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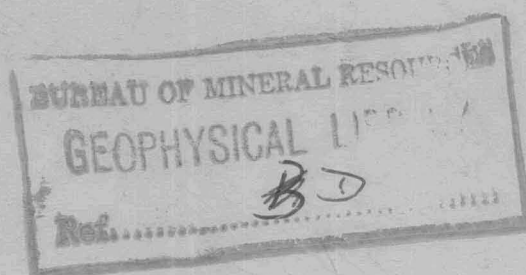
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DEPARTMENT OF NATIONAL DEVELOPMENT
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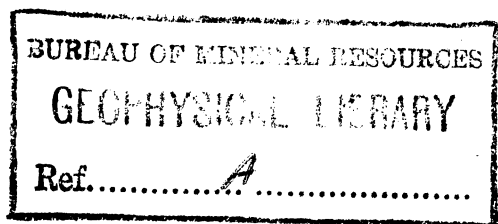
RECORDS 1955, No. 112

PRELIMINARY
SEISMIC REFLECTION INVESTIGATION,
BROOME AREA,
KIMBERLEY DIVISION,
WESTERN AUSTRALIA



by

K. R. VALE and L. W. WILLIAMS



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- PLATE 1. Locality map, position of seismic crosses and possible sub-surface contours.
2. Cross A, east-west section
 3. Cross A, north-south section
 4. Cross B, east-west section
 5. Cross B, north-south section
 6. Cross C, east-west section
 7. Cross C, north-south section
 8. Fig. 1, Cross E, east-west section
Fig. 2, Cross E, north-south section

ABSTRACT.

The preliminary investigation described was made when the Bureau's seismic party was held up by flooded rivers, while on its way to Christmas Creek in May, 1954. Results show that the seismic method is applicable to the Broome area, and that a sedimentary section of the order of 12,500 feet exists. They further show that a syncline and anticline not known from the surface geology may possibly exist at depth.

1. INTRODUCTION.

The area surveyed is a few miles east of Broome, a small port in the Kimberley Division of Western Australia (Plate 1). The area lies within the Canning Basin, which is adjacent to the Fitzroy Basin.

Oil was first discovered in the Fitzroy Basin in 1919 by Harry Price, a well sinker, and since then the Freney Kimberley Oil Company has drilled about twenty bores in the search for commercial quantities. During the past six years intensive geological and geophysical investigations have been made in the Fitzroy Basin in connection with the search for oil. Several private and government geological parties have made surveys, culminating in the recent geological and geophysical surveys by the Bureau of Mineral Resources and by the West Australian Petroleum Pty. Ltd.

The survey described in this report was made in May 1954 and was arranged to occupy the period during which the field party was delayed by swollen rivers while en route for Christmas Creek. Part of the equipment was stranded at Hall's Creek, about 500 miles away, but the drilling plant was available at Broome, and it was possible to fly the essential recording instruments from Hall's Creek. The seismic party comprised L.W. Williams (party leader), E.R. Smith and E.W. Turner, geophysicists.

The survey was planned to give information on:-

- (a) The thickness of the sedimentary section.
- (b) Any major unconformities within the sedimentary section.
- (c) The attitude of various stratigraphic units within the section.
- (d) Whether the surrounding area warrants intensive geophysical investigation.

Because of the shortage of equipment and time, the survey was confined to the alluvial flats a few miles from Broome where access was easy and the water table shallow (see Plate 1).

2. GEOLOGY.

Little is known of the geology around Broome. Mesozoic rocks crop out nearby, but are generally considered to have no petroleum prospects. The section below the Mesozoic rocks is unknown, but it could contain Permian, Carboniferous, Devonian, Ordovician and Cambrian rocks, any of which could contain formations suitable for the generation and accumulation of petroleum. The geology of the adjacent Fitzroy Basin has been described by Guppy (1953). Cambrian rocks have not been observed in outcrop in that Basin, but they are known in the Ord River Basin (further to the north-east) and could exist in the Canning Basin under cover.

The following possible section for the Broome area is based on the work of Guppy and others. It has been supplied by the Geological Section of the Bureau:-

<u>Period</u>	<u>Rock Type</u>	<u>Thickness (feet)</u>
Cretaceous	Sandstone	960
Jurassic	Shale with limestone beds	800
-----Unconformity-----		
Triassic	Sandstone and shale	1,000
Permian	Sandstone	2,500
	Shale and shaly sandstone.	1,300
	Sandstone	1,200
-----Unconformity-----		
	Hard sandstone and shale	3,500
-----Unconformity-----		
Carboniferous	Shale and limestone	700+
Devonian	Limestone	5,000
-----Unconformity-----		
Ordovician	Limestone and shale	3,000+
Cambrian	Possible, but not known in outcrop	
Basement	Probably Proterozoic schists	

N.B. The section from Permian downwards is based on outcrops 100 to 240 miles away. Until proved otherwise, any Permian rocks in the Broome area must, because of possible facies changes from outcrop, be regarded as likely to contain source rocks.

3. FIELD OPERATIONS.

Field work commenced on 3rd May, 1954 and finished on 28th May, 1954. Five crosses, designated "A" to "E" were surveyed, drilled and shot (see Plate 1). Equipment included a set of 24-channel portable reflection instruments made by the Technical Instrument Co., U.S.A., and a mobile Failing "750" drill. As water tenders were not available it was difficult to transport sufficient water for the drilling, and the shooting relied to a large extent on the holes making sufficient water for tamping. Surveying was carried out by a surveyor from the Department of the Interior and the drilling was carried out by officers of the Petroleum Technology Section of the Bureau.

Several reflections were recorded and after making the necessary corrections for weathering, elevation and spread effects, the reflections were plotted on two cross-sections for each cross. Dips indicated are components of dip along the profile.

4. RESULTS.

(a) Cross "A".

East-west section (Plate 2).

Several poor to fair reflections are shown between 2,000 and 6,000 feet indicating a component of dip along the traverse of

about 2° to the east. Two doubtful reflections of no dip significance were recorded from approximately 10,000 feet, indicating the probable existence of reflecting horizons at that depth.

North-south section (Plate 3).

A few reflections, mostly of poor quality, were recorded from depths down to 5,500 feet. They indicate a component of dip that is approximately zero.

Summary.

There is an apparently conformable section down to 6,000 feet showing east dip of about 2° . The sedimentary section may extend to at least 10,000 feet.

(b) Cross "B".

East-west section (Plate 4).

Numerous reflections were recorded from depths down to 8,000 feet, and one fair quality reflection was recorded from 9,500 feet. The average component of dip along the traverse of the beds down to 7,000 feet in this section is about $\frac{1}{2}^{\circ}$ to the west. Below 7,000 feet, the dip information is not very reliable, but a value for the component of about 3° east is indicated.

North-south section (Plate 5).

Several reflections were recorded from depths down to 7,000 feet. A strong south dip component of about 10° to 12° is indicated, the dip tending to increase with depth.

Summary.

There is an apparently conformable section down to 7,000 feet, showing south dip of about 11° . The sedimentary section may extend to at least 10,000 feet, but insufficient information is available to give an approximate value of dip below 7,000 feet.

(c) Cross "C".

East-west section (Plate 6).

Numerous reflections were recorded down to 7,000 feet and indicate a component of dip along the traverse of about 1° to the east. Some reflections were also recorded from depths between 7,000 and 12,500 feet. The information at these depths is not good, but indicates a possible component of dip of about 3° east.

North-south section (Plate 7).

Numerous reflections were recorded down to 7,000 feet, and indicate a component of dip along the traverse of 6° or more to the south, the dip values tending to increase with depth and decreasing to zero to the south. Two poor reflections were recorded at 8,500 feet and 10,500 feet.

Summary.

There is an apparently conformable section down to 7,000 feet, dipping at approximately 6° to the south. The sedimentary section may extend to at least 12,500 feet.

(d) Cross "D".

No clear reflections were recorded on this cross. The holes fell in during, and immediately after, drilling and did not make sufficient water for proper tamping of the explosive charges. Because of the lack of bentonite, casing and water tenders, the cross was not tested very thoroughly.

(e) Cross "E".

East-west section (Plate 8, Fig. 1)

A few reflections were recorded from depths down to 5,500 feet. Component of dip along the traverse of about 2° to the east is indicated.

North-south section (Plate 8, Fig. 2)

Some poor to fair reflections were recorded from depths down to 6,000 feet. They indicate a component of dip along the traverse that is approximately zero.

Summary.

There is a conformable section down to at least 6,000 feet, dipping at about 2° to the east.

5. CONCLUSIONS.

The following conclusions can be drawn from consideration of the foregoing results:-

- (i) The thickness of the sedimentary section appears to be of the order of 12,500 feet. Although the seismic results obviously cannot indicate the probable age of these sediments, it seems reasonable to assume, on the basis of the geological section on page 2 and the wide distribution of Permian sediments in the Fitzroy and Canning Basins, that a considerable thickness of Permian sediments underlies the Mesozoic rocks which are known at the surface.
- (ii) A major unconformity may exist at about 7,000 feet, but the geophysical evidence in support of this is not conclusive.
- (iii) The dips shown at the various crosses indicate that the survey was made on what may be the south-western flank of a north-west/south-east anticline. The decrease in dip on the south side of cross "C" indicates that the axis of a syncline may be near. The near-horizontal attitude of the beds at cross "E" indicates that this cross may be near the axis of the possible anticline. An attempt has been made to correlate between the crosses on the basis of the character of the records. In this method, known as "character correlation", a reflecting band on one cross is correlated with what is taken to be the same reflecting band on the other crosses. On this basis a possible sub-surface contour plan has been drawn (Plate 1). The point recorded as being furthest down dip ($\frac{1}{4}$ -mile south of C5) has been taken as zero, and the other contours are relative to that point. "Character correlation" is subject to grave errors, and the contour plan should only be taken as indicative of the type of flexure of the sediments which may be expected and not as a true sub-surface picture. It is, however, consistent with the dips measured.

- (iv) Although many assumptions are included in the conclusions arrived at in (iii) above, it is considered that the results definitely show that an intensive geophysical investigation of the area near Broome is warranted and that such an investigation might well lead to the discovery of a concealed anticline. It is unlikely that such a structure will be very complicated by faulting, judging by the quality of the reflections, and, if the possible geological section shown on page 2 approaches a true representation of the section, it is likely that the structure will extend through the Permian section. The structure may extend, with modifications, into older sediments. The general picture is, in fact, most encouraging.

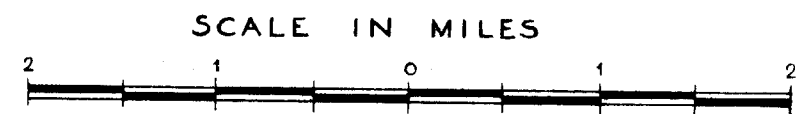
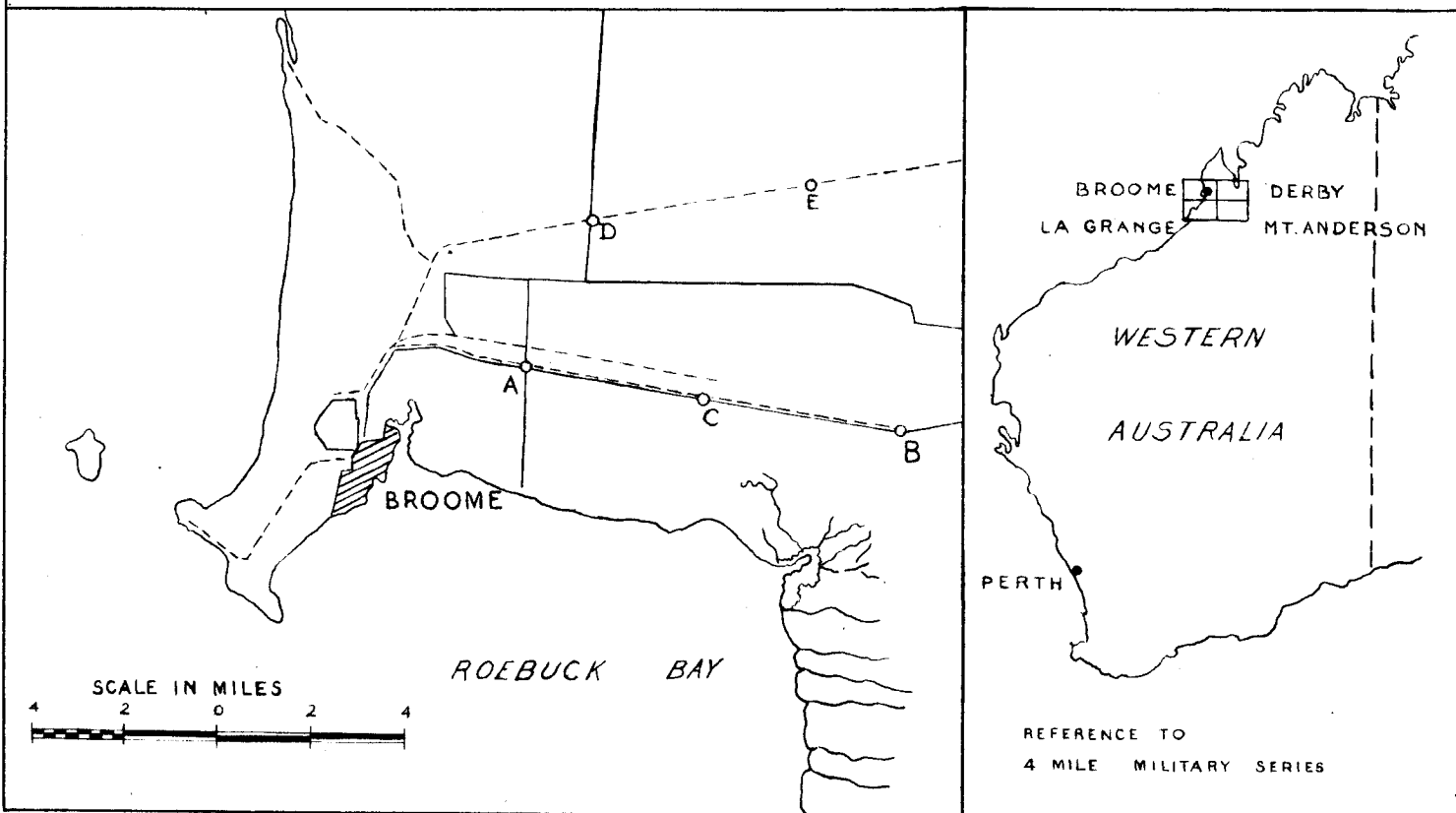
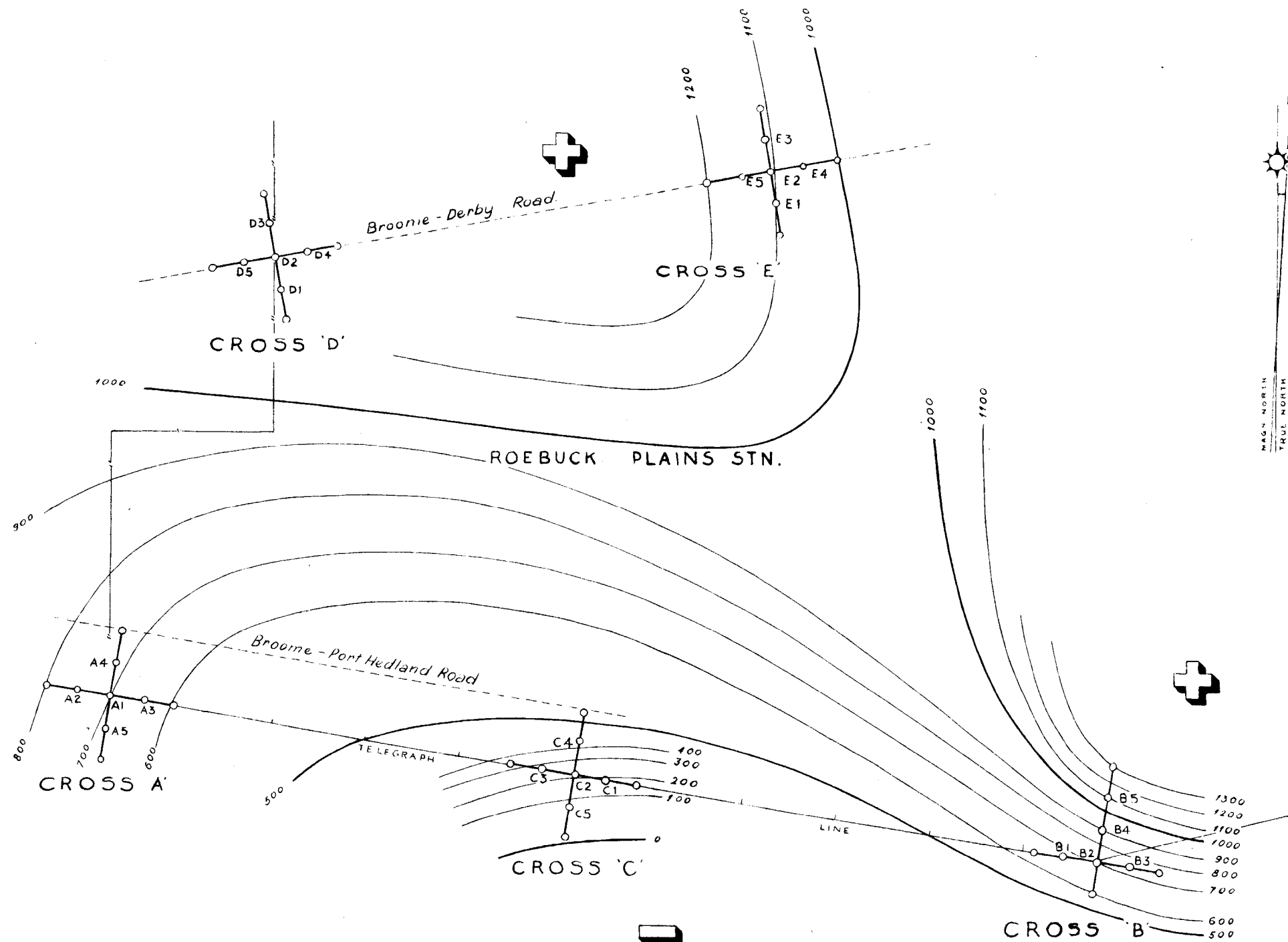
6. RECOMMENDATIONS.

Further investigation of the area should be based on the following sequence:-

- (i) Regional gravity survey, with detailed work extending from the area of the seismic survey.
- (ii) A north-south seismic traverse extending northwards from cross "B", aimed at establishing a reversal of the strong dip recorded there, and further detail planned on consideration of (i) above and the seismic results as they come to hand.
- (iii) Geological and geophysical appraisal of the above results, to plan further exploration and development.

7. REFERENCE.

GUPPY, D. J., 1953 - Preliminary report on the geology of the Fitzroy Basin, Kimberley Division, Western Australia. Aust. Bur. Min. Resour., Records 1953, No. 146.



CONTOUR INTERVAL 100'

PRELIMINARY SEISMIC REFLECTION INVESTIGATION,
BROOME AREA,
KIMBERLEY DIVISION, W.A.

LOCALITY MAP,
POSITION OF SEISMIC CROSSES AND
POSSIBLE SUBSURFACE CONTOURS

ARBITRARY DATUM: POINT RECORDED AS BEING FURTHEST DOWN DIP
(1/4 MILE SOUTH OF C5)

A 2

A 1

A 3

Datum Level (2.5' above L.W.O.S.T. Broome)

→ E

$\frac{667FF}{+043}$ $\frac{1072}{+087}$ $\frac{702FF}{121PP}$ $\frac{586PP}{705PP}$ $\frac{-029}{-030}$
 $\frac{732RP}{+059}$ $\frac{1065}{707FF}$

$\frac{226}{951PP}$ $\frac{979PP}{+083}$

$\frac{-026}{1154FP}$

$\frac{1197PF}{+009}$

$\frac{1231PF}{-131}$ $\frac{+061}{1233RP}$

$\frac{-312}{1703RP}$

$\frac{1729RP}{+513}$



SCALE IN FEET

PRELIMINARY SEISMIC REFLECTION INVESTIGATION,
BROOME AREA, KIMBERLEY DIVISION, W.A.

CROSS "A" EAST-WEST SECTION

A5

A1

A4

Datum Level (25' above L.W.O ST Broome)

N

350 PF

020

354 PF

1031

1014 549RP

619PP

623PF 1028

028

665RP 1021

0 672 PP 670PP - 064

1014 693PP

1012 RP

- 009

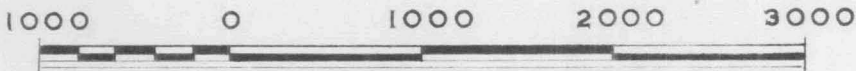
1140 PF + 138

1161 PP

1026

5000'

5000'



SCALE IN FEET

10000'

10000'

PRELIMINARY SEISMIC REFLECTION INVESTIGATION,
BROOME AREA, KIMBERLEY DIVISION, W. A
CROSS "A", NORTH-SOUTH SECTION

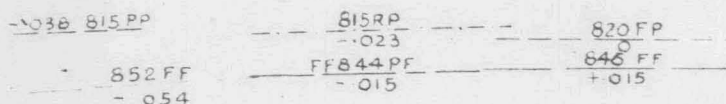
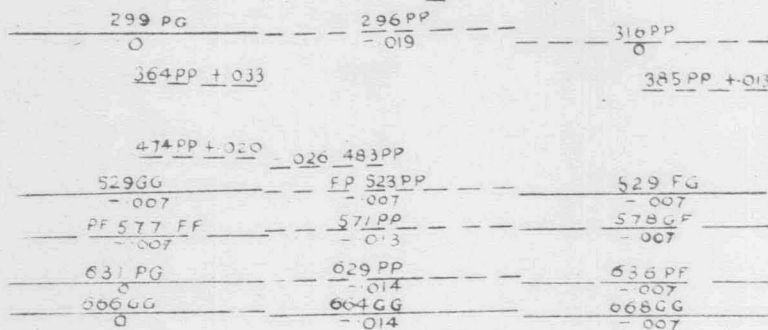
B 1

B 2

B 3

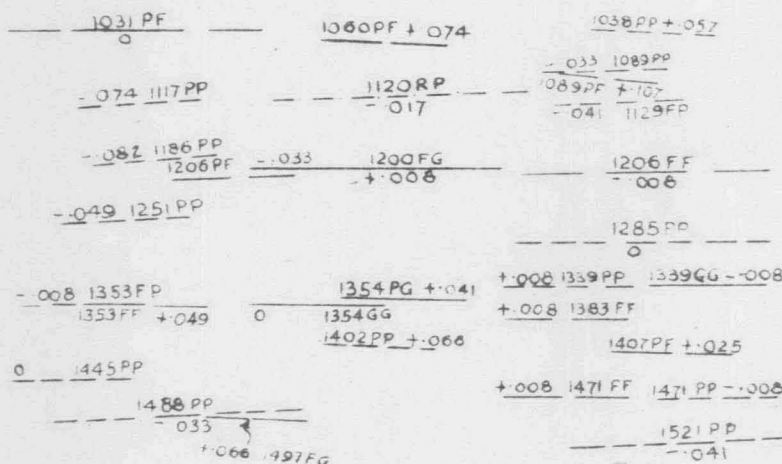
Datum Level (2.5' above L.W.O.S.T. Broome)

→ E



- 040 907 PP

963 RP - 025



1608 FF + 074

+ 041 1718 FF 1718 PP + 074

- 083 1756 PF

+ 025 1833 FG

2004 FF
+ 051

1000 0 1000 2000 3000



SCALE IN FEET

PRELIMINARY SEISMIC REFLECTION INVESTIGATION,
BROOME AREA, KIMBERLEY DIVISION, W.A.

CROSS "B" EAST-WEST SECTION

B2

B4

B5

0' Datum Level (2.5' above L.W.O.S.T. Broome)

→ N

299RP
104 331RP 026

FG 526FP -- 124 508FF 508PP -- 130
153 573FF 573PP -- 133
631PF -- 122
667GG -- 131
585PF -- 140
623GG -- 135
585GG -- 087

PP 774FP -- 140
143 802FF 802FP -- 151
080 757PF 757PP -- 036

147 847GG
847PF -- 069

970RP
123

NP 068FF -- 164

1053PP -- 172
123 998PG

5000'

5000'

115 1201PF

1267FP -- 221
1310PP -- 131
197 1319PP

1251PP -- 191 1162FF
267

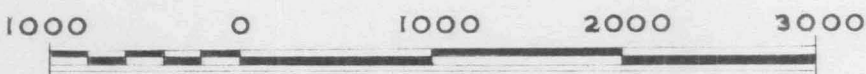
1311PP -- 221
271 1408PP -- 156 1351RP
246 1331FF

1504FF -- 156

370 1563PP

10 000'

10 000'



SCALE IN FEET

PRELIMINARY SEISMIC REFLECTION INVESTIGATION,
BROOME AREA, KIMBERLEY DIVISION, W. A.
CROSS "B", NORTH-SOUTH SECTION

Datum Level (2.5' above L.W.O.S.T. Broome)

→ E

343 PP + .007	335 FP - .007	337 RP + .007
------------------	------------------	------------------

535 PP 0	FG 533 PG FP 572 PP 0	537 PP + .014 575 PG + .014
-------------	-----------------------------	--------------------------------------

698 GG + .022	702 GG 0	707 FG + .022
------------------	-------------	------------------

+ .034 951 PF

960 PP + .017	960 PP + .124	999 PP + .042
------------------	------------------	------------------

1024 PF + .068

+ .069 1157 PF

1162 PP
+ .061

+ .087 1227 PF

1227 PP

0

1223 PF
+ .017

+ .009 1228 PP 1228 PG + .017

1275 PP + .097

1317 PF + .009	1334 PF + .097
-------------------	-------------------

1347 FF
+ .018

1362 FF + .018

+ .072 1391 PF

1481 PP - .047

1480 PP - .019

1595 PP - .010

FF 1638 PF
+ .110

+ .051 1644 PF

10 000'

10 000'

1753 PF + .107

- .042 1739 PP

- .011 1785 PF

+ .095 1948 PF

2046 PP + .051

1000 0 1000 2000 3000

SCALE IN FEET

PRELIMINARY SEISMIC REFLECTION INVESTIGATION,
BROOME AREA, KIMBERLEY DIVISION, W. A.

CROSS "C", EAST-WEST SECTION

C 5

C 2

C 4

0' Datum Level (25' above L.W.O.S.T. Broome)

→ N

338PP 0 341RP +.014 342PP +.007

553 PP .027 PF 608 F 533 RP .062 571PP 571PP .062 540PP .110

+014 710PF 710FG -.022 GG 702 FG -.058 GG 677 FG -.086

767PP +.007

-.059 765PP

-.090 927PG

+025 960PP 960FF -.033

-.042 999PF

1011PP -.152

-.119 1043PP

5000'

+009 1072PP 1072FF -.034 -.077 1061PP

5000'

+089 1136PP

1127PF 0

1163PP -.113

1221PP -.052

1231PP -.146

1320PP -.151

1349PP 0

1345PP -.018

+098 1586PF

10000'

10000'

1775PP -.098

1000 0 1000 2000 3000

SCALE IN FEET

PRELIMINARY SEISMIC REFLECTION INVESTIGATION,

BROOME AREA, KIMBERLEY DIVISION, W.A.

CROSS "C", NORTH-SOUTH SECTION

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics

G178-7

E 5

E 2

E 4

0' Datum Level (2.5' above L.W.O.S.T. Broome)

→ E

FF 607
-021

PF 612 FF
+056
638 FF
+035
PP 667
+043
PP 716
-036

717 PF
+007

5000'

5000'

1160 PF
+035

FF 1124
+034
FF 1154
+038

CROSS "E" EAST-WEST SECTION

E 1

E 2

E 3

0' Datum Level (2.5' above L.W.O.S.T. Broome)

FIGURE 2

→ N

412 PF
-089

PP 725 RP
-007

556 PP
-076

629 PP
+021

RP 708
-051

5000'

5000'

1100
FF
-0
PP 1126
-026
PP 1158
+007
FF 1150 PP
+052
PP 1246
+018

RP 1154
+069

1000 0 1000 2000 3000

SCALE IN FEET

PRELIMINARY SEISMIC REFLECTION INVESTIGATION,
BROOME AREA, KIMBERLEY DIVISION, W.A.

CROSS "E" NORTH-SOUTH SECTION