COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1962/109

COOKERNUP SEISMIC SURVEY,

WESTERN AUSTRALIA 1955-56

by

K. R. VALE and F. J MOSS

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ILLUSTRATIONS

SUMMARY

Seismic reflection traverses were surveyed across the Perth Basin at Cookernup, W.A. These traverses were planned to find the thickness and dip of the Basin sediments adjacent to the Darling Scarp and to discover any faulting or folding within them; also to determine the applicability of the seismic method as a tool for both regional and detailed investigation in this area. Seismic refraction traverses were surveyed to help in the solution of problems encountered in the interpretation of the reflection cross-sections.

The survey indicated a considerable thickness of sediments, about 20,000 ft, at the eastern margin of the Basin near the Darling Scarp, and suggested tectonic structure that is not indicated in surface geology. The reflection traverses indicated that sediments (presumably Lower Palaeozoic or Precambrian) lying deep in the Perth Basin may continue underneath the Darling Scarp and abut the granitic gneisses etc. of the Western Australian Shield on an overthrust fault plane. The overthrust fault, if it exists, does not reach the surface, but is covered to a depth of possibly some few hundred feet by younger sediments and also by alluvium eroded from the Darling Scarp. Some reflection and refraction shooting was done in an attempt to test this and other hypotheses, but the results are inconclusive. Gravity results strongly suggest a normal fault, and if normal faulting is the case, the reflections from beneath the outcropping basement are possibly derived from shear zones. Some probable 'reflected refractions' were also observed. There is scope for further seismic testing but it is considered that conclusive evidence could only be provided by drilling.

1. INTRODUCTION

The Cookernup area, about 75 miles miles south of Perth, lies in the Perth Basin which extends from Cape Leewin in the south to Geraldton in the north. Gravity work by the Bureau of Mineral Resources, Geology and Geophysics in the Perth Basin (Thyer & Everingham, 1956; and Neumann & Flavelle, in preparation) indicates a considerable thickness of sediments and shows steep Bouguer anomaly gradients in the vicinity of the Darling Scarp.

During February and March 1955 a Bureau seismic party carried out surveys in the Gingin area, about 45 miles north of Perth, and in the Cookernup area, to verify conclusions drawn from the gravity results, and to continue the study of the Perth Basin, using the seismic reflection method. This was part of a proposal to use the seismic surveys to assist in determining the thickness of sediments and the structure of the Basin at several locations. The Bureau seismic party revisited the Perth Basin in 1956 to do surveys at Busselton and Rockingham; additional work was done at Cookernup in 1956.

The results of the work done during the two visits to Cookernup are embodied in this Record.

Mr A. Bigg-Wither of BMR Geophysical Branch has supplied the gravity interpretations of Plate 15.

2. GEOLOGY

A general discussion of the known geology of the Perth Basin is given by Fairbridge (1949) and McWhae, Playford, Lindner, Glenister and Balme (1956). The Basin consists of a belt of mostly Mesozoic sediments, about 400 miles long and maximum width 55 miles, bounded at its eastern margin along the Darling Scarp by the Precambrian Western Australian Shield.

Along the Darling Scarp, sediments of early Precambrian and Ordovician age crop out in two areas. In one area, the Cardup Series of presumed Proterozoic age extends in outcrop from the Gosnells region through Armadale and Cardup to Mundijong. At Cardup this Series, which consists of shale, slate, and sandstone, is considered to be 2300 ft or more thick. It overlies Precambrian granite and gneiss unconformably, and dips at about 60 degrees to the west. The Cardup Series does not crop out at Cookernup, but it was thought that it might form part of the sedimentary sequence indicated by the reflection seismograph (Plate 15, Fig. 2 & 3). In the other area, the Yandanooka Group, now known to be of Ordovician age (Opik and Tomlinson, 1955), consists of shale, quartzite, limestone, and volcanic tuff, and extends from Moora to Mingenew. Dolerite dykes intrude both the Cardup Series and Yandanooka Group. About 3500 ft of Permian sediments (the Irwin River Coal Measures, High Cliff Sandstones etc.) is found in the Irwin River area in the north.

Very little is known of the geological formations under the Quaternary sand and coastal limestone in the Perth Basin. However, bore BMR 10, drilled for the Bureau at Beagle Ridge in the northern part of the Basin, showed that possible Permian reservoir-beds and cap-rocks exist (McTavish, 1960); this enhances prospects of discovering petroleum accumulations in the Perth Basin. Condon (1955) discusses the possible presence of a marine sequence ranging from Cambrian to Permian.

3. FIELD WORK

Personnel, equipment, and general statistics are shown in Appendices A and B.

During the first survey at Cookernup, in 1955, no reflections were recorded west of Shot-point 108 in the coastal limestone area. Neither the time available nor the seismic equipment being used permitted experimentation with pattern hole-shooting and multiple-geophone setups. In 1956 an air-shot, offset 3000 ft perpendicular to the line of the traverse at Shot-point 126, was shot but no reflections were recorded. However, a 36-hole pattern shot (hole depths 30 ft) at Shot-point 126 gave recognisable reflections (Plate 6). The geophone array (4 per trace at 5-ft intervals) was similar for all reflection shots.

4. COMPUTING METHODS

A summary of the information and techniques used in computing results is given in Appendix B.

A t: Δt analysis was made and the velocity distribution was found to be almost identical to that found at Gingin (Vale, 1956). The Gingin/Cookernup velocity distribution was used for plotting unmigrated sections for Traverses A, B, E, and F (Plates 8, 10, 11, and 13) and a migrated dip section for Traverse E (Plate 12). The migrated dip section shows the reflections plotted approximately where they should be using straight ray techniques.

A velocity distribution, linearly relating velocity and reflection time, and closely corresponding to the distribution derived from the t: Δt analysis, was used for the 'curved path' dip plotting along Traverse A (Plate 9). The velocity distribution is probably substantially in error for any Palaeozoic or Proterozoic sediments or, more particularly, for reflections recorded east of the Darling Scarp. This would tend to cause the west-dipping reflections to be plotted farther west and with a smaller dip than they should have, but it may not alter the general picture significantly.

Curves relating reflection time, average velocity, and depth are shown on Plate 5.

A phantom horizon (Horizon A) is shown at a depth of about 3500 ft along Traverse B. It is largely controlled by a nearly continuous reflector and is continued along Traverses A, E, and F. A second phantom horizon (Horizon B) is shown at a depth of about 12,500 ft along Traverse B and is continued along Traverses A and E. This phantom horizon is continued across the 'no-reflection gaps' in the cross-sections along Traverses A and E assuming a linear change of gradient. Contour maps showing depths to both phantom horizons are shown on Plate 3.

5. RESULTS

Individual traverses

Traverse A This traverse extends 11½ miles west from the outcropping Precambrian Western Australian Shield. Good 'reflections' were obtained from Shot-point 91 in the east to Shot-point 108, a distance of 4½ miles.

A preliminary unmigrated cross-section was plotted (Plate 8). This is confusing because of criss-crossing east and west-dip 'reflections' (see also seismic records on Plate 7). A migrated cross-section was plotted using 'curved-path' dip technique (Plate 9), but this also presents problems in interpretation. Four hypotheses are offered to explain the west-dipping alignments:

(a) Reflected refractions

(b) Overthrust fault

(c) Normal faulting

(d) Unconformities

Theoretical gravity profiles, representing versions of hypotheses (b), (c), and (d), are shown on Plate 15 (Fig. 2, 3, and 4); they are superimposed on the Bouguer anomaly profile derived from field gravity observations along Traverse A. The simplified models and the densities assumed are also shown.

(a) Reflected refractions (Plate 15, Fig. 1). A likely explanation for the existence of the steep west-dipping 'reflections' is that they may be 'reflected refractions'; i.e. seismic refracted energy that has travelled eastward along a relatively high-velocity, east-dipping bed in the Basin has been reflected back along the same layer from a fault plane or unconformity at the eastern termination of the bed. A trace analysis of the shallowest west-dipping 'reflections' shows them to fall on an approximately straight 'time/distance' line, whereas they should lie, if they are true reflections, on a curve related to spread correction.

The probable minimum depth and velocity of a sedimentary bed that would transmit 'reflected refractions' corresponding to the shallowest (or most westerly) of the steep west-dipping events has been calculated, assuming that the travel path is in the plane of the cross-section. This is illustrated on Figure 1 of Plate 15. Further seismic recording would be necessary to check whether there is such a bed.

Some of the later west-dipping events recorded at the eastern end of Traverse A may also be 'reflected refractions' from other sedimentary beds, and in some cases the travel path may have been well outside the plane of the cross-section. At the times at which they are recorded the spread correction is small and so it cannot be used to check the hypothesis.

(b) Overthrust Fault (Plate 15, Fig. 2). At the east of the cross-section there could be an overthrust fault, with the fault plane dipping east. The strong west-dip reflections may come from Palaeozoic or Proterozoic sediments, while the shallower east-dip reflections may come from younger sediments. 'Reflecting horizons' are present right up to the fault, although the 'reflections' are generally of poor quality. Upturn on the 'reflections' beneath the overthrusting is evident.

Sediments that were deposited after the overthrusting are present to a depth of at least 6000 ft below Shot-point 96 but could quite well be 13,000 ft below Shot-point 104. These younger sediments have an east dip of approximately 10 degrees and, at least in the shallower zones, can be seen to abut the older sediments on a depositional unconformity.

Between Shot-points 91 and 92, first-break refraction times recorded on reflection records (Plate 14) indicate sub-weathering velocities of 16,000 ft/sec near Shot-point 91 changing abruptly to 8000 ft/sec towards Shot-point 92. Abrupt changes in subsurface conditions are indicated. A not-unreasonable interpretation of these velocities that is consistent with the overthrust fault hypothesis may be:

8000 ft/sec - Basin sediments, Shot-point 92.

16,000 ft/sec - granitic gneiss (Precambrian) (probably weathered), Shot-point 91.

The theoretical and the measured Bouguer anomaly profiles do not correlate at all well for the model shown. It is hard to imagine any reasonable alternative, consistent with this hypothesis, that would give a good correlation.

(c) Normal Faulting (Plate 15, Fig. 3) may be present. The sediments west of Shot-point 92 have a thickness of at least 13,000 ft and possibly 20,000 ft. The deeper sediments may be Palaeozoic or Proterozoic in age. The Archaean granite, gneiss etc. east of the fault may contain a number of substantial shear and fault zones more or less parallel to the front face of the fault. Energy alignments may be recorded from some of these zones. This hypothesis is not unreasonable when it is noted that somewhat similar alignments were recorded west of Busselton (Lodwick, 1962) at times and under circumstances that leave little doubt that they originated within the granite complex.

The theoretical and the measured Bouguer anomaly profiles correlate quite well for the model shown, particularly if a small wedge of low-density sediments (A in the model) is introduced near the surface. This model also represents a limiting condition for the model shown on Plate 15, Figure 4.

(d) Unconformities (Plate 15, Fig. 4). Younger sediments west of Shot-point 92 have a thickness probably exceeding 13,000 ft. Resting unconformably on the granite, etc. we have a steeply-dipping band of Proterozoic sediments which are similar to the Cardup Series but entirely covered.

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These sediments may underlie the younger sediments to a depth exceeding 16,000 ft. The west-dipping 'deep reflections' may be explained as reverberations from within the steeply-west-dipping Proterozoics. The Basin sediments abut the steeply-dipping Proterozoics on a depositional unconformity. The shallow refraction velocities between Shot-points 91 and 92 may be interpreted as follows:

8000 ft/sec - Younger sediments, Shot-point 92

16,000 ft/sec - Palaeozoic or Proterozoic sediments, Shot-point 91.

The general line of the Darling Scarp is approximately at Shot-point 91.

The theoretical and the measured Bouguer anomaly profiles correlate fairly well for the model shown but the correlation improves as block B thins, or its density approaches that of block C; i.e. as the model approximates to the model shown on Plate 15, Figure 3.

It would be possible for the steep-dipping events to be explained in part by 'reflected refractions', and in part by any of the other three hypotheses. The theory favoured by the authors is that the structure is a normal fault in the basement with a throw of about 16,000 ft down to the west; the down-thrown side has been filled with sediments. The postulated cross-section is similar to the model shown on Plate 15, Figure 3 and the basement east of the fault is characterised by inhomogeneities (possibly shear zones) that run sub-parallel to the fault plane. Some of the shallower west-dipping events are almost certainly 'reflected refractions'.

<u>Traverse B</u> This traverse runs in a northerly direction for $4\frac{3}{4}$ miles at a distance of about $3\frac{1}{2}$ miles west of the Scarp, and roughly along strike. Very good reflections were obtained along its entire length.

An unmigrated cross-section only is presented (Plate 10). A migrated dip section is considered unnecessary because of the small dip angles. There are relatively few reflections below 16,000 ft, and most of the reflections fall within three zones:

Zone 1. 1000 ft to 2500 ft

Zone 2. 3000 ft to 6000 ft

Zone 3. 9000 ft to 16,000 ft

The general component of dip is towards the north. There is gentle synclinal reversal below about Shot-point 206 in Zone 2 and Shot-point 196 in Zone 3. North dips of 8 degrees and more are indicated in Zone 3 at the northern end of the traverse.

Traverse E This traverse runs east and west, and cuts Traverse B between Shot-points 211 and 212. Fair-quality reflections were recorded along the traverse between Shot-points 300 and 309. No reflections were recorded from shot-points east of Shot-point 309. An unmigrated cross-section (Plate 11) and a migrated dip cross-section (Plate 12) are presented.

A sedimentary sequence of at least 16,000 ft is indicated. The dip is to the east, and above 10,000 ft depth the dip appears to increase progressively from about 5 degrees in the west to about 20 degrees in the east. Below about 10,000 ft depth the dips do not exceed 6 degrees. East of Shot-point 309 the migrated cross-section shows only a few poor-to-doubtful reflections. They dip very steeply to the west and correlate with, and presumably are derived from the same cause as, the steep west-dipping events recorded at the eastern end of Traverse A.

Traverse F. This traverse runs north and south, crossing Traverse A between Shot-points 95 and 96. An unmigrated cross-section (Plate 13) was plotted.

Fair-quality reflections to 8000 ft and scattered, poor-quality reflections to 13,000 ft were obtained. The component of dip changes from zero at the southern end of the traverse to about 10 degrees of north dip at the northern end. It was hoped that some reflections, that could correlate with the steep westerly-dipping 'reflections' recorded on Traverse A, would be recorded on long spreads (i.e. shot-to-geophone distances of up to 1 mile), and that it would be possible to calculate a reasonable velocity distribution by t: Δt analysis for the strata associated with those reflections. This attempt was unsuccessful.

Traverse C and D. These were the most westerly traverses shot. About every fourth shot-point was tested but no reflections were recorded.

Traverse G (Plate 14). A half-mile refraction spread was laid on the Precambrian granitic gneiss. The spread ran north-east. The recorded velocity was approximately 17,000 ft/sec.

Traverse H. This traverse (Plate 14) runs for some 5 miles in a northerly direction along the South-western Highway more or less at the foot of, or within $\frac{1}{4}$ mile of, the Darling Scarp. The object of placing the traverse in this position was to detect velocities that would help to decide whether or not the steep westerly-dipping 'reflections' recorded on Traverse A were being recorded from sediments that may be correlated with the Cardup Series. Unfortunately the traverse proved to be poorly located for this purpose and made little contribution towards solving the problem. Along most of the traverse, velocities of over 19,000 ft/sec were recorded, and these are regarded as representing the granitic gneiss and possibly volcanic intrusions.

Results indicated refractor velocities of 13,900 ft/sec and 19,800 ft/sec at shallow depths. Weathering spreads indicated a 7000-ft/sec velocity that undoubtedly represents alluvium eroded from the scarp. The 13,900 ft/sec velocity may represent either partial weathering of the gneiss or Cardup Shale equivalent.

Traverse I. This traverse (Plate 14), a refraction traverse some 4 miles in length along Traverse A, was surveyed to determine whether there is shallow basalt that could explain the lack of reflections west of Shot-point 108 on Traverse A.

A maximum shot-to-geophone distance of 1 mile was used. It is considered that unweathered basalt shallower than 1200 ft would refract energy that would be clearly recorded with a shot-to-geophone distance of $\frac{3}{4}$ mile; any deeper basalt would give reflections. No velocity attributable to basalt was found.

Traverse J. This traverse was surveyed but not shot.

Traverse K (Plate 14). A north-trending 1-mile refraction traverse was shot on the south side of Traverse A between Shot-points 93 and 94. The highest velocity recorded was a little over 8000 ft/sec.

It is considered that shot-to-geophone distances might have to be as great as 2 miles to record refracted waves that would test whether there is an unconformity (hypothesis 'd') or normal fault (hypothesis 'c') and help resolve the question of the presence of Cardup equivalents. A similar shot-to-geophone distance would be required to record refracted waves from a refractor that could give rise to 'reflected refraction' as discussed in hypothesis (a).

General Discussion

A phantom horizon (Horizon A) to indicate structure within the Basin sediments has been drawn on the cross-sections for Traverses A, B, E, and F. It ranges in depth between 2600 and 6800 ft. Along Traverse B an almost continuous horizon was followed. Good dip control was available along Traverse A but the control along Traverse E east of Shot-point 305 was poor. Traverse F provided good dip control. A contour map of this phantom horizon is shown on Plate 3. The steep east dip masks any minor features but at the eastern end of Traverse A a north component of dip is evident.

A phanton horizon (Horizon B) representing older Palaeozoic or Precambrian sediments is also shown on Plate 3 (based on the assumption that the reflections below 10,000 ft to the west of the Darling Fault, and the steep westerly-dipping events recorded on the eastern end of Traverses A and E, are from continuous beds of this age). This assumption requires the further assumption that the Darling Fault is actually a depositional unconformity and that these older sediments abut an overthrust fault such as is illustrated on Plate 15, Figure 2.

The refraction velocity of the granitic gneiss on Traverse G was found to be about 17,000 ft/sec, and at Mundijong (Moss, 1962) it was found to be about 16,400 ft/sec. Between Shot-points 91 and 92 on Traverse A an immediate sub-weathering velocity of 16,000 ft/sec was indicated. This velocity can be attributed to the granitic gneiss, but on Traverse H velocities of 13,900 ft/sec and 19,800 ft/sec were found and these velocities could more likely be attributed to the Cardup Shale (or weathered granitic gneiss) and to the possible inclusion of a basic igneous dyke that would have to be sub-parallel to, and within 500 ft of, Traverse H. At Mundijong, the refraction velocity of the Cardup Shale was found to be about 13,000 ft/sec (this low velocity is possibly caused by partial weathering near the surface).

The present view of the authors is that the Darling Scarp is the surface expression of a normal fault in the basement which was down-thrown by more than 16,000 ft to the west. The down-thrown side has been filled with sediments, possibly ranging in age from Proterozoic to Tertiary. It is considered unlikely that there was significant deposition across the fault, with consequent draping of sediments on its front face. It is considered that the basement faulting continued during deposition, with a hinge line some distance to the west, resulting in the present east dip of the sediments.

6. RECOMMENDATIONS.

Insufficient time was available during the Cookernup seismic surveys to complete the proposed programme. Further seismic surveying is desirable for the following reasons:

(a) To clarify the structure in the vicinity of the Darling Scarp. Further refraction shooting to detect possible Cardup equivalents is desirable.

(b) To investigate the sedimentary sequence west of Shot-point 108. The attempt to obtain reflections using a multiple-hole pattern at Shot-point 126 with a simple geophone setup was successful. Further shooting using multiple-hole patterns and multiple-geophone setups should give reasonable results.

(c) To investigate the cause of the relatively high gravity anomaly south-west of Cookernup (shown on Plate 2).

The final geophysical conclusions on the sedimentary sequence and structure related to the Darling Scarp will need confirmation. Drilling is the obvious method to do this and it may be that a relatively shallow hole (say 2000 ft) will be adequate. Such a hole should be quite cheap to drill provided coring is not made a major part of the operation.

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APPENDIX A

STAFF AND EQUIPMENT

Staff	1955	1956
Party Leader	K.R. Vale	M.J. Goodspeed
Geophysicists	E.W. Turner	F.J. Moss
Surveyors *	A.J. Symons	W.A. Dawson
Observer	E.W. Turner	R.O. Franklin
Shooter	K.A. Mort	C.A. Fogarty
Drillers **	J. Halls	L. Sprynskyj
	L. Sprynskyj	B.G. Findlay
		A.J. McCrae
Mechanic	-	G.C. Bennett
Clerk	-	S. Butkus

Up to 12 assistants including cooks, drill helpers etc. were employed as required.

Equipment

Seismic amplifier	TIC model 521. Filter curves are attached
Seismic oscillograph	TIC 24-trace. 6 in.
Geophones	TIC 20-c/s
Drills **	2 Failing-750 with $4\frac{1}{2}$-in. x 5 in. mud pumps
Water tanker	3700-gallon, vacuum filling
Shooting truck	1700-gallon, vacuum filling.

A workshop truck, 4 Land Rovers, a 15-cwt utility truck, a number of trailers, and camping equipment completed the party equipment; not all the vehicles were continuously employed.

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* Provided by Department of the Interior

** Provided by Petroleum Technology Section of the Bureau.

APPENDIX B

TABLE OF OPERATIONS

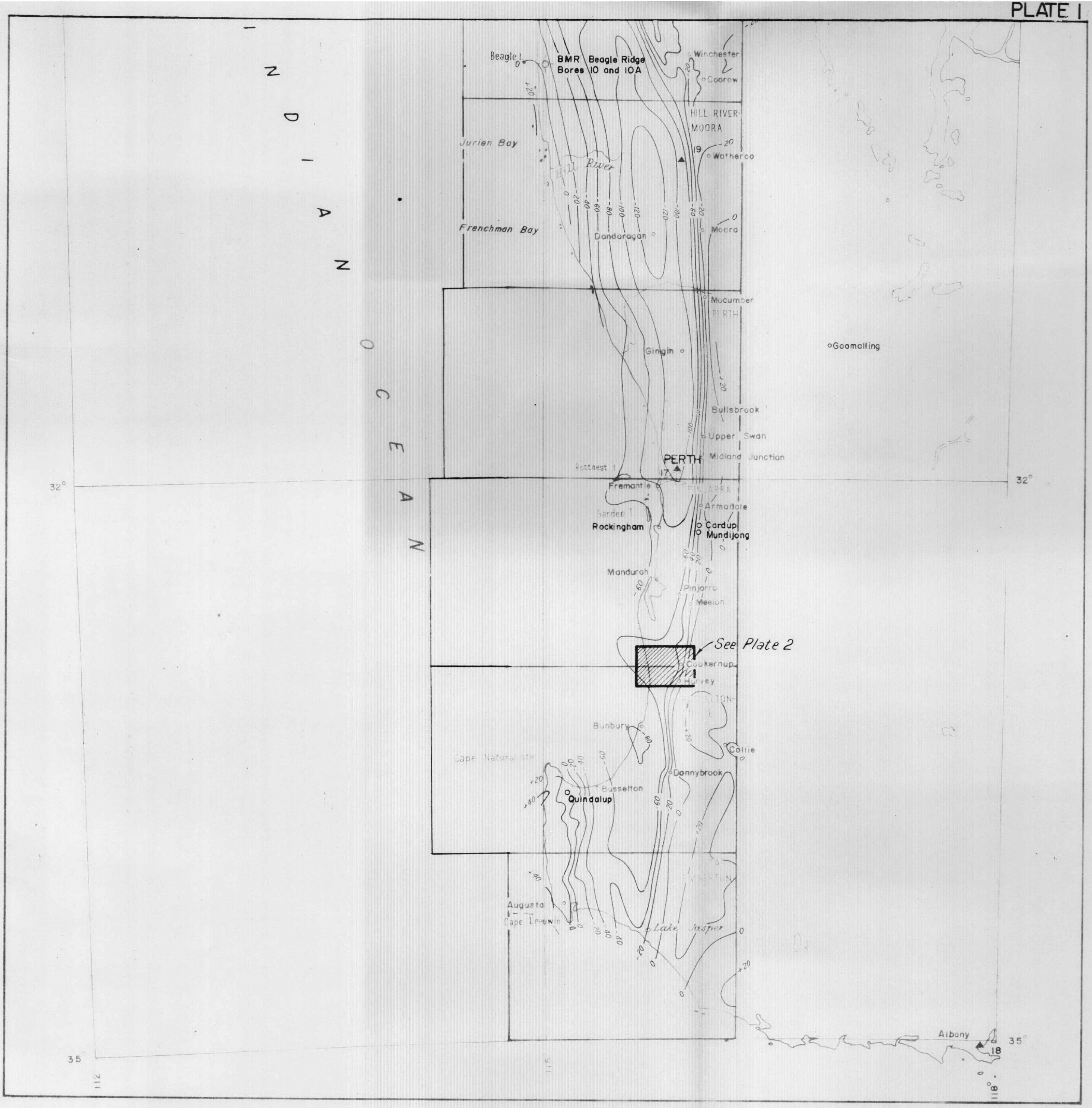
Sedimentary basin:	Perth Basin, W.A.	
Area:	Cookernup	
Camp sites:	Harvey (1955)	Cookernup (1956)
Established camp:	24.2.55	3.4.56
Surveying commenced:	24.2.55	3.4.56
Drilling commenced:	25.2.55	4.4.56
Shooting commenced:	25.2.55	5.4.56
Operations concluded:	29.3.55	26.4.56
Miles surveyed:	32	12
Topographic survey control:	Railway B.M.	Railway B.M.
Total footage:	7680	3021
No. of holes drilled:	111	63
Deepest hole (ft):	107	108
Geophex used (lb):	2865	1120
Datum level for corrections:	Sea level (reflection); + 100 ft (refraction)	
Weathering velocity:	2000 ft/sec	
Sub-weathering velocities:	6000-7000 ft/sec	
Source of velocity distribution:	See under 'Computing Methods'	

Reflection Shooting Data

Shot-point interval:	1320 ft
Geophone group:	4 per trace, 5 ft between geophones
Geophone group interval:	110 ft
Holes shot:	89 (reflections were recorded from 54 holes)
Miles traversed:	32
Common shooting depth:	70 ft - 30 ft
Usual recording filter:	L_1H_4 - L_3H_4 (nominal pass band, 25-40 c/s)
Common charge size:	10 - 15 lb
Weathering corrections:	Graphical and adjacent geophones - see Vale (1960)
Grading system:	After Gaby (1947)

Refraction Shooting Data

Geophone group:	4 in cluster
Geophone group interval:	220 ft
Holes shot:	16
Number of refraction traverses:	4
Usual recording filter:	L_1H_2
Charge sizes:	5 - 100 lb
Weathering control:	From reflection shooting when available, otherwise from weathering spread.



LEGEND

Isogals (values in milligals)
Gravity high anomaly
" low "
▲18 B.M.R. gravity pendulum station
PERTH " gravity and aeromagnetic area (scale 1" = 4mile)

COMPILED AUGUST 1960

COOKERNUP SEISMIC SURVEY,
PERTH BASIN, W.A., 1955-56

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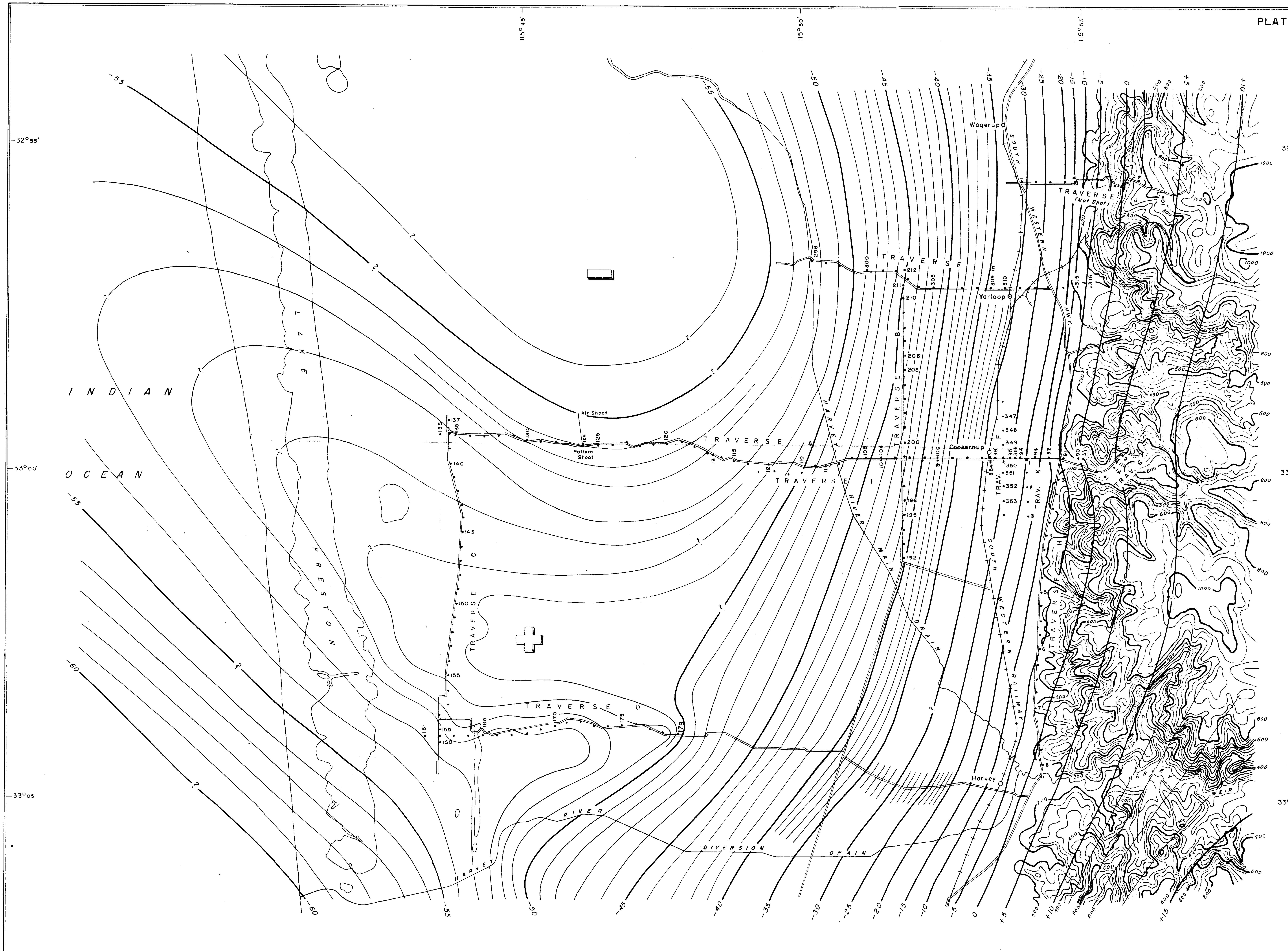
LOCALITY MAP AND BOUGUER ANOMALIES

SCALE IN MILES
40 0 40 80 120

Reference - W.A. Mines Dep't 1950 geological sketch map

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS G193-29

To Accompany Record No 1962/109



LEGEND

TOPOGRAPHY	GRAVITY
RAILWAY	+20 ISOGALS
ROAD	HIGH ANOMALY
RIVER	LOW ANOMALY
400 CONTOURS (50' INTERVALS)	

Note: Gravity contours based on Bouguer Anomaly values B.M.R. (1960)
See plates G69-340 and G69-341

Magnetic North
True North

SCALE IN MILES

1 0 1 2 3 4

COOKERNUP SEISMIC SURVEY

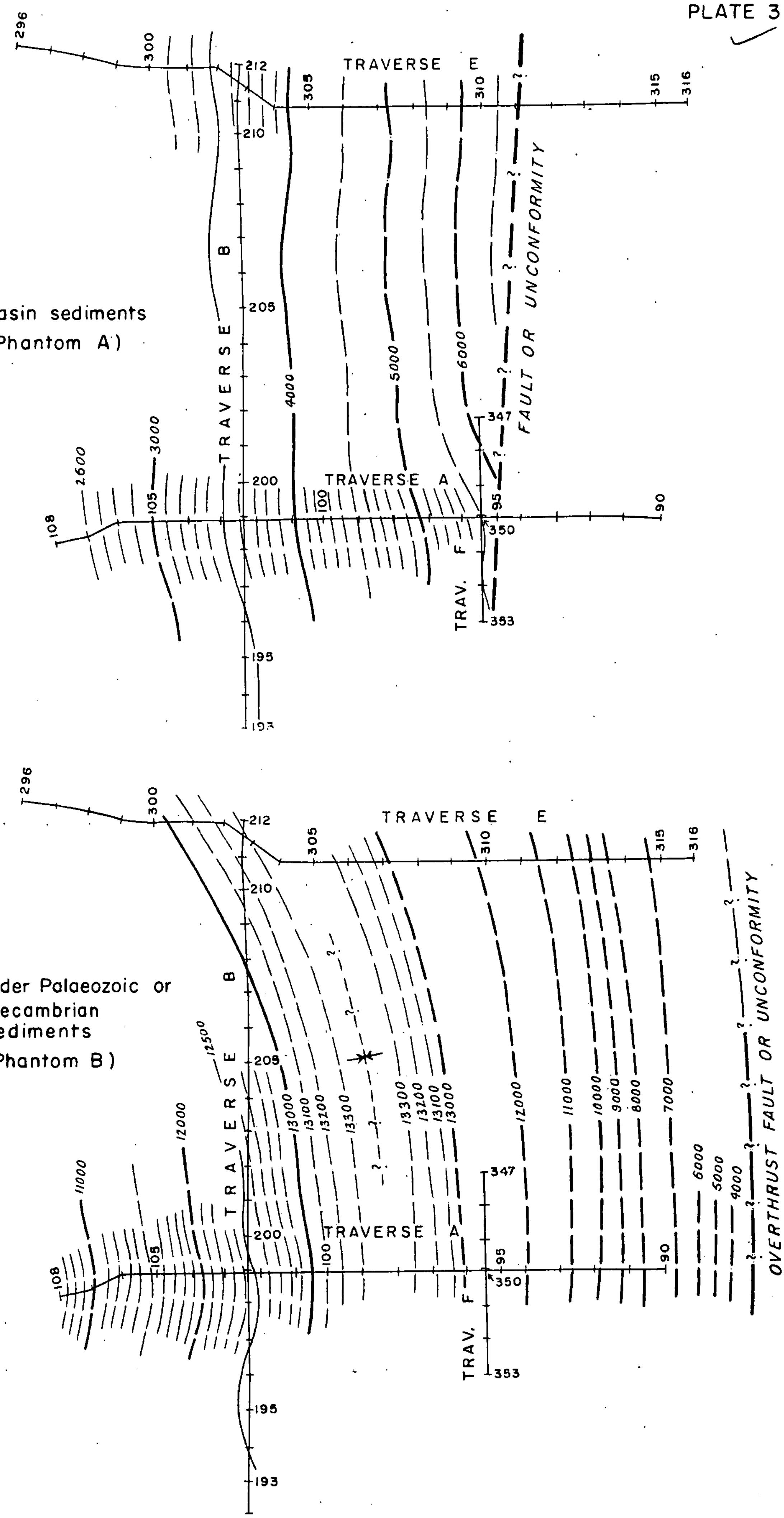
PERTH BASIN W.A. 1955-1956

SEISMIC TRAVERSES, TOPOGRAPHY AND BOUGUER GRAVITY ANOMALY CONTOURS

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 193-30

To Accompany Record No 1962/109

PLATE 3



CONTOURS SHOWING DEPTHS TO PHANTOM HORIZONS

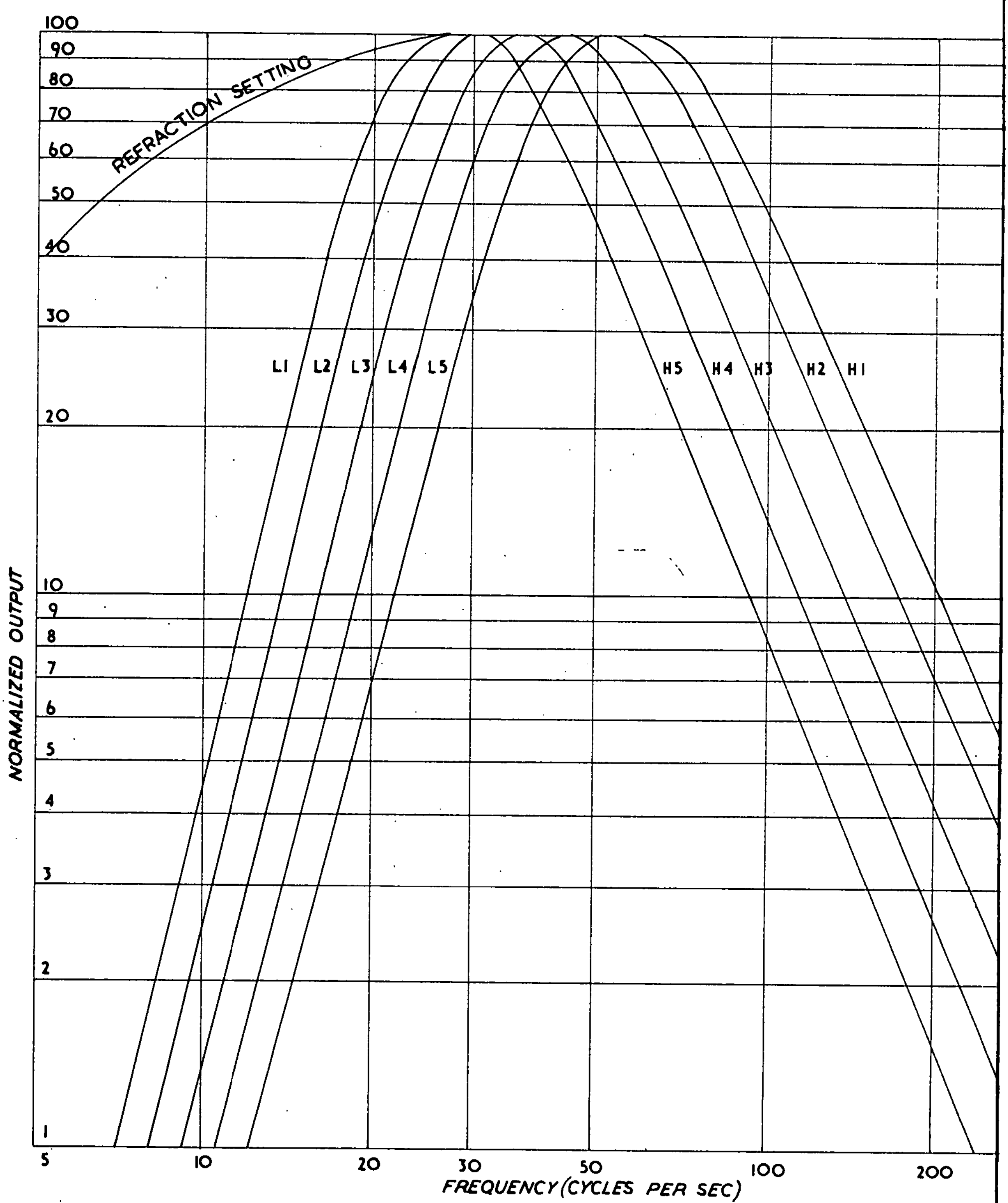
DATUM MSL

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 193-41

To Accompany Record No.1962/109

COOKERNUP

PLATE 4



FILTER CURVES

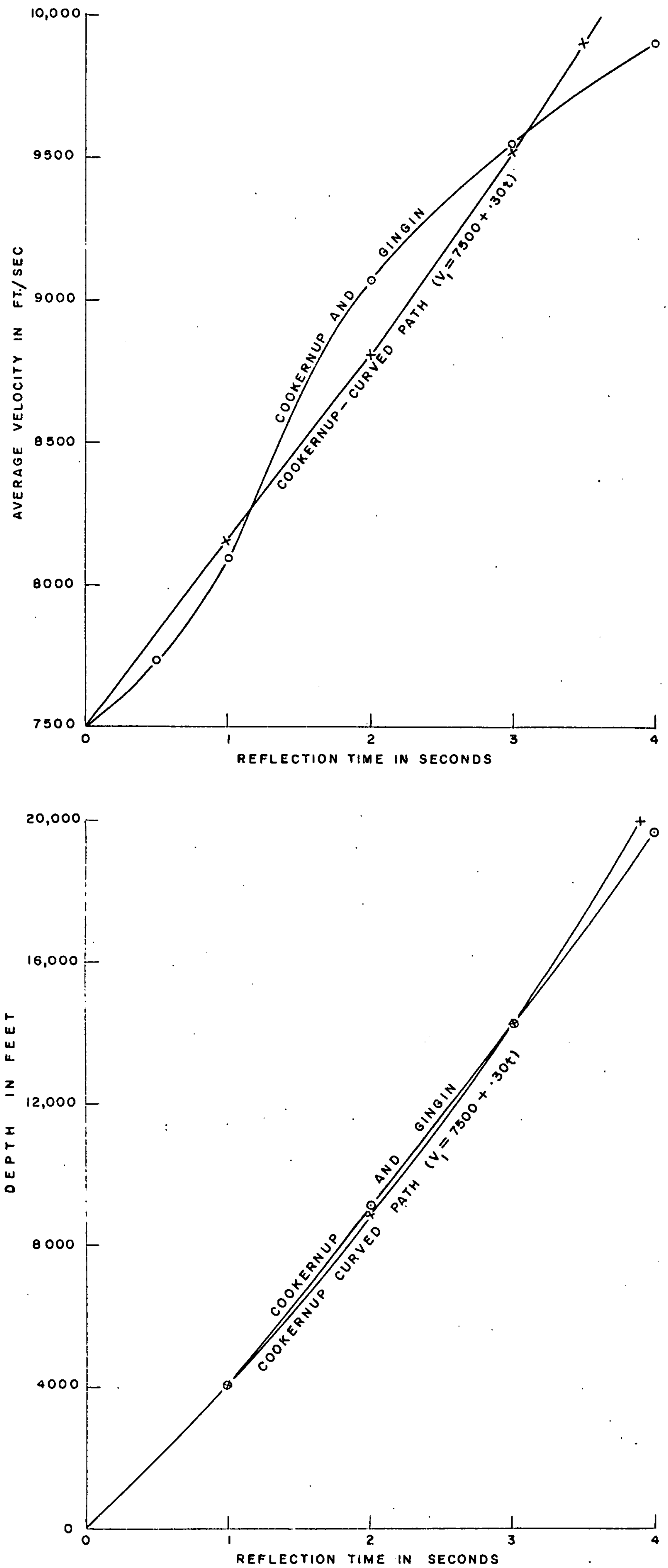
T I Co AMPLIFIER TYPE 521

G 193-31

TO ACCOMPANY RECORD No 1962/109

ROCKINGHAM

PLATE 5



REFLECTION TIME/DEPTH AND TIME/AVERAGE VELOCITY CURVES

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 193-32

To Accompany Record No 1962 /109

COOKERNUP

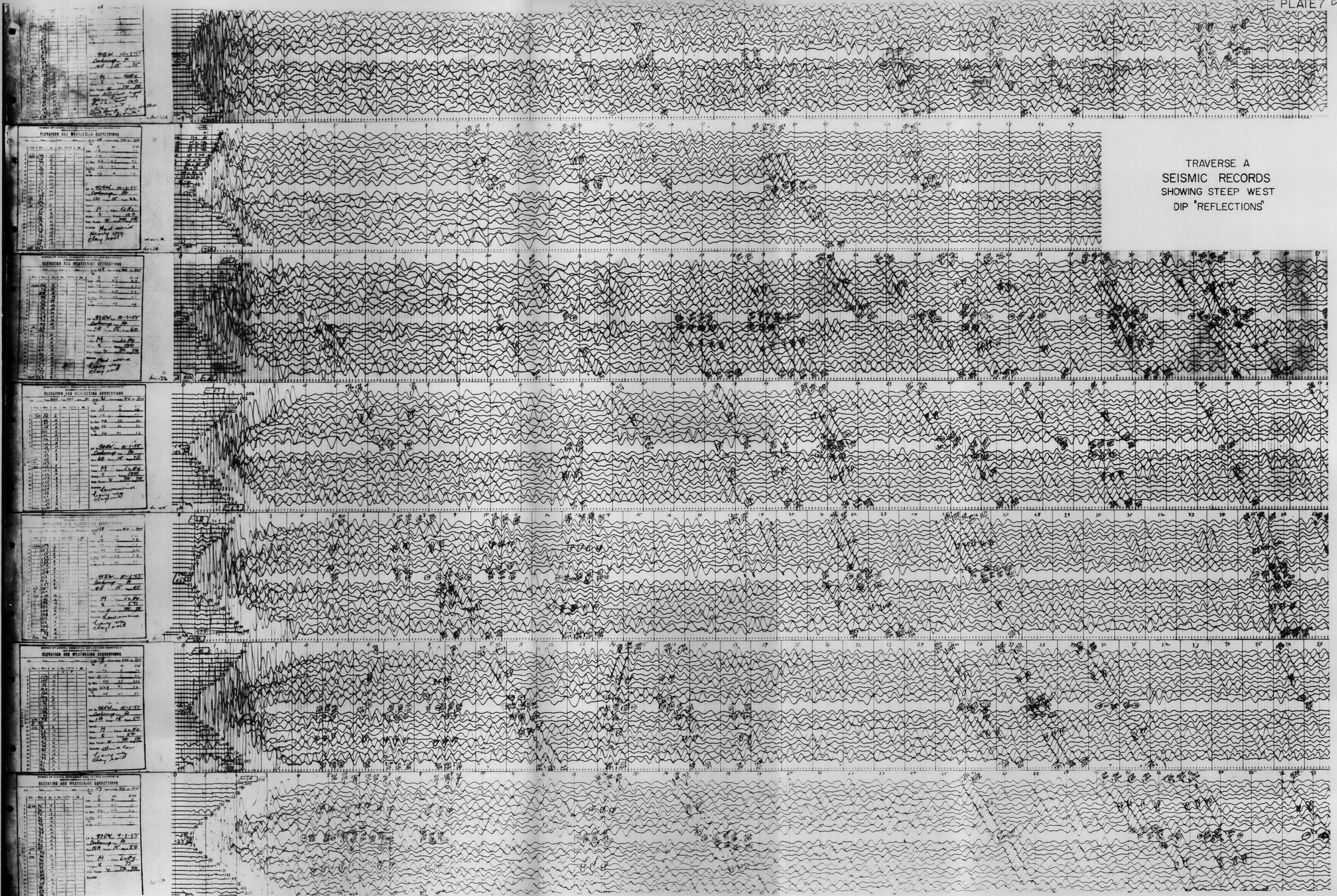
SEISMIC SURVEY COOKERNUP PERTH BASIN WA

SEISMIC RECORDS, SINGLE AND PATTERN SHOTS

G 193-73

TO ACCOMPANY RECORD NO 1962/109

TRAVERSE A
SEISMIC RECORDS
SHOWING STEEP WEST DIP "REFLECTIONS"



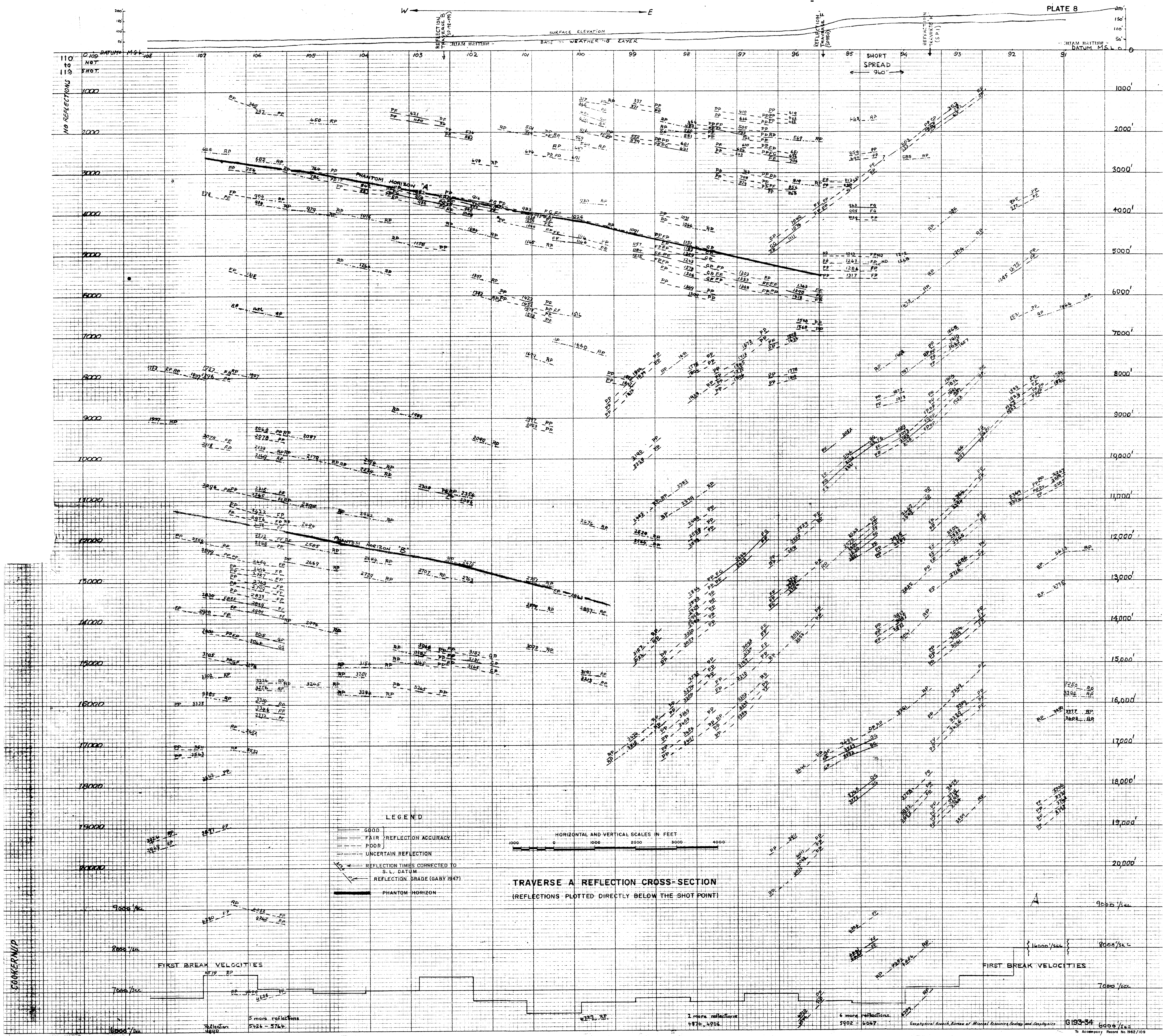


PLATE 8
W
E
SURFACE ELEVATION
BASE OF WEATHERING LAYER
DATUM M.S.L.
SHORT SPREAD 960'
NO REFLECTIONS
PHANTOM HORIZON "A"
PHANTOM HORIZON "B"
LEGEND
GOOD
FAIR
POOR
REFLECTION ACCURACY
UNCERTAIN REFLECTION
REFLECTION TIMES CORRECTED TO S.L. DATUM
REFLECTION GRADE (GABY 1947)
PHANTOM HORIZON
HORIZONTAL AND VERTICAL SCALES IN FEET
TRAVERSE A REFLECTION CROSS-SECTION
(REFLECTIONS PLOTTED DIRECTLY BELOW THE SHOT POINT)
FIRST BREAK VELOCITIES
FIRST BREAK VELOCITIES
COOKERNUP
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TRAVERSE A REFLECTION CROSS-SECTION

(REFLECTIONS PLOTTED IN APPARENT CORRECT POSITION BY CURVED PATH TECHNIQUE)

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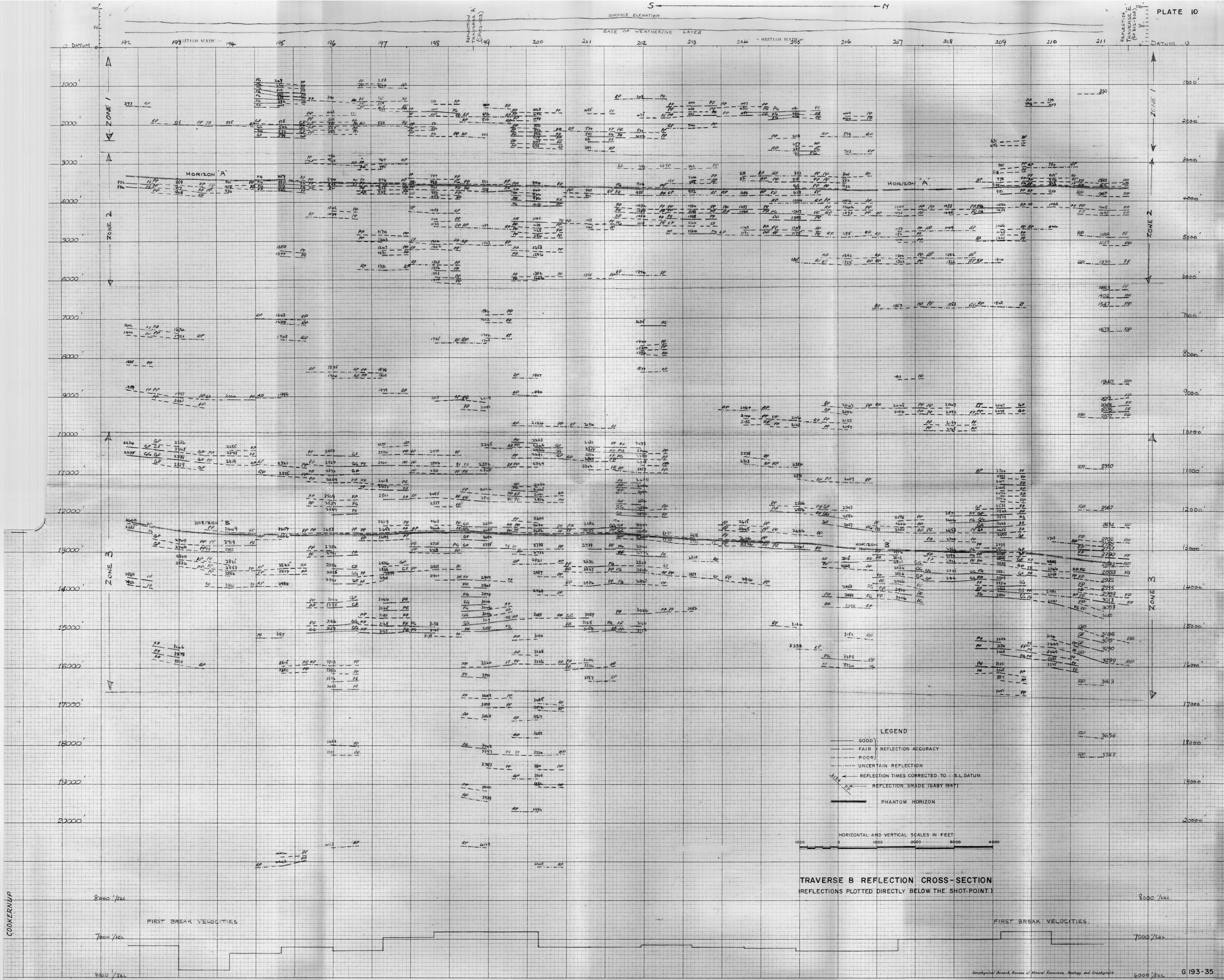
PLATE 10



TRAVERSE B REFLECTION CROSS-SECTION
(REFLECTIONS PLOTTED DIRECTLY BELOW THE SHOT-POINT)

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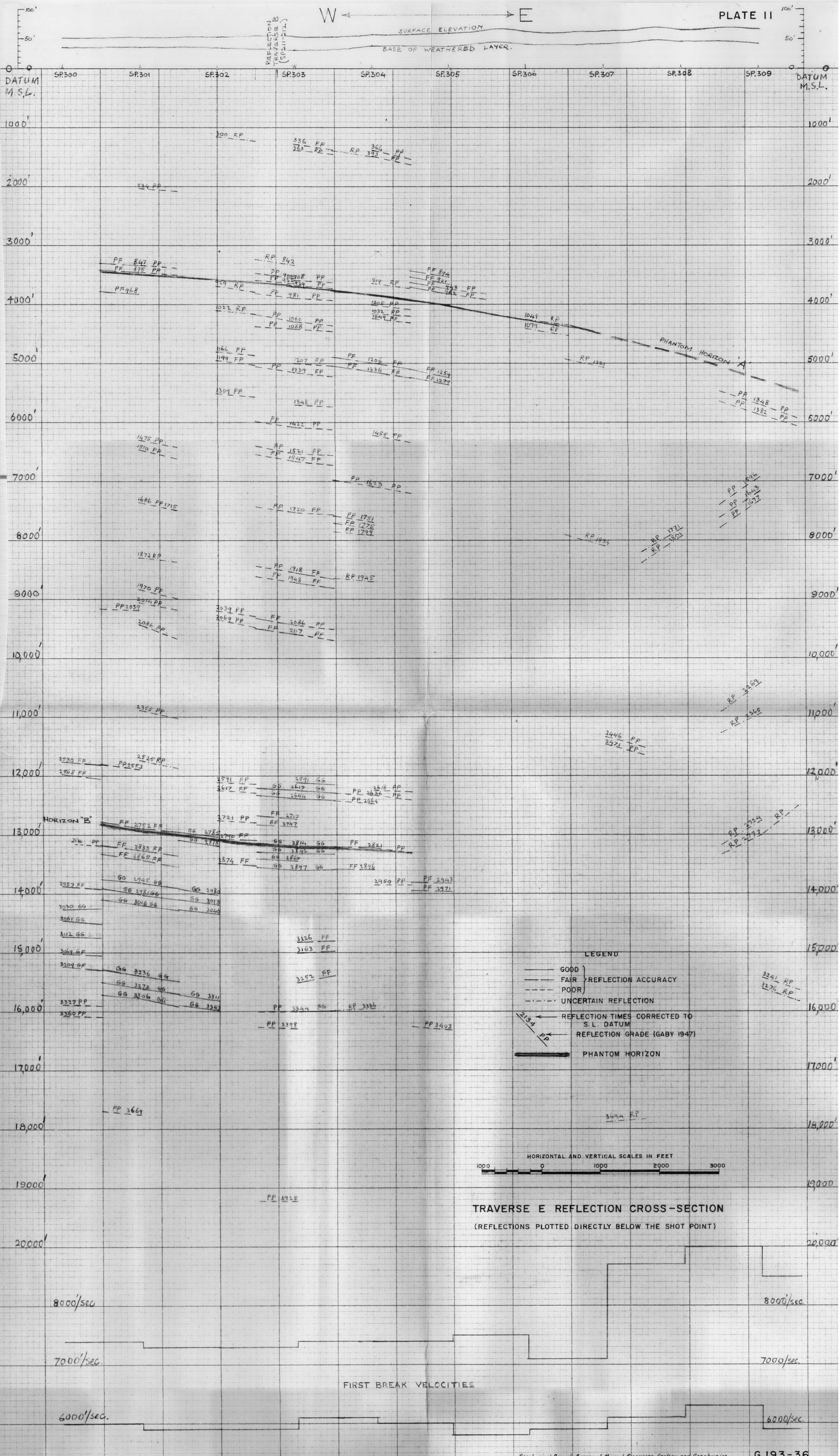
To Accompany Record No. 1962/109

PLATE II



W
E
SURFACE ELEVATION
BASE OF WEATHERED LAYER
REFLECTION TRAVERSE B (SP.211-SP.212)
DATUM M.S.L.
SP.300
SP.301
SP.302
SP.303
SP.304
SP.305
SP.306
SP.307
SP.308
SP.309
PHANTOM HORIZON 'A'
HORIZON "B"
LEGEND
GOOD
FAIR
POOR
REFLECTION ACCURACY
UNCERTAIN REFLECTION
REFLECTION TIMES CORRECTED TO S.L. DATUM
REFLECTION GRADE (GABY 1947)
PHANTOM HORIZON
HORIZONTAL AND VERTICAL SCALES IN FEET
TRAVERSE E REFLECTION CROSS-SECTION
(REFLECTIONS PLOTTED DIRECTLY BELOW THE SHOT POINT)
8000'/sec
7000'/sec.
6000'/sec.
FIRST BREAK VELOCITIES

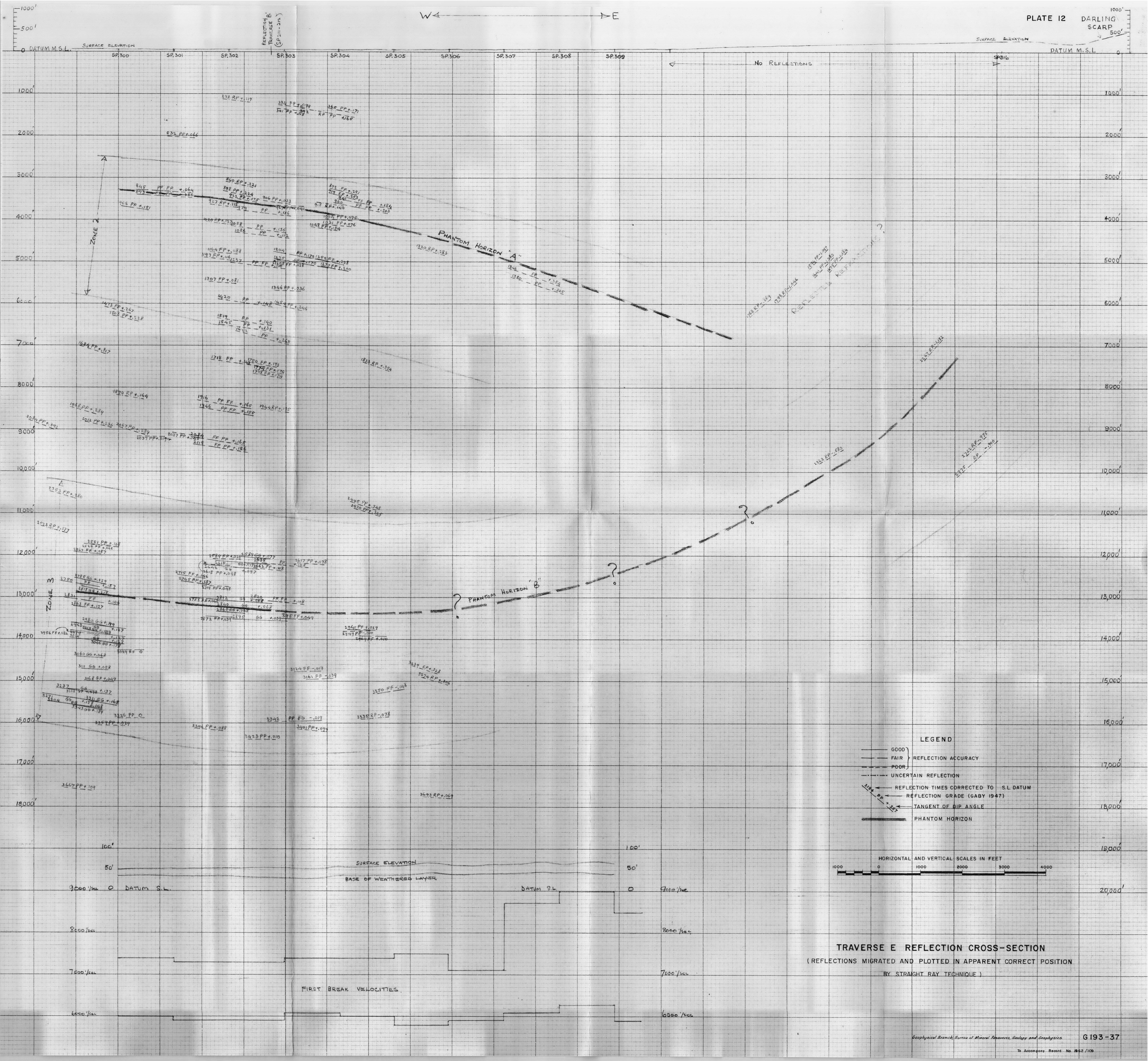


PLATE 12
DARLING SCARP
W — E
DATUM M.S.L.
SURFACE ELEVATION
REFLECTION TRAVERSE B
SP.300
SP.301
SP.302
SP.303
SP.304
SP.305
SP.306
SP.307
SP.308
SP.309
SP.316
NO REFLECTIONS
ZONE 2
ZONE 3
PHANTOM HORIZON "A"
PHANTOM HORIZON "B"
LEGEND
GOOD
FAIR
POOR
REFLECTION ACCURACY
UNCERTAIN REFLECTION
REFLECTION TIMES CORRECTED TO S.L. DATUM
REFLECTION GRADE (GABY 1947)
TANGENT OF DIP ANGLE
PHANTOM HORIZON
HORIZONTAL AND VERTICAL SCALES IN FEET
BASE OF WEATHERED LAYER
DATUM S.L.
FIRST BREAK VELOCITIES
TRAVERSE E REFLECTION CROSS-SECTION
(REFLECTIONS MIGRATED AND PLOTTED IN APPARENT CORRECT POSITION BY STRAIGHT RAY TECHNIQUE)
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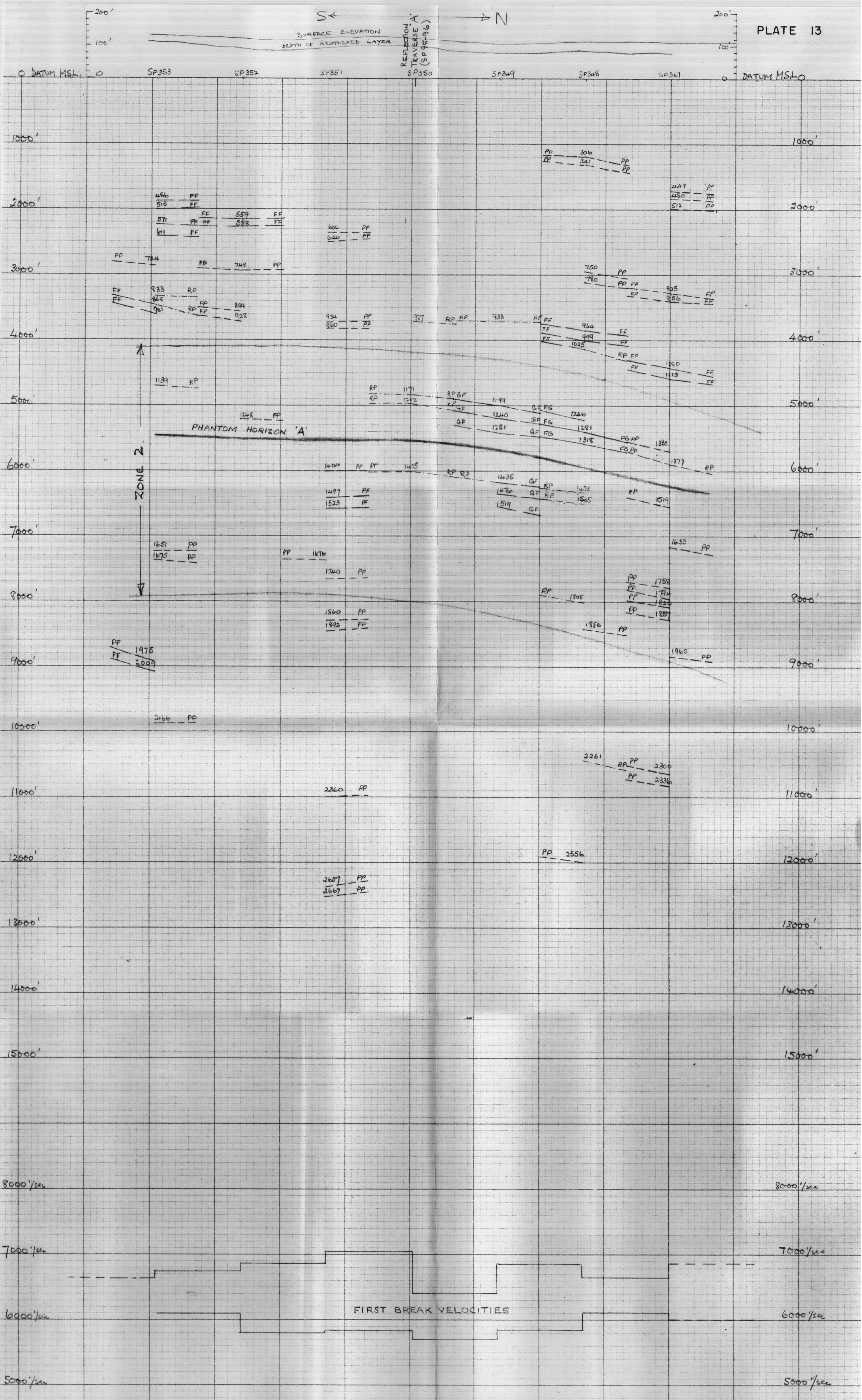
To Accompany Record No. 1962/109

PLATE 13



LEGEND

- GOOD, FAIR, POOR — REFLECTION ACCURACY
- UNCERTAIN REFLECTION
- REFLECTION TIMES CORRECTED TO S.L. DATUM
- REFLECTION GRADE (GABY 1947)
- PHANTOM HORIZON

HORIZONTAL AND VERTICAL SCALES IN FEET

1000 0 1000 2000 3000 4000

TRAVERSE F REFLECTION CROSS-SECTION

(REFLECTIONS PLOTTED DIRECTLY BELOW THE SHOT POINT)

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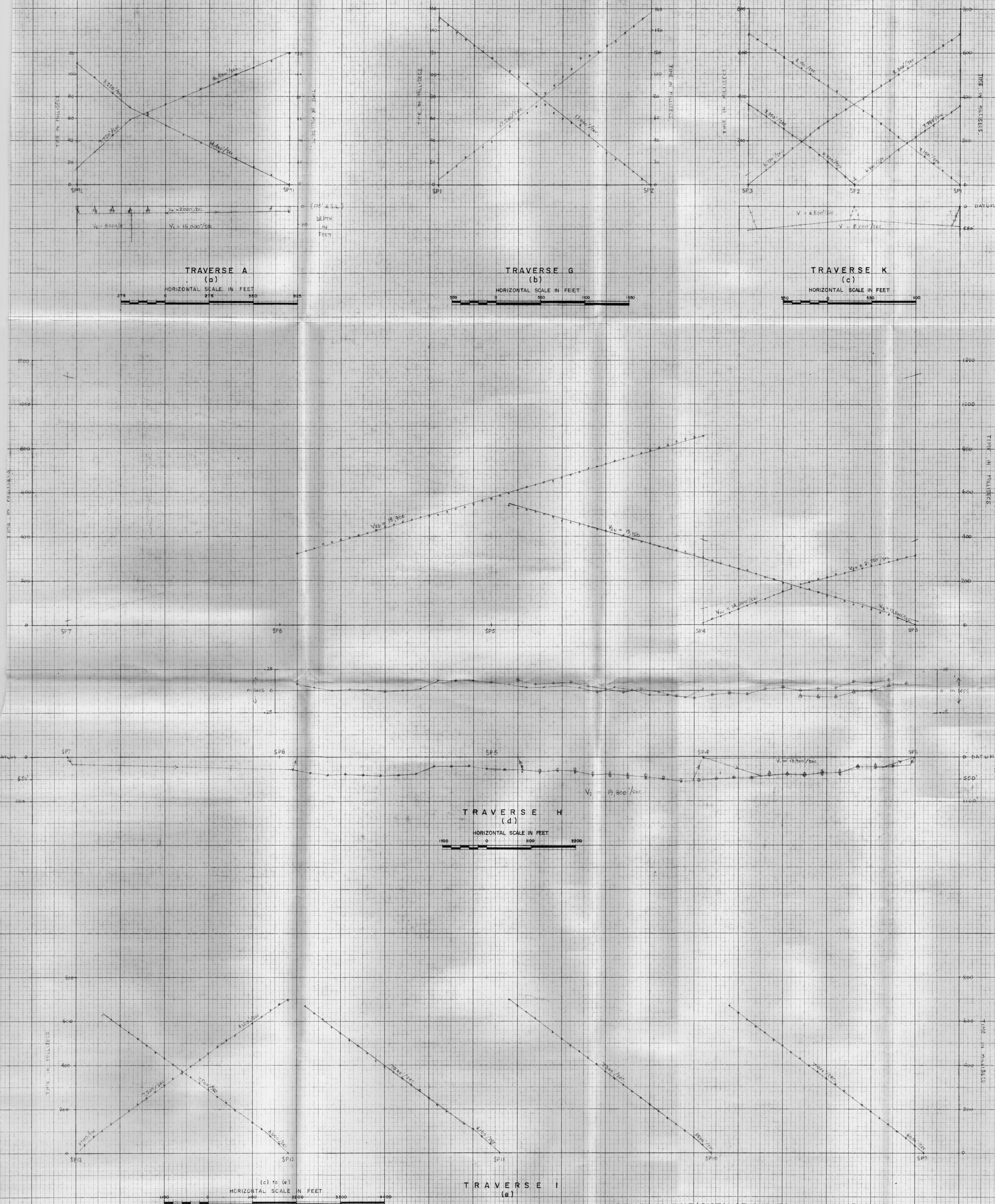

REFRACTION TIME/ DISTANCE CURVES AND INTERPRETATION

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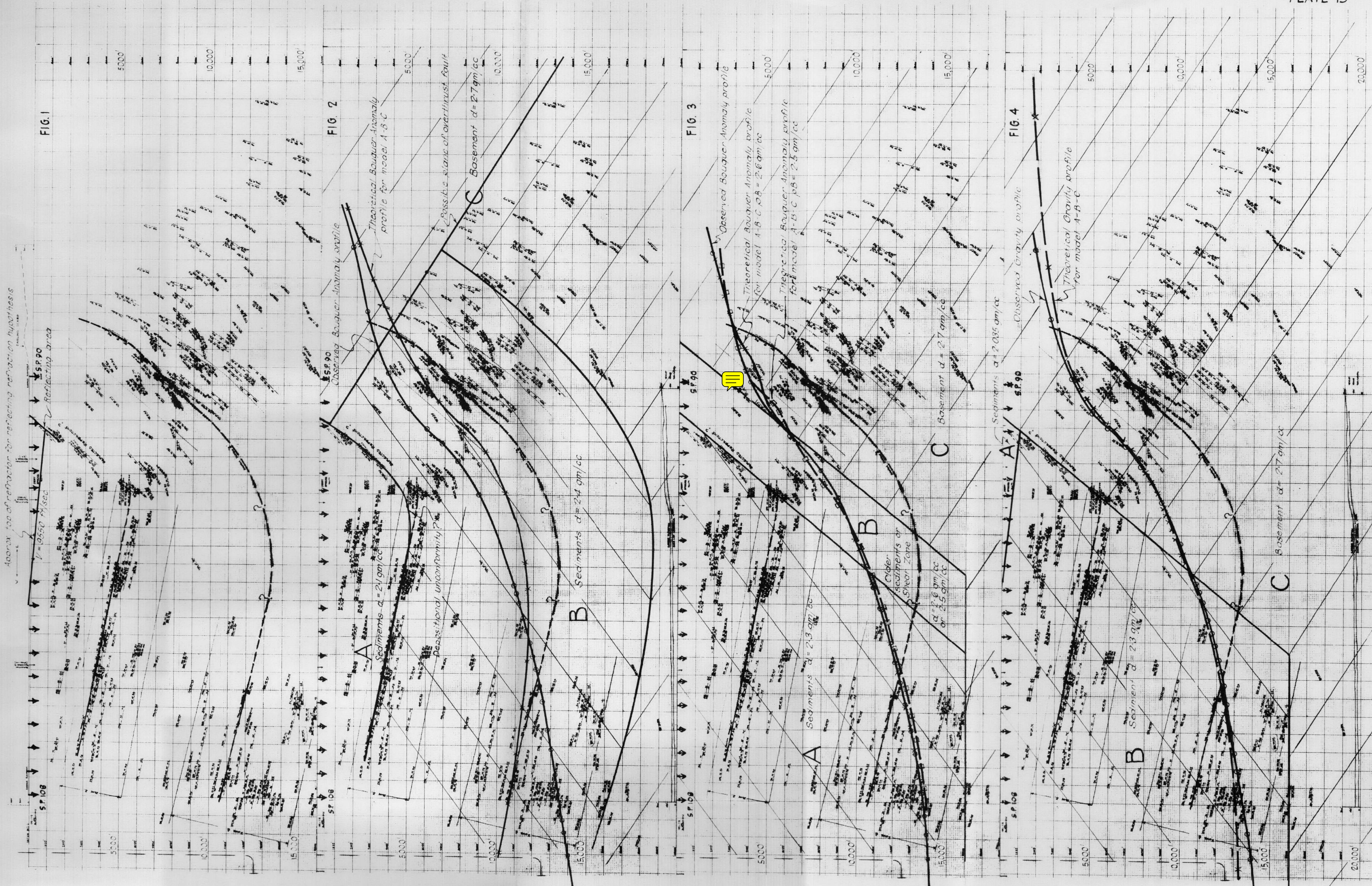
COOKERNUP



NOTE : Calculation of Gravity Effects by A. Bigg-Wither

TENTATIVE SECTION ALONG
TRAVERSE A
INDICATING POSSIBLE SUBSURFACE STRUCTURE

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