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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORDS 1956, No. 66

SEISMIC REFLECTION SURVEY IN THE POOLE RANGE-CHRISTMAS CREEK AREA, KIMBERLEY DIVISION, W.A.

by

L. W. WILLIAMS

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ILLUSTRATIONS

ABSTRACT

A seismic reflection survey was made to the south-west, south and east of the Poole Range Structure, Kimberley Division, W.A. as an extension of a previous seismic survey.

The results obtained confirm the surface information and show the existence of an anticlinal structure,the axis of which plunges to the east and whose axial plane probably dips to the south. A total thickness of sediments of the order of 20,000 feet is shown.

Some slight evidence of deep faulting down to 10,000 feet was recorded, but is not conclusive.

Insufficient evidence was obtained to select a site for a test bore, but further seismic work is not recommended at present.

1. INTRODUCTION

The work described in this report is a continuation of the seismic work done in the Poole Range area by the Geophysical Section of the Bureau of Mineral Resources in 1953 (Smith, 1955).

For the survey described in this report the camp was established approximately 3 miles south of Christmas Creek Homestead (Plate 1) and headquarters were maintained there for the duration of the survey, from June to August, 1954.

The object of the survey was to find the total thickness and structure of the sedimentary rocks at selected points on the eastern, southern and south-western sides of the Poole Range Structure. It was known from the previous survey (Smith, 1955) that there was little likelihood of reflections being recorded near the axis of the structure.

2. GEOLOGY

A general description of the geology of the area is given by Smith (1955), based on earlier reports by Schneeberger (1952) and Guppy (1953). The following brief notes are based on the above reports.

The Christmas Creek Area is at the south-eastern end of the Poole Range Dome, which itself is at the south-eastern end of a line of folding which includes the St. George Range Dome and the Nerrima Dome.

Geological mapping of the Poole Range Dome is complicated by a system of northerly-trending high-angle normal faults which cut across the structure at intervals of ½ to 1 mile. All the Permian formations known in this area crop out on the structure, Grant Formation and Poole Sandstone forming the core and the Noonkanbah Formation and Liveringa Group cropping out on the grassy flats surrounding the core. The structure has a surface closure in the Noonkanbah Formation. Available information indicates that in the Poole Range Dome the Grant Formation is more than 3,500 ft. thick, the Poole Sandstone about 200 ft., and the Noonkanbah Formation about 1,260 ft. The upper members of the Liveringa Group have been largely eroded in this area.

The Poole Range Dome is considered to be favourably located for the accumulation of oil (Schneeberger, 1952), as, of the various structures mapped in the Fitzroy Basin, it is the closest to the Ordovician and Devonian limestones which crop out to the north-east. It is possible, therefore, that one or both of the Ordovician and Devonian sequences occur in the Poole Range Dome. Three shallow bores put down in the Ordovician rocks near Price's Creek in 1922/23 showed traces of oil. The Ordovician rocks have a known thickness of 2,450 feet, but as the base of the lower Ordovician formation is not exposed, this is not the total thickness.

Between the Poole Range Dome and the Ordovician and Devonian limestones to the north-east are the Talbot Syncline and the Pinnacle Fault, which has a downthrow on the south-west side, probably of several thousand feet

3. STAFFING, EQUIPMENT AND METHODS

The staffing, equipment and methods used in this survey differed in the following respects from those of the 1953 survey:-

(a) Reflection methods only were used in the present survey.

(b) Three drillers were employed instead of a driller and drill assistant as previously. Two of the drillers worked separate shifts and the third supervised the whole drilling programme. This resulted in a marked improvement in the rate of drilling.

(c) The Swedish recording instruments used in 1953 were replaced by a set manufactured by the Technical Instrument Company, Houston, Texas. The performance of this set was very reliable.

(d) Four geophones per trace were used throughout the survey. These were set out five feet apart in the line of traverse and were connected so that there were two parallel pairs of two geophones in series. The distance between successive groups of geophones was always 110 feet.

(e) Either two or three phantom horizons were calculated for each traverse. The average dip within the zone of the phantom horizon was calculated every 330 feet and these average dips were then used in calculating the depth at each shot point.

(f) The same velocities and velocity distribution were used as in the previous survey, except that the average velocity in the weathered layer was taken as 2,000 feet/sec.

During the course of this survey, holes were normally drilled and shot each mile along the traverses until a position was found, as close to the structure as possible, where reliable reflections were recorded. Holes were then drilled and shot at ¼-mile intervals along the traverse, and a cross-traverse was shot, also at ¼-mile intervals, to give the components of dip of the reflectors in two directions.

4. DISCUSSION OF RESULTS

The table below sets out the portions of each traverse which were shot at ¼-mile intervals and 1-mile intervals, and shows where usable reflections were recorded. The positions of the traverses are shown on Plate 2.

Traverse	¼-mile Interval	1-mile Interval	Usable reflections recorded
1	S.P.216 to S.P.232	S.P.204 to S.P.216	S.P.216 to S.P.232 and S.P.212
2	S.P.212 to S.P.240	S.P.240 to S.P.264	S.P.212 to S.P.240 and S.P.244
2X	S.P.314 to S.P.316	———	S.P.314 to S.P.316
3	S.P.300 to S.P.308	———	S.P.300 to S.P.308
3X	S.P.318 to S.P.320	———	S.P.318 to S.P.320
4	S.P.266 to S.P.267	S.P.267 to S.P.294	S.P.266 to S.P.267 and S.Ps.270,274 and 278
4X	S.P.296 to S.P.299S	S.P.299S to S.P.328	———
5	———	S.P.330 to S.P.349	———

Only those portions of the traverseswhich were shot at $\frac{1}{4}$-mile intervals and on which usable reflections were recorded, are plotted on Plates 3 to 5, and they are the only portions dealt with in the following discussion.

(a) Traverses 1 and 4 (Plate 3).

On these traverses, phantom horizons have been drawn through three zones. The first of these zones is 3,000 feet wide with its centre at 6,500 feet at S.P.232, the second is 2,000 feet wide centred at 11,000 feet at S.P.232, and the third is 5,000 feet wide centred at 16,000 feet at S.P.231.

(i) First phantom horizon.

On Traverse 1 this horizon shows a general rise to the north totalling 300 feet in 4 miles. On Traverse 4 it shows that the component of dip in the direction of the traverse is 3° to the east. On Traverse 1 there is a syncline of small relief with its axis at S.P.222.

(ii) Second phantom horizon.

This horizon rises gently to the north between S.P.232 and S.P.229 on Traverse 1, then shows a wide syncline with its axis at S.P.223. There are insufficient reflections to continue the horizon north of S.P.222. On Traverse 4 the horizon shows a dip component of approximately $4\frac{1}{2}^{\circ}$ to the east.

(iii) Third phantom horizon.

The main feature of this horizon on Traverse 1 is a syncline with its axis at S.P.224. From there to S.P.216 the dip component is to the south gradually decreasing going north. Apart from slight dips at each end based on a limited number of reflections of poor quality, the horizon is generally flat on Traverse 4.

Traverses 1 and 4 intersect at S.P.224, but the components of dip shown on the phantom horizons on Traverse 1 are not sufficiently consistent for a true dip to be calculated.

The position of the syncline shown on the three phantom horizons on Traverse 1 indicates that the axial plane dips to the south at approximately 76°. If the axial plane of the anticline shown on Plate 2 has the same dip, the axis would be expected to appear on the third phantom horizon about 4,000 feet north of S.P.216. No reflections were recorded near this point and hence there is no seismic evidence to indicate whether or not the anticlinal structure persists to this depth.

(b) Traverses 2 and 2X (Plate 4).

Phantom horizons have been drawn through the centres of three zones on these traverses. The first of these zones is 1,000 feet wide with its centre at 1,500 feet at S.P.233, the second is 3,000 feet wide with its centre at 6,000 feet at S.P.212, and the third is 2,000 feet wide centred at 10,250 feet at S.P.212.

(i) First phantom horizon.

This horizon shows a general east dip component of approximately 2° on Traverse 2. On Traverse 2X the phantom horizon is very short because of lack of reflections, but indicates a slight north dip component.

(ii) Second phantom horizon.

On Traverse 2 this horizon shows a general east dip component of approximately 4°. It is flat between S.P.316 and S.P.240 on Traverse 2X and then shows a component of dip of approximately 2° to the north between S.P.240 and S.P.314.

(iii) Third phantom horizon.

On Traverse 2 this horizon has a general dip component of 4° to the east. On Traverse 2X it is almost flat from S.P.316 to S.P.240 and then has a component of dip to the south of 2° from S.P.240 to S.P.314.

Only on the first phantom horizon are the dip components sufficiently consistent on Traverse 2X for a true dip to be calculated. In this case the true dip is approximately 2° east.

There is no exact time correlation between the phantom horizons shown on Traverses 1 and 2 because of the lack of reflections, but the first phantom horizon on Traverse 1, which is 6,273 feet deep at S.P.216, is rising to the north at that point and would apparently be about 6,000 feet deep at S.P.212. This was taken as the starting point for the second phantom horizon on Traverse 2.

Because there were no reflections recorded north of S.P.222 in the second zone on Traverse 1, it is not possible to get a similar correlation between the second phantom horizon on Traverse 1 and the third phantom horizon on Traverse 2.

(c) Traverses 3 and 3X (Plate 5).

Only two phantom horizons have been drawn on these traverses because of the lack of deep reflections. The zone for the first is 1,000 feet wide with its centre 1,500 feet deep, midway between S.P.300 and S.P.301. The second zone is 3,000 feet wide centred at 7,000 feet at S.P.300.

(i) First phantom horizon.

It was possible to draw this phantom horizon over only a short distance on both traverses. The dip component is 1° north-north-east on Traverse 3 and 2° east-south-east on Traverse 3X. These components indicate a true dip of approximately 2° to the east.

(ii) Second phantom horizon.

On Traverse 3 this horizon has a dip component of 2° north-north-east between S.P.300 and S.P.303 and 1° south-south-west between S.P.303 and S.P.307. Over the whole length of Traverse 3X the dip component is 4° east-south-east. Thus a true dip of approximately 4½° to the east is indicated.

Traverses 3 and 3X are not connected to the other traverses and so the starting depths for the phantom horizons were selected by comparison of the reflection patterns.

The second phantom horizon on these traverses is deeper than the second phantom horizon on Traverses 2 and 2X. This would be expected if Traverses 3 and 3X are down the flank of an anticlinal structure while Traverses 2 and 2X are near the axis.

(d) Possible Faulting.

Steep dips of approximately 50-60° were recorded from many shot points throughout the area, and it is suspected that these may be from fault planes. However, from only one shot point (S.P.240) was it possible to correlate such a reflection with one recorded when ~~shooting a cross traverse.~~ Assuming that ~~these~~ reflections were both recorded from the same fault plane, this plane would have a dip of 59° to the north-north-west and a strike of 57°. There is no indication of such a fault on the surface geological map.

Additional shooting would have been required to record the other steep dips in a second direction and this was not considered warranted at that stage of the investigations.

5. CONCLUSIONS

The evidence recorded is that which would be expected from an easterly plunging anticlinal structure with its axis at the surface as marked on the geological map (Plate 2). The axial plane of a syncline to the south of the Poole Range Anticline dips to the south at approximately 76°, as shown on Traverse 1, and this is taken as indirect evidence that the axial plane of the Poole Range Anticline also dips in this direction.

The cross-sections here described show little evidence of an angular unconformity such as that observed by Smith (1955), but it is noticeable that on all the sections there is a sharp change from numerous reflections to few or no reflections at approximately 8,000 feet. This is consistent with a lithological change at a depth of approximately 8,000 feet. The total thickness of sedimentary rocks is shown by the seismic work to be at least 20,000 feet.

Reflections showing steep dips were recorded from several shot-points; these were generally at a depth of 10,000 feet or less and possibly indicate faulting. A major programme would be required to map these steep dips in more detail and the information which would be gained on possible faulting would not justify additional surveys at present.

It was not possible on the basis of the present survey to prove closure at any depth and consequently a site for a test bore cannot be recommended from the seismic work alone. However, the work which has been done reasonably confirms that the surface geological mapping can be taken as a guide to deeper structure and a test bore site could be selected from the map and the seismic results.

Because of the lack of reflections near the centre and the southern and south-western flanks of the structure, detailed mapping of the structure is not possible using conventional seismic methods. It is possible that more elaborate and costly techniques would yield the additional data required for locating test bores subsequent to a first test if required, but it is considered that such an effort would, at this stage, be better spent in investigating less complicated structures and those where positive seismic information is easier to obtain.

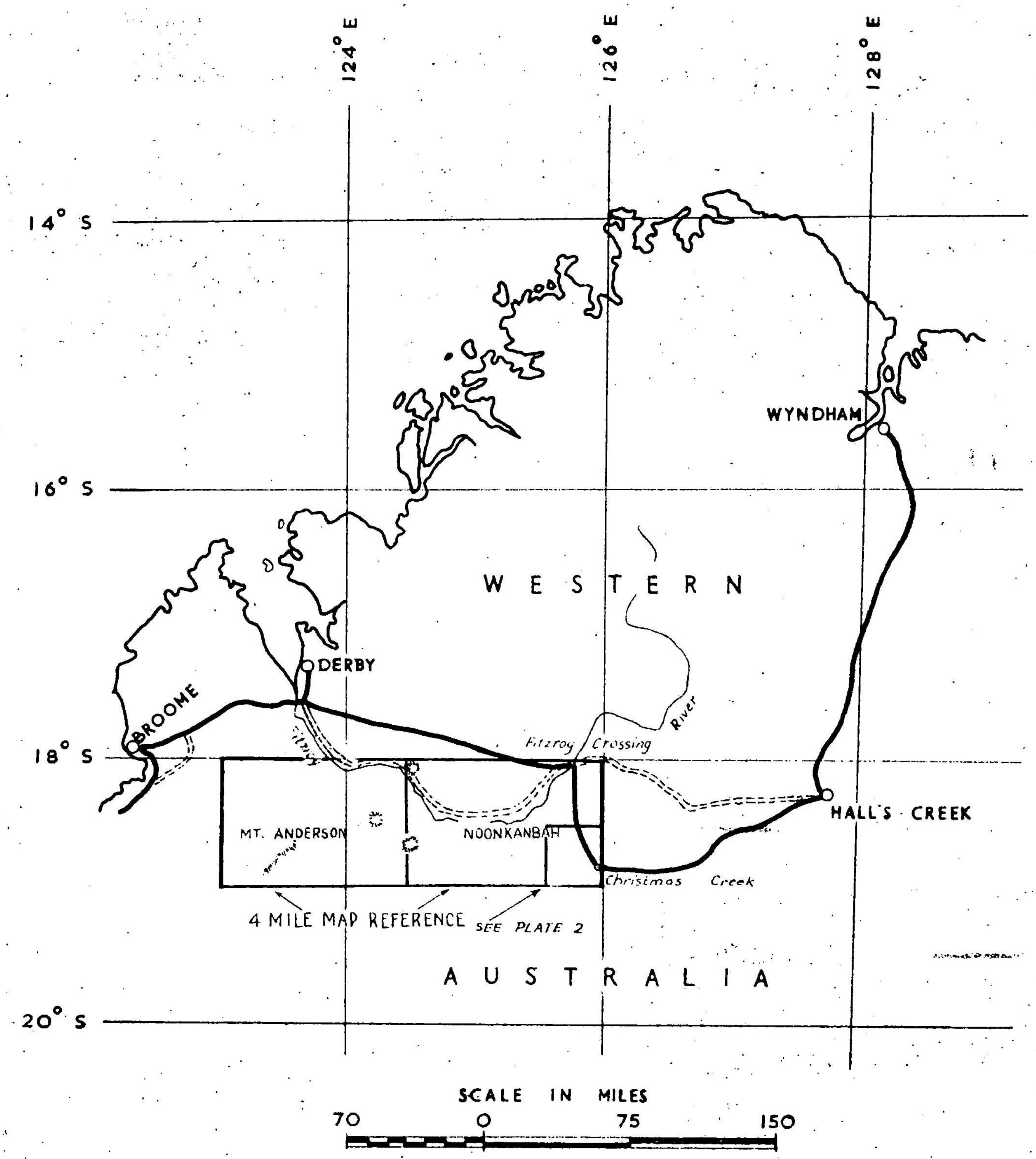
6. REFERENCES

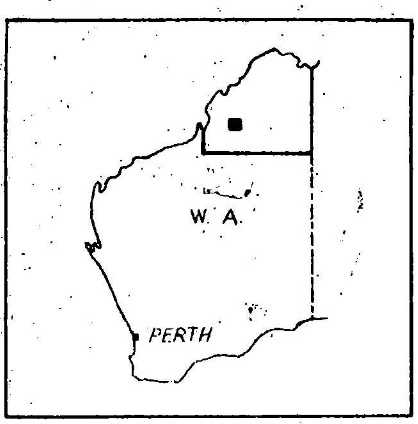
Guppy, D.J., 1953 - Preliminary Report on the Geology of the Fitzroy Basin, Kimberley Division, W.A. Bur.Min.Res.Geol. & Geophys., Records 1953, No.146.

Schneeberger, W.F., 1952 - A review of the Petroleum Prospects of the North-West and Fitzroy Basins of Western Australia. Bur.Min. Res.Geol. & Geophys., Records 1952, No.59.

Smith, E.R., 1955 - Progress Report on a Seismic Survey of the Poole Range - Price's Creek Area, Kimberley Division, W.A. Bur.Min.Res. Geol. & Geophys., Records 1955, No.35.

PLATE I





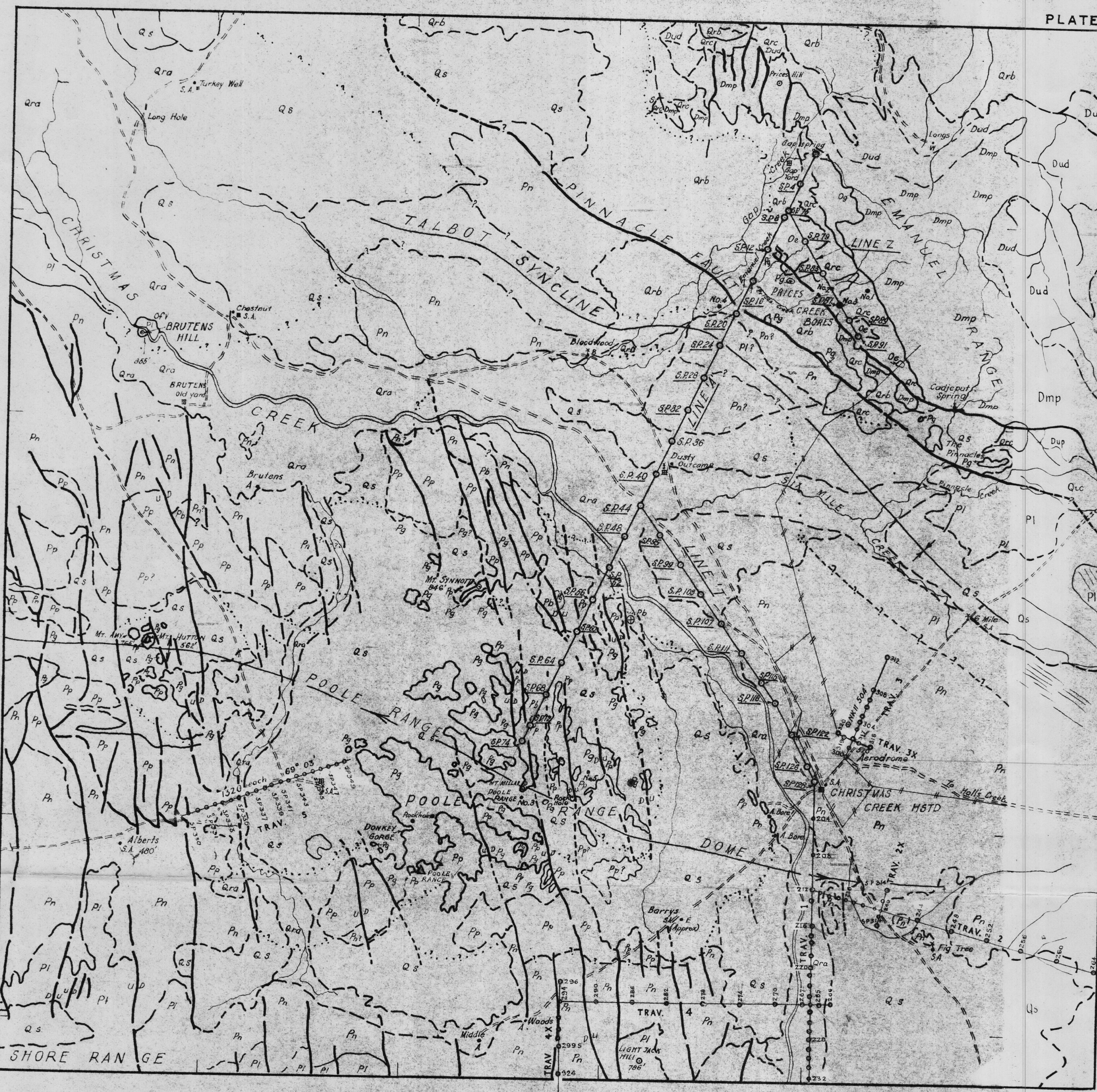
SEISMIC REFLECTION SURVEY IN THE
POOLE RANGE-CHRISTMAS CREEK AREA,
KIMBERLEY DIVISION, W. A.

LOCALITY MAP

SHOWING POSITION OF AREA DEALT WITH IN REPORT
AND REFERENCE TO AUSTRALIAN FOUR MILE SERIES

G 149-5

Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics



SCALE IN MILES

2 0 2 4 6

SEISMIC REFLECTION SURVEY
IN THE POOLE RANGE - CHRISTMAS CREEK AREA,
KIMBERLEY DIVISION, W.A.

SEISMIC TRAVERSES

IN RELATION TO SURFACE GEOLOGY

(AFTER D. J. GUPPY, 1953)

LEGEND

Quaternary	Qrb	RESIDUAL BLACK SOIL
	Qrr	OTHER RESIDUAL SOILS
	Qra	ALLUVIUM
	Qrc	CALICHE
	Qs	SAND, SAND-DUNES
Permian	Pl	LIVERINGA GROUP
	Pn	NOONKANBAH FORMATION
	Pp	POOLE SANDSTONE
	Pg	GRANT FORMATION
Upper Devonian	Dub	BUGLE GAP LIMESTONE
	Dup	MT. PIERRE GROUP
	Duj	J8 CONGLOMERATE
	Dud	SADDLER BEDS
Mid Devon.	Dmp	PILLARA FORMATION
Ordovician	Og	GAP CREEK DOLOMITE (PRICE'S CREEK GROUP)
	Oe	EMANUEL LIMESTONE (PRICE'S CREEK GROUP)

GEOLOGICAL BOUNDARIES

- ESTABLISHED BOUNDARY - ACCURATE
- ESTABLISHED BOUNDARY - APPROX.
- INFERRED BOUNDARY
- ESTABLISHED BOUNDARY - CONCEALED
- INFERRED BOUNDARY - CONCEALED

FOLDS

- ESTABLISHED ANTICLINAL CREST
- ESTABLISHED SYNCLINAL TROUGH
- ANTICLINAL CREST - APPROX.
- SYNCLINAL TROUGH - APPROX.

BORES

- B · BORE
- A · ARTESIAN
- SA · SUB-ARTESIAN
- S · SPRING
- Ⓢ HOTSPRING
- W · WELL
- T■ TANK (EARTH)

FAULTS

- ESTABLISHED FAULT - ACCURATE WITH RELATIVE MOVEMENT
- ESTABLISHED FAULT - APPROX.
- INFERRED FAULT
- INFERRED FAULT - CONCEALED
- ESTABLISHED FAULT - CONCEALED

TOPOGRAPHIC SYMBOLS

- MAIN ROAD
- TRACK
- FENCE
- TELEPHONE LINE
- ■ HOMESTEAD
- ⊞ YARD
- ⊙ HILL

SHOT POINTS NUMBERED OVER 200 IN 1954 SURVEY

⊙ SHOT POINTS ACTUALLY SHOT

L.W. Williams

Geophysicist


PLATE 3
TRAVERSE 1
TRAVERSE 4
SURFACE ELEVATION ABOVE DATUM (FEET)
DATUM
DEPTH BELOW DATUM (FEET)
N
E
AXIAL PLANE
3°
4½°
SEISMIC REFLECTION SURVEY IN THE
POOLE RANGE-CHRISTMAS CREEK AREA,
KIMBERLEY DIVISION, W.A.
CROSS-SECTION ALONG TRAVERSES 1 & 4
REFLECTIONS AND PHANTOM HORIZONS
HORIZONTAL SCALE IN FEET
1000 0 1000 2000 3000
VERTICAL SCALES AS SHOWN
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PLATE 4

SEISMIC REFLECTION SURVEY IN THE POOLE RANGE-CHRISTMAS CREEK AREA, KIMBERLEY DIVISION, W.A.

CROSS-SECTION ALONG TRAVERSES 2 & 2X
REFLECTIONS AND PHANTOM HORIZONS

HORIZONTAL SCALE IN FEET
1000 0 1000 2000 3000
VERTICAL SCALES AS SHOWN

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics. G149-9


TRAVERSE 3
TRAVERSE 3X
PLATE 5
SURFACE ELEVATION ABOVE DATUM (FEET)
DATUM
NNE
ESE
DEPTH BELOW DATUM (FEET)
300
301
302
303
304
305
306
307
308
320
319
302
317
318
SEISMIC REFLECTION SURVEY IN THE
POOLE RANGE-CHRISTMAS CREEK AREA,
KIMBERLEY DIVISION, W.A.
CROSS-SECTION ALONG TRAVERSES 3 & 3X
REFLECTIONS AND PHANTOM HORIZONS
HORIZONTAL SCALE IN FEET
1000
0
1000
2000
3000
VERTICAL SCALES AS SHOWN
Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics G1910