Rept. Bk. No. 57/81
G.S. No. 2735
D.M. 1474/62

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

EXPLORATION GEOPHYSICS SECTION

FIRST REPORT

ON

RESISTIVITY TESTS

IN THE

POLDA BASIN

by

J. McG. Hall
Geophysicist

20th November, 1963

D.M. ~~1474/62~~ 2087/63

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Rept. Bk. No. 57/81
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FIRST REPORT

ON

RESISTIVITY TESTS

IN THE

POLDA BASIN

ABSTRACT

A series of resistivity tests has been carried out in the Polda Basin in an attempt to determine whether it will be possible to map the sub-surface aquifer by resistivity methods.

Results indicate that this should be possible using logged bore-holes for correlation and control of resistivity characteristics.

It is recommended that a more extensive survey be made with a view to mapping the sub-surface water structure.

1. INTRODUCTION

In the last ten days of August, preliminary resistivity tests were carried out in the Polda Basin, Eyre Peninsula by J.C. Benlow and J. McG. Hall. Although the first results were inconclusive, it was felt that the difficulties causing the poor results could be overcome.

Probably the greatest difficulty at the time of these first tests was the excessive amount of surface water in the area due to recent heavy rains. This certainly caused fluctuations in the resistivity readings which were not indicative of normal sub-surface conditions. Also, it is likely that the level of the water table was different at this time from that found when the bores were drilled, also because of the heavy rains. A third problem was the low power of the instrument used which became very unreliable at the low resistivities encountered in the clay.

A second series of tests was carried out in the last ten days of September, by J. McG. Hall, B.J. Taylor, and J.C. Benlow, using more powerful equipment. In the intervening month the country had dried out considerably and the level of water in the bores had retreated almost to the level at the time of drilling. These second tests were considerably more encouraging.

2. METHODS USED

Initially, readings were taken at bores number 33, 12, 34, 35, 36, 20, 11, 9, 10, 8 in that order (see fig. I). At each bore-hole, a measured current was passed into the ground via two brass electrodes and the resulting potential measured between another two brass electrodes, all four electrodes being collinear. This was done for electrode spacings of 3, 6, 9, 12, 15, 20, 25,--------, 45, 50, and in some cases, 60, 70, -----, 100, feet. The current and potential electrodes were arranged in three different patterns as shown in fig. II, and three curves of apparent resistivity, ρ_a , against electrode separation, s, were plotted for each bore-hole. To improve the ground contact of the electrodes, the earth at the base of each was soaked with salt water.

On completion of this programme, traverses were run between bores 33 and 12, 12 and 34, 9 and 12, with stations at 500 feet intervals between the bores, the distances measured by pacing. At each station three sets of readings were taken with the electrode spacings increasing as above out to 60 feet. This method, known as the tri-potential method, is described in Geophysics XXI, no. 2, page 455, 1956.

The surface topography shown on fig. X is very approximate only as the elevations of the stations between the bore-holes were estimated by eye.

3. RESULTS AND INTERPRETATION

The apparent resistivity, ρ_a, for each electrode spacing was obtained from the following formulae:

Wenner configuration:

$$\rho_a = \frac{V}{I} \cdot \frac{2\pi S}{3.281} \quad \text{ohm-metres}$$

Dipole-Dipole configuration:

$$\rho_a = \frac{V}{I} \cdot \frac{6\pi S}{3.281} \quad \text{ohm-metres.}$$

Interposed configuration:

$$\rho_a = \frac{V}{I} \cdot \frac{3\pi S}{3.281} \quad \text{ohm-metres}$$

V is measured potential between electrodes P_1 and P_2.

I is measured current passed into the ground through electrodes C_1 and C_2.

s is the electrode spacing in feet.

$\frac{1}{3.281}$ is a factor converting feet to metres.

The above formulae are obtained from the general resistivity formula:

$$\rho_a = 2\pi \cdot \frac{V}{I} \cdot G$$

where G, the configuration factor, is given by:

$$G = \left(\frac{1}{X_{11}} + \frac{1}{X_{22}} - \frac{1}{X_{12}} - \frac{1}{X_{21}} \right)^{-1}$$

where X_{11} is the distance between C_1 and P_1,
X_{12} " " " " C_1 and P_2,
X_{21} " " " " C_2 and P_1,
X_{22} " " " " C_2 and P_2, (see fig. II)

The values of apparent resistivity obtained were plotted against electrode spacing as in fig. III.

In addition, in the case of the traverses 33 to 12, 12 to 34, and 9 to 12, the resistivities were plotted in line as in figs. IV, V, and VI, and characteristics of the curves correlated along the traverses. The correlations are shown in figs. VII, VIII, and IX.

It is apparent from the curves in fig. III that there is no simple relationship between the apparent resistivity and the sub-surface structure as shown by the bore logs. In several cases there are anomalous features of the curves corresponding approximately to sub-surface horizons in the bore logs, but these features are not consistent over all, or even a majority, of the bore-holes, and no reliable predictions can be made from them.

However, it is possible to correlate features of the traverse curves 33 to 12, 12 to 34, and 9 to 12 from the bore-hole at one end to that at the other. This correlation of geophysical information should be accurate to within about 2 feet to an electrode separation of 15 feet, but to within about 3 feet only beyond this as the electrode separation then increases in increments of 5 feet. The depth of the clay horizon, traced through by these general correlations, agrees well with its logged depth at the other end of each traverse except in the case of 9 to 12. It is possible to trace the upper surface of the water by this method also, although with even less surety than the clay horizon, and not at all for the traverse 9 to 12. (see fig. X).

4. CONCLUSIONS AND RECOMMENDATIONS

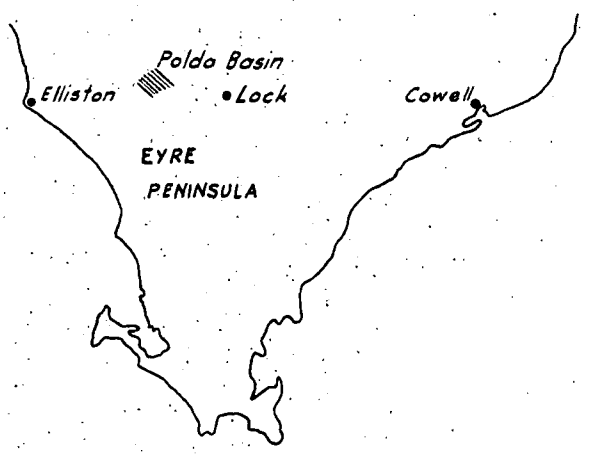
The above results indicate that there is a good possibility that resistivity will furnish a complementary method to drilling in the mapping of the Polda Basin aquifer. It must be understood, however, that at the present stage of development it cannot replace drilling to any great extent. However, it can aid in the better siting of drill holes. In addition, the accuracy of the method will be unknown until test bores are drilled along traverses 33 to 34 and 9 to 12, preferably at intervals of 1000 feet.

A reconnaissance survey using depth probes at 500 feet intervals can be run along traverses from bore to bore. The area under investigation will be gradually covered with a triangulation system, utilizing the boring density of one drill-hole to a mile to the fullest advantage. See Fig. XI. This triangular coverage should provide enough values to construct a contour generalization of the sub-surface structure. All stations will have to be levelled to reduce the depths to a common datum.

J. McG. Hall

J. McG. HALL
GEOPHYSICIST

JMcGH:AGK
20/11/63



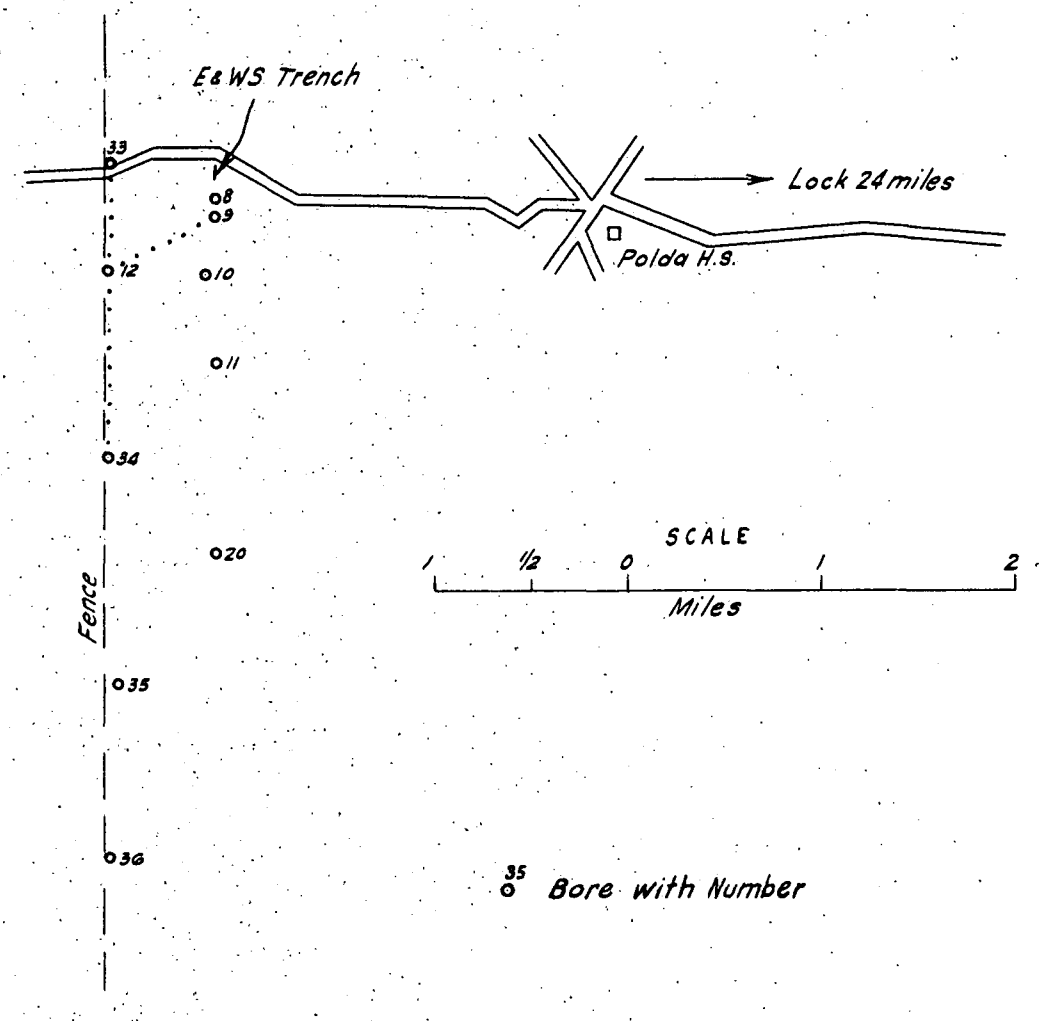


FIG.1

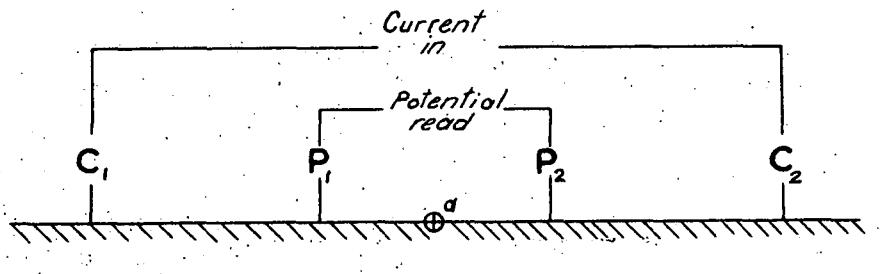
To accompany report by J. Hall

S.A. DEPARTMENT OF MINES

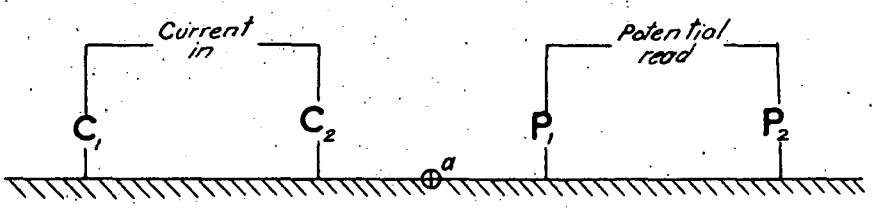
Approved	Passed	Drn.	POLDA BASIN RESISTIVITY TESTS LOCALITY PLAN	D.M.	Scale As shown
		Tcd.		Req.	S3537
		Ckd.			DI 2/4
Director		Exd.			Date 13-11-63

200—7-61 3803

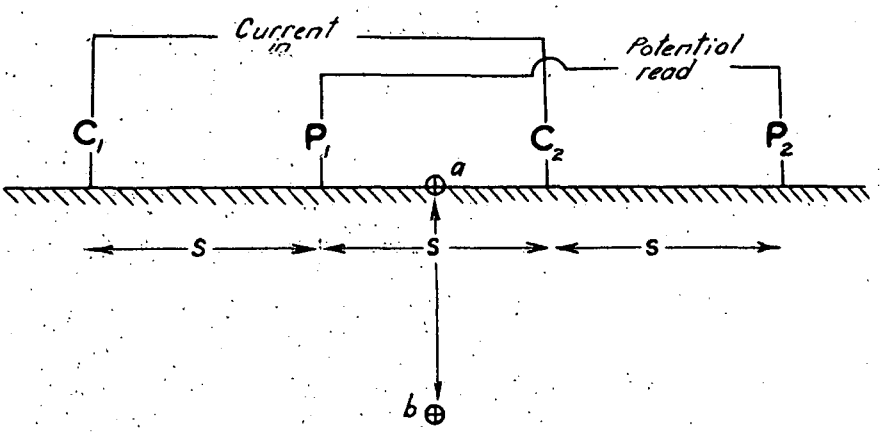
WENNER CONFIGURATION



DIPOLE – DIPOLE CONFIGURATION



INTERPOSED CONFIGURATION



a. = Centre point of exponding spread

b. = Point about which apparent resistivity is plotted

Note : Distance a b = Distance between electrodes.

FIG. 2

To accompany a report by J. Hall.

S.A. DEPARTMENT OF MINES

Approved	Passed	Drn.	POLDA BASIN	D.M.	Scale
		Tcd. B.G.	RESISTIVITY TESTS	Req.	S 3538
		Ckd.			Dl. 2/4
Director		Exd.	ELECTRODE ARRANGEMENTS		Date 13·11·63.

200—2-61 8305

Topsoil

Limestone

Sandstone

Clay

Water

Wenner Configuration

Dipole - Dipole Configuration

Interposed Configuration

Reference to figures on Resistivity Curves, plans 63-990 A-D

10 / 33-12 / 2

Bore Number or Traverse between bores

Station Number

FIG. 3

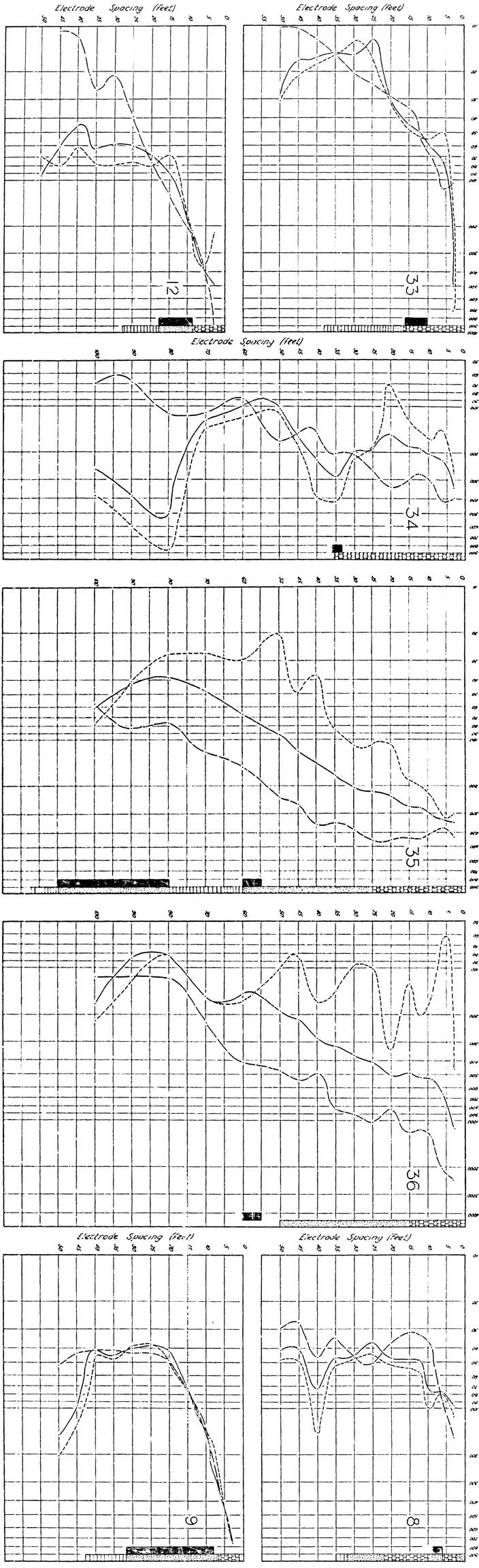
To accompany report by J. Hall

S.A. DEPARTMENT OF MINES

Approved	Passed	Drn.	POLDA BASIN-RESISTIVITY TESTS	D.M.	Scale
		Tcd. F.B	LEGEND FOR DEPTH RESISTIVITY CURVES AND BORE LOGS FIG III	Req.	S 3539 D1 2/4
		Ckd.			
Director		Exd.			Date 13·11·63

200—2-61 3805

9



S. A. DEPT. OF MINES

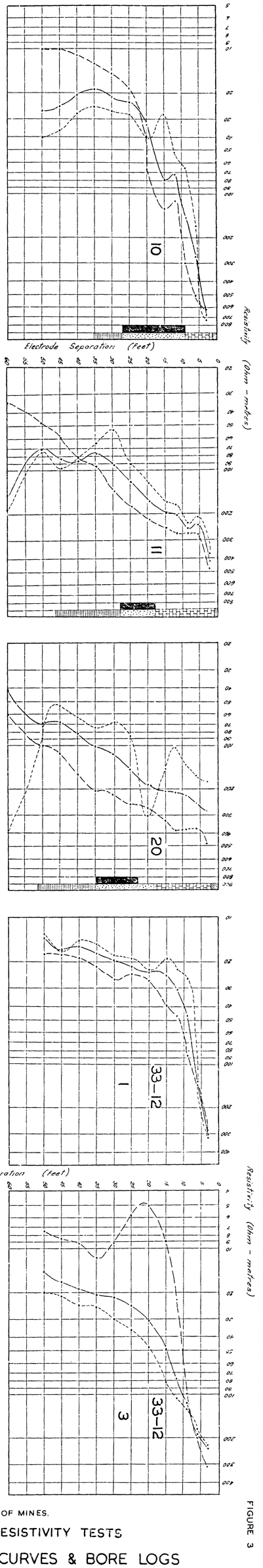
POLDA BASIN – RESISTIVITY TESTS

DEPTH RESISTIVITY CURVES & BORE LOGS

To accompany a report by J. Hall.

FIGURE 3

63-990A



S. A. DEPT. OF MINES.

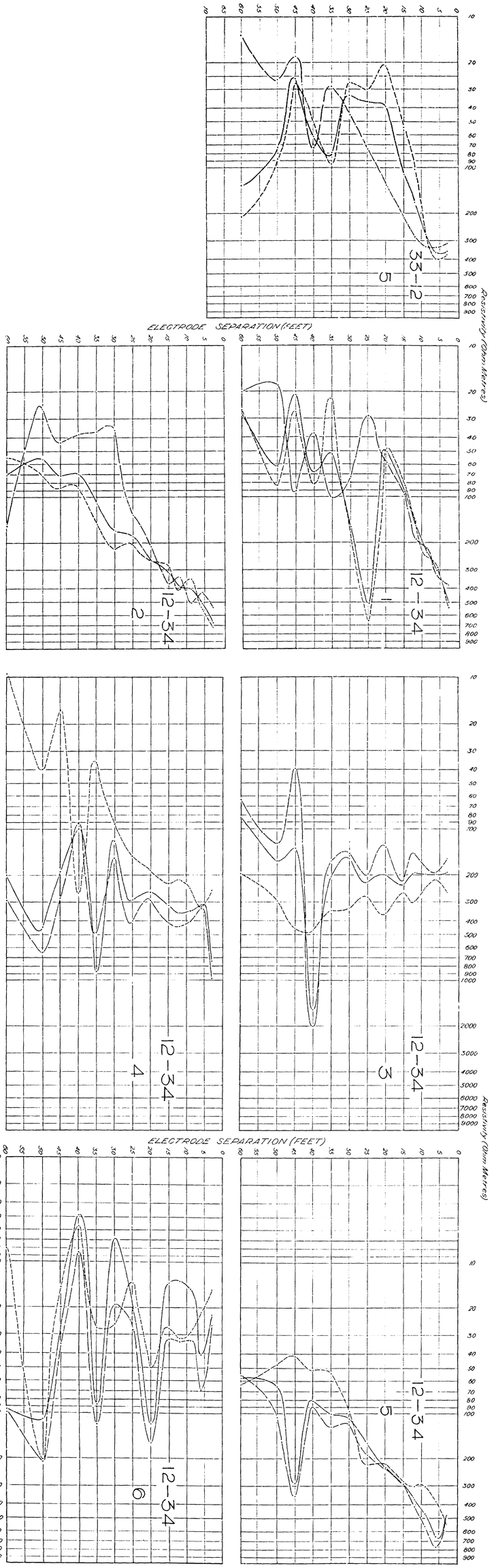
POLDA BASIN – RESISTIVITY TESTS

DEPTH RESISTIVITY CURVES & BORE LOGS

To accompany a report by J. Hall.

FIGURE 3

63-990B



S.A. DEPT OF MINES

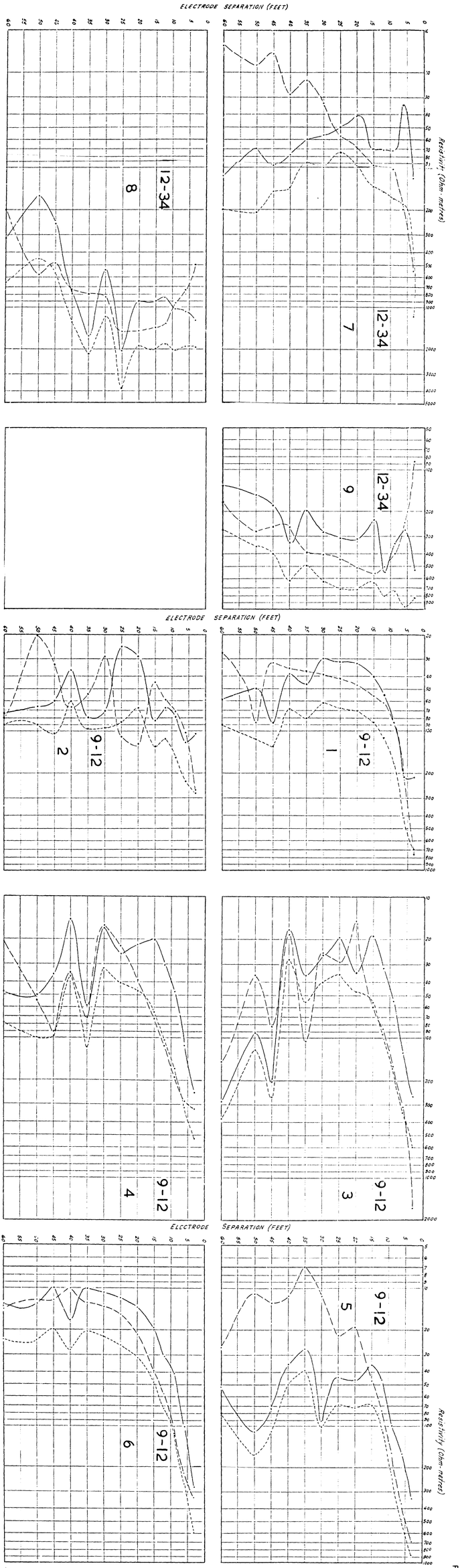
POLDA BASIN – RESISTIVITY TESTS

DEPTH RESISTIVITY CURVES & BORE LOGS

To accompany a report by J. Hall.

FIGURE 3

63-990C
DWN: 27.11.63



S. A. DEPT. OF MINES

POLDA BASIN – RESISTIVITY TESTS

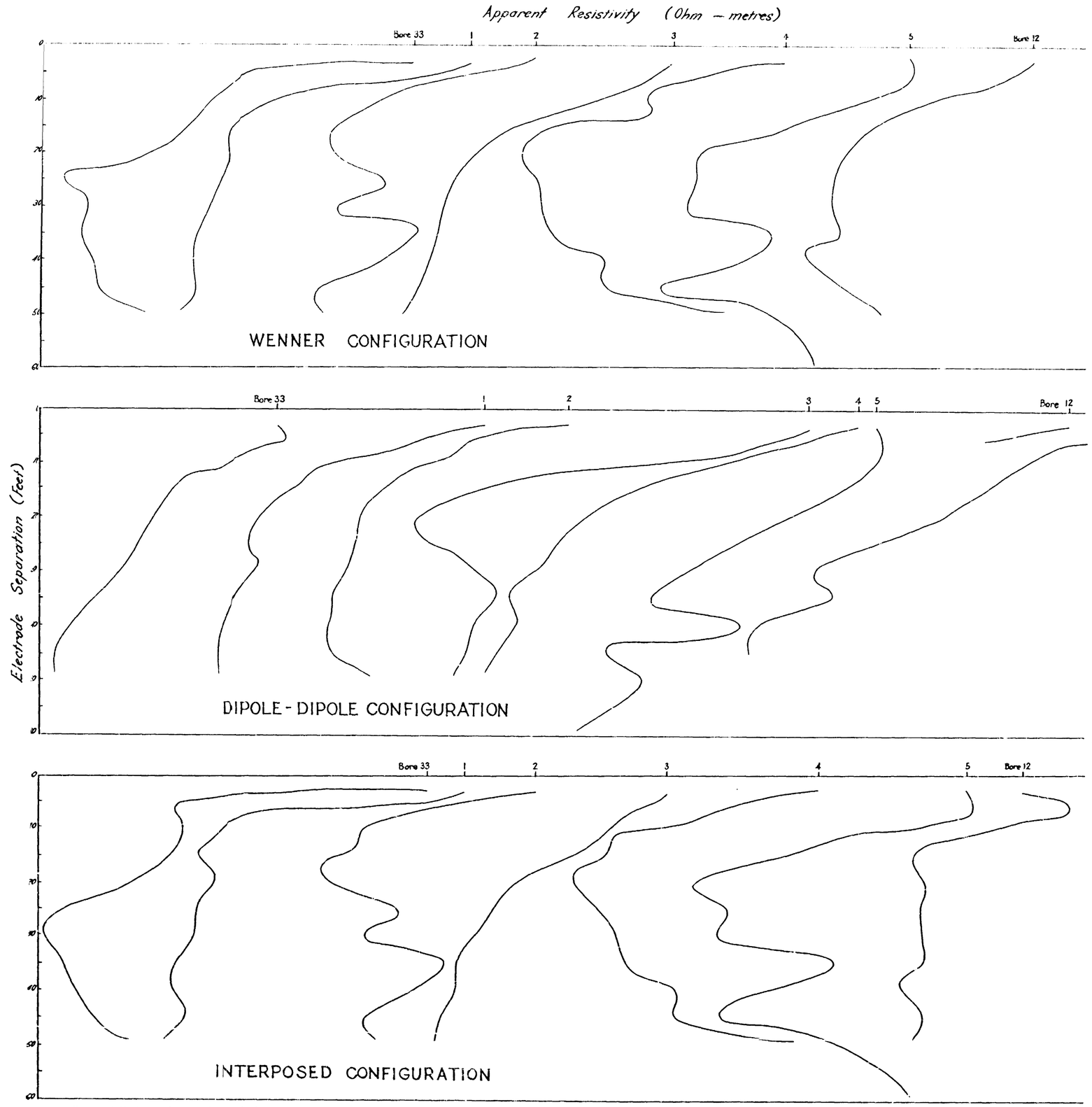
DEPTH RESISTIVITY CURVES & BORE LOGS

To accompany a report by J. Hall.

FIGURE 3

63-990D

Drawn: [illegible]
Date: 27-11-63



For resistivity scale see figure 3 (plans 63-390 A.D)
Position of stations between bore-holes diagrammatic to avoid overlay of curves

For correlation see figure 7

To accompany report by J. Hall

FIGURE 4

S.A. DEPT. OF MINES

Associated Drawing No.	No.	Amendment	Exd.	Date	

Req. No.
D.M.
Compiled from

POLDA BASIN - RESISTIVITY TESTS
RESISTIVITY CURVES
Bore 33 to Bore 12

Approved Passed

Director of Mines

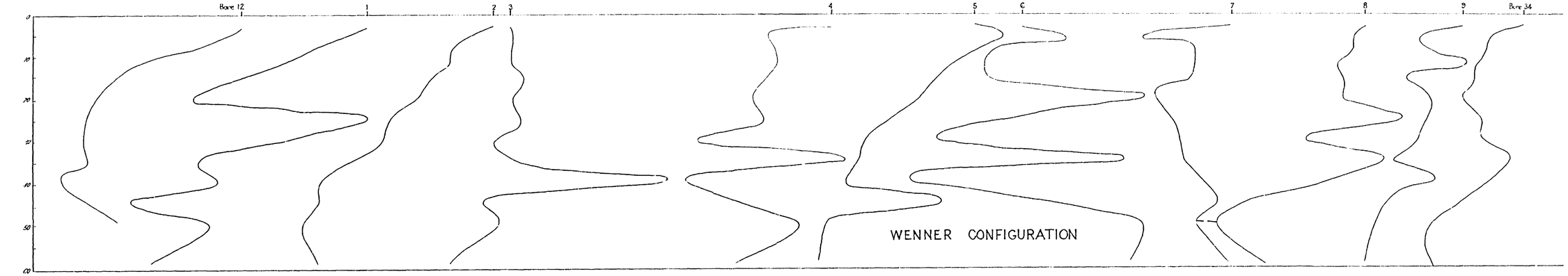
Drn.
Tcd. F.B
Ckd.
Exd.

Scale :

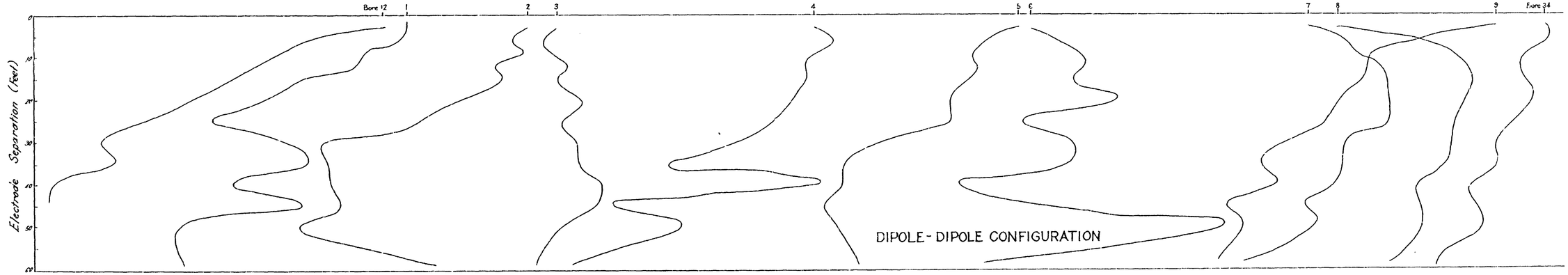
63-991
DI 2/4

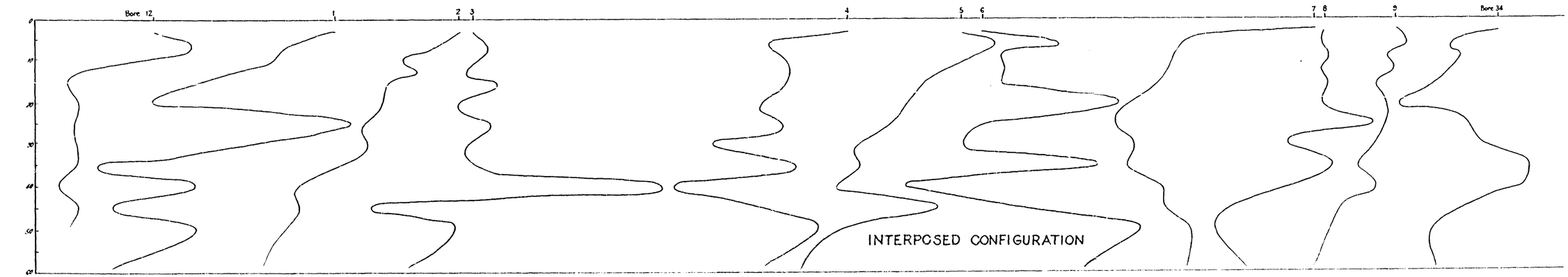
Date 27 · 11 · 63

Apparent Resistivity (Ohm — metres)



Electrode Separation (feet)





For resistivity scale see figure 3 (plans 63-390 A-D)
Position of stations between bore-holes diagrammatic
around overlay of curves

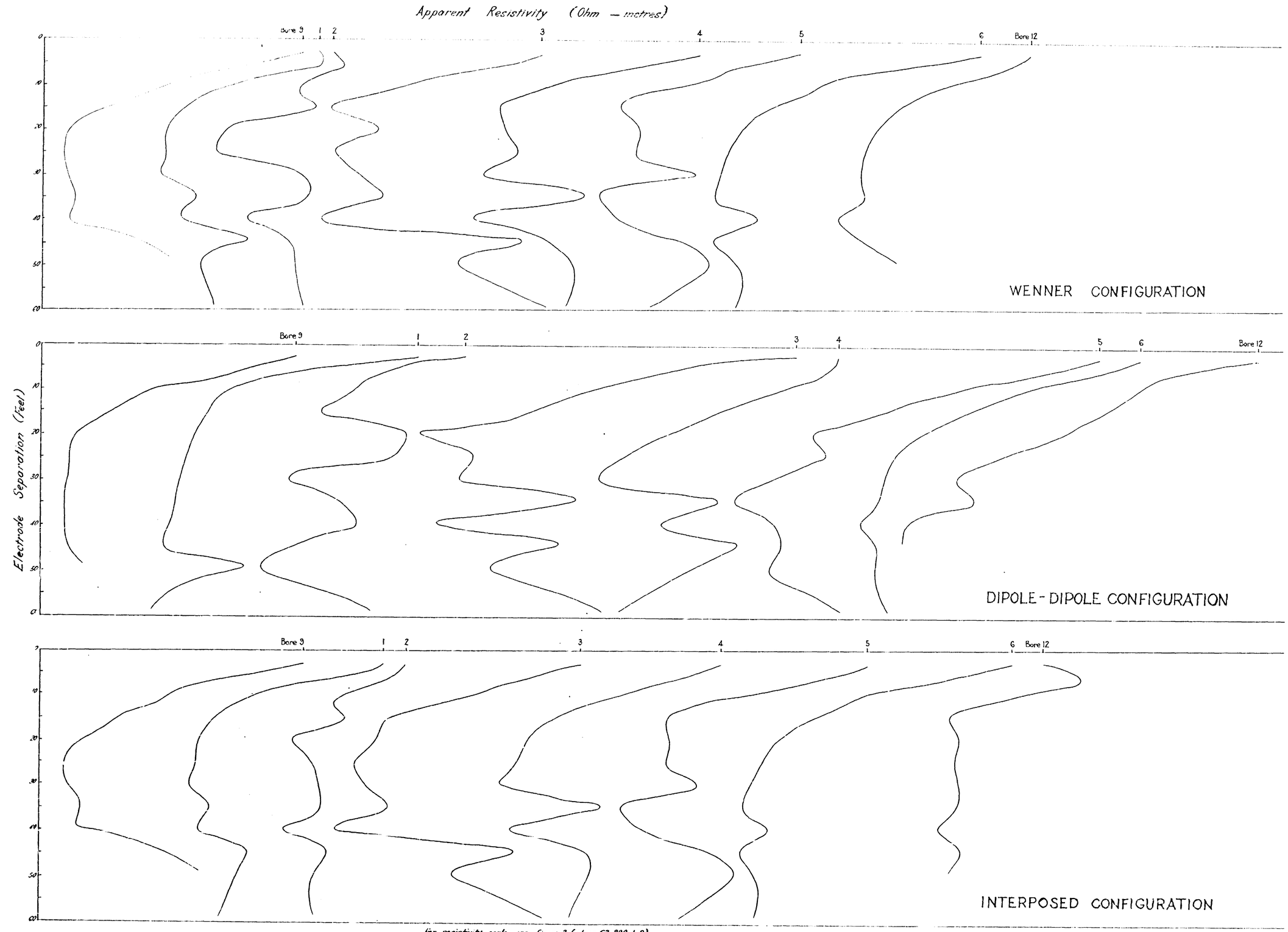
For correlation see figure 8

To accompany report by J. Hall

FIGURE. 5

S.A. DEPT. OF MINES

Associated Drawing No.	No. Amendment Exd. Date	Req. No. D.M. Compiled from	POLDA BASIN RESISTIVITY TESTS RESISTIVITY CURVES Bore 12 to Bore 34	Approved Passed Director of Mines Drn. Tcd. F.B. Ckd. Exd. Scale : 63-992 DI 2/4 Date 27 · 11 · 63



For resistivity scale see figure 3 (plans 63-390 A.D)
Position of stations between bore-holes diagrammatic to avoid overkey of contours

For correlation see figure 9

To accompany report by J. Hall

FIGURE.6

S.A. DEPT. OF MINES

Associated Drawing No.	No. Amendment Exd. Date	Req. No. D.M. Compiled from	POLDA BASIN - RESISTIVITY TESTS RESISTIVITY CURVES Bore 9 to Bore 12	Approved Passed Director of Mines	Drn. Tcd. Ckd. Exd.	Scale : 63-993 DI 2/4 Date 27 - 11 - 63

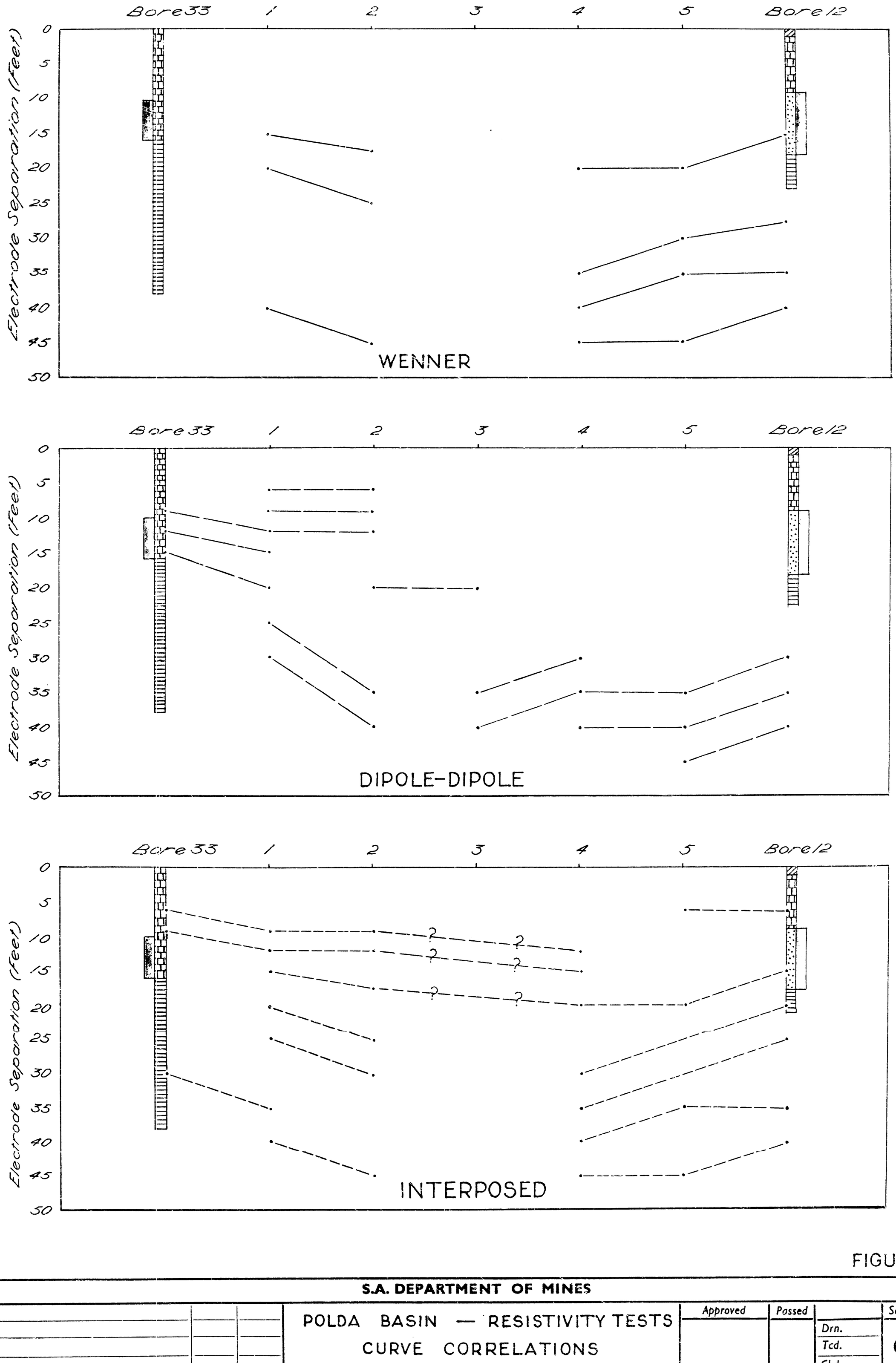


FIGURE 7

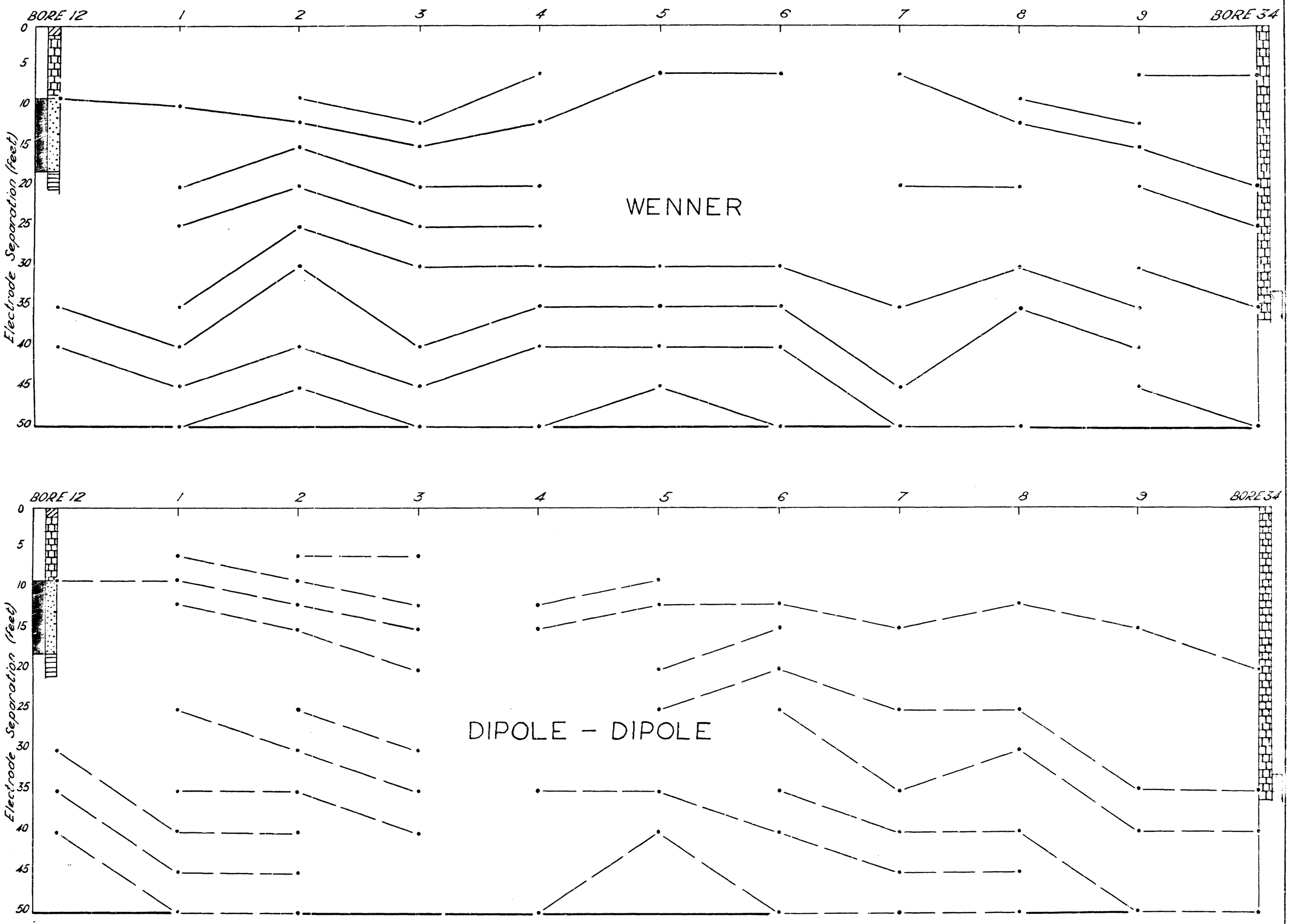
S.A. DEPARTMENT OF MINES

No.	Amendment	Exd.	Date

POLDA BASIN — RESISTIVITY TESTS
CURVE CORRELATIONS
BORES 33–12

Approved	Passed		Scale :
		Drn.	
		Tcd.	63-994
		Ckd.	Dt 2/4
Director		Exd.	Date 27·11·63

200—6.63 1423



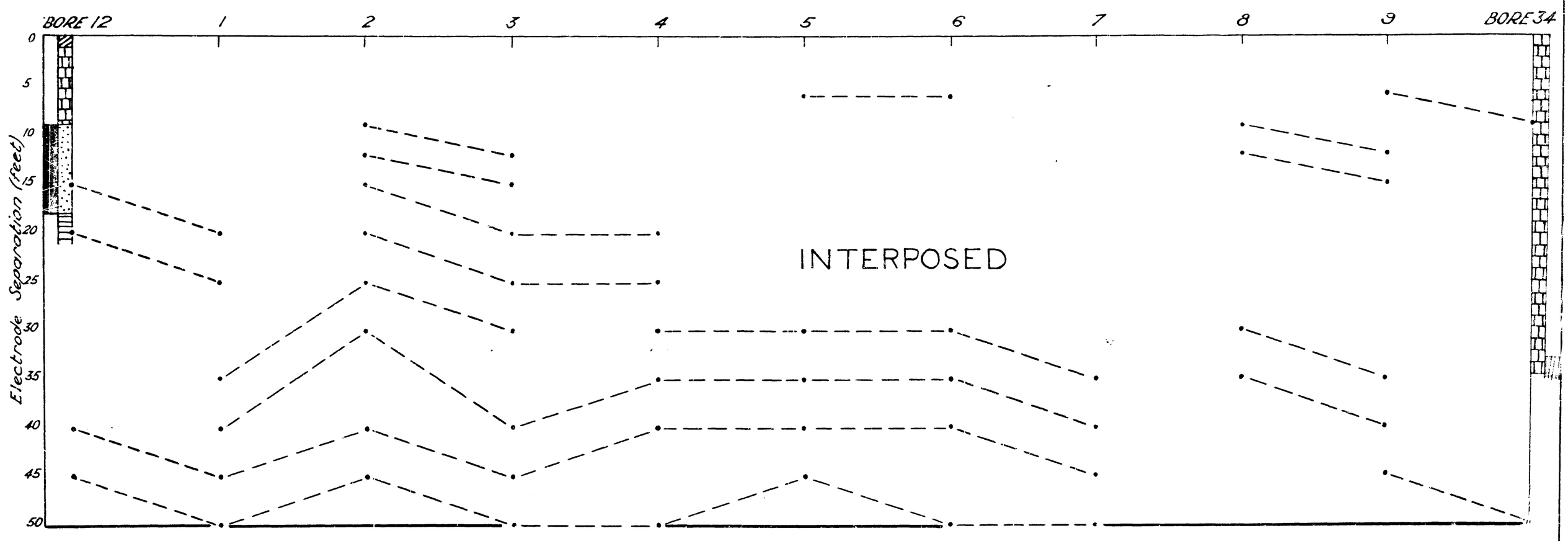


FIGURE 8

S.A. DEPARTMENT OF MINES

No.	Amendment	Exd.	Date

POLDA BASIN – RESISTIVITY TESTS
CURVE CORRELATIONS
BORES 12 to 34

Approved	Passed		Scale :
		Drn.	63-995
		Tcd.	Dl2/4
		Ckd.	
Director		Exd.	Date 27·11·63

200—6.63 1423

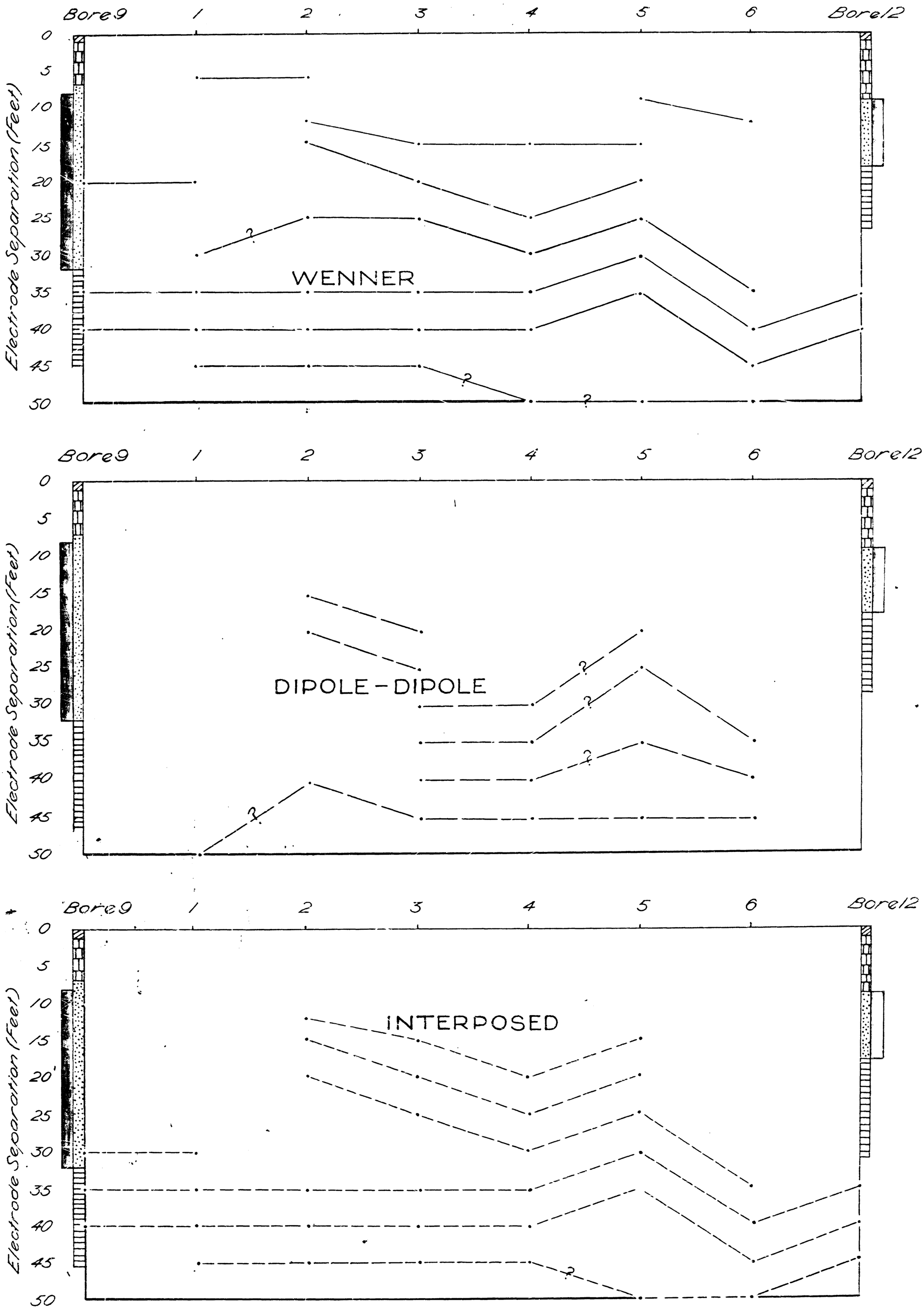


FIGURE 9

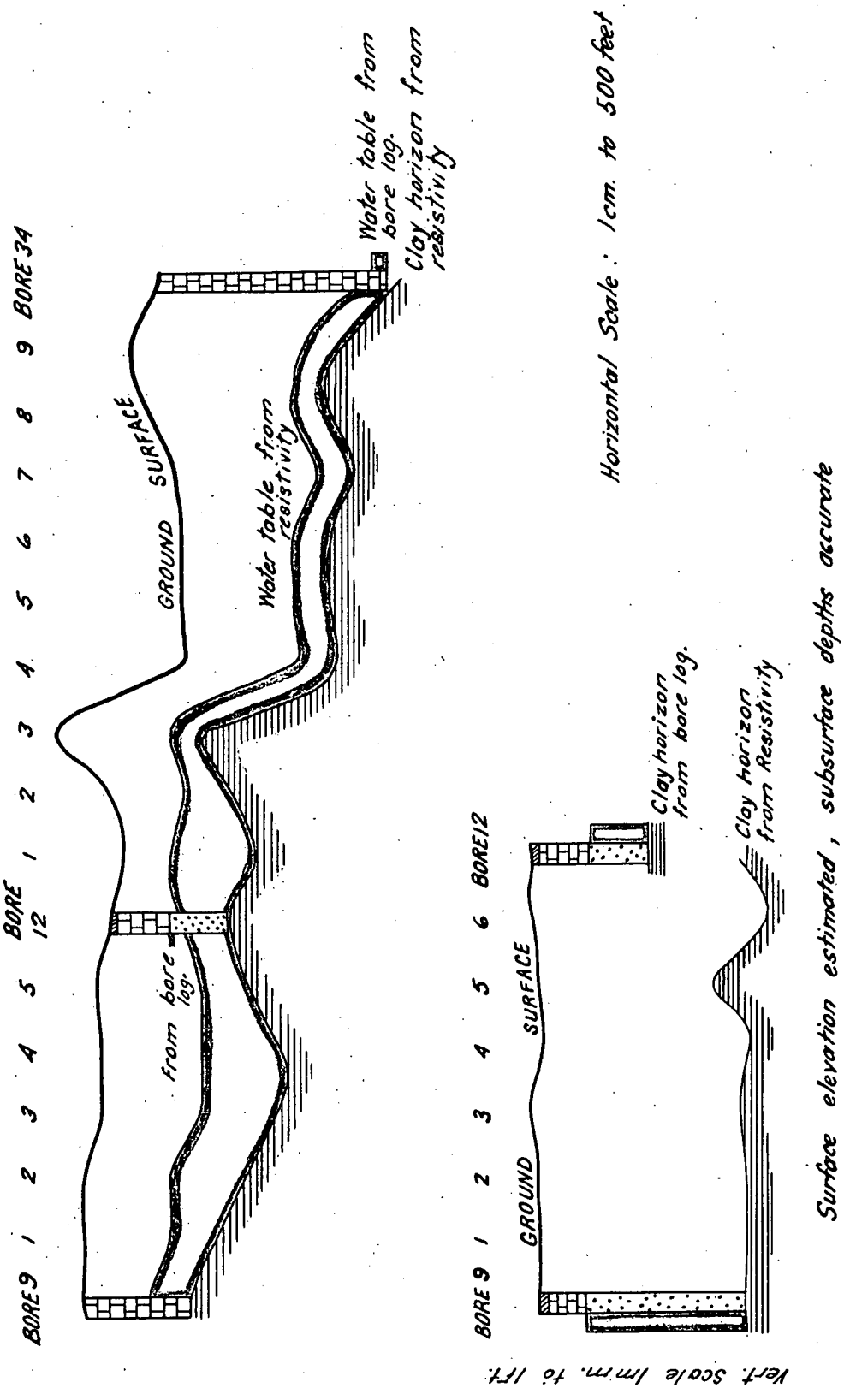
S.A. DEPARTMENT OF MINES

No.	Amendment	Exd.	Date

POLDA BASIN – RESISTIVITY TESTS
CURVE CORRELATIONS
BORES 9–12

Approved	Passed		Scale :
		Drn.	63-996
		Tcd. G M.	D12/4
		Ckd.	
Director		Exd.	Date 27·11·63

200—6.63 1423



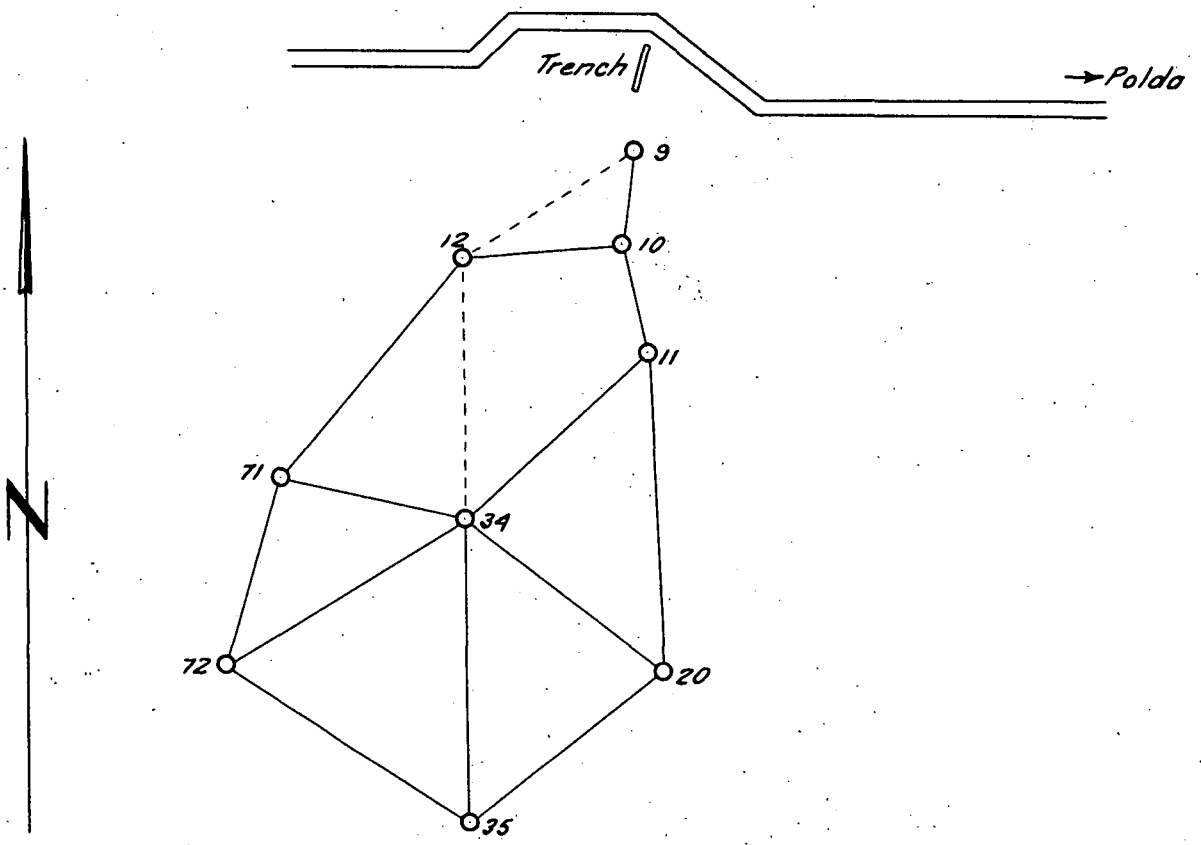
To accompany a report by J. Hall.

FIG. 10

S.A. DEPARTMENT OF MINES

Approved	Passed	Drn.	POLDA BASIN RESISTIVITY TESTS SURFACE AND SUB-SURFACE PROFILES	D.M.	Scale
		Tcd. B.G.		Req.	S3549
		Ckd.			DI 2/4
Director		Exd.			Date 21-11-63.

200—9·61 8805



NOTES.

a) Lines drawn with solid line to be pegged at 500' horizontal intervals. Pegs to be marked with traverse no. and peg no. Thus, a traverse running from bore 11 to bore 20 should be marked on each peg as 11-20, with the appropriate peg serial no. (1, 2, 3 etc.)

b) All pegs to be levelled, and tied in with bore elevations.

c) Geophysical readings have been taken along the traverses marked with dotted lines. J. Hall will place pegs at these observation points. They can be levelled later.

d) When traversing, the last peg on a traverse should not be greater than 600' from the bore of destination. Record should be kept of the actual chainage between bores.

SCALE

Miles 1 1/4 1/2 3/4 0 1 Miles

To accompany a report by J. Hall.

FIG. 11

S.A. DEPARTMENT OF MINES

Approved	Passed	Drn.	POLDA BASIN	D.M.	Scale 60 Chns. to 1".
		Tcd. B.G.	RESISTIVITY TESTS	Req.	S3550
		Ckd.	PROPOSED		D1 2/4
Director		Exd.	GEOPHYSICAL TRAVERSES		Date 20-11-63.