Section

Rept. Bk. No. 61/116
G.S. No. 3293
D.M. 1679/64

RB 61/116

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

PETROLEUM EXPLORATION DIVISION

PRELIMINARY REPORT ON A SEISMIC REFRACTION AND REFLECTION SURVEY IN THE WOOLTANA AREA OF THE FROME EMBAYMENT 1964

by

P. W. Taylor
Geophysicist

SEISMIC GEOPHYSICS SECTION

28th October, 1965

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SOUTH AUSTRALIA

PRELIMINARY REPORT ON A SEISMIC REFRACTION AND REFLECTION SURVEY IN THE WOOLTANA AREA OF THE FROME EMBAYMENT 1964

SUMMARY

The survey delineates the subsurface extension eastward of the Early Proterozoic formations of the eastern Flinders Ranges, thereby indicating the economic basement for oil exploration in the area.

It also indicates the western termination of the Transition beds in the area, by wedge out against the rising basement.

INTRODUCTION

A refraction and reflection seismic survey was carried out by the Department in the Wooltana area of the Frome Embayment in July, 1963 as part of the general exploration of the Great Artesian Basin in South Australia.

This report deals with the PC line which runs from position 30° 11' 44"S, 139° 27' 36"E at shot point PC 32 W for about 27 miles east to shot point PC 82. The western extremity of the line is situated about ½ mile northwest of Paralana homestead and 1 mile east of the outcropping Early Proterozoic formations of the eastern margin of the Flinders Range.

Refraction coverage extended the whole length of the line for the deepest refractor, and depth probes were shot for all refractors at positions centered on shot points PC 78, 28, 11 and PC 37 W. Total reverse coverage of the deep refractor was not obtained because of difficulties caused by rain in the area.

Continuous reflection coverage was shot from PC 24 to PC 53. The quality of the records varied from poor to fair.

REFRACTION INTERPRETATION METHODS

The interpretation of the refraction records has been made difficult by the absence of reverse coverage over much of the section, also by the poor quality of the records at the eastern end of the line.

In view of these difficulties, where possible, three methods of interpretation were used and the results plotted together to provide a check against one another.

Method I

This method was used at those points on the section where depth probes provided coverage of all refractors.

Starting at the shallowest interface:-

$$d_1 = \frac{T_1 V_1 V_o}{2(V_1^2 - V_o^2)^{\frac{1}{2}}}$$

where d_1 = thickness of 1st refractor

T_1 = intercept time " "

V_1 = velocity " "

V_o = velocity of medium above refractor

The thickness of the next refractor was then calculated from:-

$$T_2 = 2d_1 \frac{(V_2^2 - V_o^2)^{\frac{1}{2}}}{V_2 V_o} + 2d_2 \frac{(V_2^2 - V_1^2)^{\frac{1}{2}}}{V_2 V_1}$$

where T_2 = intercept time of 2nd refractor

V_2 = velocity "

d_2 = thickness "

For the third refractor:-

$$T_3 = 2d_1 \frac{(V_3^2 - V_o^2)^{\frac{1}{2}}}{V_3 V_o} + \frac{2d_2(V_3^2 - V_1^2)^{\frac{1}{2}}}{V_3 V_1} + \frac{2d_3(V_3^2 - V_2^2)^{\frac{1}{2}}}{V_3 V_2}$$

Where T_3 = intercept time of 3rd refractor

V_3 = velocity " " "

d_3 = thickness " " "

The depth points were plotted beneath the appropriate shot points and marked thus X

Method II

This method was used where there were points of inflexion on the time distance curves giving the critical distances and times for the deeper refractor. The formula used was;-

$$d = \tfrac{1}{2} x_c \left(\frac{V_1 - V_a}{V_1 - V_a} \right)^{\frac{1}{2}} \quad \ldots\ldots\ldots (1)$$

$$S = \frac{x_c}{2\left(1 - {}^{V_1}/_{V_a}\right)} \quad \ldots\ldots\ldots (2)$$

where d = depth of refractor

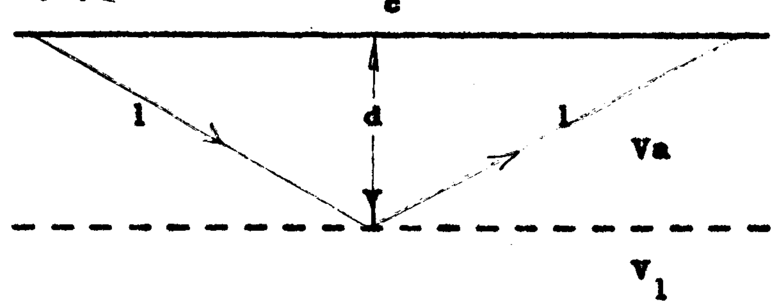
x_c = critical distance

S = horizontal distance between shot point and point on refractor from which critical distance energy comes.

V_1 = velocity of refractor

V_a = average velocity down to refractor

The calculation was done in two stages. First an approximate value of V_a was calculated by dividing the critical distance by the critical time.



G is geophon
recording
critical
distance
energy

This was put into formula (1) and an approximate value for d obtained. Using d and $\frac{1}{2} x_c$ the value of l was calculated and from this and the critical time a more accurate value of V_a calculated. This was again put into (1) and a new value of d calculated.

It was found that a third repetition of the calculation produced no significant change in the depth value, so the process was not taken beyond the second approximation. The offset distance was then calculated from (2) and the depth point plotted at the offset distance and marked thus

<u>Method III</u>

The intercept time was again used in this method but each refractor was reduced to a two layer problem by using the average velocity to refractor calculated in Method II and averaged along the traverse. The formula used:-

$$D = \frac{T_1 \quad V_a}{2 \cos i}$$

where T_1 = intercept time

V_a = average velocity to refractor

V_r = velocity of refractor

i = angle whose sine is $\frac{Va}{V_r}$

d = depth of refractor

The depth points were plotted under the appropriate shot points.

INTERPRETATION

The interpretation shows the following structure. First there is a layer, velocity 5,000'/sec. to 5,600'/sec. with a base that lies about 200' above datum (300' above M.S.L.) at the western end of the line, which dips irregularly to the east. At the eastern end of the traverse the depth of the base is about 500' below datum.

Next below we have a layer of velocity 6500'/sec to 8000'/sec whose base is about 200' below datum at the western end of the traverse and which dips at about 2° to the east to shot point PC 7 where it reaches a depth of 1700'. From here it continues level to the eastern end of the line.

East of shot point PC 7 a layer of velocity 14,000'/sec to 15,000'/sec lies beneath the 6,000'/sec layer. Its base dips at 1¼° from about 2,000' at PC 7 to 4,000' at PC 62. From here it rises slightly to about 3,500' at the eastern end of the line. The western end of this layer appears to wedge out against the deepest refractor at PC 7.

The top of the deepest refractor lies at 200' below datum at the western end of the line. It dips at angles 1½° to 2° to a maximum depth of about 4000', at PC 62, from whence it rises slightly to 3,500' at the end of the line. The velocity is about 16,500'/sec at the shallow western end. At PC 7 the velocity is about 19,000 /sec and continues approximately at this value to the eastern end of the line.

The velocity and depth values given above are affected by the lack of information from reverse coverage and cannot be given an accuracy higher than ± 10% of the indicated values.

It is possible that the deep refractor shown on the section may not be a single continuous formation. More detailed shooting would be necessary to resolve this.

Reflection Interpretation

Continuous reflection profiles were shot in the central part of the traverse between PC 24 and PC 53.

The records are of poor to fair quality. No pronounced dips are shown on the cross section. The two strongest bands of energy are centred at .5 secs and .75 secs two way time.

A T - ΔT examination of the records leads to the conclusion that events below the .75 sec energy band are multiples of earlier events.

Correlation of Refraction and Reflection Work

The equivalent two way reflection time of the 14,000 / sec refractor and the 19,000 /sec refractor were calculated from their depths and average velocity to the refractor for points between PC 22 and PC 57 and plotted on the reflection cross section. The shallower layer was plotted thus, x, and the deeper layer thus, (x)

It will be seen that they fall respectively within the .5 sec. and .75 sec energy bands. Taking into account the uncertainty of depth and velocity of the refractors they correlate well with the reflection section.

Correlation of Seismic and Geological horizons

The 14,000'/sec refractor lies at a depth of about 1700' below datum. This is in the region of the depth of the "C" horizon of the Great Artesian Basin which the Petroleum Geology Section has mapped at about 1600' at a point coinciding with the eastern end of the traverse. The "C" horizon is a seismic event, occurring at the top of the "Transitional Beds" which lie between the Cretaceous Roma beds and the Jurassic Mooga Equivalent beds.

The proximity of the outcropping Early Proterozoic formations of the eastern margin of the Flinders Range to the shallow eastward dipping high velocity refractor at the western end of the traverse leads to the strong presumption that this refractor is the subsurface continuation of those formations. If this is so it represents the economic basement for petroleum exploration.

P. W. Taylor

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SEISMIC GEOPHYSICS SECTION

PWT:AGK
28/10/65

multiples of earlier events.

Correlation of Refraction and Reflection Work

The equivalent two way reflection time of the 14,000 / sec refractor and the 19,000 /sec refractor were calculated from their depths and average velocity to the refractor for points between PC 22 and PC 57 and plotted on the reflection cross section. The shallower layer was plotted thus, x, and the deeper layer thus, $(\bar{x})$

It will be seen that they fall respectively within the .5 sec. and .75 sec energy bands. Taking into account the uncertainty of depth and velocity of the refractors they correlate well with the reflection section.

Correlation of Seismic and Geological Horizons

Due to the lack of any deep bores in this area any attempt to correlate the seismic events with geological horizons must be approached with caution. The refractor with a velocity of 14,000 ft./sec. has been interpreted to lie at a depth of about 1700 ft. This depth may be in error due to velocity inversions. In this area the 'C' reflector occurs at approximately this depth, but the relatively high velocity makes it unlikely that the refractor does in fact coincide with the 'C'. A more possible correlation is with an unconformity at the base of the Mesozoic. This view is supported by the probable lack of section between the base of the marine cretaceous and the pre-cretaceous sediments.

The refractor of velocity 19,000 ft./sec. presents similar problems with regard to the correlation. Because of the large number of reflections recorded from beneath this refractor it is suggested that it represents a sedimentary horizon rather than a true basement. There is no direct evidence as to the nature of this horizon but it is possible that it represents a Cambrian limestone or a sedimentary member of the upper Adelaidean. Velocity analyses of the reflection records in the area have failed adequately to derive the velocity distributions, and much doubt still exists as to the validity of many of the deep reflections. It is considered however that at least some of these reflections can be identified as primaries thus lending credence to the supposition of a fairly thick sedimentary section. At present it would seem that a deep hole is required in order to give adequate geological control to the seismic events.

for P. W. Taylor
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PWT:AGK
28/10/65

HORIZONTAL SCALE 1 CM = 300'
INTERPRETATION : P. W. TAYLOR
VERTICAL SCALES 1 CM = 200'
DATUM 1250'
DATE 30·4·1965

DEPARTMENT OF MINES · SOUTH AUSTRALIA

SEISMIC SURVEY

REFRACTION
GREAT ARTESIAN BASIN
WOOLTANA AREA
TIME DISTANCE CURVES & INTERPRETATION

F 1

L 65-79 Cd.


F 2
CENTIMETRES
INCHES


F 3
CENTIMETRES
INCHES

F 4

CENTIMETRES
0 5 10

LEGEND

Mile Post . . . .
Reflection Shot Point . . . . ∘
Refraction Shot Point . . . . ×
Reflection Spread . . . .
Permanent Marker (2" diam G.I. pipe) . . . . ○
Underlining indicates approximate position only

CENTIMETRES
0 5 10
0 1 2 3 4
INCHES

S.A. DEPT. OF MINES
SEISMIC SURVEY
STRZELECKI - LAKE FROME AREA
SHOT POINT LOCATION PLAN
SHEET 1

SCALE: 10,000 FEET TO 1 INCH
DATE: 11 - 1 - 65

L65 - 2
Cb+d


300000W
200000W
100000W
00000
300000S
400000S
500000S
600000S
PRISM HILL TRIG POINT
F 2
LEGEND
Mile Post
Reflection Shot Point
Refraction Shot Point
Reflection Spread
Permanent Marker (2" diam G.I. pipe)
Underlining indicates approximate position only
CENTIMETRES
0
5
10

LEGEND

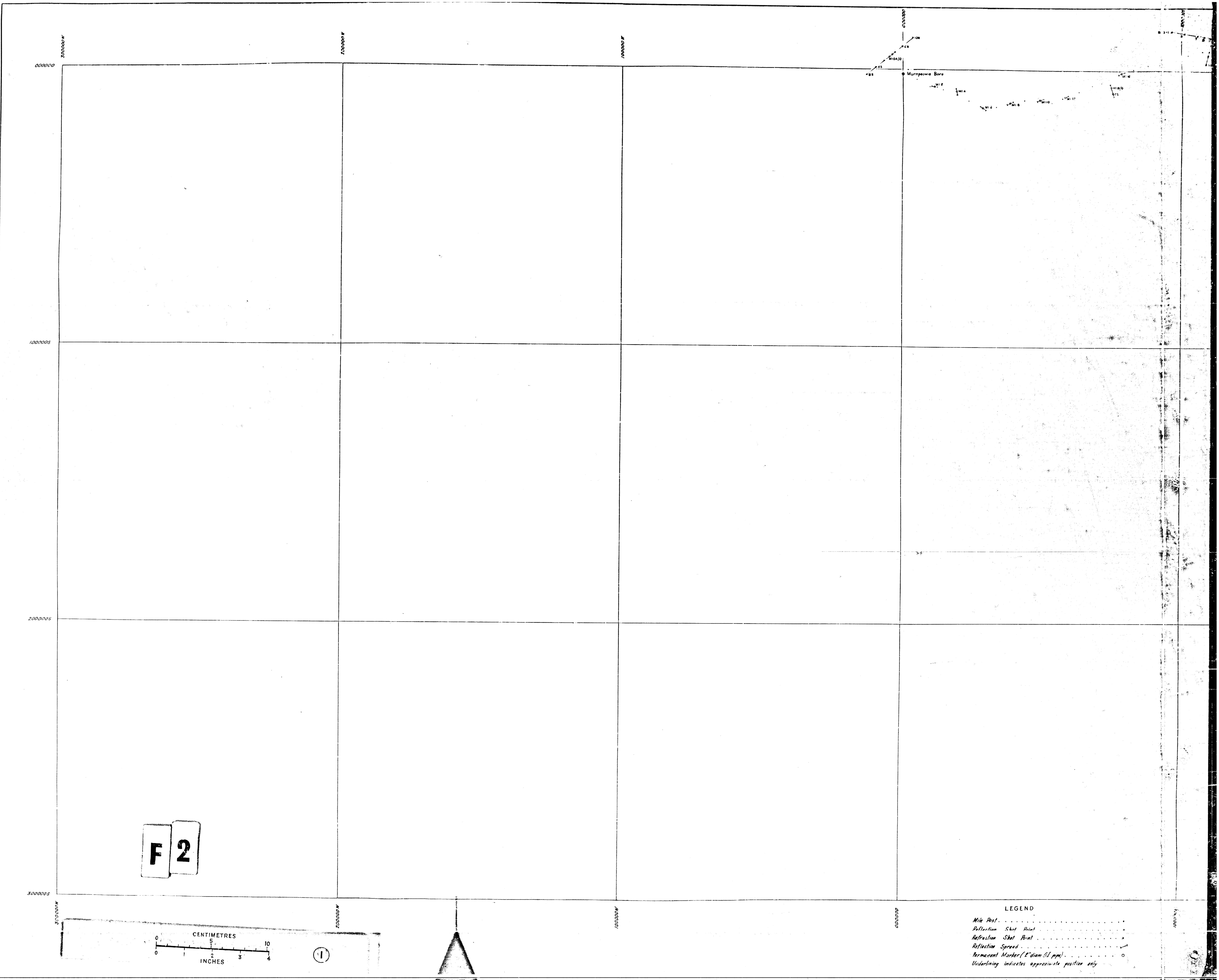
Mile Post . . . . •
Reflection Shot Point . . . . ∘
Refraction Shot Point . . . . ×
Reflection Spread . . . .
Permanent Marker (2" diam G.I. pipe) . . . . ○
Underlining indicates approximate position only

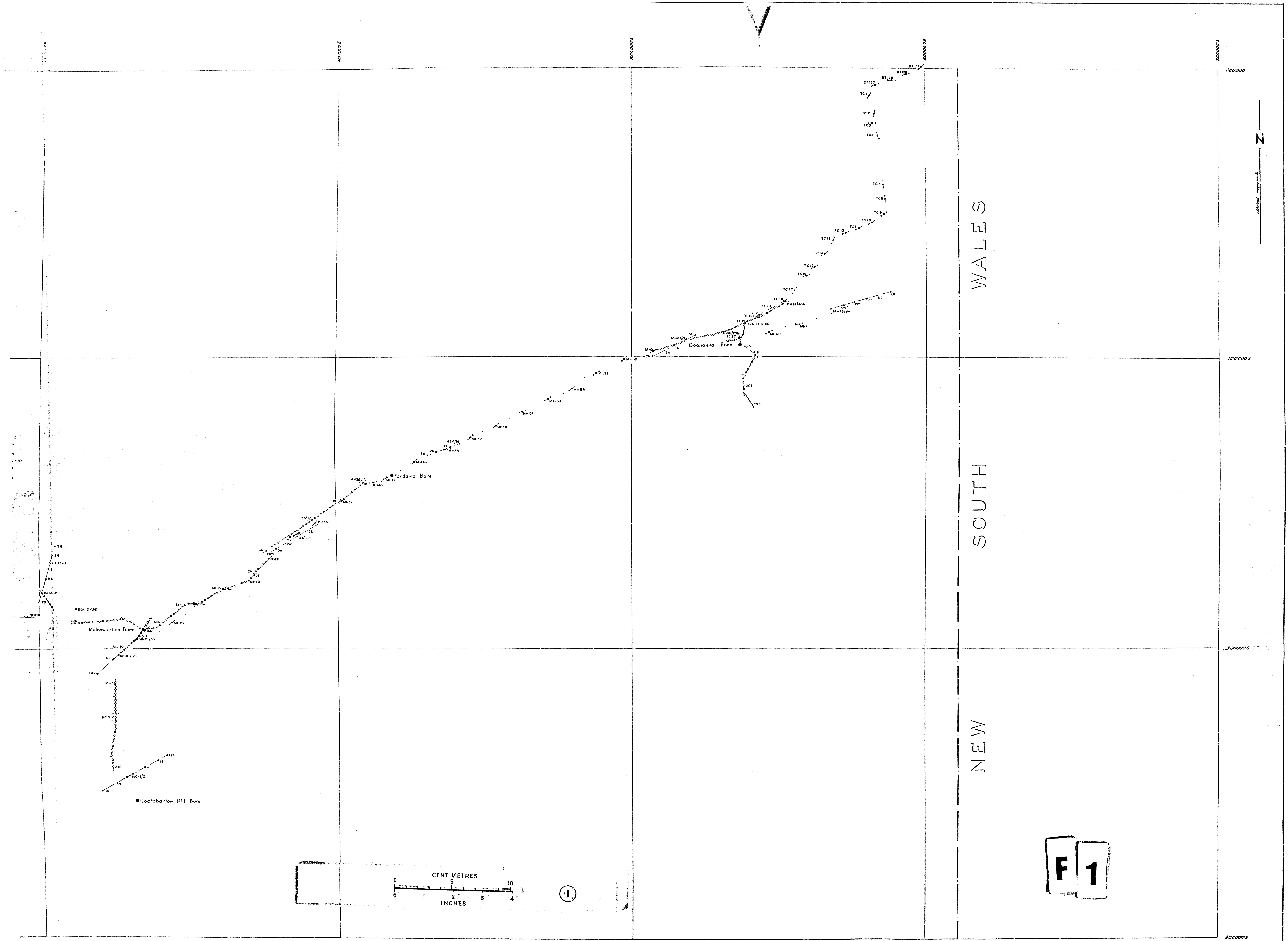
S.A. DEPT. OF MINES
SEISMIC SURVEY
STRZELECKI LAKE FROME AREA
SHOT POINT LOCATION PLAN
SHEET 3

SCALE : 10,000 FEET TO 1 INCH
DATE : 11 - 1 - 65

F 1

L65 – 2a
C b + d


300000W
200000W
100000W
000000
000000
100000S
200000S
300000S
10N
6N
M10A/0
4S
8S
Murnpeowie Bore
M12
M14
M16
M18
M110
M112
M116
F2
CENTIMETRES
0
5
10
0
1
2
3
4
INCHES
1
LEGEND
Mile Post
Reflection Shot Point
Refraction Shot Point
Reflection Spread
Permanent Marker (2" diam G.I. pipe)
Underlining indicates approximate position only



LEGEND

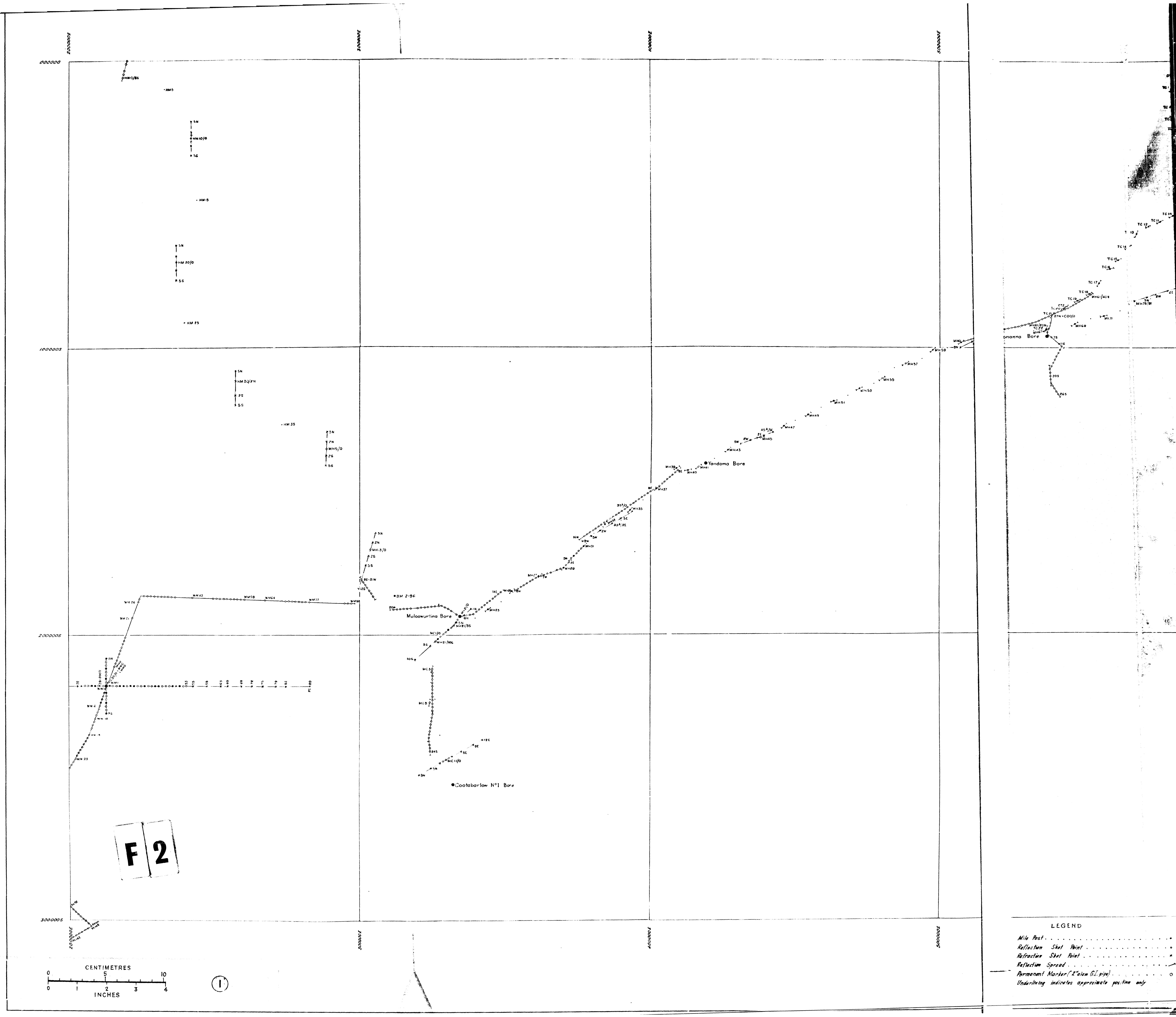
Mile Post	•
Reflection Shot Point	•
Refraction Shot Point	▪
Reflection Spread	⟋
Permanent Marker (2" diam G.I. pipe)	○

Underlining indicates approximate position only

S.A. DEPT OF MINES
SEISMIC SURVEY
STRZELECKI - LAKE FROME AREA
SHOT POINT LOCATION PLAN
SHEET 4

SCALE : 10000 FEET TO 1 INCH
DATE : 11 - 1 - 65

L65 - 2b



200000E
300000E
400000E
500000E
000000
1000000S
2000000S
3000000S
Yandama Bore
Muloowurtina Bore
Cootabarlow N°1 Bore
BM 2-9E
F2
LEGEND
Mile Post
Reflection Shot Point
Refraction Shot Point
Reflection Spread
Permanent Marker (2" diam G.I. pipe)
Underlining indicates approximate position only
CENTIMETRES
0
5
10
INCHES
1
2
3
4

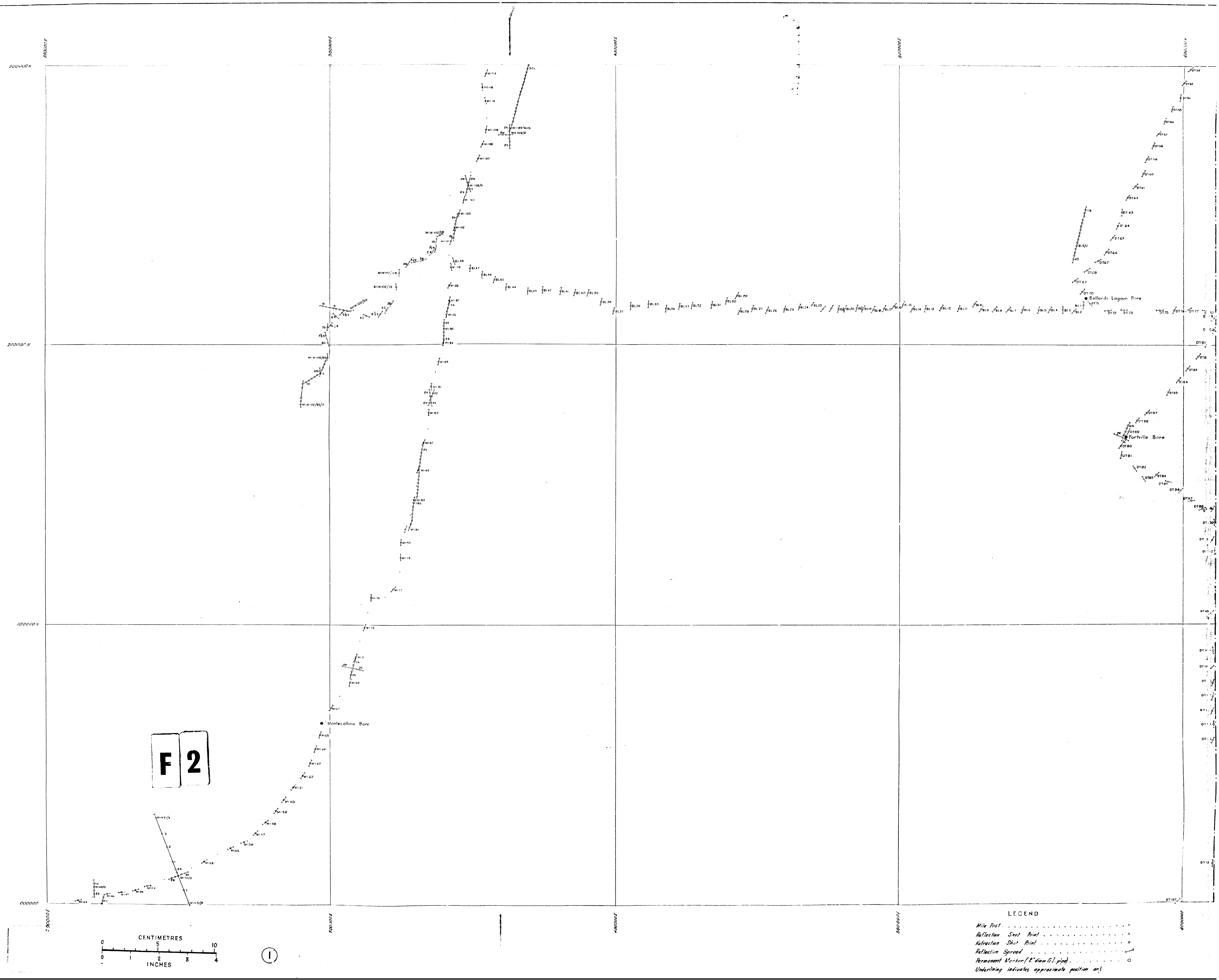
LEGEND

Mile Post . . . .
Reflection Shot Point . . . .
Refraction Shot Point x
Reflection Spread . . . .
Permanent Marker (2" diam G.I. pipe) . . . . o
Underlining indicates approximate position only

S.A. DEPT. OF MINES
SEISMIC SURVEY
STRZELECKI - LAKE FROME AREA
SHOT POINT LOCATION PLAN
SHEET 6

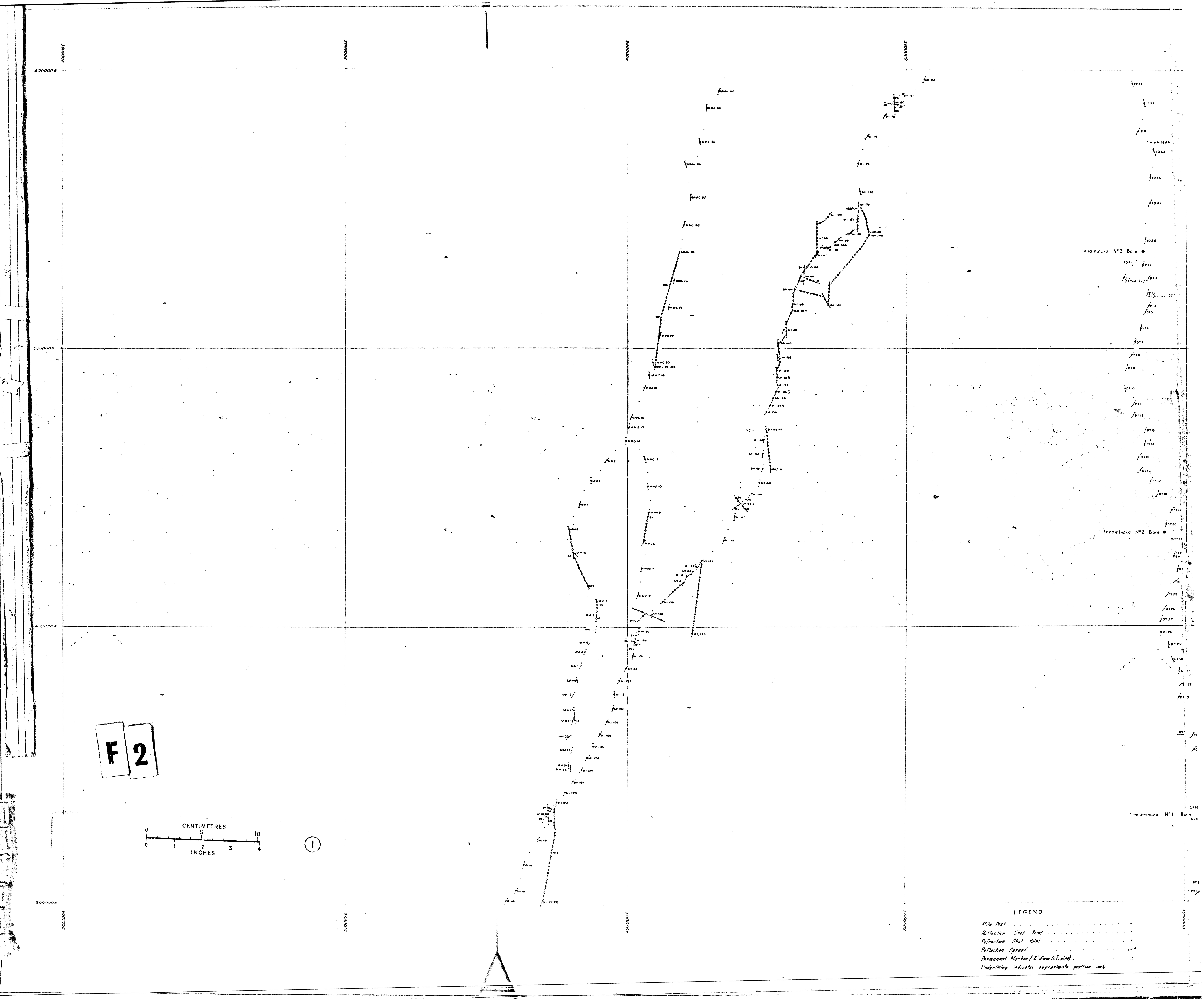
SCALE: 10,000 FEET TO 1 INCH
DATE: 11 - 1 - 65

L65 - 2c
Cb + d

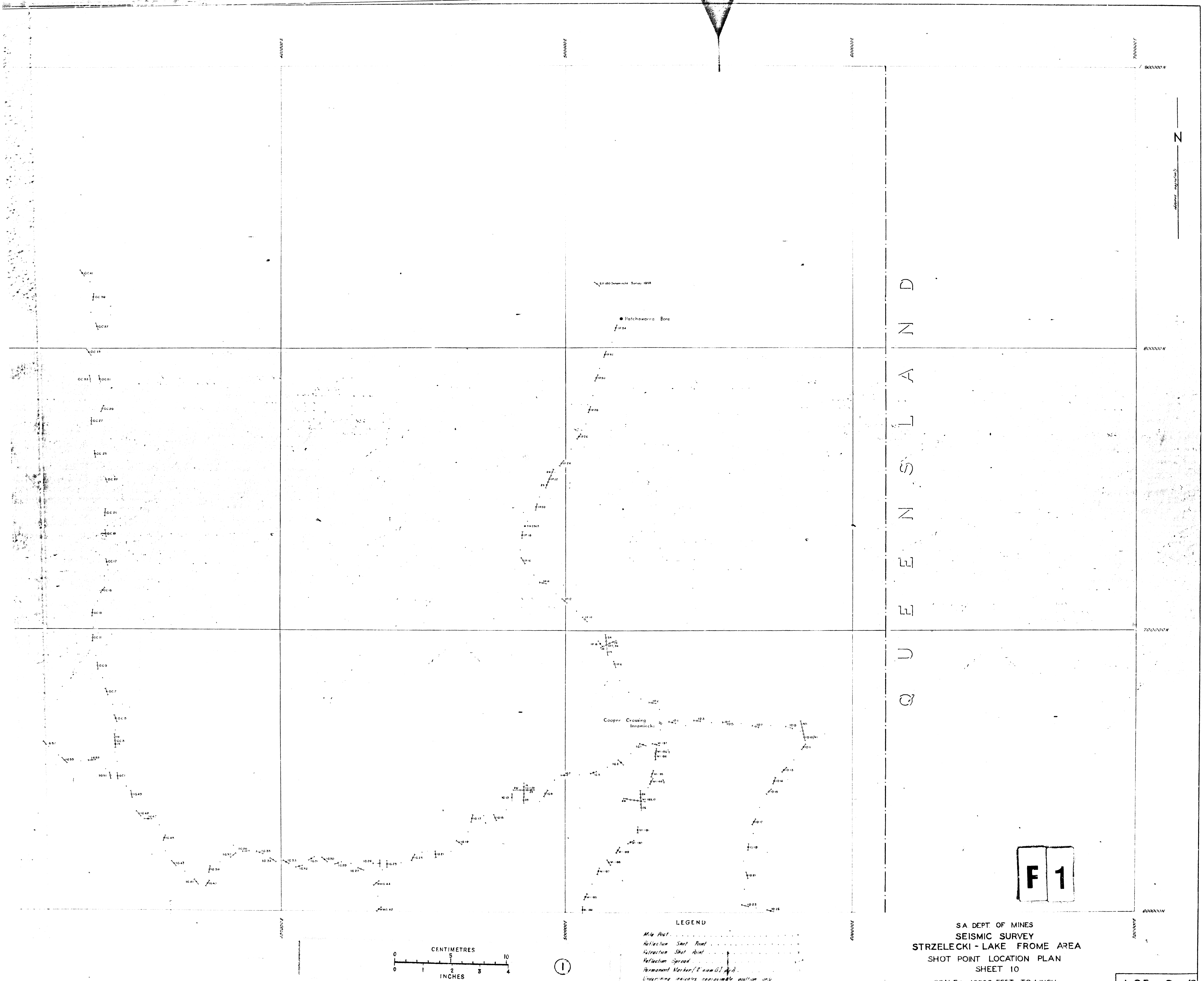


300000 N
200000 N
100000 N
000000
200000 E
300000 E
400000 E
500000 E
600000 E
Montecollina Bore
Bollards Lagoon Bore
Fortville Bore
F 2
CENTIMETRES
0 5 10
0 1 2 3 4
INCHES
1
LEGEND
Mile Post
Reflection Shot Point
Refraction Shot Point
Reflection Spread
Permanent Marker (2" diam G.I. pipe)
Underlining indicates approximate position only


QUEENSLAND
Innamincka N°3 Bore
Innamincka N°2 Bore
Innamincka N°1 Bore
CENTIMETRES
0 5 10
INCHES
0 1 2 3 4
F 1
LEGEND
Mile Post
Reflection Shot Point
Refraction Shot Point
Reflection Spread
Permanent Marker (2" diam G.I. pipe)
Underlining indicates approximate position only
S.A. DEPT. OF MINES
SEISMIC SURVEY
STRZELECKI - LAKE FROME AREA
SHOT POINT LOCATION PLAN
SHEET 8
SCALE: 10,000 FEET TO 1 INCH
DATE: 11 - 1 - 65
L65 - 2d/6



Innamincka N°3 Bore
Innamincka N°2 Bore
Innamincka N°1 Bore
F 2
CENTIMETRES
0 5 10
0 1 2 3 4
INCHES
1
LEGEND
Mile Post
Reflection Shot Point
Refraction Shot Point
Reflection Spread
Permanent Marker (2" diam G.I. pipe)
Underlining indicates approximate position only



LEGEND

Mile Post

Reflection Shot Point

Refraction Shot Point

Reflection Spread

Permanent Marker (2" diam G.I. pipe)

Underlining indicates approximate position only

S.A. DEPT. OF MINES

SEISMIC SURVEY

STRZELECKI - LAKE FROME AREA

SHOT POINT LOCATION PLAN

SHEET 10

SCALE : 10,000 FEET TO 1 INCH

DATE : 11 - 1 - 65

L65 - 2e/6


QUEENSLAND
Patchawarra Bore
Cooper Crossing
Innamincka
F2
CENTIMETRES
INCHES
LEGEND
Mile Post
Reflection Shot Point
Refraction Shot Point
Reflection Spread
Permanent Marker (2" diam G.I. pipe)
Underlining indicates approximate position only
S.A. DE
SEISM
STRZELECKI -
SHOT POINT
SCALE: 100
DATE: 11 -