COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORDS 1959, No. 4

PRELIMINARY REPORT ON A SEISMIC SURVEY IN THE CARPENTARIA BASIN, QUEENSLAND

JULY-DECEMBER, 1958

by

C. S. ROBERTSON and F. J. MOSS

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ABSTRACT

The Bureau of Mineral Resources carried out a seismic survey of four months duration in the Carpentaria Basin, North Queensland, in the second half of 1958. The purposes and main results of the survey are described briefly in this report. The Basin was found to be deepening gradually towards the southeastern corner of the Gulf of Carpentaria. The maximum thickness of sediments measured was 3,300 feet. It was found that the gravity anomalies in the area do not correlate with basement relief.

1. INTRODUCTION

From July to December, 1958 the Bureau of Mineral Resources, Geology and Geophysics carried out a seismic survey in the Carpentaria Basin at the request of Associated Australian Oilfields N.L., supported by the Queensland Mines Department. Seismic work was also requested in the same region by Associated Freney Oilfields N.L., but this company relinquished its Authority to Prospect before the survey took place.

The objects of the survey were:-

(a) to determine the general form of the Basin from its western margin to its eastern margin.

(b) to establish the structural position of the Karumba bore (A.A.O.No.8) and, if practical, determine the site for a new bore to test this structure should the Karumba bore be too far off the culmination of the structure.

(c) to determine the structural significance of the line of positive gravity anomalies from Magoura south of Karumba to Macaroni about 10 miles inland from mouth of Gilbert River, and to detail the structure below one of the anomalies if previous work should suggest this desirable (Plate 3).

The seismic party arrived at Normanton to commence the survey on 11th July and terminated the survey near Burketown on 11th November. The locations of these towns are shown on the map of plate 1.

2. FIELD WORK.

The survey was conducted by geophysicists C.S.Robertson and F.J.Moss assisted by 5 staff members of the Bureau and 11 wages employees. The staff members of the party consisted of a senior radio technician, 2 drillers, a field assistant (shooter) and a mechanic.

A twenty-four channel set of seismic amplifiers (T.I.C.621) manufactured by Technical Instrument Company of Texas (now Clevite Corporation) was used in conjunction with a T.I.C. 50-trace, 10 inch camera. Twenty-four unmixed traces, twenty-four mixed traces, a time break trace and an uphole trace were recorded.

The recording equipment was carried in a specially designed, light-proof cab mounted on the back of a L.W.B. Land-Rover. For reflection work T.I.C. 20 c.p.s. geophones were used in groups of 6 per trace placed in line along the traverse at 22 foot intervals, the conventional ½ mile split spread set-up being employed. For refraction work T.I.C. 6 c.p.s. geophones were used close together in pairs at the geophone pegs which were 220 feet apart.

Shot hole drilling was carried out by two Failing 750 truck-mounted drills, except during the last 3 weeks of the survey when only one drill was in operation. Four water tenders were used to supply the drills with water (one of these was kept as spare or camp tender) and a fifth water tender was used as shooting truck. The seismic party carried out seismic work at twenty-eight separate localities in the northern part of the basin, working from four main base camps. Reflection traverses were surveyed to provide detailed information on the depth and structure of sediments in the basin.

Refraction profiles were shot, at some places on gravity anomalies, to determine the depth to basement at various localities in the basin. These refraction profiles consisted of two refraction shots, one from either side of a one mile geophone spread. A single reflection hole was shot at the centre of each refraction profile. It was hoped that the profiles on prominent gravity anomalies would provide a basis for gravity interpretation.

Field work was carried out in the Karumba area (see plate 2) from 14/7/58 to 5/8/58. This included 20 miles of continuous profile reflection shooting and two refraction profiles. While working from Haydon from 8/8/58 to 21/8/58 the party shot six refraction profiles at intervals of about 20 miles from Croydon to Magoura. From 28/8/58 to 6/10/58, while based near Macaroni, the party surveyed an 8-mile reflection traverse near the camp, a 2-mile reflection traverse near the F.B.H. No.1 bore (Wyaaba Creek) and twelve refraction profiles to the north and east of Macaroni. Between 8/10/58 and 21/10/58 refraction profiles were shot at Midlothian, Retreat and Morning Inlet. Working from a base camp at the Gregory River crossing, the party surveyed seven refraction profiles west of Burketown between 23/10/58 and 11/11/58.

During the survey a total footage of 23,070 feet was drilled, including 268 single reflection and refraction shot holes and 131 holes for reflection patterns shots. Depths of reflection holes were usually 35 to 55 feet and refraction holes were usually 105 feet deep.

3. RESULTS

Both the reflection and refraction seismic methods proved very successful in providing useful sub-surface data in the Carpentaria Basin. In reflection work it was found that at most places satisfactory results could be obtained using relatively small charges in relatively shallow holes with multiple-six geophones. The Carpentaria region proved particularly suitable for refraction work since only two main velocities, very different in magnitude, were recorded in almost all parts of the basin.

A refraction velocity of about 7000 ft/sec was recorded from the sediments. This was in agreement with a constant vertical velocity of 7000 ft/sec determined from a $T - \Delta T$ analysis of the Karumba reflection records. A refraction velocity of about 18,000 ft/sec was recorded from the basement rocks. The occurrence of only two refraction velocities made the determination of first arrival times on the records relatively easy and enabled the simple 2-layer method of refraction calculations to be employed with good justification.

Reflection Work.

The results of the reflection traverses will not be discussed in detail in this report. No significant structures likely to produce oil traps were indicated by the reflection work. Indications were that the sediments were generally flat or gently dipping in conformity with the regional basement surface as indicated by the refraction work. The locations of reflection traverses A, B, C and D at Karumba with relating gravity information are shown on the map on plate 3. The resulting correlation cross-sections are shown on plates 4 to 7. It will be noticed on the cross-sections that reflections deeper than the known basement are shown. The drill hole (A.A.O. No.8) and the refraction results showed clearly that basement (felspathic quartzite) is at a depth of about 2300 feet. Most of those deeper reflections which have been analysed critically are clearly multiples whose source of energy is the initial reflection

from basement which is re-reflected from the surface; the times of arrivals of the deeper reflections being consistent with this interpretation. Similar deep reflections on other cross-sections are probably multiples, although some may be reflections from within the basement complex.

On both of the east-west traverses a fault was encountered near the western side of the gravity anomaly with the downthrow side to the west and with a vertical displacement of about 130 feet.

The locations of traverse G, Macaroni, traverse I, Wyaaba Creek, traverse M, Dunbar, and traverse W, Gregory River are indicated on the map of plate 2. These are at the same locations as traverses GG, II, MM and WW respectively. The plotted results of these traverses are shown on the cross-sections on plates 8 to 11.

The reflection work at Karumba and Macaroni showed that the gravity highs in those areas did not correspond to anticlinal structures in the sediments. The horizontal attitude of the sediments as revealed by the reflections near Karumba indicated that another test bore in that area was unwarranted at this stage.

Refraction Work (and associated reflection work).

The considerable number of refraction-reflection profiles shot in the northern part of the basin have provided much useful information on the general configuration and depth of the basin. The results are summarized on the map on plate 2, which shows the locations of the refraction-reflection profiles, the spot depths to basement obtained and contours on the basement surface derived from refraction-reflection spot depths and bore data. Gravity contours at 3 milligal intervals are also shown for portion of the area.

One of the most important results of the seismic work has been to show that there is little or no correlation between gravity anomalies and depth to basement in the area. No structural significance as far as the sediments are concerned can be attached to the line of positive gravity anomalies from Magoura to Macaroni. The refraction work indicates that the basement surface has many minor irregularities and is commonly faulted with a displacement of 200 feet or less. Local basement dips of up to several degrees (over a one mile geophone spread) were encountered in a number of places, but sediments were nearly everywhere horizontal or gently dipping away from the margins of the basin.

The seismic work has also provided information on the nature of the western and eastern margins of the basin. Before this survey various theories were held to explain the change in level of the basal Cretaceous sandstone from 2300 feet below sea level at Burketown to heights of up to 500 feet above sea level at places 100 miles further west. These theories variously postulated a series of arcuate faults, a single fault or a monocline. However seismic work has shown that the basin shallows gradually from a depth of about 2400 feet at Burketown to a depth of 200 feet or less near Doomadgee without any appreciable faulting or sudden folding. A similar gradual shallowing was observed from Magoura to Croydon at the eastern side of the basin. To the northeast, near Gamboola, the situation is less clear. Between Highbury and Gamboola a depth of 1500 feet was recorded only about 20 miles from the margin of the basin. It is inferred that either the basin deepens more rapidly from the margin in this area or the margin is faulted.

Demonstration by the seismic party that the substantial

gravity anomalies in the area are not connected with basement relief has posed a problem in gravity interpretation. If the anomalies originate below the basement surface large and sharp density contrasts are required to explain the gravity gradients, which are as steep as 4 milligals per mile in some places. The theory that the gravity anomalies occur over denser basement rocks appears to be contradicted by the bore data available. The Karumba bore (A.A.O. No.8), which is situated on a gravity ridge, bottomed in relatively light felspathized quartzite, and the Wyaaba bore (F.B.H. No.1) terminated in a weathered basic igneous rock.

The other possible interpretation of the gravity results depends on the assumption that the anomalies arise from density contrasts in matter close to the surface, within the sedimentary section. However there is no known geological or other evidence to suggest that the density of the sediments should change appreciably over a relatively short horizontal interval in the manner suggested by the gravity results. There is not, for instance, any reason to suspect the existence of dense limestone reefs so far into the basin as the Magoura-Galbraith line of positive gravity anomalies. No considerable thickness of dense limestone were encountered in the Karumba bore.

4. CONCLUSIONS

The seismic survey carried out in the Carpentaria Basin from July to December, 1958 has shown that both the reflection and refraction seismic methods are very suitable for providing subsurface information in the basin. Seismic work can be carried out relatively cheaply and without unusually elaborate seismic equipment. Shot hole drilling presents few problems.

Seismic work north and east of Normanton has shown that the basin deepens gradually towards the Gulf of Carpentaria in this area. The western margin of the basin is not fault-controlled south-west of Burketown; but rather the basin deepens gradually towards the south-east corner of the Gulf as is the case on the eastern side. The gravity anomalies do not correspond to basement "highs" and "lows".

The basement surface has local irregularities, but the sediments are in most places horizontal or nearly so. Sediments and basement surface are displaced by faults in many places so that fault traps may provide the best possibility for accumulations of oil within the basin. If such traps exist they could be located using the seismic method. However experience at Karumba has shown that a considerable amount of detailed seismic work may be necessary to map the faults and to determine whether they are possible oil traps suitable for drilling. At Karumba reflection work on the two main traverses suggested the possible existence of a fault near the western side of the gravity anomaly, but refraction work was necessary in order to prove the faults existence.

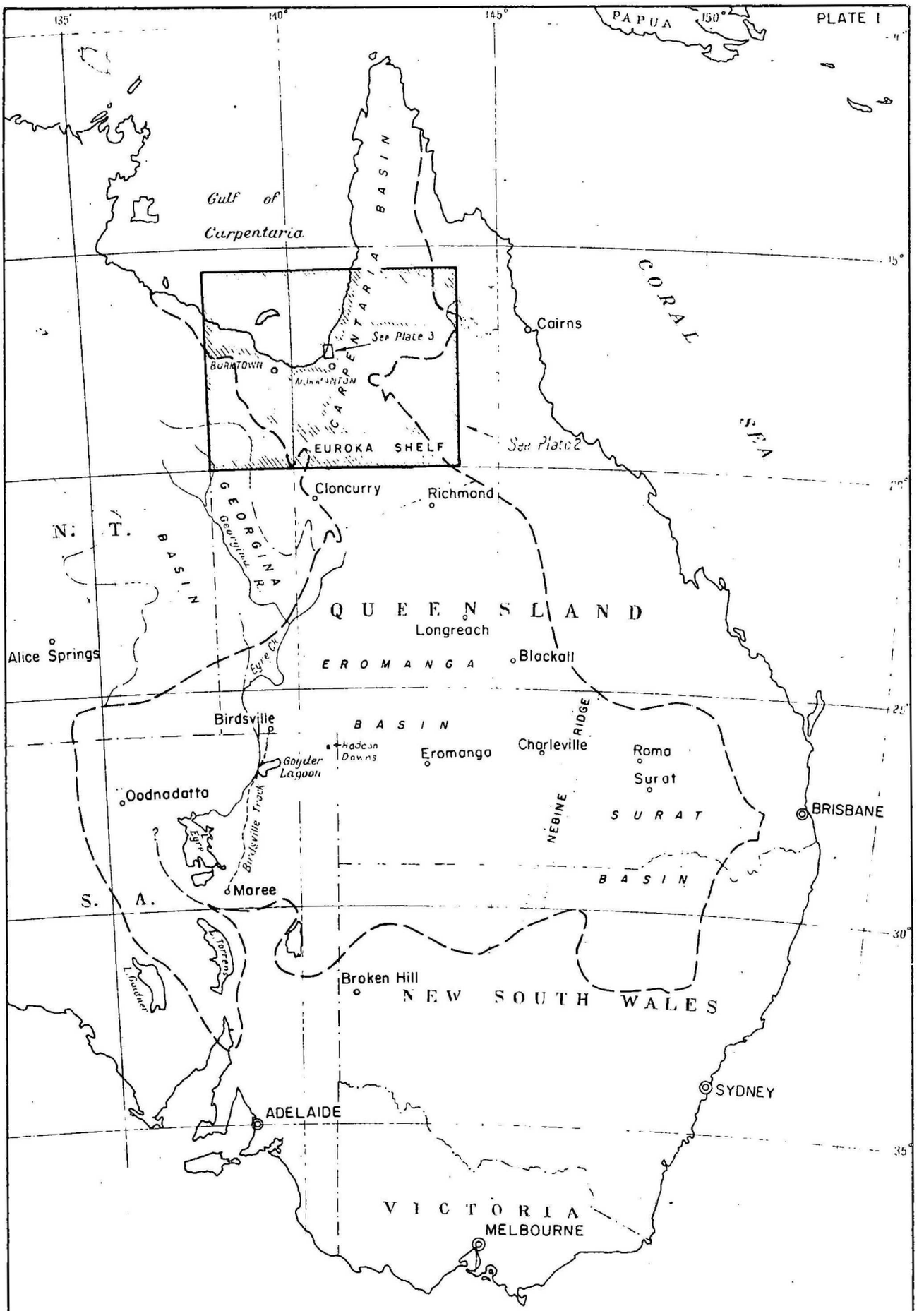
The maximum thickness of sediments measured within the basin was 3300 feet, but there are indications that a greater thickness may exist under the southeast corner of the Gulf of Carpentaria and possibly north of Rutland Plains.

5. REFERENCES

Laing, A.C.M., Power, P.E., and Stanley, L.J., 1957 - Geology and Geophysics of Carpentaria Authority to Prospect 9P Qld. Mines Admin.Pty.Ltd. Report 1956.

K.A. Richards, 1957 - Reconnaissance Gravity Surveys in Gulf of Carpentaria. Frome Report No. 5100-P-2.

PLATE I



SEISMIC SURVEY, CARPENTARIA BASIN, Q'LD.

LOCALITY MAP

LEGEND

Boundary of Great Artesian Basin

SCALE IN MILES

100 0 100 200 300

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PLATE 2

GULF OF CARPENTARIA

LEGEND

YY 100 — Seismic Refraction - Reflection Traverses showing basement depth in feet referred to mean sea level.

Bore Depths referred to mean sea level.

-3 — Gravity Contours (milligals) after Starkey & Laing (1957)

2000 — Basement Contours from depth determination by seismic work referred to mean sea level.

Surface Outcrop - basement rocks.

SEISMIC SURVEY, CARPENTARIA BASIN, QUEENSLAND

POSITIONS OF SEISMIC TRAVERSES IN RELATION TO BOUGUER GRAVITY ANOMALIES

BASEMENT CONTOURS SHOWN REFERRED TO MEAN SEA LEVEL

SCALE IN MILES

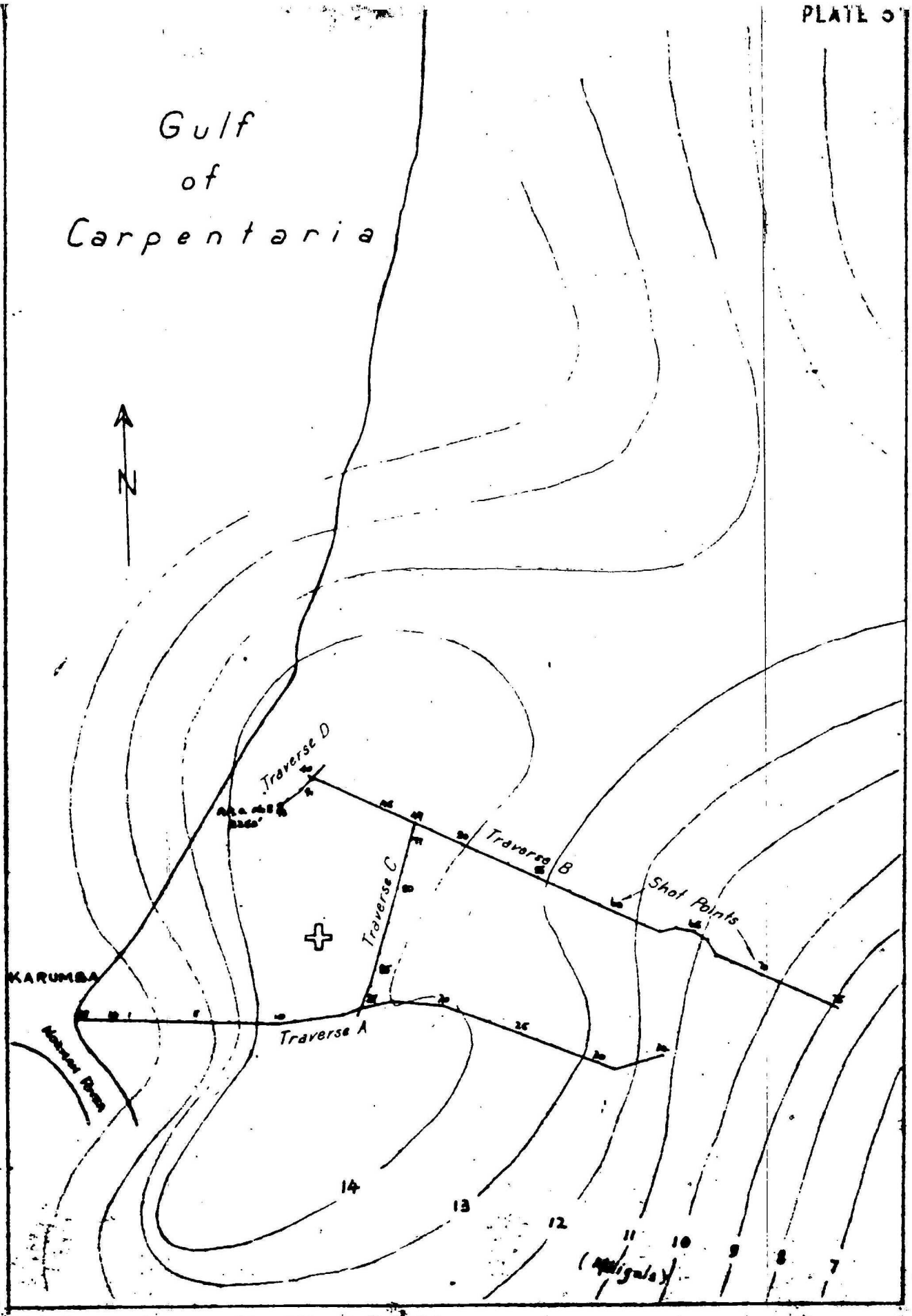
10 5 0 10 20 30

CONTOUR INTERVAL 3 MILLIGALS

GEOPHYSICIST

Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics G 318 – 13

TO ACCOMPANY RECORDS 1959 No 4



GRAVITY CONTOURS AFTER STARKEY & LAING 1957

SCALE IN MILES

1 0 1 2 3 4

J. J. Moss
S. Robertson
GEOPHYSICISTS

SEISMIC SURVEY, CARPENTARIA BASIN, Q'LD.

PLAN OF REFLECTION TRAVERSES - KARUMBA

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TO ACCOMPANY RECORDS 1957/

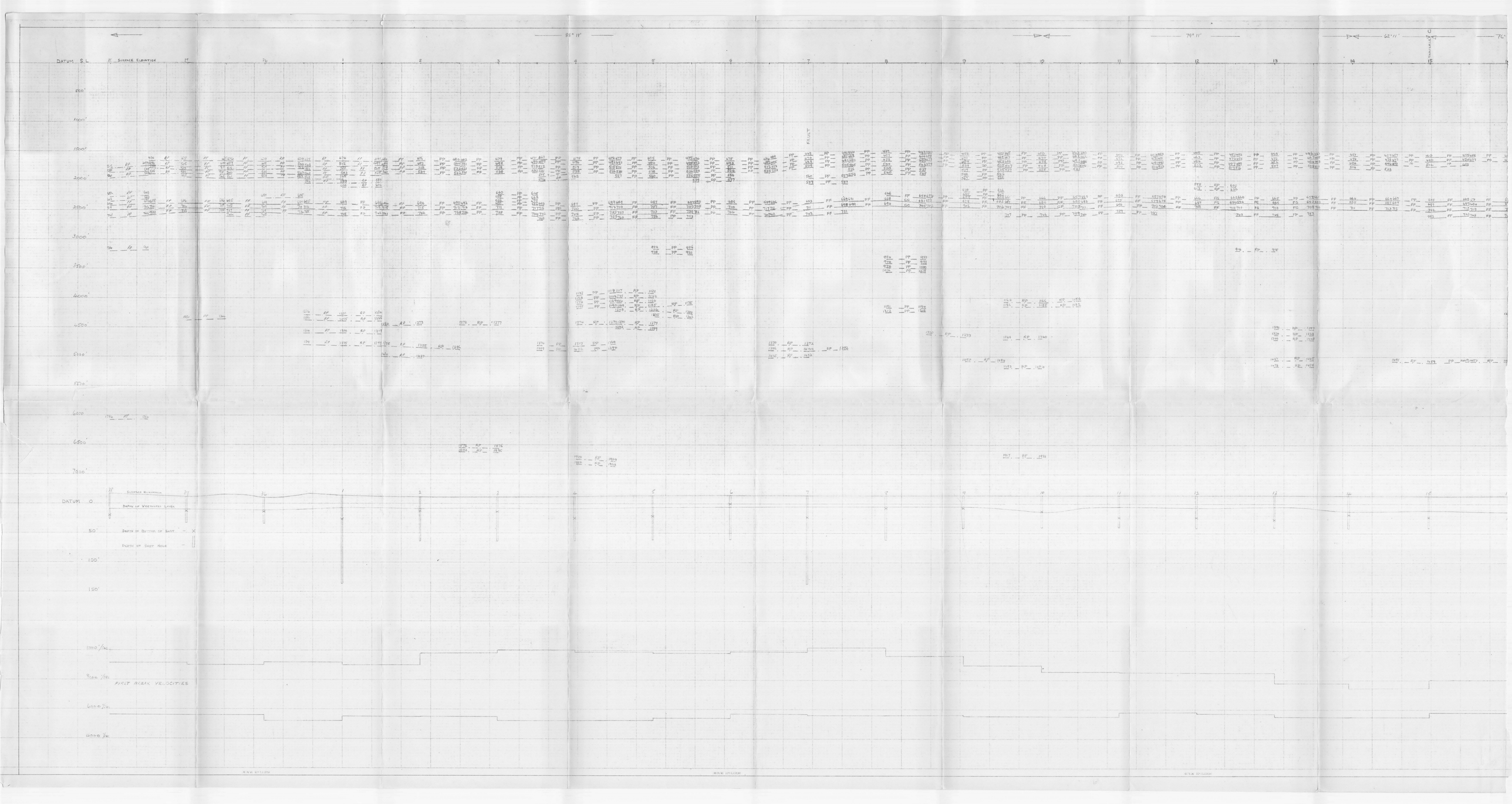
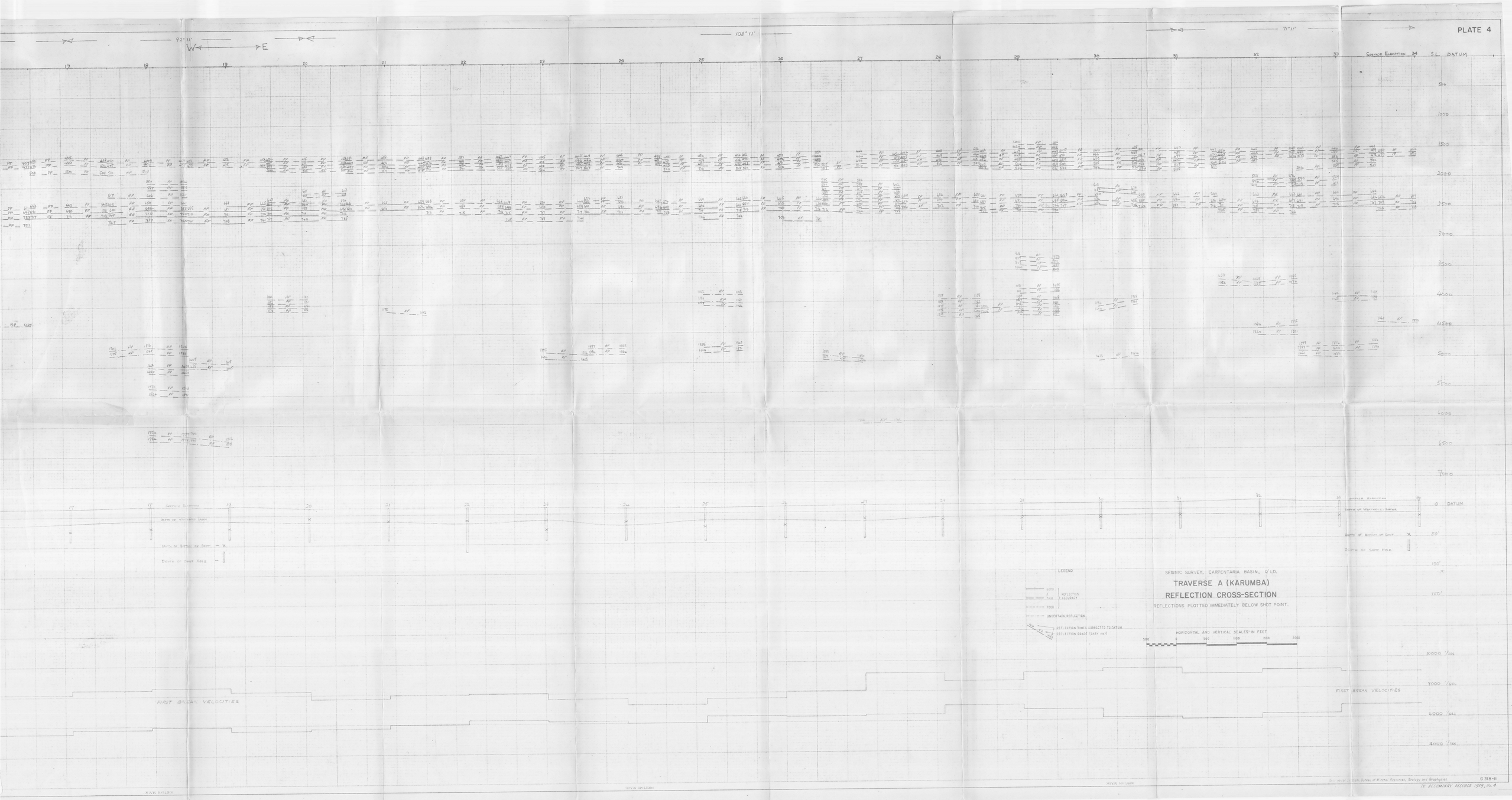

DATUM SL
SURFACE ELEVATION
FAULT
DATUM 0
SURFACE ELEVATION
DEPTH OF WEATHERED LAYER
DEPTH OF BOTTOM OF SHOT
DEPTH OF SHOT HOLE
FIRST BREAK VELOCITIES

PLATE 4



SHELL REGION

SHELL REGION

SHELL REGION

Bureau of Mineral Resources, Geology and Geophysics

G 318-B

TO ACCOMPANY RECORDS 1959, No. 4

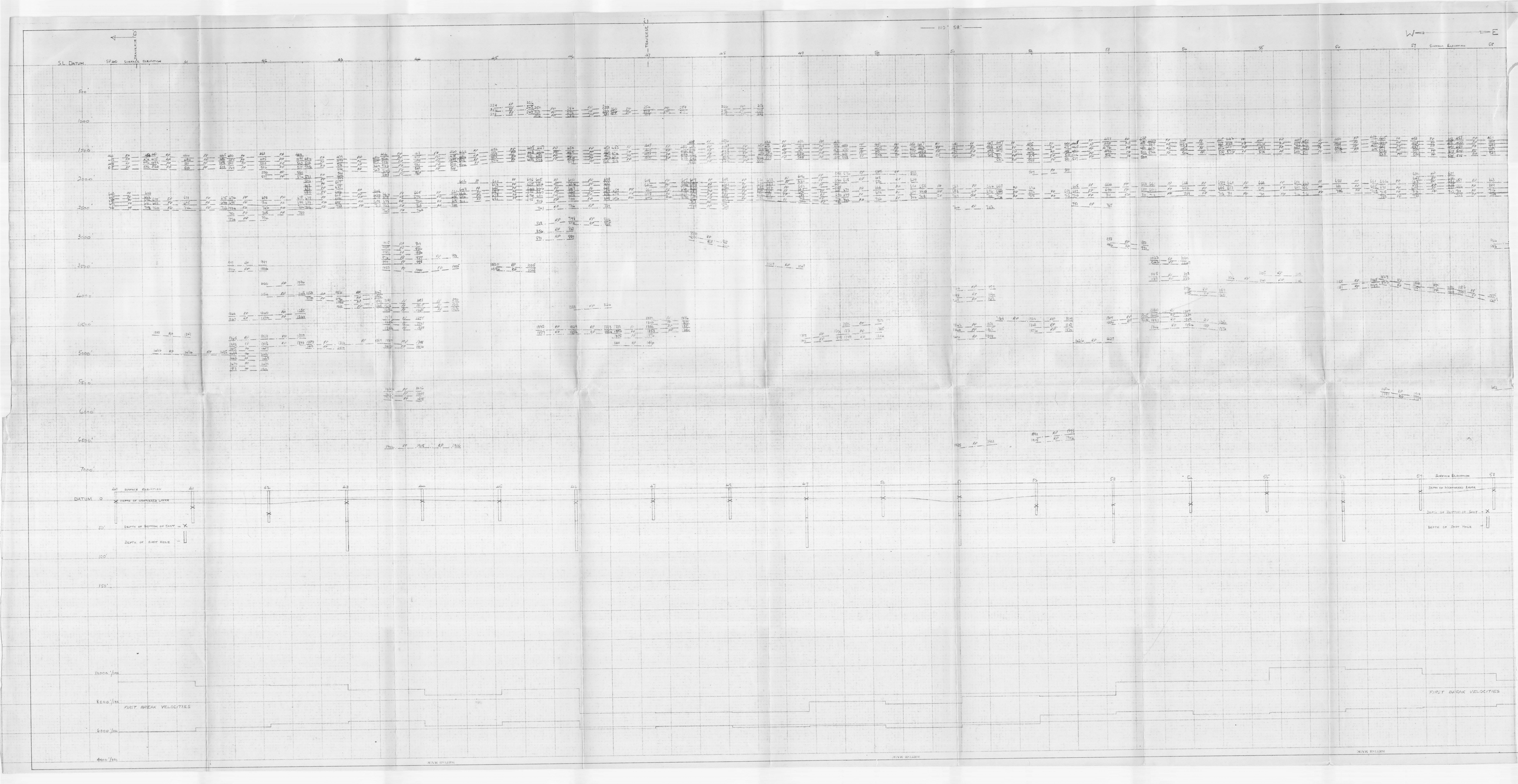
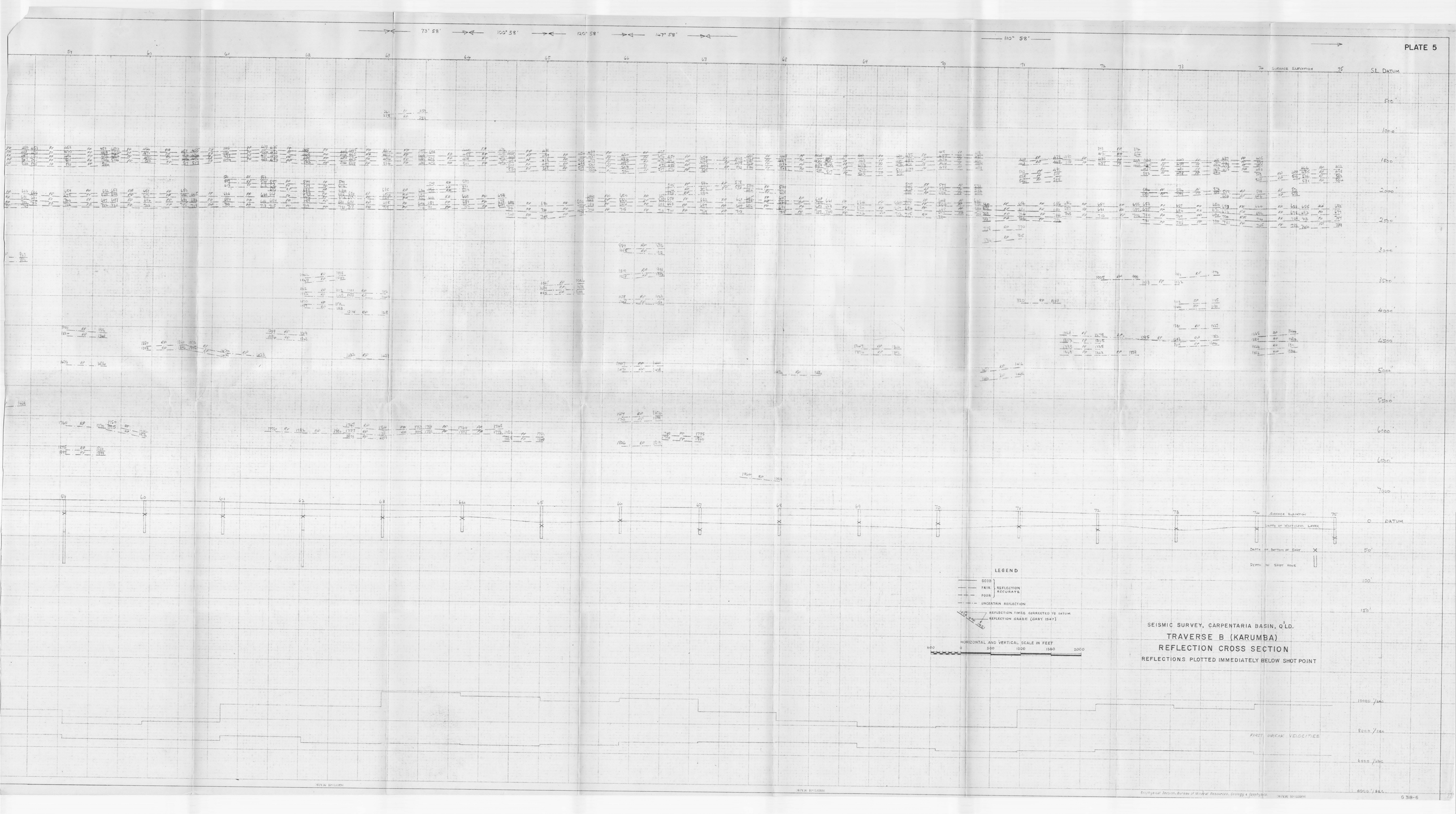

TRAVERSE (D
TRAVERSE (C
110' 58'
W
E
SL DATUM
SURFACE ELEVATION
DATUM 0
DEPTH OF WEATHERED LAYER
DEPTH OF BOTTOM OF SHOT
DEPTH OF SHOT HOLE
FIRST BREAK VELOCITIES
16000'/sec
8000'/sec
6000'/sec
4000'/sec
SHOT POSITION

PLATE 5



SEISMIC SURVEY, CARPENTARIA BASIN, QLD.

TRAVERSE B (KARUMBA)

REFLECTION CROSS SECTION

REFLECTIONS PLOTTED IMMEDIATELY BELOW SHOT POINT

G 318-6

PLATE 6

S — N
DATUM SL
SL DATUM
500'
1000'
1500'
2000'
2500'
3000'
3500'
4000'
4500'
5000'
5500'
6000'
6500'
7000'
87
86
85
84
83
82
81
80
79
78
77
47A
DATUM 0
50'
100'
150'
SURFACE ELEVATION
BASE OF WEATHERED LAYER
DEPTH OF BOTTOM OF SHOT
DEPTH OF SHOT HOLE
LEGEND
GOOD
FAIR
POOR
REFLECTION ACCURACY
UNCERTAIN REFLECTION
REFLECTION TIMES CORRECTED TO DATUM
REFLECTION GRADE (GABV 1947)
HORIZONTAL AND VERTICAL SCALES IN FEET
500 0 500 1000 1500 2000
SEISMIC SURVEY, CARPENTARIA BASIN, Q'LD.
TRAVERSE C (KARUMBA)
REFLECTION CROSS SECTION
REFLECTIONS PLOTTED IMMEDIATELY BELOW SHOT POINT
10000'/sec
8000'/sec
6000'/sec
FIRST BREAK VELOCITIES
G 318-8
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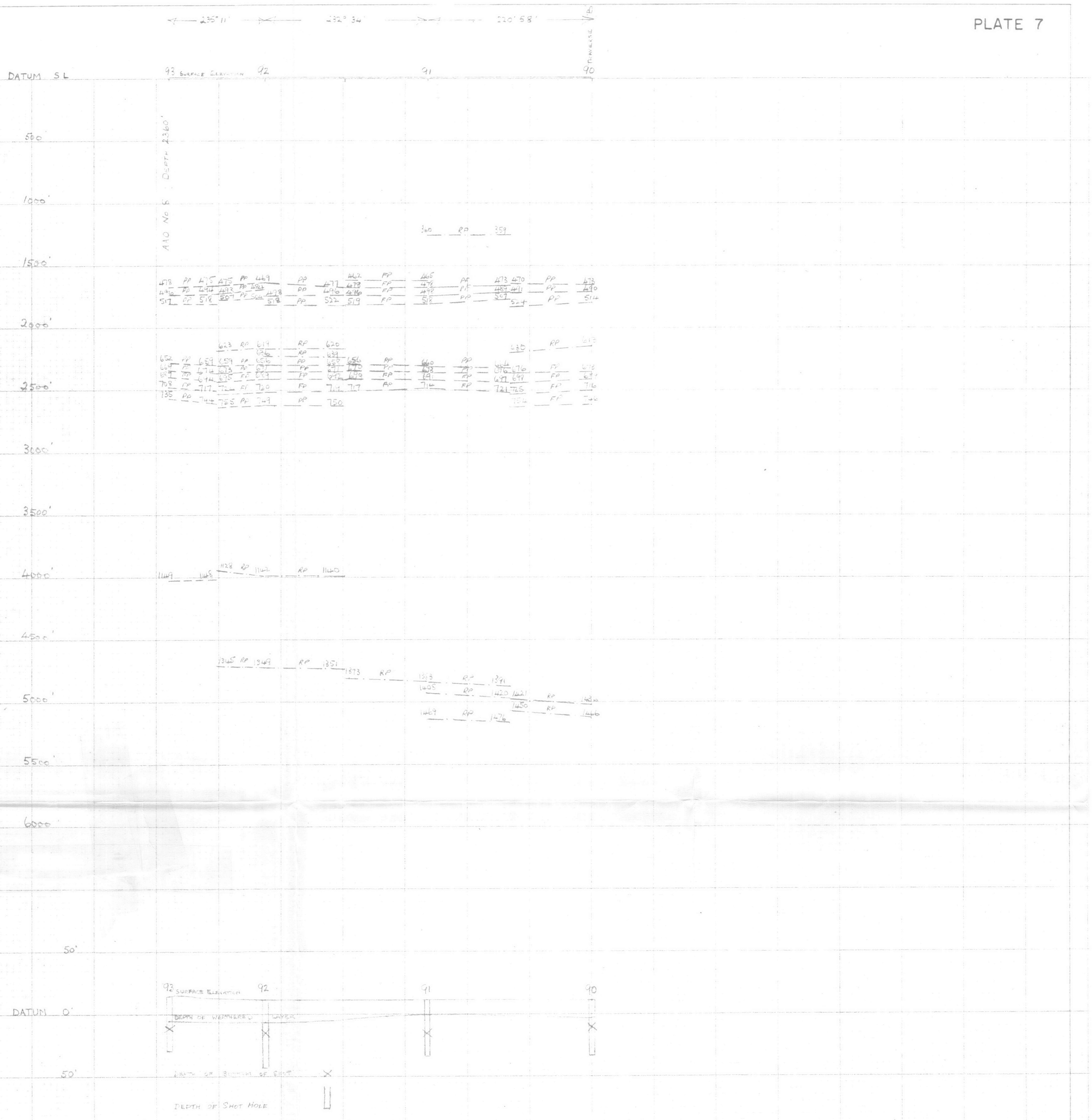
TO ACCOMPANY RECORDS 1959, No. 4

PLATE 7



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TO ACCOMPANY RECORDS 1954, No. 2


110° 3'
170° 5'
DATUM S.L.
SURFACE ELEVATION
189
190
191
192
193
194
195
196
197
198
199
200
201
245
246
247
248
500'
1000'
1500'
2000'
2500'
3000'
3500'
4000'
4500'
5000'
DATUM 0
SURFACE ELEVATION
DEPTH OF WEATHERED LAYER
50'
DEPTH OF BOTTOM OF SHOT - X
DEPTH OF SHOT HOLE
100'
150'
8000'/sec
7000'/sec
FIRST BREAK VELOCITIES
6000'/sec
5000'/sec

PLATE 8

125.34

249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264

SURFACE ELEVATION

DATUM

5000'

4500'

4000'

3500'

3000'

2500'

2000'

1500'

1000'

500'

0 DATUM

50'

100'

150'

8000'/sec

7000'/sec

6000'/sec

5000'/sec

249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264

DEPTH OF WEATHERED LAYER

DEPTH OF BOTTOM OF SHOT

DEPTH OF SHOT HOLE

FIRST BREAK VELOCITIES

LEGEND

GOOD
FAIR
POOR
} REFLECTION ACCURACY

UNCERTAIN REFLECTION

REFLECTION TIMES CORRECTED TO DATUM

REFLECTION GRADE (GABY 1947)

SEISMIC SURVEY, CARPENTARIA BASIN, Q'LD.

TRAVERSE G (MACARONI)

REFLECTION CROSS-SECTION

REFLECTIONS PLOTTED IMMEDIATELY BELOW SHOT POINT.

HORIZONTAL AND VERTICAL SCALES IN FEET

500 0 500 1000 1500 2000

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← NW — 101° 30' — SE →

DATUM SL.

217 218 219 220 221 222 223 224

DATUM SL.

500'
1000'
1500'
2000'
2500'
3000'
3500'
4000'
4500'
5000'

50'
0
50'
100'
150'

SURFACE ELEVATION
BASE OF WEATHERED LAYER
DEPTH OF BOTTOM OF SHOT
DEPTH OF SHOT HOLE

0' DATUM

LEGEND

GOOD
FAIR
POOR
} REFLECTION ACCURACY
UNCERTAIN REFLECTION
REFLECTION TIMES CORRECTED TO DATUM
REFLECTION GRADE (GABY 1947)

SEISMIC SURVEY, CARPENTARIA BASIN, Q'LD.

TRAVERSE I (WYAABA)

REFLECTION CROSS-SECTION

REFLECTIONS PLOTTED IMMEDIATELY BELOW SHOT POINT.

HORIZONTAL AND VERTICAL SCALES IN FEET

500 0 500 1000 1500 2000

7000'/sec

6000'/sec

5000'/sec

FIRST BREAK VELOCITIES

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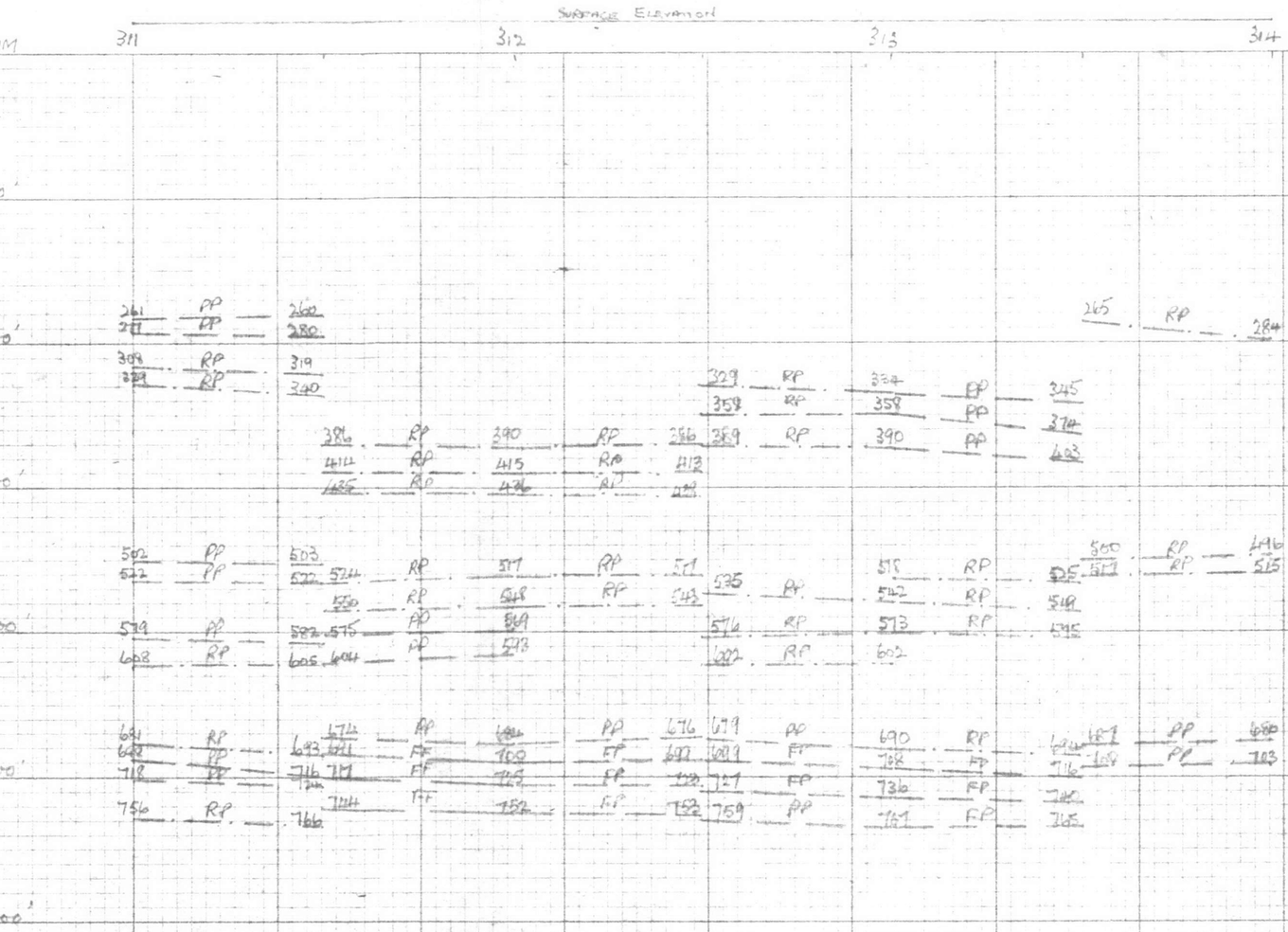
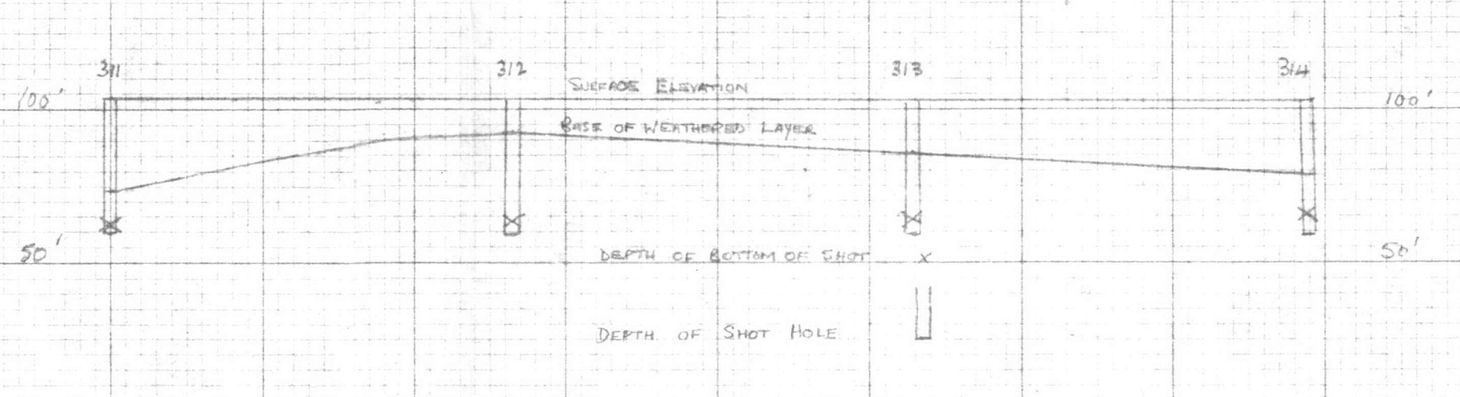
- BRITISH MADE -

PLATE 10

328° 30'





LEGEND

- GOOD
- FAIR
- POOR

REFLECTION ACCURACY

UNCERTAIN REFLECTION

263 / RP / 234 — REFLECTION TIMES CORRECTED TO DATUM; REFLECTION GRADE (GABY 1947)

SEISMIC SURVEY, CARPENTARIA BASIN, Q'LD.

TRAVERSE M (DUMBAR)

REFLECTION CROSS-SECTION

REFLECTIONS PLOTTED IMMEDIATELY BELOW SHOT POINT

HORIZONTAL AND VERTICAL SCALES IN FEET

500 0 500 1000 1500 2000

8000'/sec

7000'/sec

6000'/sec

5000'/sec

FIRST BREAK VELOCITIES

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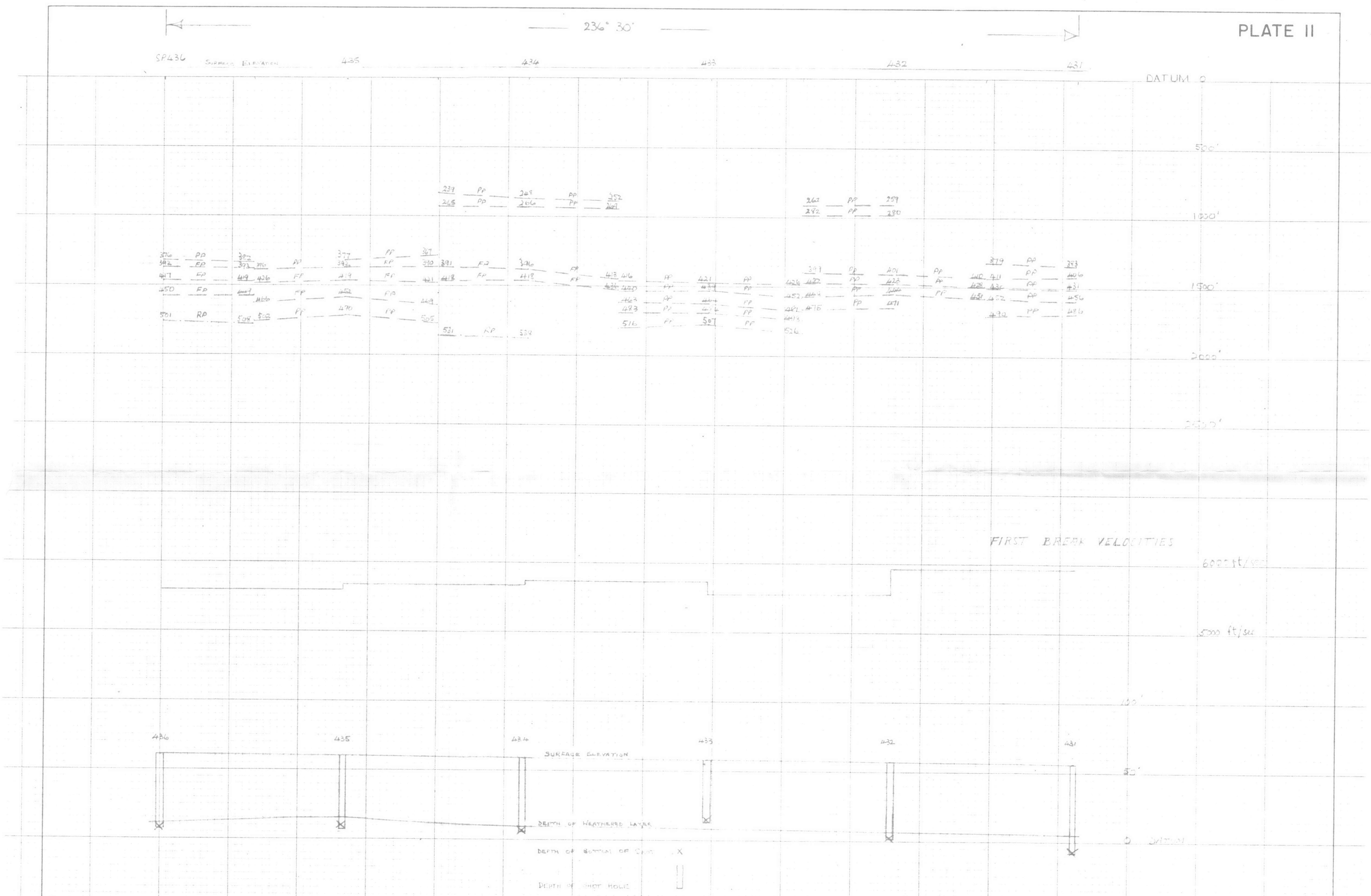
TO ACCOMPANY RECORDS 1959, No. 4

PLATE II



LEGEND

GOOD
FAIR
POOR
} REFLECTION ACCURACY

UNCERTAIN REFLECTION

379 PP 383 — REFLECTION TIMES CORRECTED TO DATUM; REFLECTION GRADE (GABY 1947)

SEISMIC SURVEY, CARPENTARIA BASIN, Q'LD.

TRAVERSE W (GREGORY CROSSING)

REFLECTION CROSS-SECTION

REFLECTIONS PLOTTED IMMEDIATELY BELOW SHOT POINT

HORIZONTAL AND VERTICAL SCALES IN FEET

500 0 500 1000 1500 2000

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