Author

Rept. Bk. No. 59/154
G.S. No. 3046
D.M. 875/64

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

GEOPHYSICAL SECTION
(SEISMIC)

REFLECTION SEISMIC SURVEY - NORTHERN ADELAIDE PLAINS, 1964

by

K. R. Seedsman
Senior Geophysicist (Seismic)

16th December, 1964

D.M. 875/64

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SUMMARY

A short seismic reflection survey was carried out in the Port Gawler - Lower Light area of the St. Vincent Basin. One event has been correlated extensively and interpreted as originating from the basement surface. A map of this horizon is included and shows a basement high north and east of Lower Light, and greatest depth to basement in the area surveyed near Port Gawler. Reflections from the Tertiary sediments are not extensive but show gentle southerly dip and wedging of the lower part of the succession against the basement high.

Earlier, reconnaissance gravity maps show similarities to the basement reflection map and additional gravity observations are recommended in the area of seismic control to assess the reliability of the gravity method for further exploration.

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INTRODUCTION

This report presents the results of a short seismic reflection survey carried out in the Port Gawler - Lower Light area of the St. Vincent Basin.

The area covered is located approximately 25 miles north of Adelaide in flat, farming country used for sheep, grain and vegetables. The location is shown on plan 64-1075. Numerous roads and tracks are present in the area and access is easy.

The survey was carried out during a wet winter and minor delays were caused by rain and boggy ground.

GEOLOGY

Prior to the commencement of this survey the only well which had penetrated the entire sedimentary section in this part of the St. Vincent Basin was Observation Bore F, at Port Gawler. This bore encountered a Recent-Tertiary section, predominantly sandy clays, limestones, marls and mudstones, to 1148 feet, at which depth it entered hard dolomitic limestone, presumably of Precambrian age.

Scattered shallower wells, drilled for water and other purposes to the north of Port Gawler indicate that the Tertiary section becomes thinner northward and eastward.

The geology of the area is more fully discussed by Cornish(1).

PREVIOUS GEOPHYSICAL WORK

A number of reconnaissance gravity traverses have been made in that part of the Adelaide Plains under investigation. Some of these are described and interpretation discussed in a report by I.S. Rowan[2].

A more extensive gravity contour plan than that included in the above report has been compiled by I.A. Mumme. This plan is on the files of the Exploration Geophysics Section but has not yet been drafted for reproduction.

Several short seismic traverses were shot in 1959 near Two Wells and between Virginia and Elizabeth. One of these, Line A, is incorporated in the basement map accompanying this report.

METHODS OF OPERATION AND INTERPRETATION

Camp

A mobile camp containing accommodation for 19 men, cooking and dining facilities, ablutions, refrigeration, food and spare parts storage, 240 volt power supply, mechanic's workshop and field office, housed the party. By courtesy of Mr. Malcolm Brooks, the camp was set up several miles west of Two Wells on the Brooks' property, "Buckland Park".

P.W. Taylor was in charge of operations in the early stages but later returned to Adelaide and G.W. Kendall acted as party chief. These two officers were responsible for most of the field interpretation.

Surveying

Shot and geophone points were located along section boundaries, chained and levelled and plotted directly on Lands Department Hundred maps at a scale of 1 inch = 40 chains. Levels were tied to various government survey bench marks and reduced to mean sea level datum.

Drilling

Most of the drilling was done with a Mayhew 1000 combination air/water rig, mounted on an International R 190 truck. Shot Points E 40 to E 53, on tidal flats near Port Gawler were inaccessible to the Mayhew rig and were drilled with a Gemco auger drill.

Weathering was generally thin and shot holes were seldom needed deeper than 35 feet. Drilling was generally through clays and sands and water was used as a drilling fluid.

Shooting and Recording

A set of Texas Instruments Inc. 7000B 24 channel seismic instruments was used with photographic recording only. After some experimentation a shot point interval of 600 feet was fixed with trace interval 50 feet for the 24 trace split spread. Eight Electro-Tech EVS 2 geophones at intervals of ten feet were used for each trace. The filter pass band employed was from 30 to 75 cycles per second.

Charges of five pounds of Geophex at depths from 20 to 35 feet were generally used.

Reflection quality was generally fair to good, with the total reflecting section occupying less than half a second. Occasional line-ups were recorded deeper than this but were usually found to be multiple reflections.

Computing

Reflection times were reduced to a datum at mean sea level by a normal uphole method, using an elevation velocity of 6000 feet per second. Over a large part of the survey area, the shot was placed within a few feet of sea level.

Velocity Control

Short, well geophone, velocity surveys were run in Observation Bore F, Port Gawler, and Light No. 1 Well. Results gave average velocities from datum to basement of 6350 and 6150

ft./sec. respectively.

A moveout analysis over the survey area of reflections assumed to originate at the basement surface gave an average datum to basement velocity of 5700 ft./sec.

It seems likely that the average velocity varies over the survey area with the changing depth to basement, but good control of this variation is not available. For the preparation of the basement map (64-1075) an average velocity of 5800 ft./sec. has been used.

RESULTS AND INTERPRETATION

Time sections of the four lines shot (E,F,G,H) are shown on plans L64-172 and L64-213.

Observation Bore F, at Port Gawler, entered "basement" (Precambrian or Cambrian dolomite) at 1148 feet. Adjacent to this bore, primary reflections are recorded to a time of approximately 0.4 seconds. Northward, the reflecting section becomes thinner, and beyond Lower Light, the deepest primary reflections are shallower than 0.2 seconds.

Insufficient velocity information is available to convert reflection times accurately to depths. For the purpose of identifying reflections, a constant average velocity of 5800 ft./sec. has been used to convert depths in Observation Bore F and Light No. 1 to the time scale of the plotted sections, and these depths are shown on the section of line E (L64-172). Stratigraphic boundaries, from preliminary investigations only, were supplied by J.M. Lindsay (Port Gawler) and B. Cornish (Light No. 1).

The reflection at .200 secs. at E 126 probably originates at the basement surface (530 feet below sea level). This reflection can be followed with good continuity northward to E 165 (.168 secs. = 485 feet below sea level), and southward to E 60 (.331 secs. = 960 feet below sea level). At E 40, adjacent to Observation Bore F, the reflection at .406 seconds probably originates at the basement surface. This can be

followed northward to E 55 (.281 secs. = 815 feet below sea level). Between E 55 and E 60 complex faulting is apparent. The records are poor and the basement reflection can not be identified, nor can the exact nature of the fault movement be seen.

This basement reflection has been labelled "B" on the time sections. Westward of line E, "B" dips to .252 secs. (730 feet) at G 34 and to .211 secs. (610 feet) at F 92. Faulting displaces the basement at a number of places along line G. Southerly dip is shown along line H. Eastward of Light No. 1, along line F, "B" remains almost flat as far as F 136, before rising to .177 secs. (515 feet below sea level) at F 139. In this locality reflection quality deteriorates and "B" can not be identified east of F 139.

The basement reflection "B" has been contoured on plan 64-1075. A basement high is apparent east of the northern portion of line E, nosing south-south-westwards near Light No. 1. The strike direction of the faults shown on the sections is not known and on the map they have been tentatively shown perpendicular to the line of section concerned. Generally the fault movement does not greatly affect the contour pattern. An exception may be in the area few miles northeast of Port Gawler. However, insufficient control is available for reliable contouring in this area, and in fact, between E 40 and E 55, where linear control only is available, contour segments have been shown approximately perpendicular to the seismic traverse. The actual contour direction may be considerably different from this.

The gravity maps of Rowan and Mumme referred to above show marked similarities in contour pattern to the basement reflection map. (If the density of basement rocks is constant over the area concerned, and that of the overlying sediments similarly so, variations in gravity anomaly could be caused by relief on the basement surface.) However the gravity coverage is not sufficiently detailed to allow reliable assessment of the

relationship between the gravity and basement maps.

Reflections from within the Tertiary sediments are less continuous than "B" and more difficult to identify geologically. One labelled "B-B" appears to originate within the Batesfordian or Balcombian beds of the Port Gawler Bore. It is almost flat-lying from Port Gawler to E 73, beyond which, for unknown reasons, it is not recorded. It is not affected by the basement faulting between E 55 and E 60.

Another reflection ("BPM") at .277 secs. at E 40, originates within the Blanche Point Marls. It can be traced to .251 seconds at E 55. In this distance (9000 feet) the interval between this reflection and basement has thinned from approximately 375 feet to approximately 90 feet. The reflection is not recorded across the fault zone between E 55 and E 60, and correlation across this interval is doubtful, but it may continue, without significant fault displacement, but with very gentle southward dip, to .227 seconds at E 96. Here again it is only 90 feet above basement, and between this point and E 126 (Light No. 1) this interval either wedges or is faulted out altogether.

Wedging of the lower part of the section is also apparent on line G.

Generally, control within the Tertiary section is not extensive, but the section appears to have very gentle southerly dip, and thins northward against the basement high in the northern portion of the area surveyed. Most of the thinning is brought about by wedging in the lower portion of the Tertiary sequence.

East of shot point 108 on line F, where the basement surface is less than 600 feet below sea level, primary reflections varying in quality from questionable to good, are recorded from below the basement surface, down to a depth of approximately 1000 feet. In the vicinity of F 113 one band is strongly unconformable with the basement surface and the overlying section. Between F 123 and F 139 they are closely conformable.

Beyond F 139, the basement surface "B" cannot be identified but lower reflections continue, commonly with stronger dip than is recorded anywhere on "B" or overlying reflections. On the other lines shot, these reflections from within basement are not recorded with certainty.

CONCLUSIONS AND RECOMMENDATIONS

The survey has shown that the surface of basement rocks can be reliably mapped by reflection shooting in the Lower Light - Two Wells - Port Gawler area of the St. Vincent Basin. Northward of Lower Light, and east of shot point F 139, the basement surface becomes too shallow, or loses its reflecting properties, and can not be located by the technique used. The surface shows marked relief, and much of the lower Tertiary section present in the deeper areas wedges out against basement highs. The Tertiary sediments are little disturbed by folding or faulting, and show very gentle southerly dip.

Because of the possibility that detailed gravity maps might be capable of quite accurately indicating the basement configuration, it is recommended that a detailed gravity survey be made over the area of seismic coverage to investigate this possibility as the next stage of geophysical investigations.

ACKNOWLEDGEMENTS

The author is indebted to P.W. Taylor and G.W. Kendall (Geophysics (Seismic) Section) for the conduct of field operations and preliminary interpretation, and to B.E. Cornish (Petroleum Geology Section) and J.M. Lindsay (Palaeontology Section) for geological information.

K. R. Seedsman
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KRS:AGK
16/12/64

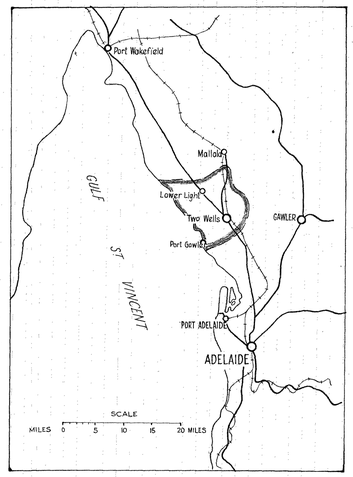
REFERENCES

Cornish, B.E. (1964) - "Light No. 1 - Well Completion Report," Geol. Surv. S.Aust. Report No. G.S. 3009.

Rowan, I.S. (1964) - "First Report on Gravity Survey of the North Adelaide Plains," Geol. Surv. S.Aust. Report No. G.S. 2807.

STATISTICS

Date shooting commenced	10th July, 1964.
Date shooting completed	20th August, 1964.
Number of recording days	37
Number of holes shot	289
Number of holes drilled	298
Footage drilled	9457 feet
Dynamite used	1880 lbs.
Detonators used	348
Total traverse length	31 miles



Hp DUBLIN

Hp GRACE

Hp PORT GAWLER

LOWER LIGHT

To Mallala

733 A
Hallions Bore

344 A
Light No1

MIDDLE BEACH

TWO WELLS

To Adelaide

PORT GAWLER

OBSERVATION BORE F

F?

N

Contour Interval = 50 feet
Datum - Sea Level
Interpretation by: K.R. Seedsman
Velocity function: $\bar{V}$ = 5,800 ft/sec.
Date: 27-11-64

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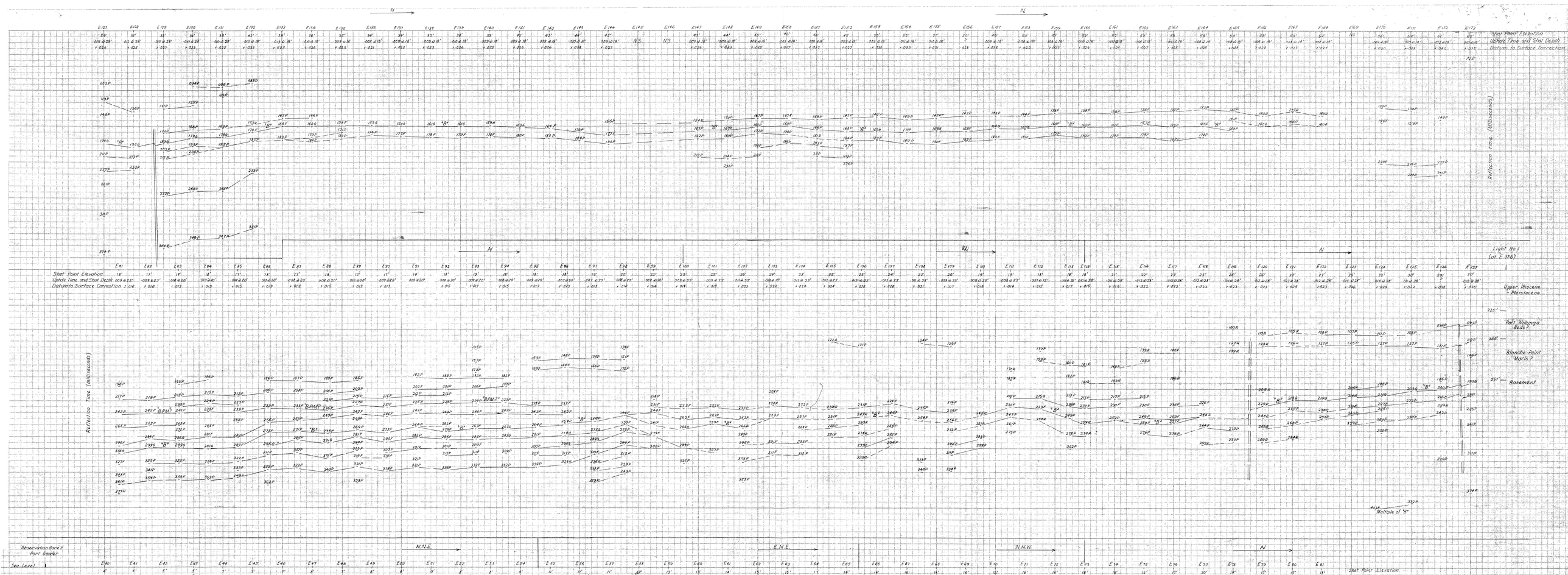
SEISMIC SURVEY - ADELAIDE PLAINS 1964
BASEMENT REFLECTION MAP

SCALE
Miles 1 ½ 0 1 2 Miles
Chains 80 40 0 80 160 Chains

64-1075
GH
Date: 27-11-64



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REFLECTION SEISMIC SURVEY - ADELAIDE PLAINS - 1964

TIME SECTION - LINE "E"

Horizontal scale :- 1cm. = 240 ft.

Vertical scale :- 1cm. = 20 milliseconds

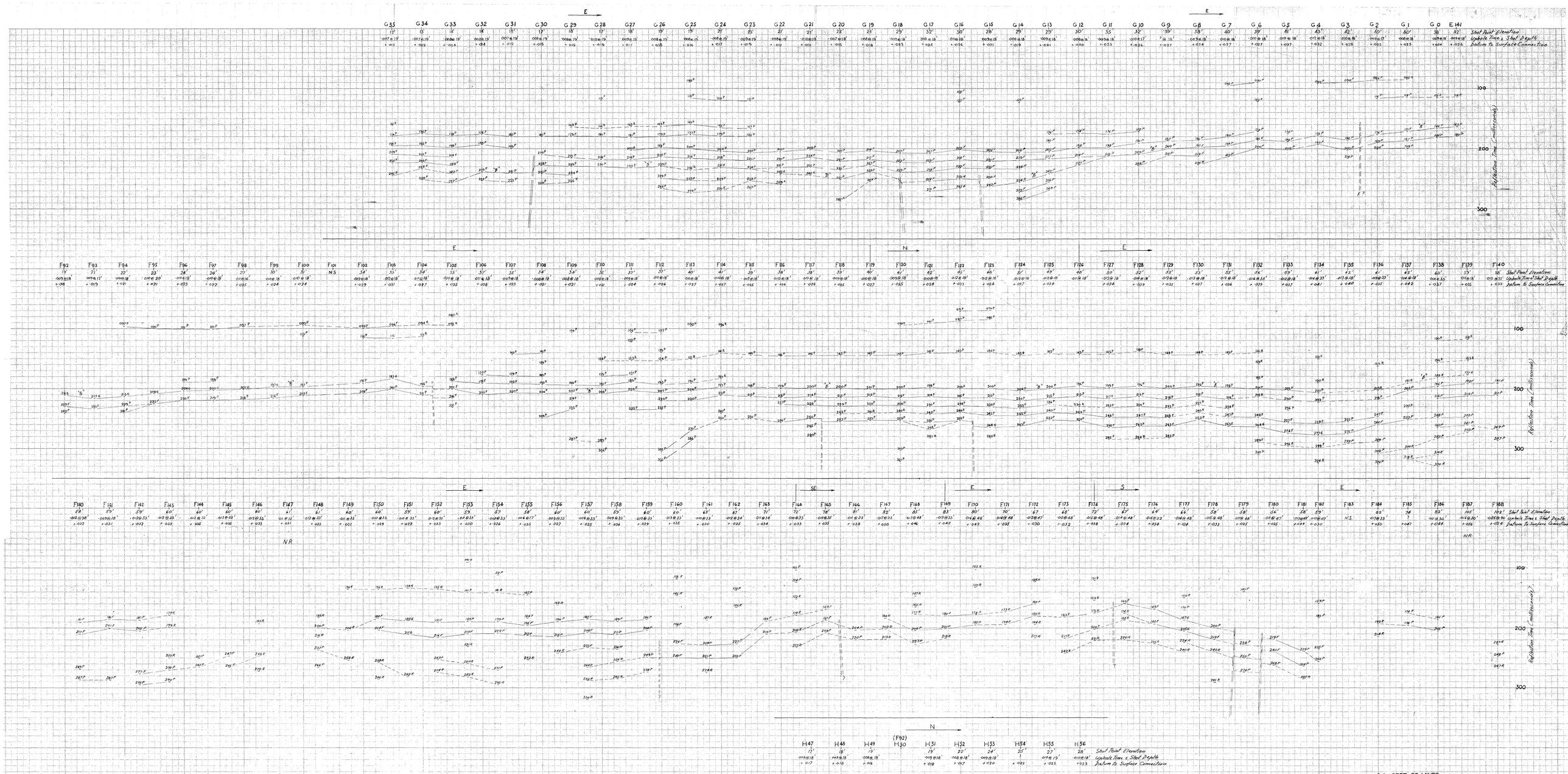
Datum :- Sea level.

Interpretation - K.R. Seedsman.

Date :- 1st Oct. 1964.

L64-172

Gi 5/6·8



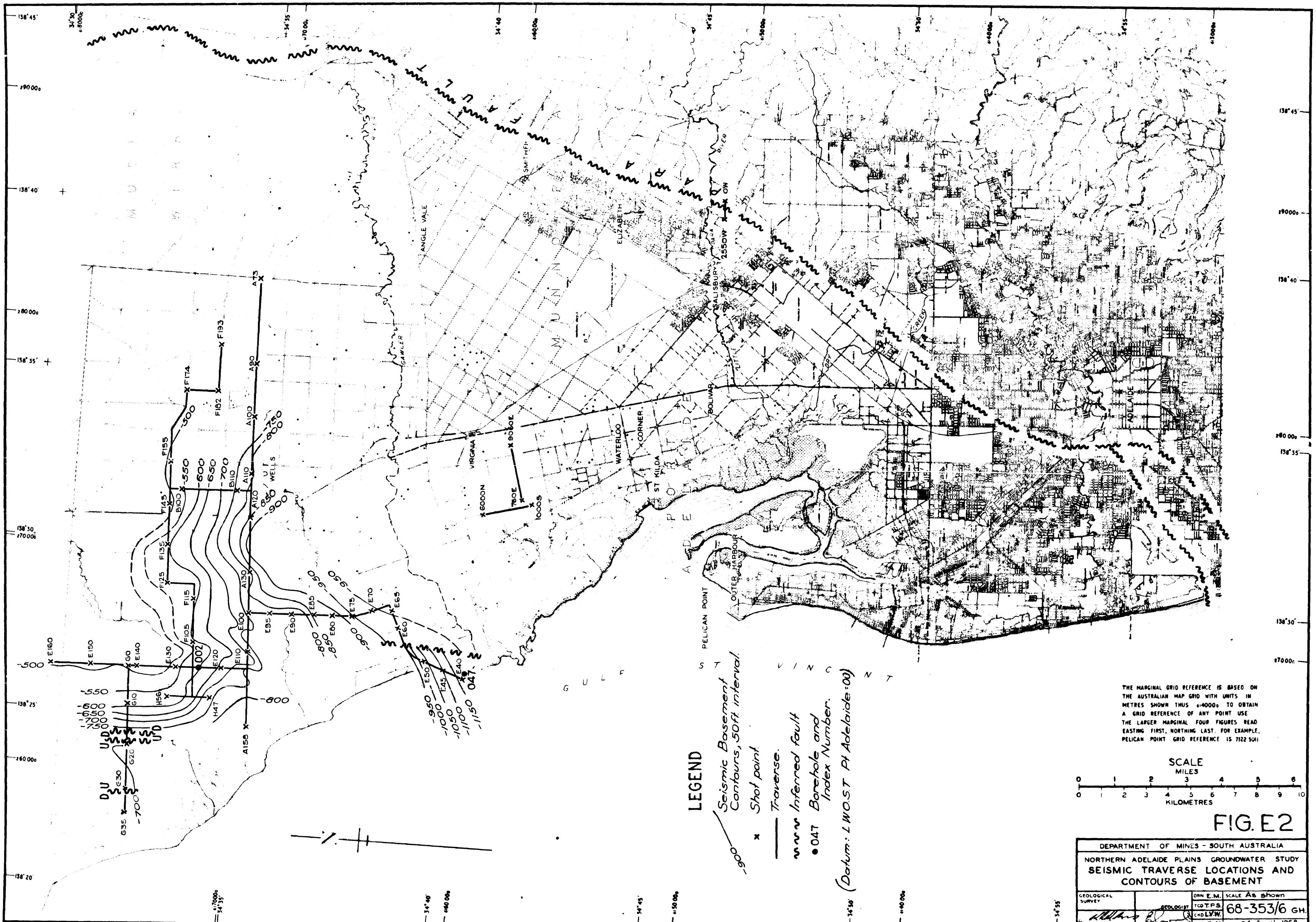
S.A. DEPT. OF MINES

REFLECTION SEISMIC SURVEY - ADELAIDE PLAINS 1964

TIME SECTION - LINE F.G.H.

Horizontal Scale:	1 cm. = 240 ft.
Vertical Scale:	1 cm. = 20 milliseconds
Datum:	Sea Level
Interpretation:	K.R. Seedsman
Date:	23rd. Oct. 1964.

L 64-213
GH



LEGEND

-900 Seismic Basement Contours, 50ft. interval.

× Shot point.

— Traverse.

∿∿∿ Inferred fault

● 047 Borehole and Index Number.

(Datum: LWO.S.T Pt Adelaide = 00)

THE MARGINAL GRID REFERENCE IS BASED ON THE AUSTRALIAN MAP GRID WITH UNITS IN METRES SHOWN THUS 6140000 TO OBTAIN A GRID REFERENCE OF ANY POINT USE THE LARGER MARGINAL FOUR FIGURES READ EASTING FIRST, NORTHING LAST. FOR EXAMPLE, PELICAN POINT GRID REFERENCE IS 7122 5011

SCALE

MILES 0 1 2 3 4 5 6

KILOMETRES 0 1 2 3 4 5 6 7 8 9 10

FIG. E2

DEPARTMENT OF MINES - SOUTH AUSTRALIA

NORTHERN ADELAIDE PLAINS GROUNDWATER STUDY

SEISMIC TRAVERSE LOCATIONS AND CONTOURS OF BASEMENT

GEOLOGICAL SURVEY

DRN E.M. SCALE As shown

GEOLOGIST TCD T.P.S.

CHD L.V.W. 68-353/6 GH.

DIRECTOR OF MINES SENIOR GEOLOGIST EXD E.M. DATE 24 April 1968