COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1963/44

WEST MORETON COALFIELD, EXPERIMENTAL BORE LOGGING
QUEENSLAND 1953

by

W.A. Wiebenga, S. Gunson and F. Jewell

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SUMMARY

Electric logs of three bores in the North Ipswich area of the West Moreton coalfield indicate that the coal seams penetrated have some shale content and are also permeable.

The logs can be correlated by reference to the lithologic logs of the bores. However, as the resistance of the coal seams is no higher than that of the conglomerate encountered, electric logging could not entirely replace mechanical coring.

1. INTRODUCTION

During November 1953, the Bureau of Mineral Resources logged Australian Associated Oilfields NL Well No. 3 in Roma. The Queensland Mines Department State Mining Engineer, who watched the operations, was favourably impressed with the possibilities of electric logging and suggested experimental logging of a number of bores in the West Moreton coalfield, 20 miles west of Brisbane, where the State Mines Department was carrying out a drilling programme to prove the coal reserves of the field. As a result of the State Mining Engineer's suggestions, three bores were logged before the Bureau party returned to Melbourne. W.A. Wiebenga and S. Gunson did the logging using a Widco single-electrode logger.

The purposes of the experiment were:

(a) to observe whether electrical logging could provide an additional tool in correlating the geological cross-sections of bores,

(b) to observe whether the presence of coal seams and possibly their quality could be deduced from electrical logs.

If successful, electrical logging could be economically used in open-hole drilling or in checking those parts of the holes from which no information was obtained owing to core losses.

For a discussion of the theory of electrical logging and a description of the equipment, the reader is referred to Wiebenga and Gunson (1956).

2. GEOLOGY

The Ipswich Coal Measures, which are of Triassic age, underlie the basal conglomerate of the Triassic Bundamba Group. In the Ipswich district the strata are folded into two anticlines trending roughly south, separated by the Booval syncline. The anticlines have been eroded revealing two areas of outcropping coal seams.

The seams cropping out in the North Ipswich area are lower stratigraphically than those in the Bundamba area to the east. In the Bundamba area the Aberdare Seam, which is the top seam of the coal measures, is exposed, but in the North Ipswich area the top seam exposed is the Garden Seam. Numerous faults, trending for the most part north-west, affect the coal measures, so that many seams are partly sunk in fault troughs. Dips are generally south-easterly, except near faults. Facies changes are common and some of the seams tend to split.

Tertiary sediments have been deposited in hollows erodedin the coal measures; near the Bremer River the beds are hidden by alluvium.

The succession of coal seams in the North Ipswich area, where the three bores were drilled, is given by Allen, Staines, and Wilson (1960):

Garden Seam

Tantivy Seam

Fiery Seam

Waterstown Seam

Tivoli Seam

The Tivoli Formation, in the upper part of which the seams are found, underlies the Cooneana Formation, a succession of massive sandstones with thick lenses of shale. The shales of the Cooneana Formation include a few coal seams.

3. INTERPRETATION OF LOGS

Resistance logs.

The single-electrode resistance curve gives a measure of the resistivity of the formations. However, it should be pointed out that:

(a) the resistance scale is compressed in the higher range. Thus the higher resistivities may be much larger than would appear from the resistance log,

(b) the resistance of thin beds, being affected by the formations above and below, may not be recorded accurately on the log.

The resistivity of a formation depends on the fractional pore space (porosity) of the rock, the salinity of the pore solution, and the degree of saturation of the pores. Most rocks below the water table are fully saturated. As a general rule, the resistivity in cemented rocks is approximately inversely proportional to the square of the porosity. If the pore solutions are only moderately saline, this means:

(a) fractured or porous beds have a resistance lower than that of tight formations but higher than that of clays and shales, which are very porous and usually contain highly saline water.

As the porosity or degree of fracturing increases, the resistance diminishes,

(b) the resistance of a porous bed is diminished by interbedded shale or interstitial clay.

Self-potential Logs

It is customary to adopt the self-potential curve along the shale intersections as the zero reference line. The explanation of the self-potentials opposite permeable beds is complex but the following factors play an important part in the magnitude of the self-potentials:

(a) the presence of shale or clay in the formation causes a reduction in the observed potential,

(b) the greater the salinity contrast between the drilling mud and the interstitial water, the greater the potential,

(c) as with resistance, thin beds do not show their full self-potentials, being affected by the beds above and below.

Interpretation

The following observations are based on a comparison of the electric logs with the lithological logs obtained from core information (Plates 2, 3, & 4).

Coal Seams

Clean, unfractured coal seams should show a high resistance (higher than that of the sandstone) and zero self-potential. The jagged appearance and only moderately-high value of the resistance of the coal seams is caused by interbedded shales and the negative self-potentials indicate that the seams are permeable, i.e. they are fractured.

However, the self-potentials are reduced by the shale content e.g. the Tantivy and Fiery seams in Borehole N.S. 78 (Plate 4) seem to be particularly shaly. Although the absence of self-potential could indicate either a high shale content or a completely unfractured seam, the resistance log shows that these two seams do not possess the very high resistance of clean unfractured seams, being less resistant than the conglomerate at 262 to 276 feet.

Conglomerate sandstone

The conglomerates and sandstones penetrated are permeable, as shown by the negative self-potentials. Evidently, in N.S. 77 (Plate 3) the formations encountered at 325 to 337 ft and 346 to 362 ft are more porous than that at 262 to 276 ft in N.S. 78, their resistance being lower. In N.S. 78, the self-potential returns almost to the shale value at 268 to 270 ft, indicating that this part of the bed is probably shaly. Because of their shale content, most of the sandstone encountered show resistances lower than that of the conglomerate.

Carbonate rocks

These show high resistances and almost zero self-potential indicating that they are impermeable, i.e. unfractured (e.g. N.S. 78, 635 to 652 ft; N.S. 77, 192 to 216 ft and 366 to 400 ft).

4. CORRELATION

Plate 5 shows the suggested correlation of the three Ipswich bores, based on the anomalies in the self-potential and resistance logs. The coal seam struck in N.S. 76 at 200 to 202-ft depth below surface has been correlated with the Garden Seam in N.S. 77 and 78. The unnamed seam found in N.S. 77 at 276 to 283 ft below surface has been correlated with the coal and shale bed at 185 to 190 ft below surface in N.S. 78, and with what may be a weathered coal and shale bed at 80 to 90 ft below surface in N.S. 76.

5. CONCLUSIONS

The electric logs indicate that the coal seams have some shale content and are also permeable, i.e. none of them constitute clean coal seams without fractures. The Tantivy and Fiery Seams cut by N.S. 78 are particularly shaly.

The logs are an aid to correlation, but could not entirely replace coring because of the similar appearance of the curves opposite coal seams and conglomerate.

6. RECOMMENDATION

It is recommended that electrical bore-logging (two-channel equipment : single-electrode resistance and self-potential) be used as a routine tool in exploratory drilling for coal. It should be of assistance in solving correlation problems in the field. It might serve as a check on coring and should detect coal seams that were missed in open-hole drilling. After gaining experience, it should be possible to judge the quality of the coal from the electrical logs.

7. REFERENCES

ALLEN, R.J., STAINES, H.R.E., and WILSON, E.G. 1960 — The Ipswich Basin. In THE GEOLOGY OF QUEENSLAND. Melbourne University Press, 252-262.

WIEBENGA, W.A. and GUNSON, S. 1956 — "Electrical logging of No. 3 bore, Associated Australian Oilfields N.L., Roma, Queensland. Bur. Min. Resour. Aust. Rec. 1956/3. (unpubl.)

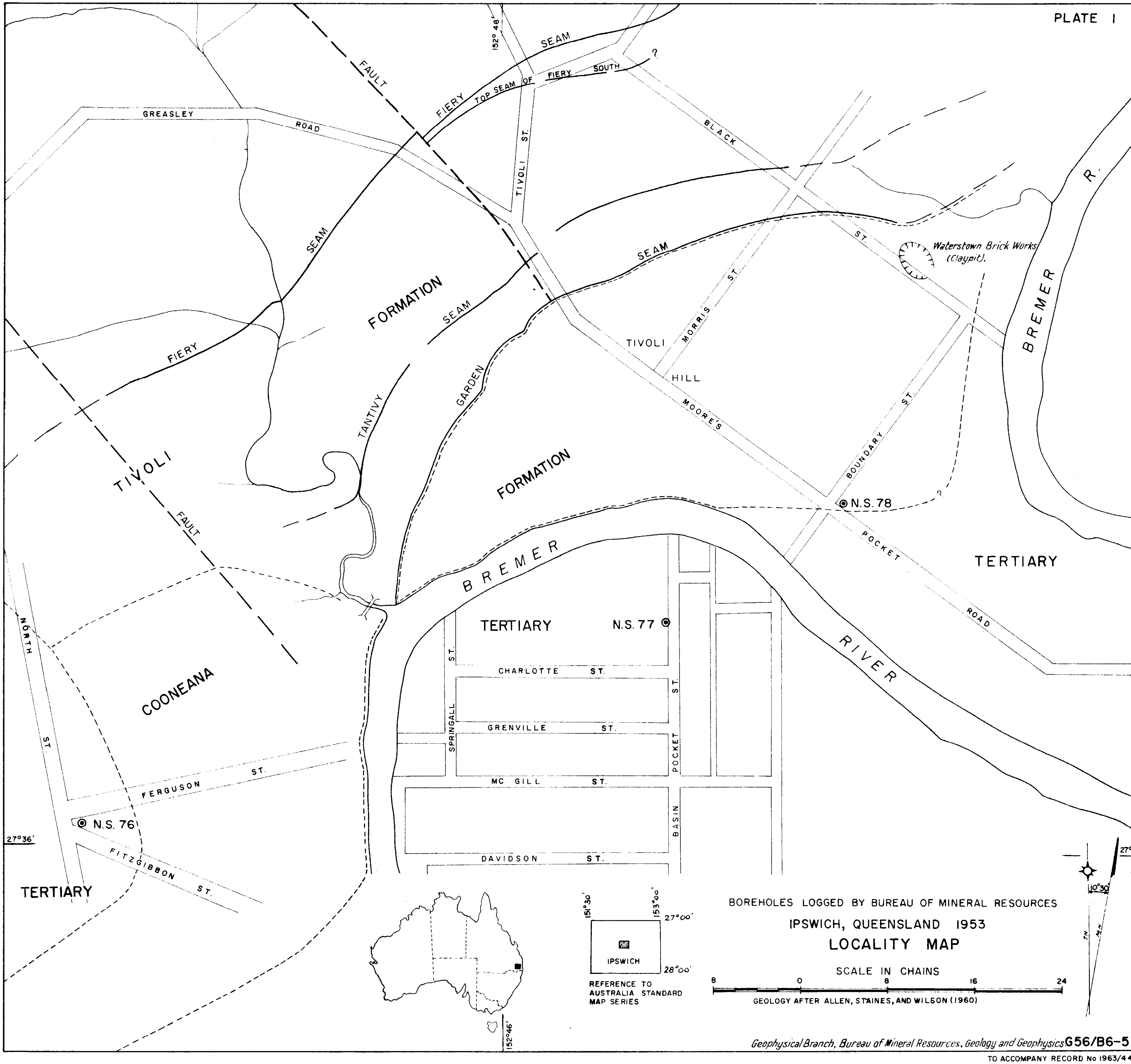

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PLATE 2

REMARKS

BIT DIAMETER : 5⅞" SURFACE TO 82' DEPTH
3⅞" 82' DEPTH TO 380' DEPTH
3¼" 380' DEPTH TO BOTTOM

DATE : 7.12.53.

ELEVATION : 70·5 ft

LEGEND

SHALE	IRON CARBONATE
SILTSTONE	COAL INCL. INF. COAL AND BLUEY
SANDSTONE	COALY SHALE
CONGLOMERATE	INTERBEDDED COAL AND SHALE
LIMESTONE	ALLUVIUM

VERTICAL SCALE 20 FT – 1 INCH

BORE LOGGING, IPSWICH

QUEENSLAND STATE MINES DEPT COAL DRILLING BORE No N.S.76

SELF-POTENTIAL, SINGLE-POINT RESISTANCE, AND GEOLOGICAL LOGS

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PLATE 3

REMARKS

BIT DIAMETER : 5⅞" SURFACE TO 181' DEPTH
3⅞" 181' DEPTH TO BOTTOM

MUD RESISTIVITY : 71 OHM METRE t = 87°F

DATE : 8.12.53.

ELEVATION : 71.5 ft approx

LEGEND

SHALE	IRON CARBONATE
SILTSTONE	COAL INCL. INF. COAL AND BLUEY
SANDSTONE	COALY SHALE
CONGLOMERATE	INTERBEDDED COAL AND SHALE
LIMESTONE	ALLUVIUM

VERTICAL SCALE 20 FT - 1 INCH

BORE LOGGING, IPSWICH

QUEENSLAND STATE MINES DEPT COAL DRILLING BORE No N.S.77
SELF-POTENTIAL, SINGLE-POINT RESISTANCE, AND GEOLOGICAL LOGS

TO ACCOMPANY RECORD No 1963/44

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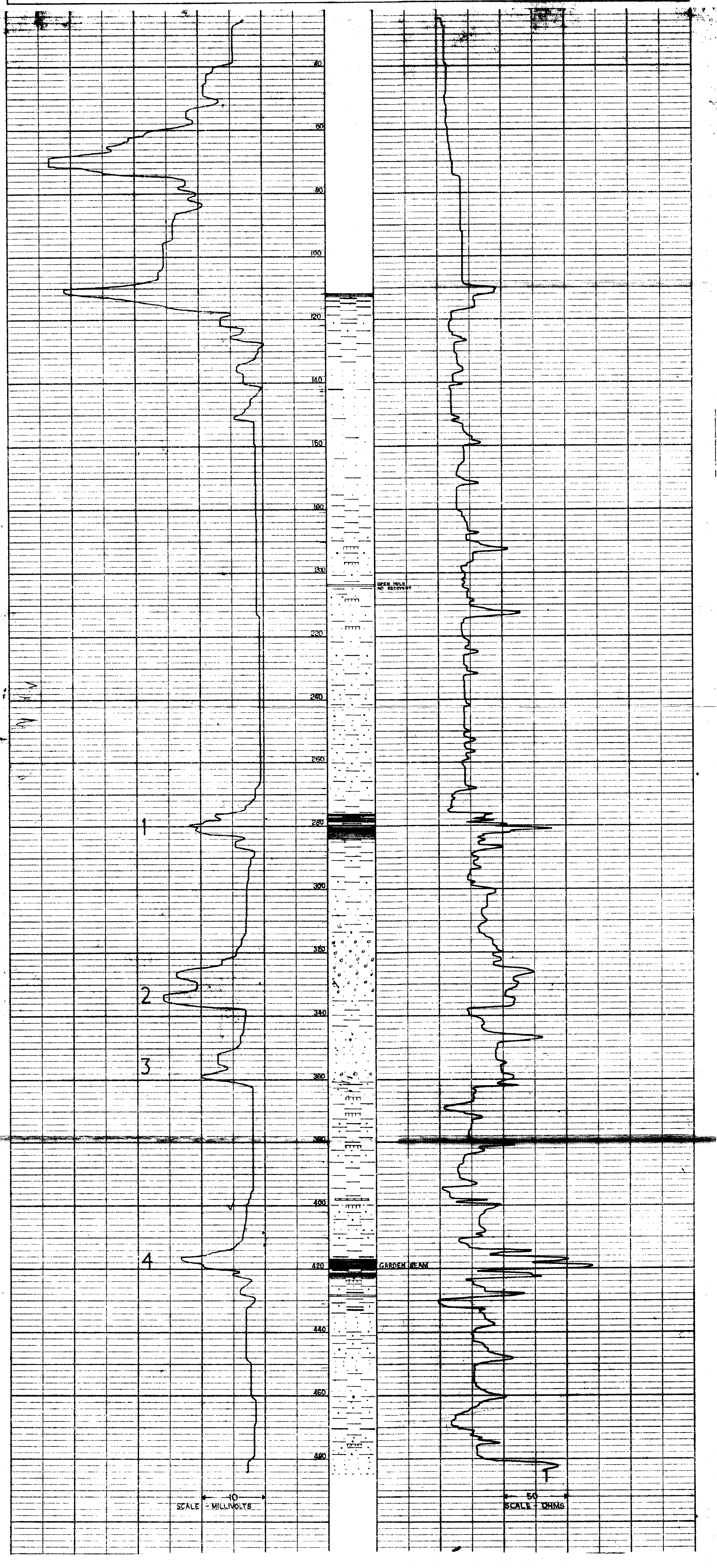

PLATE 4

REMARKS

BIT DIAMETER : 3 7/8" SURFACE TO 259' DEPTH
3" 259' DEPTH TO BOTTOM
MUD RESISTIVITY: 8.6 OHM METRE @ 91°F
120' 4" CASING
DATE : 7.12.53.
ELEVATION : 71ft.

LEGEND

SHALE — SILTSTONE — SANDSTONE — CONGLOMERATE — LIMESTONE — IRON CARBONATE — COAL INCL. INF. COAL AND BLUEY — COALY SHALE — INTERBEDDED COAL AND SHALE — ALLUVIUM

VERTICAL SCALE 20 FT – 1 INCH

BORE LOGGING, IPSWICH

QUEENSLAND STATE MINES DEPT COAL DRILLING BORE No N.S.78
SELF-POTENTIAL, SINGLE-POINT RESISTANCE, AND GEOLOGICAL LOGS

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PLATE 5

ELECTRIC LOG CORRELATION
IPSWICH COAL BASIN

G56/B6-9

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