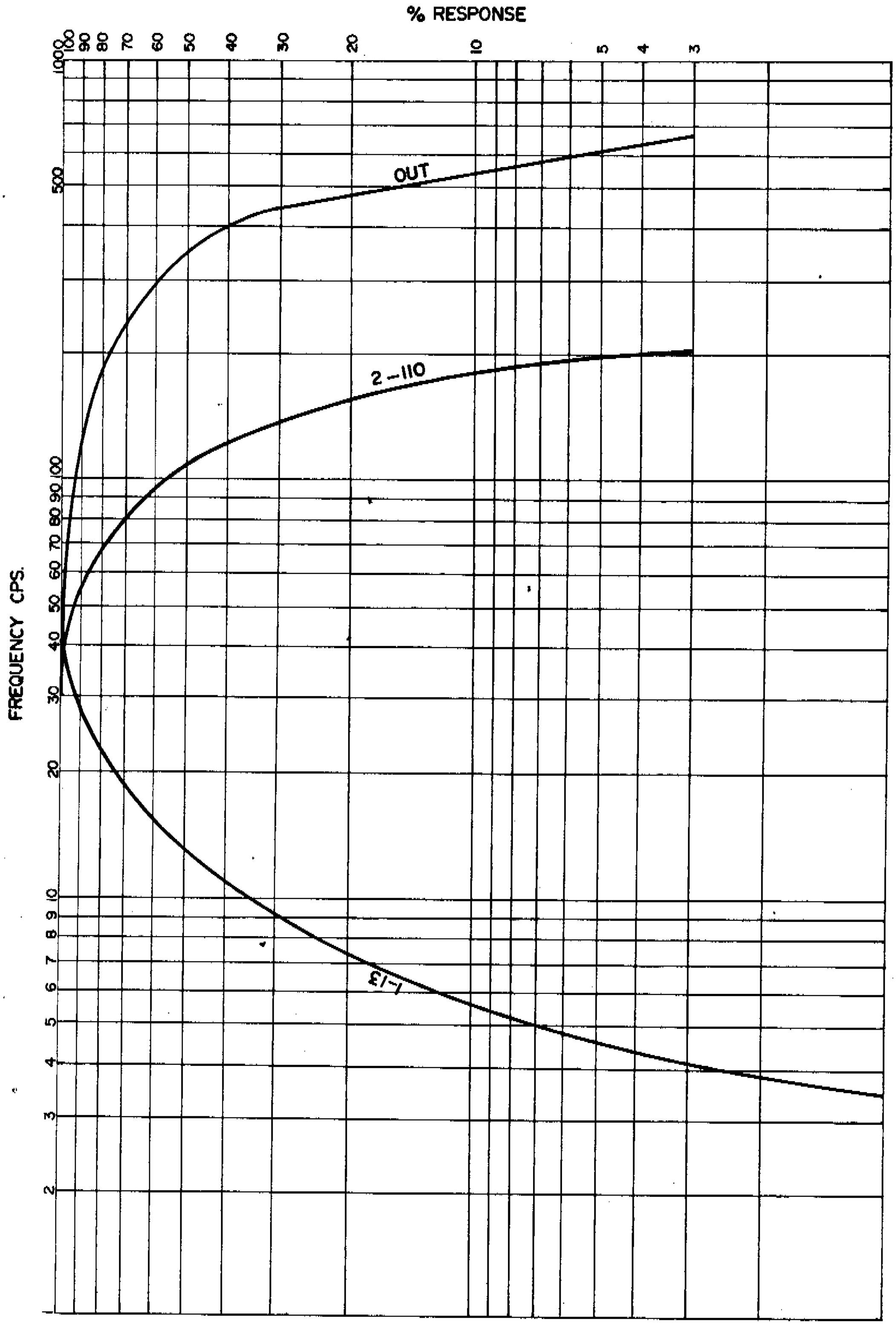
Fig.3



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GEOSPACE III AMPLIFIER RESPONSE RECORDING FILTERS

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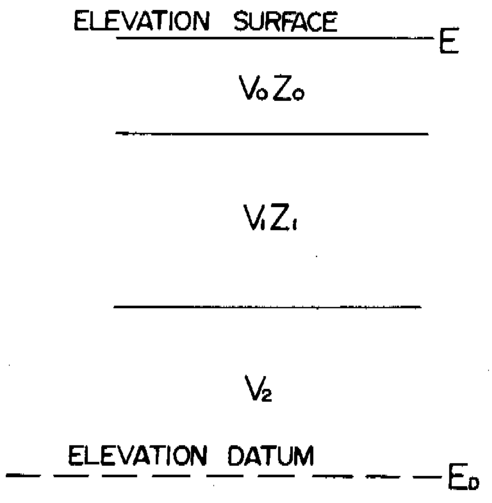
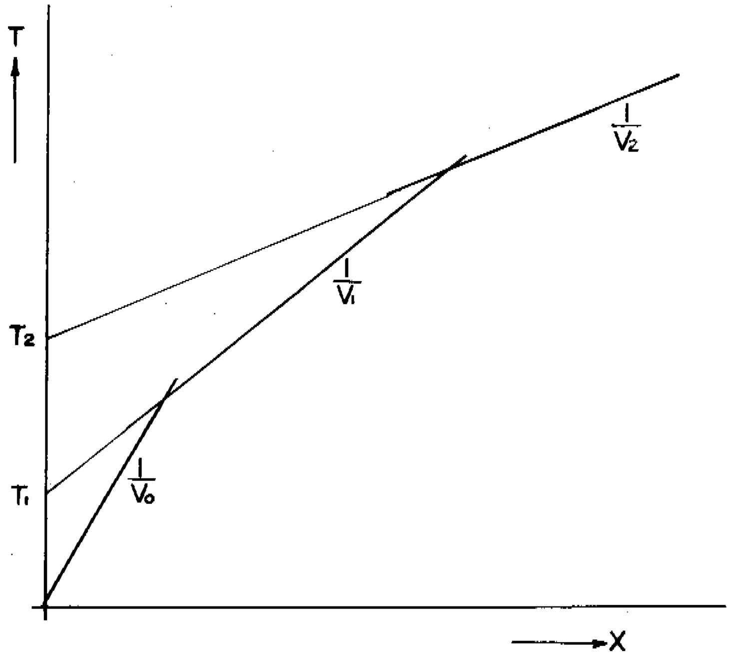
Drg.Nº BP1118 Report Nº 1971/34 Fig.4





$$Z_o = \frac{T_1 V_o}{2 \mathrm{Cos}\, i_{01}}$$

$$Z_1 = \left(T_2 - \frac{2 Z_o \mathrm{Cos}\, i_{02}}{V_o} \right) \frac{V_1}{2 \mathrm{Cos}\, i_{12}}$$

$$T_{wo} = \frac{Z_o}{V_o} - \frac{Z_o}{V_r} \quad \text{and} \quad T_{w1} = \frac{Z_1}{V_1} - \frac{Z_1}{V_r}$$

$$T_g = \frac{E - E_D}{V_r} + T_{wo} + T_{w1}$$

Where V_r is datum correction velocity

T_g is one-way time, surface to datum

$$i_{01} = \mathrm{Sin}^{-1} \frac{V_o}{V_1}$$

$$i_{02} = \mathrm{Sin}^{-1} \frac{V_o}{V_2}$$

$$i_{12} = \mathrm{Sin}^{-1} \frac{V_1}{V_2}$$

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STATIC CORRECTION

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Drg.Nº. BP1119 Report Nº.1971 / 34 **Fig.5**

WEATHERING SPREADS WX-1 to WX-6

LAID AT RIGHT ANGLES TO LINE OF PROFILE

SPREAD LENGTHS –:

0–30–360' CHARGE 1lb at 2'

0–360–690' CHARGE 2lb at 2'

WX-4 LOCATED AT INTERSECTION 2K-2E

BEACH PETROLEUM N.L.

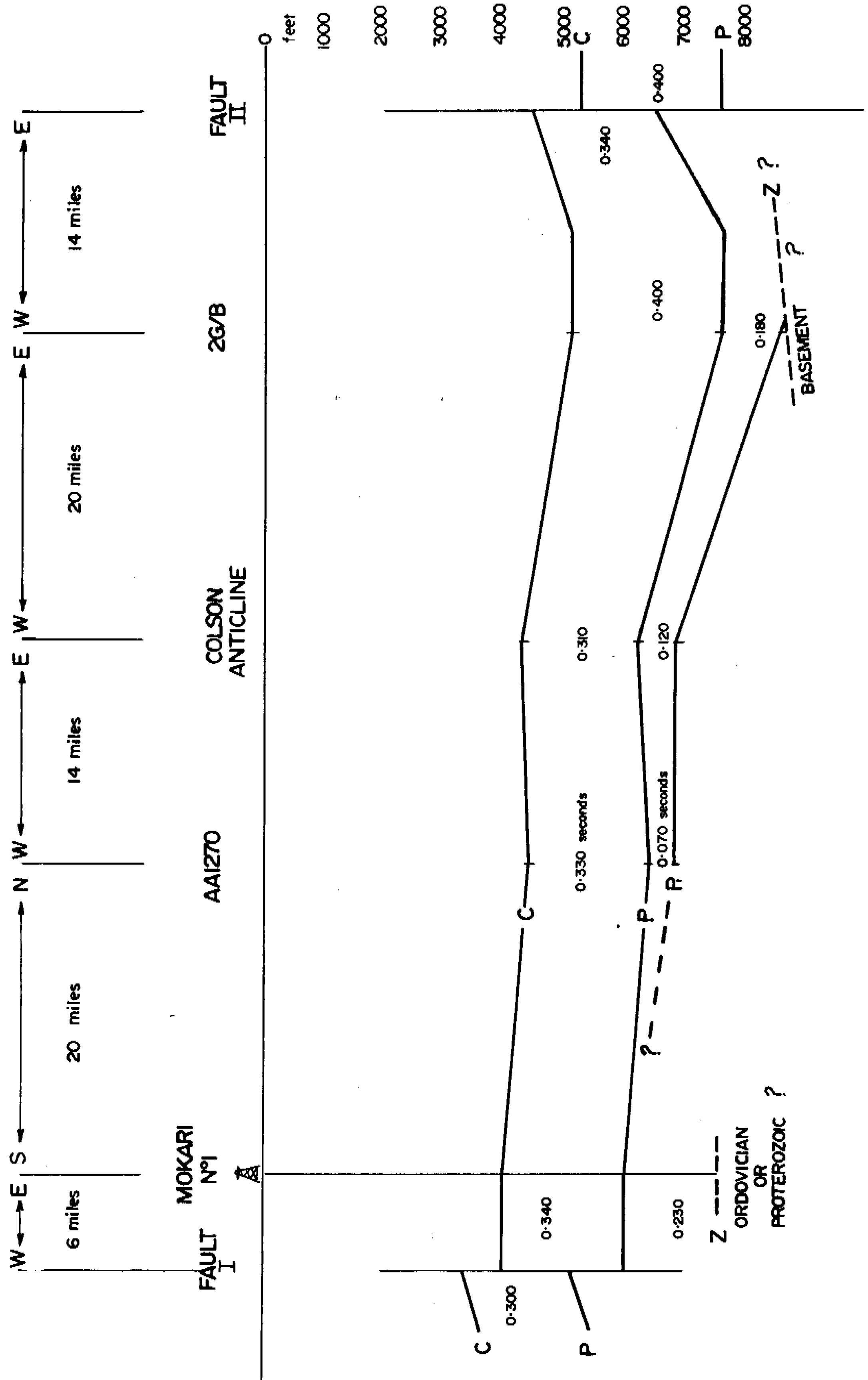
O.P. 177 N.T.

THREE CORNERS
SEISMIC AND GRAVITY SURVEY
1971

PROFILE ACROSS TWO DUNES ILLUSTRATING SENSIBLY CONSTANT ELEVATION OF BASE OF V_0 LAYER

GEOSURVEYS OF AUSTRALIA PTY. L.T.D.

Drg. No. BP1120 Report No. 1971 /34 Fig.6



BEACH PETROLEUM N.L

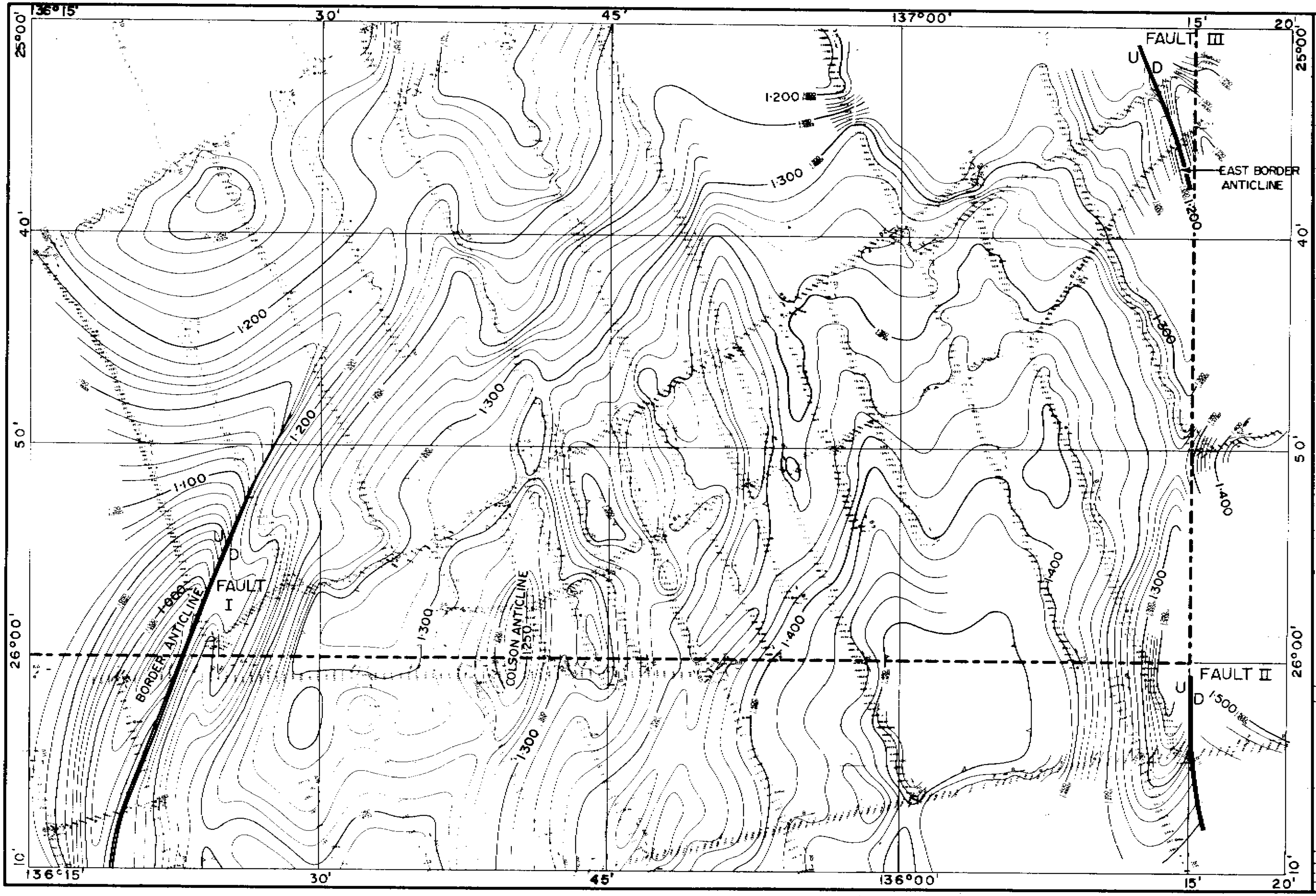
O.P. 177 N.T.

THREE CORNERS
SEISMIC AND GRAVITY SURVEY
1971

SEISMIC CROSS SECTION ALONG SOUTHERN BORDER OF O.P.177

GEOSURVEYS OF AUSTRALIA PTY. LTD.

Drg Nº BP1121 Report Nº 1971/34 Fig 7



The Map incorporates Data From -

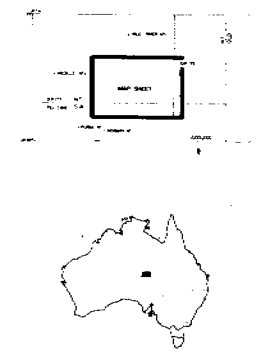
F.P.C. PEDIRKA SEISMIC SURVEY 1963
F.P.C. POOLOWANNA SEISMIC SURVEY 1964-5
AUSTRALIAN AQUITAINE KILPATHA SEISMIC SURVEY 1964
AMERADA SIMPSON DESERT 'A' SEISMIC SURVEY 1965-6
BEACH PETROLEUM THREE CORNERS SEISMIC SURVEY 1971

SEISMIC DATUM 300 Feet above Sea Level
CONTOURS IN TWO-WAY RECORD SECTION TIME
CONTOUR INTERVAL 0·010 seconds (approx 40 ft)

WELL DATA CRETACEOUS TRANSITION BEDS

	DEPTH BELOW 300 ft DATUM	RECORD SECTION TIME
HALE RIVER No 1	2644 feet	0·836 seconds
PURNI No 1	3263	0·985
MOKARI No 1	3988	1·165

Depth Estimates Shown Below The Contour Values Are Approximate Only and Are Derived From Sonic Logs of PURNI and MOKARI



SCALE 1:500,000
MILES
KILOMETRES

BEACH PETROLEUM N.L

O.P. 177 N.T.
(FORMERLY O.P. 57 N.T.)

THREE CORNERS
SEISMIC AND GRAVITY SURVEY

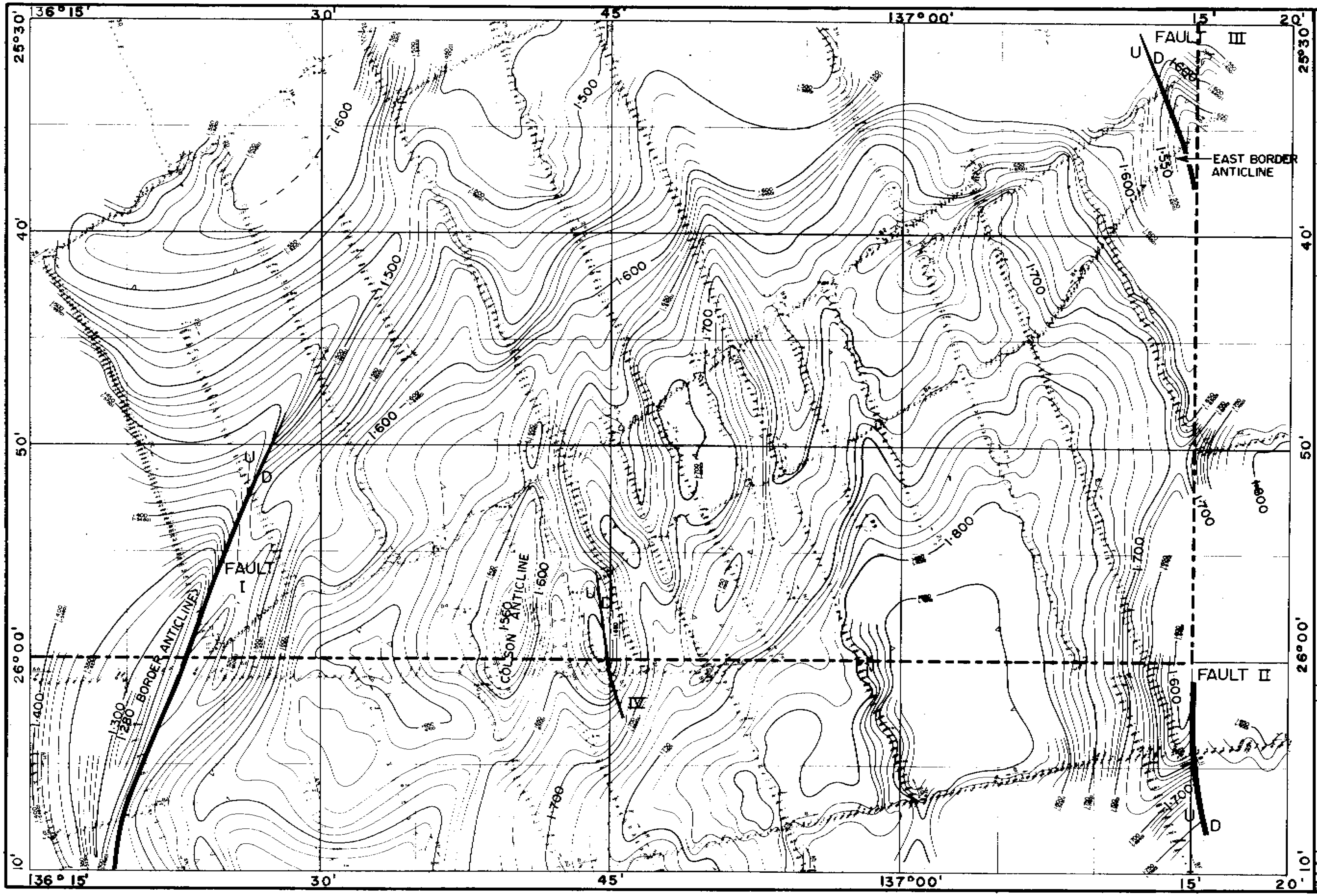
SEISMIC HORIZON 'C'

APPROXIMATE TOP CRETACEOUS
TRANSITION BEDS

GEOSURVEYS OF AUSTRALIA PTY. LTD

Author B. PROCTOR	Date February 1972	Fig 8
Map Ref G-53-7,8,11,12	BP 1128	
Report No 1971/34		

Fig 9



This Map Incorporates Data From -

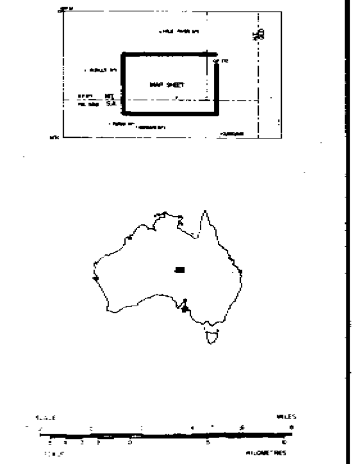
F.P.C. PEDIRKA SEISMIC SURVEY 1963
F.P.C. POOLOWANNA SEISMIC SURVEY 1964-5
AUSTRALIAN AQUITAINE KILPATHA SEISMIC SURVEY 1964
AMERADA SIMPSON DESERT "A" SEISMIC SURVEY 1965-6
BEACH PETROLEUM THREE CORNERS SEISMIC SURVEY 1971

SEISMIC DATUM 300 Feet above Sea Level
CONTOURS IN TWO-WAY RECORD SECTION TIME
CONTOUR INTERVAL 0·010 seconds (approx 50ft)

WELL DATA : TOP OF PERMIAN

	DEPTH BELOW 300ft DATUM	RECORD SECTION TIME
HALE RIVER No 1	4051 feet	1·088 seconds
PURNI No 1	4695	1·239
MOKARI No 1	5992	1·505

Depth Estimates Shown Below The Contour Values Are Approximate Only and Are Derived From Sonic Logs of PURNI and MOKARI



BEACH PETROLEUM N.L.

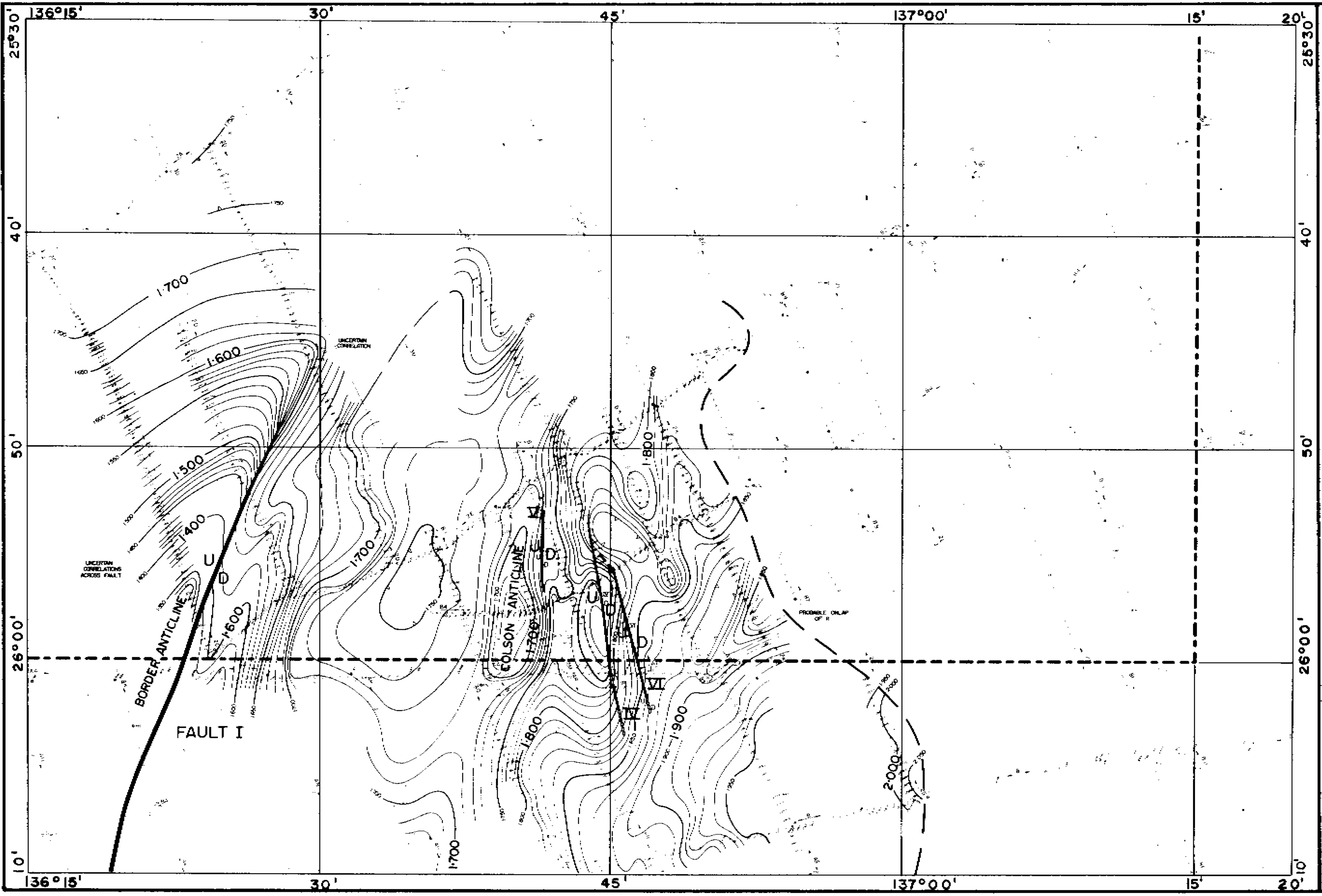
O.P. 177 N.T.
(FORMERLY O.P. 57 N.T.)

THREE CORNERS
SEISMIC AND GRAVITY SURVEY
SEISMIC HORIZON "P"
APPROXIMATE TOP PERMIAN UNCONFORMITY

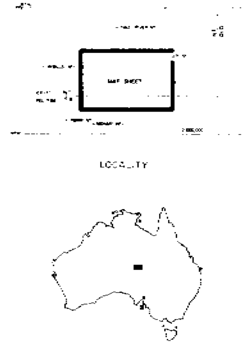
GEOSURVEYS OF AUSTRALIA PTY LTD

Author B. PROCTOR
Date February 1972
Map Ref. G-53-7,8,11,12
Report No 1971/34
BP 1129
Fig 9

Fig 10



SEISMIC DATUM 300 Feet above Sea Level
CONTOURS IN TWO-WAY RECORD SECTION TIME
CONTOUR INTERVAL 0·010 seconds (approx 60ft)



1:500,000

BEACH PETROLEUM NL

THREE CORNERS
SEISMIC AND GRAVITY SURVEY

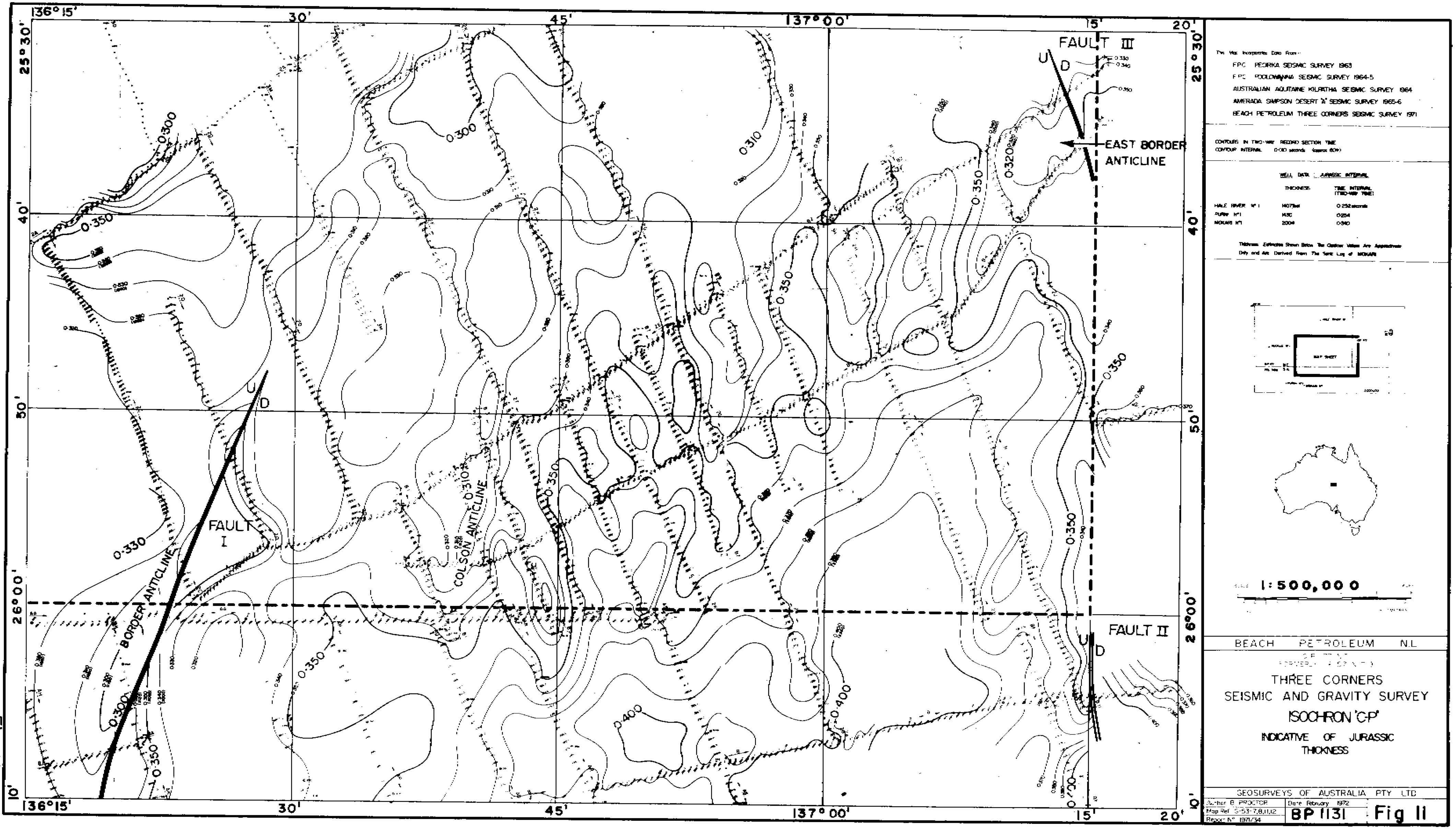
SEISMIC HORIZON 'R'

STRATIGRAPHIC UNIT
IN UPPER SECTION OF
PERMIAN

GEOSURVEYS OF AUSTRALIA PTY LTD

Author S. PROCTOR
Map Ref [illegible]
Report N° 97/34
Date February 1972
BP 1130
Fig 10

Fig 11



This Map Incorporates Data From:-

FPC PEORKA SEISMIC SURVEY 1963
FPC POOLOWANNA SEISMIC SURVEY 1964-5
AUSTRALIAN AQUITAINE KILPATHA SEISMIC SURVEY 1964
AMERADA SIMPSON DESERT 'A' SEISMIC SURVEY 1965-6
BEACH PETROLEUM THREE CORNERS SEISMIC SURVEY 1971

CONTOURS IN TWO-WAY RECORD SECTION TIME
CONTOUR INTERVAL 0·010 seconds (approx 60ft)

WELL DATA : JURASSIC INTERVAL

	THICKNESS	TIME INTERVAL (TWO-WAY TIME)
HALE RIVER No 1	1407feet	0·252 seconds
PURNI No 1	1430	0·254
MOKARI No 1	2004	0·340

Thickness Estimates Shown Below The Contour Values Are Approximate Only and Are Derived From The Sonic Log of MOKARI

SCALE 1:500,000

BEACH PETROLEUM N.L

THREE CORNERS
SEISMIC AND GRAVITY SURVEY

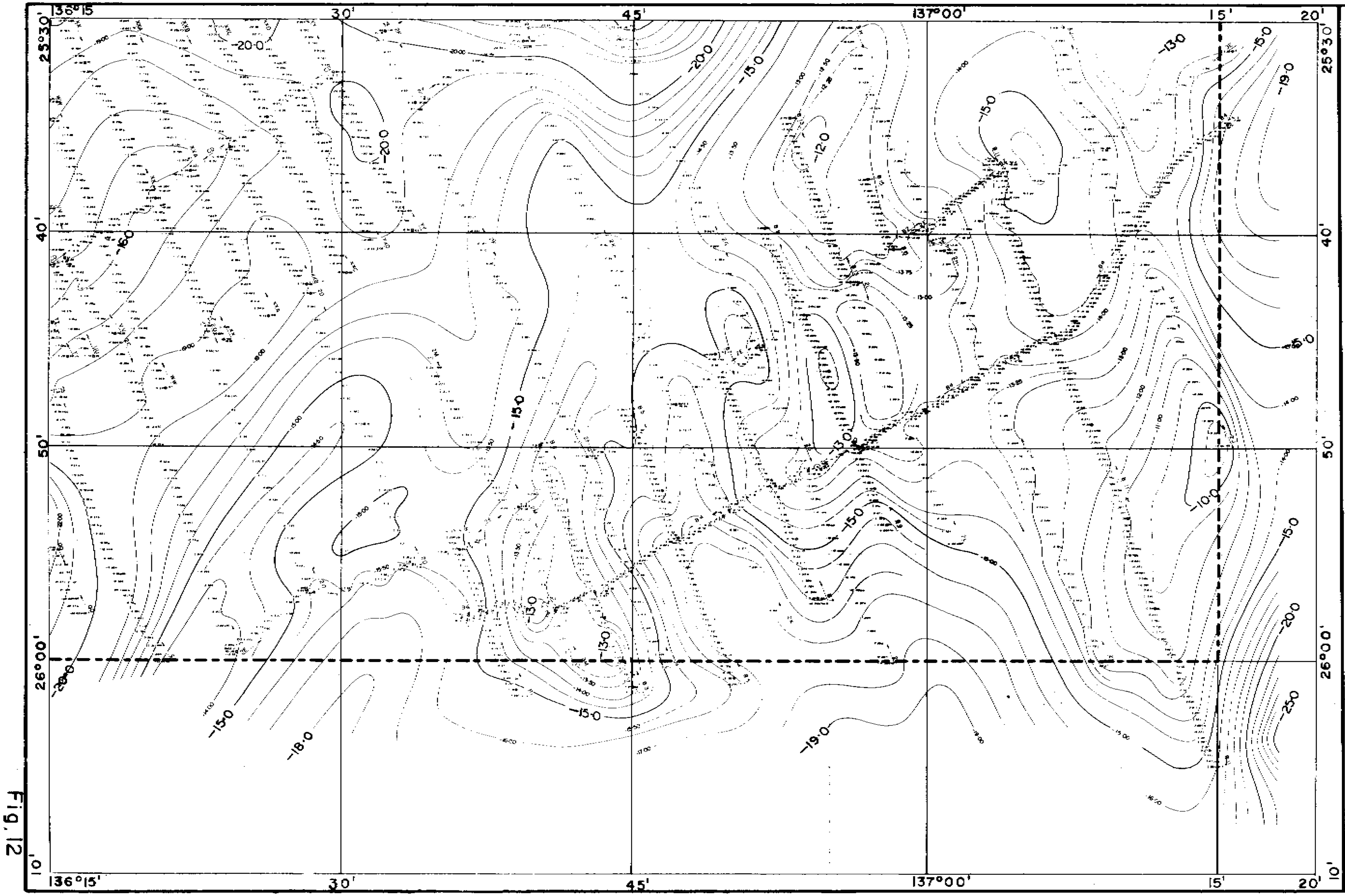
ISOCHRON 'C-P'

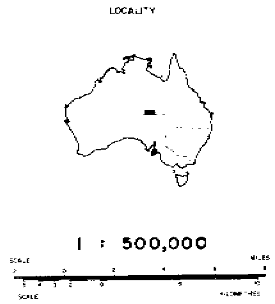
INDICATIVE OF JURASSIC THICKNESS

GEOSURVEYS OF AUSTRALIA PTY LTD

Author B. PROCTOR	Date February 1972	Fig 11
Map Ref S-53-7,8,11,12	BP 1131	
Report No 1971/34		

Fig. 12





1 : 500,000

BEACH PETROLEUM N.L.

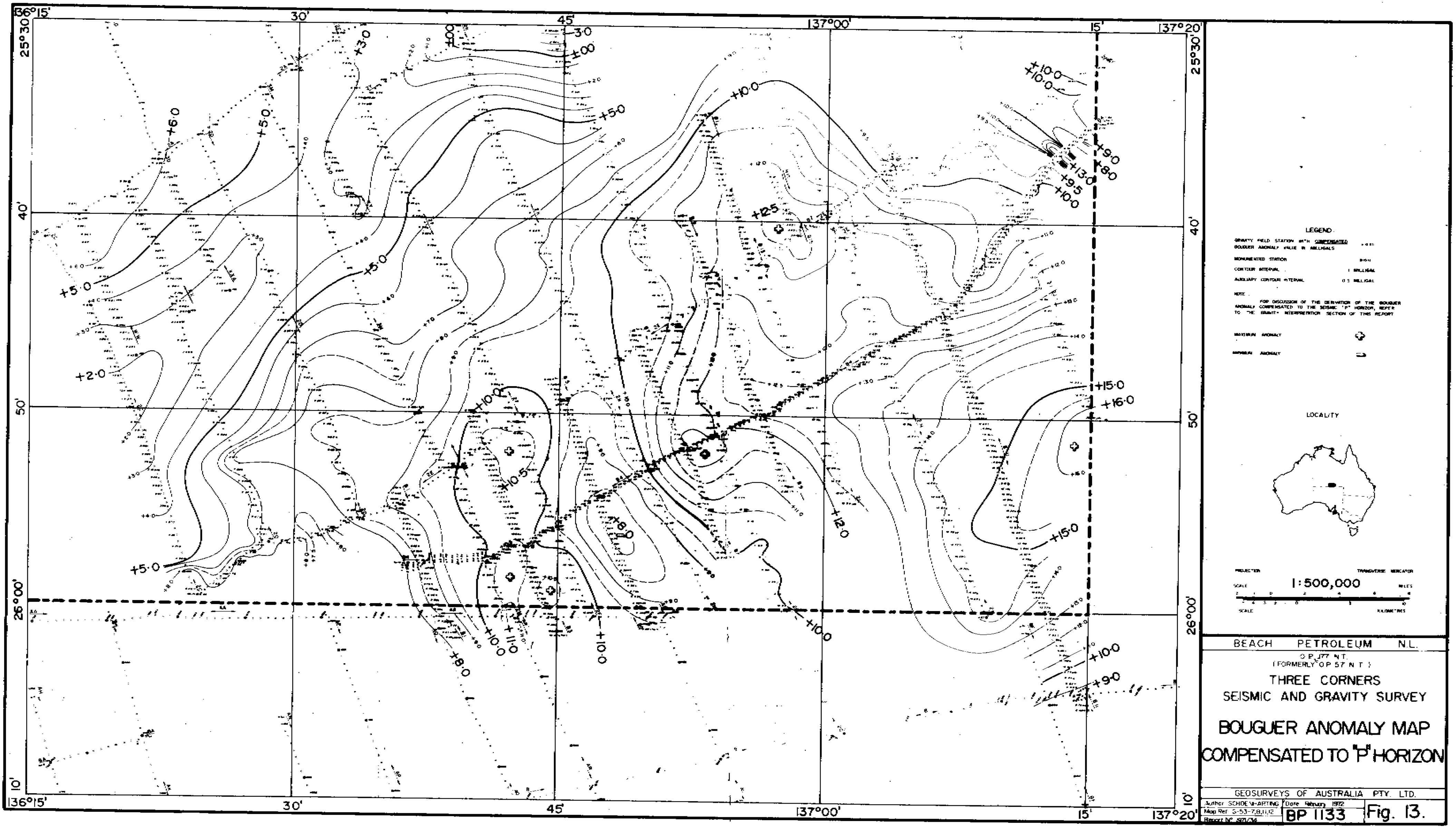
O.P. 77 N.T.
(FORMERLY O.P. 57 N.T.)

THREE CORNERS
SEISMIC AND GRAVITY SURVEY

BOUGUER ANOMALY MAP

GEOSURVEYS OF AUSTRALIA PTY. LTD.

Map Ref. G-53-7,8,11,12
Report Nº 1971/34
Date February 1972
BP 1132
Fig. 12



BEACH PETROLEUM N.L.

O.P. 177 N.T.
(FORMERLY O.P. 57 N.T.)

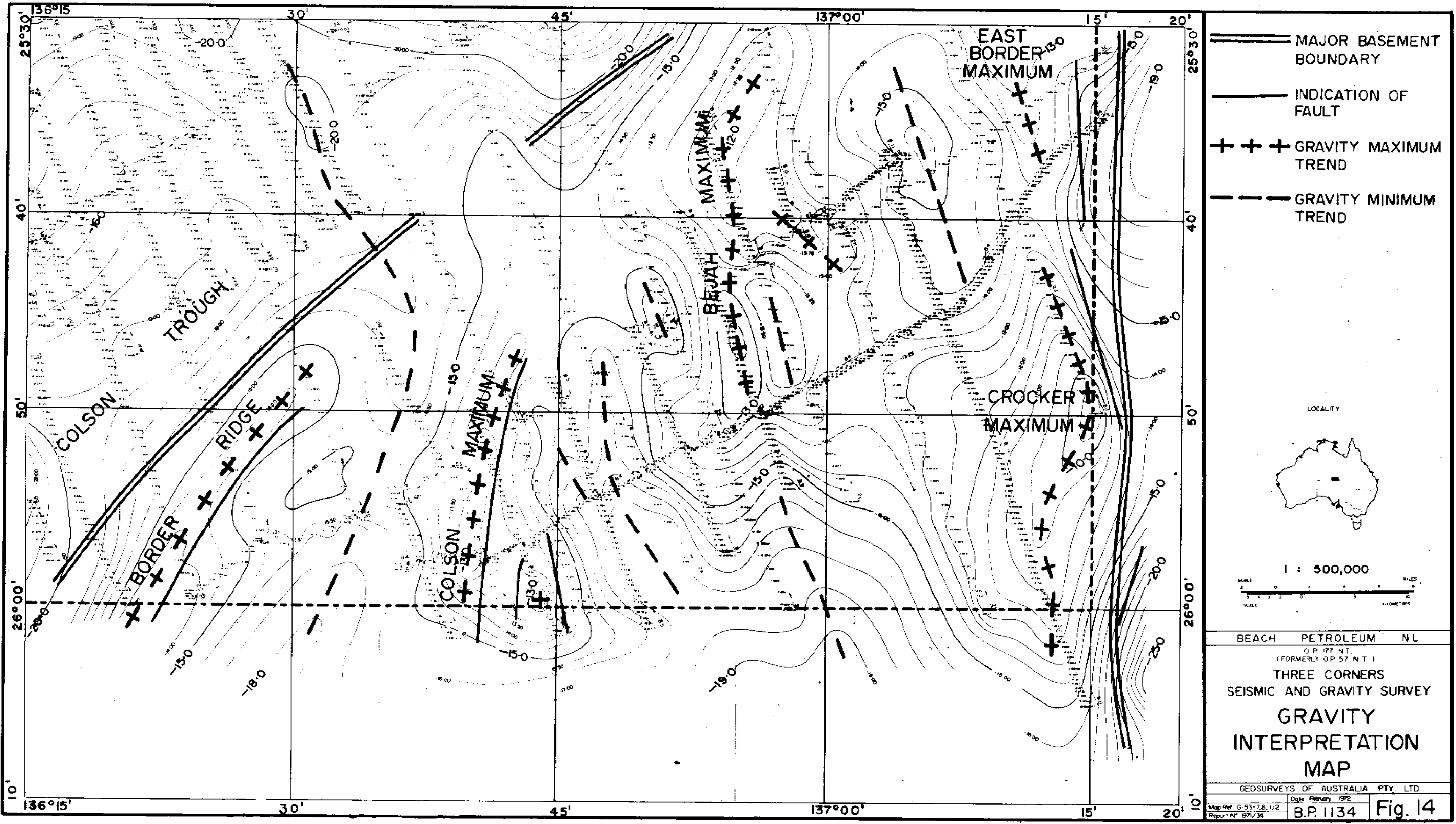
THREE CORNERS
SEISMIC AND GRAVITY SURVEY

BOUGUER ANOMALY MAP
COMPENSATED TO "P" HORIZON

GEOSURVEYS OF AUSTRALIA PTY. LTD.

Author SCHOENHARTING
Map Ref. G-53-7,8,11,12
Report No. 1971/34
Date February 1972
BP 1133
Fig. 13.

Fig. 13



BEACH PETROLEUM N.L.

O.P. 177 N.T.
(FORMERLY O.P. 57 N.T.)

THREE CORNERS
SEISMIC AND GRAVITY SURVEY

GRAVITY
INTERPRETATION
MAP

GEOSURVEYS OF AUSTRALIA PTY. LTD.

Map Ref. G-53-7,8,1,2
Report Nº 1971/34
Date February 1972
B.P. 1134

Fig. 14

Fig. 14.

APPENDIX I

Statistics

Duration of survey	August 17 - October 20, 1971
Recording field hours	363 hours
Recording driving hours	69½ hours
Camp move hours	11¼ hours
Total contract recording hours	443¾ hours
Weather standby recording hours	9 hours
Total subsurface cover	159.7 miles
Total reflection profiles	504 profiles
Total refraction profiles	16 profiles
Total shots	903 shots
Total tapes	566 tapes
Total gravity stations established	552 stations
Total gravity line miles	176.2 miles

Bulldozer D-6

Access road hours	176 hours
Line cutting hours	232½ hours
Cord laying hours	63 hours
Standby hours	35 hours
Miles cut	238 miles

Bulldozer TD-9

Access road hours	113 hours
Line cutting hours	5 hours
Cord laying hours	347½ hours
Standby hours	125 hours
Miles cut	27 miles

APPENDIX I (CONTINUED)

Bulldozer TD-14

Access road hours	209	hours
Line cutting hours	139½	hours
Standby hours	0	hours
Miles cut	216	miles

Total bulldozer access road hours	498	hours
Total bulldozer line cutting hours	377	hours
Total bulldozer cord laying hours	410½	hours
Total bulldozer standby hours	160	hours
Total miles cut (approx.)	454	miles

Explosives used:

Detonating cord	534,000	feet
Hi-drive	1,150	pounds
Ammonium nitrate	14,560	pounds
Detonators	3,000	
Boosters	200	

Average seismic miles per contract 10-hour day	3.60	miles
Average profiles per contract 10-hour day	11.7	profiles
Average shots per contract 10-hour day	20.3	shots
Bulldozer miles cut per contract 10-hour day	5.0	miles

APPENDIX II

Crew Personnel

Supervising seismic geophysicist	A. Yakunin
Supervising gravity geophysicist	G. Schoenharting
Operations Manager	D.H.A. von Sanden
Party Chief	J.B. Proctor
Party Manager	A. Willmett
Observer	R. Hasee
Surveyor	J. Owens
Additional temporary surveyors	P. Brunt and D. Owen
Chief computer/gravity operator	J. Radus
Administration officer	R. Barnes
Computer	A. Woodland/J. Gowland
Junior Observer	D. Thompson
The permanent field crew totalled	24 personnel

Geologist

G.E. Williams

Data Processors

Geophysical Service International, Sydney.
Party 103, Party Chief D. Layson

Consultants

R.C. Sprigg and W.F. Stackler

APPENDIX III

Automotive Equipment

Recording truck	Toyota L.W.B. Landcruiser 4 x 4
Shooting truck	Toyota L.W.B. Landcruiser 4 x 4
Cable truck	Toyota L.W.B. Landcruiser 4 x 4
Survey truck	Toyota L.W.B. Landcruiser 4 x 4
Survey truck	Toyota L.W.B. Landcruiser 4 x 4
Mechanic's truck	Toyota L.W.B. Landcruiser 4 x 4
P.C. vehicle	Toyota L.W.B. Landcruiser 4 x 4
Supply truck	Bedford 4 x 4
Supply truck	Mack 6 x 6 + dog trailer

Bulldozers

1	D6-B	fitted with cord laying tynes
1	TD-9	fitted with cord laying tynes
1	TD-14	(after September 12)

Camp Equipment

14 two-man personnel tents; 1 mess tent; 1 supply tent;
1 kitchen caravan; 1 15 KVA lighting plant.
3 office billy-huts.
1 Eilco base camp radio, O.P.R. network Alice Springs
4 Eilco line unit radios, O.P.R. network Alice Springs

APPENDIX IV

Recording Equipment

System	24 trace, analogue, f.m.
Amplifiers	Geospace III
Tape Recorder	Geospace FM 300
Camera	S.I.E. VRO-6D
Blaster	Geospace
Cables	Four, 12-takeout, 1800 feet
Geophones	Reflection HSJ model K 20 c.p.s. (300) Refraction HSI 4½ c.p.s. (30)
Radios	Two Willis VHF remote shooting radios with Geospace remote shooting boxes
Squirters	Two

Gravity Meter

LaCoste & Romberg G215, field instrument
LaCoste & Romberg G35, spare

Theodolites

2 Wild T1A microptic

1 Wild T2 microptic

APPENDIX V

Previous Geophysical Surveys in O.P. 177, N.T. and in areas adjacent to the Three Corners Survey

Seismic	1963	Pedirka Seismic Survey, P.E.L. 5 and 6, S.A., for French Petroleum Company by Compagnie Generale de Geophysique.
Seismic	1964	Kilpattha Seismic Survey, O.P. 172, N.T., for Australian Aquitaine Petroleum by Compagnie Generale de Geophysique
Seismic	1965-6	Poolowanna Seismic and Gravity Survey, P.E.L. 5 and 6, S.A., for French Petroleum Company by Compagnie Generale de Geophysique.
Seismic	1964	Andado and Anacoora Area Seismic Survey O.P. 177, N.T., for Beach Petroleum by Geoseismic (Australia) Limited.
Seismic	1965	Dakota Bore Area Seismic Survey, O.P. 177, N.T., for Beach Petroleum by Geoseismic (Australia) Limited.
Seismic	1965-6	Simpson Desert "A" Seismic Survey, O.P. 177, N.T., for Amerada Petroleum by Austral Geoprospectors.

APPENDIX V (CONTINUED)

Seismic	1965-6	Simpson Desert "C" Seismic Survey, O.P. 177, N.T., for Amerada Petroleum by Austral Geoprospectors.
Gravity	1964	Anacoora Bore Gravity Survey, O.P. 177, N.T., for Beach Petroleum by Geosurveys of Australia.
Gravity	1965	Dakota Bore Gravity Survey, O.P. 177, N.T., for Beach Petroleum by Geosurveys of Australia.
Gravity	1965-6	Poolowanna Seismic and Gravity Survey as above.
Gravity	1967	Simpson Desert Gravity Survey, O.P. 177, N.T., for Beach Petroleum by Geosurveys of Australia.
Gravity	1970	Mount Daer Gravity Survey, O.P. 177, N.T., for Beach Petroleum by Geosurveys of Australia.

APPENDIX VI

Spread offsets and charges used for recording refraction probe B-3-123.

Record	Spread Centre	Spread	Ammonium Nitrate	Boosters	Detonators
1.	123	1725-75-0-75-1725 ft.	(calibration record, 4 x 250'. cord)		
2.	121	0-1875-5325	240 (lb.)	2	1
3.	119	0-5475-8925	320	2	1
4.	117	0-9075-12,525	480	3	1
5.	115	0-12,675-16,125	640	4	1
6.	113	0-16,275-19,725	800	5	1
7.	111	0-19,875-23,325	960	6	1
8.	109	0-23,475-26,925	1200	7	2
9.	107	0-27,075-30,525	1200	8	1
10.	105	0-30,675 34,125	1200	7	2
			7040 lb.	44	11

APPENDIX VII

Velocity function derived from Mokari No. 1 sonic log.

X = 1725 feet

D feet	Va ft/sec.	To (two-way seconds)	Δ t seconds
600	6000	0.200 sec	0.148
750	6000	.250	.130
900	6000	.300	.115
1050	6000	.350	.103
1210	6050	.400	.092
1370	6090	.450	.082
1530	6120	.500	.074
1695	6170	.550	.067
1863	6220	.600	.061
2040	6280	.650	.056
2250	6420	.700	.050
2375	6330	.750	.048
2552	6380	.800	.045
2753	6475	.850	.041
2958	6570	.900	.037
3175	6680	.950	.034
3390	6780	1.000	.032
3825	6950	1.100	.028
4330	7210	1.200	.023
4920	7570	1.300	.020
5515	7880	1.400	.017
6125	8180	1.500	.015
6720	8400	1.600	.013
7410	8720	1.700	.012

APPENDIX VIII

Modified velocity function used throughout Three Corners Survey.

X = 1750 feet

D feet	V r.m.s. ft/sec.	To (two-way, seconds)	Δ t seconds
146	5850	0.050	0.253
296	5900	.100	.213
446	5950	.150	.180
600	6000	.200	.154
756	6050	.250	.132
915	6100	.300	.115
1076	6150	.350	.101
1239	6200	.400	.090
1405	6250	.450	.080
1573	6300	.500	.072
1752	6380	.550	.065
1934	6460	.600	.058
2120	6540	.650	.053
2309	6628	.700	.048
2503	6700	.750	.044
2700	6780	.800	.041
2900	6860	.850	.037
3105	6940	.900	.035
3313	7020	.950	.032
3525	7100	1.000	.030
3766	7240	1.050	.027
4012	7380	1.100	.025

APPENDIX VIII (CONTINUED)

D feet	V r.m.s. ft/sec.	To (two-way, seconds)	△t seconds
4265	7520	1.150	0.023
4525	7660	1.200	.022
4790	7800	1.250	.020
5062	7940	1.300	.019
5340	8080	1.350	.017
5624	8220	1.400	.016
5914	8360	1.450	.015
6211	8500	1.500	.014
6530	8670	1.550	.013
6856	8840	1.600	.012
7190	9010	1.650	.011
7531	9180	1.700	.011
7880	9350	1.750	.010
8236	9520	1.800	.009
8600	9690	1.850	.009
8971	9860	1.900	.008
9349	10030	1.950	.008
9735	10200	2.000	.007

APPENDIX IX

Co-ordination of seismic data from existing surveys

The horizon maps accompanying this report were produced using the Amerada Simpson Desert V.D. record sections as base. Record section reflection times of the other surveys were adjusted to the Amerada survey. The adjustments used depend on the datum, correction velocity, instrument characteristics and processing parameters of the various surveys.

Seismic datums and replacement velocities used in the various surveys are:-

	Datum	Replacement Velocity
Pedirka, F.P.C.	+ 150 m	2000 m/sec.
Poolowanna, F.P.C.	0	2000 m/sec.
Simpson Desert "A", Amerada	+ 300 ft.	6000 ft/sec.
Three Corners, Beach	+ 300 ft.	6000 ft/sec.
Kilpattha, Aquitaine (Line K-2 reprocessed by Reef)	+ 91 m	2000 m/sec.

Adjustments to the record section reflection times are as follows:-

(i) Convert Pedirka to Poolowanna
Subtract - 0.150 seconds

(ii) Convert Pedirka to Simpson Desert "A"
Subtract - 0.075 seconds

(iii) Convert Poolowanna to Simpson Desert "A"
Add + 0.075 seconds

(iv) Convert Three Corners to Simpson Desert "A"
Add + 0.020 seconds

(v) Convert Kilpattha line K-2 to Simpson Desert "A"
The adjustment is different for each location. Aquitaine K-2 tapes were reprocessed for Reef by Digitech using an assumed elevation of 45 m for shot and geophone. For this report, static adjustments were calculated by Geosurveys using elevations obtained from an elevation profile of K-2.

APPENDIX X

Time-Depth Function used for direct conversion of record section times to depth: Datum = 300 feet a.s.l.

Derived from sonic logs of Purni No. 1 and Mokari No. 1 and from velocity survey of Hale River No. 1.

Well casing and datum adjustments at 6000 ft/sec.; reflection initiation lag taken as 0.033 seconds.

Record section times, To, incorporate adjustments listed in Appendix IX.

To seconds	Depth to Horizon "C" feet	Depth to Horizon "P" feet
0.836	2644 (Hale River)	
0.850	2700	
0.900	2910	
0.950	3120	
0.985	3263 (Purni)	
1.000	3320	
1.050	3520	
1.088		4051 (Hale River)
1.100	3720	4100
1.150	3930	4310
1.165	3988 (Mokari)	
1.200	4130	4530
1.239	4330	4693 (Purni)
1.250	4530	4750
1.300	4730	4990

APPENDIX X (CONTINUED)

To seconds	Depth to Horizon "C" feet	Depth to Horizon "P" feet
1.350	4930	5230
1.400	5130	5480
1.450	5340	5720
1.500		5970
1.505		5992 (Mokari)
1.550		6210
1.600		6450
1.650		6700
1.700		6940
1.750		7190
1.800		7430
1.850		7670
1.900		7920

APPENDIX XI

Average and Interval Velocities: Hale River, Purni and Mokari

1. Average Velocities (datum = 300 feet a.s.l.).

To Horizon "C"

Hale River	6610 ft/sec.
Purni	6870 ft/sec.
Mokari	7050 ft/sec.

To Horizon "P"

Hale River	7700 ft/sec.
Purni	7780 ft/sec.
Mokari	8140 ft/sec.

To Horizon "Z"

Hale River	7850 ft/sec.
Purni	8350 ft/sec.
Mokari	8780 ft/sec.

2. Interval Velocities

"C-P"

Hale River	11,160 ft/sec.
Purni	11,250 ft/sec.
Mokari	11,750 ft/sec.

"P-Z"

Hale River	9,830 ft/sec.
Purni	11,630 ft/sec.
Mokari	12,900 ft/sec.

APPENDIX XII

TABLE OF PRINCIPAL FACTS
OF PERMANENT GRAVITY STATIONS

Station	Latitude	Longitude	Final Elevation (Feet)	Observed Gravity (Milligals)	Bouguer Anomaly (Milligals)	Remarks
Base J	25° 45.4	136° 51.3	283.7	978986.77	-15.44	
Base Q	25° 48.0	136° 47.2	275.9	978990.35	-15.52	
Base R	25° 50.5	136° 42.6	307.7	978992.45	-13.99	
Base S	25° 52.8	136° 39.1	303.6	978995.57	-14.05	
Base W	25° 42.3	136° 56.1	277.3	978985.85	-13.21	
Base X	25° 40.8	137° 00.9	248.7	978986.39	-12.95	
B1/102	26° 01.4	136° 39.0	263.8	979007.28	-15.18	
B1/115	25° 57.8	136° 37.5	294.2	979001.14	-14.97	B4/104
B1/126	25° 54.8	136° 36.1	277.5	978998.57	-15.21	
B2/103	25° 39.6	137° 00.2	271.6	978983.27	-12.99	
B2/119	25° 37.3	137° 03.5	259.4	978979.88	-14.57	B11/204
B3/98	26° 01.2	136° 45.0	262.3	979008.51	-13.87	
B3/110	25° 58.0	136° 43.6	294.4	979002.75	-13.55	
B3/114	25° 56.8	136° 43.1	282.6	979002.27	-13.55	B4/124
B3/121	25° 54.9	136° 42.4	278.0	979000.20	-13.62	
B3/133	25° 51.6	136° 40.8	282.9	978996.39	-13.26	
B3/TN	25° 49.9	136° 40.2	327.2	978990.54	-14.01	
B4/101	25° 57.8	136° 36.6	277.7	979001.66	-15.64	
B4/104	25° 57.8	136° 37.5	294.2	979001.12	-14.99	B1/115
B4/116	25° 57.6	136° 41.0	277.0	979004.07	-13.08	
B4/124	25° 56.8	136° 43.1	280.8	979002.32	-13.63	B3/114
B4/132	25° 55.8	136° 44.9	262.6	979000.90	-15.14	
B4/142	25° 54.2	136° 47.3	286.5	978995.78	-16.72	B5/124
B4/152	25° 52.9	136° 49.9	285.6	978995.69	-15.33	
B4/161	25° 51.8	136° 52.3	252.1	978998.16	-13.86	B7/121
B4/167	25° 51.1	136° 54.0	253.5	978997.98	-13.14	
B4/177	25° 50.0	136° 56.5	252.8	978996.79	-13.05	B9/113
B4/216	25° 44.7	137° 06.6	238.0	978990.71	-14.03	
B4/241	25° 39.6	137° 10.7	246.8	978984.50	-13.59	
B4/Tail E	25° 34.6	137° 15.5	230.8	978976.28	-17.06	
B5/100	26° 00.8	136° 50.2	268.0	979005.12	-16.36	
B5/124	25° 54.2	136° 47.3	286.5	978996.00	-16.50	B4/142
B5/132	25° 52.0	136° 46.5	278.5	978995.00	-15.44	
B5/142	25° 49.3	136° 45.2	275.7	978992.44	-15.02	
B7/102	25° 57.1	136° 54.4	236.4	979003.46	-15.85	
B7/112	25° 54.3	136° 53.4	262.4	978999.46	-14.76	
B7/121	25° 51.8	136° 52.3	252.4	978998.11	-13.89	B4/161
B7/122	25° 51.5	136° 52.1	251.6	978997.84	-13.86	
B7/141	25° 46.5	136° 49.6	289.2	978988.04	-15.13	
B7/TN	25° 45.6	136° 49.2	296.8	978987.38	-14.25	

APPENDIX XII (CONTINUED)

Station	Latitude	Longitude	Final Elevation (Feet)	Observed Gravity (Milligals)	Bouguer Anomaly (Milligals)	Remarks
B9/100	25° 53.6	136° 58.0	284.5	978996.08	-15.85	
B9/106	25° 51.9	136° 57.4	243.7	978998.38	-14.41	
B9/113	25° 50.0	136° 56.5	252.8	978996.77	-13.07	B4/177
B9/116	25° 49.2	136° 56.1	275.6	978994.40	-12.93	
B9/126	25° 46.4	136° 55.0	254.3	978993.13	-12.44	
B9/136	25° 43.8	136° 53.7	267.2	978988.42	-13.10	
B9/151	25° 39.8	136° 51.7	298.9	978981.56	-13.02	
B11/105	26° 04.2	137° 14.6	182.8	979016.26	-15.27	
B11/130	25° 57.5	137° 11.7	211.0	979011.04	-10.64	
B11/145	25° 53.3	137° 10.3	224.4	979004.72	-11.09	
B11/161	25° 48.9	137° 08.5	245.0	978996.88	-12.32	
B11/190	25° 41.1	137° 05.0	230.0	978986.54	-14.51	
B11/204	25° 37.3	137° 03.5	259.4	978979.84	-14.61	B2/119
B13/114	25° 38.4	136° 54.5	295.6	978981.13	-12.09	
B13/128	25° 34.6	136° 53.0	298.4	978975.80	-12.72	
B15/100	25° 40.7	136° 58.3	258.9	978985.93	-12.62	
B15/112	25° 37.5	136° 56.9	280.5	978980.81	-12.33	

The permanent markers listed above consist of steel fence-posts with attached metal tag die-stamped with line and station identification.

APPENDIX XIII

REFERENCES

EVANS, P.R., 1966: In Mokari No. 1 Well Completion Report, French Petroleum Company (Aust.), Appendix No. 2.

FRENCH PETROLEUM COMPANY, 1966: Final Report, Poolowanna and Emery Seismic and Gravity Surveys.

HAMMER, S., 1963: Deep gravity interpretation by stripping: Geophysics vol. XXVIII, no. 3, pp. 369-378.

HOOGENRAAD, R., 1968: Simpson Desert Gravity Survey, O.P. 57, for Beach Petroleum N.L. (unpubl.).

MINERAL ADMINISTRATION PTY. LTD., 1961: Final Report, Gravity Survey of O.P. 36 N.T., for Associated Freney Oilfields N.L. (unpubl.).

SPRIGG, R.C., 1961: On the Structural evolution of the Great Artesian Basin. Jour. A.P.E.A., 1 : 37-56.

WILLIAMS, G.E., 1971: Geological Review of the Simpson Desert Sub-basin, for Beach Petroleum N.L. (unpubl.).

WONGELA GEOPHYSICAL PTY. LTD., 1963: Final Report, Dalhousie Gravity Survey for French Petroleum Company (Australia) Pty. Ltd. (unpubl.).

WOPFNER, H., 1960: On some structural development in the central part of the Great Artesian Basin. Trans. Roy. Soc. South Austr., 83 : 179-193.