COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS

1956, No.143

THE ELECTRICAL LOGGING OF COAL BORES AT NEBO COLLIERY, WOLLONGONG, NEW SOUTH WALES.

by

S. GUNSON and D.L. ROWSTON.

Records 1956. No. 143.

The Electrical Logging of Coal Bores at Nebo Colliery, Wollongong, New South Wales.

by

S. Gunson and D.L. Rowston.

CONTENTS.

ILLUSTRATIONS.

A B S T R A C T

Four coal bores were logged electrically by the Bureau of Mineral Resources at the Nebo Colliery, Wollongong, New South Wales in May, 1954. The logging, employing single point resistivity and self-potential methods, was requested by the Australian Iron and Steel Ltd. to determine whether logging techniques would augment the information obtained from normal coring practice.

The results demonstrate that the method can delineate the coal seams to within plus or minus six inches in depth. Quantitative estimates of the coal to shale ratio determined from the resistivity log were in close agreement with those of the geological core log in a particular seam. Additional logging, to prove beyond doubt that the method is a useful and reliable supplement to coring, is recommended.

1. INTRODUCTION.

Nebo Colliery, which is owned by the Australian Iron and Steel Ltd., is in the Parish of Kimbla, near the Cordeaux Dam, about 10 miles west of Wollongong. In May, 1954, at the company's request, the Bureau made electric logging tests in four bores which the Company had drilled at the colliery to prove coal seams. The four holes, Nebo Nos. 10, 11, 12 and 13 (Plate 1) were logged during two days in June, 1954. The purpose of the tests was to determine to what extent electrical logging can assist the drilling programme in providing additional data on the depths of coal seams.

Mr. B. Hopkins, a geologist of the company, accompanied the geophysical party and assisted in the logging operations. It is desired to acknowledge the ready co-operation received by the party from Mr. Hopkins and from other officers of the company.

2. GEOLOGY AND PRINCIPLES OF INTERPRETATION.

The geological data provided by the drilling logs shows the following rock types:-

Basalt.

The fresh basalt in the area is a dense compact rock of low porosity. On the electrical log it is characterized by high resistivity and low self-potential. It should be noted that it is customary to use the self-potential value of shale as a zero reference. Where the basalt is fractured or jointed, the porosity and permeability are correspondingly higher and such zones appear on the electrical log as regions of relatively low resistivity and high, negative self-potential (see Plate 2). Faults or shear zones in the basalt in which clay has formed as a result of faulting and/or weathering also have relatively low resistivity but the self-potential is negligible, or even positive, when compared with that recorded from shales (see Plate 5).

Sandstones, Shales and Clays.

The sandstones of the area contain clay and their electrical properties are similar to those of clays and shales, i.e. they show low resistivity and negligible self-potential. The resistivity of sandstones varies inversely with the porosity of the rock and the salinity of the pore solution. The self-potential varies with the permeability and is also dependent on the thickness of the formation and the salinity contrast between the pore solution and the drilling mud.

Coal.

Because coal is highly impermeable and has low porosity it is characterised on the electric log by low or zero self-potential and high resistivity. If the coal has been "coked" or "cindered", its porosity, and sometimes its permeability, is higher, resulting in a lowering of the resistivity, and often an appreciable increase in negative self-potential. The resistivity log of a coal containing shale bands has a characteristic "jagged" appearance due to the alternation of high and low resistivity material.

3. EQUIPMENT.

The equipment used was a standard "Widco" 4000ft., self-potential, single-point, resistance logger, manufactured by Well Instrument Developing Co., Bellaire, Texas, U.S.A. The recording unit was mounted in a truck, and the winch and generator on a trailer. This arrangement was not very satisfactory, because it was difficult to manoeuvre the two units on the narrow tracks in the area. A more suitable arrangement in such conditions would be to mount all the equipment in the back of a truck or van.

4. DESCRIPTION OF ELECTRICAL LOGS

It will be noticed when examining the logs 2-5 that the potential and resistivity scales are not uniform on all the logs. It would have been better for correlation purposes to have had one log for each hole on at least one standard scale. For the bores logged on this survey scales of 50 millivolts and 100 ohms to the inch would have been suitable. Extra logs on different scales could then have been made for sections of the holes where the standard scales do not give enough contrast. An example is the log of No.10 bore, Plate 2. The most sensitive scales which would log the whole depth of this bore are 10 millivolts and 100 ohms to the inch. This resistance scale, however, does not clearly show the resistance features below 265 feet. This section of the bore was then logged on a more sensitive resistance scale, 10 ohms to the inch, to accentuate the formation boundaries. It would have been better to have done all the holes in the same manner but the point was not appreciated at the time the logging was done.

(a) Nebo Bore No. 10 (Plate 2). Logged to a depth of 347 ft.

Comparison of the electric log with the ditch sample and core log indicates the following outstanding features:-

(i) Depth to standing water, 150 ft.

(ii) Porous and permeable zones in the basalt at 160ft, 178ft, 198ft, 224ft, 260ft and 270ft.

These zones are presumably the result of shearing or jointing. The base of the basalt is at 272ft.

(iii) The Balgownie Coal seam from 299ft to 301ft.

(iv) Top of the Wongawilli seam at 344 ft. This seam has a higher resistance than the Balgownie seam and the coal is of better quality.

(b) Nebo Bore No.11 (Plate 3). Logged to a depth of 338 ft.

The log is similar to that of Bore No. 10, but over the basalt section between 58 ft. and 244 ft. the log is more irregular. Features of the log are:-

(i) Depth to standing water, 58 ft.

(ii) Numerous porous and permeable zones in the basalt, and the generally low resistance in the two picrite phases below 190 ft. The base of the basalt is at 244 ft.

(iii) The Balgownie seam from 275ft. to 277 ft. 6 in., and the upper portion of the Wongawilli seam from 329 ft. to 336 ft. As in Bore No.10, the better quality of the Wongawilli seam is indicated by its higher resistance.

(c) Nebo Bore No. 12 (Plate 4). Logged to a depth of 180 ft.

The geological log shows only shales and sandstones, with a few grits and conglomerates. The electrical log shows a pattern characteristic of such a section.

(d) Nebo Bore No. 13 (Plate 5). Logged to a depth of 315 ft.

This was the only one of the four holes in which the complete thickness of the Wongawilli seam was logged.

Features of the log are:-

(i) Depth to standing water, 141 ft.

(ii) Numerous low resistance zones in the basalt, the base of which is at 211 ft. The basalt in this bore shows a positive potential due to the presence of clay or gouge in the broken sections.

(iii) The Balgownie coal seam from 240 ft. 6 in. to 243 ft.

(iv) The Wongawilli coal seam from 285 ft. 6 in. to 315 ft. As in Bores No. 10 and 11, the log indicates that the quality of this seam is better than that of the Balgownie.

As previously stated, the jagged pattern of the resistivity log in the section corresponding to the Wongawilli seam is caused by shale bands interbedded with coal. A quantitative estimate of the ratio of shale to coal was made from the pattern of the restivity log by measuring the thickness of the troughs (shale) and the peaks (coal). The measurements were made along a line midway between the troughs and the peaks (line AB on Plate 5). By this method, a seam of 30 ft. was shown to be composed of 9 ft. of shale and 21 ft. of coal. Analysis of the geological log shows this seam to comprise 9 ft. 3 in. of shale and 21 ft. 4 in. of coal. The agreement between the two sets of values is very close, and although it is better than would normally be expected, it indicates that a fairly reliable estimate of the amount of shale in a coal seam may be obtained from an electrical resistivity log.

5. CONCLUSIONS

The electrical logging of the Nebo Colliery bores has indicated the ptoential value of the technique when used in conjunction with the drilling and coring programme. More logging of cored holes in this area should be done to establish beyond doubt the reliability and usefulness of the method. The uses of the electrical log can be summarised as follows :-

(a) Correlation. Electrical logs are well suited for this purpose because of the characteristic response of most types of rock formation.

(b) Nature of the rock. Results of the present work showed that it was possible to detect, for example, broken zones in basalt and shale bands in coal seams and even make quantitative estimates of the percentage of shale.

(c) Supplement to coring. When core recovery is poor, the electrical log may provide sufficient information to fill in the gaps in the core log.

(d) Depth measurements. The electrical log provides depth measurements which are accurate to plus or minus six inches .

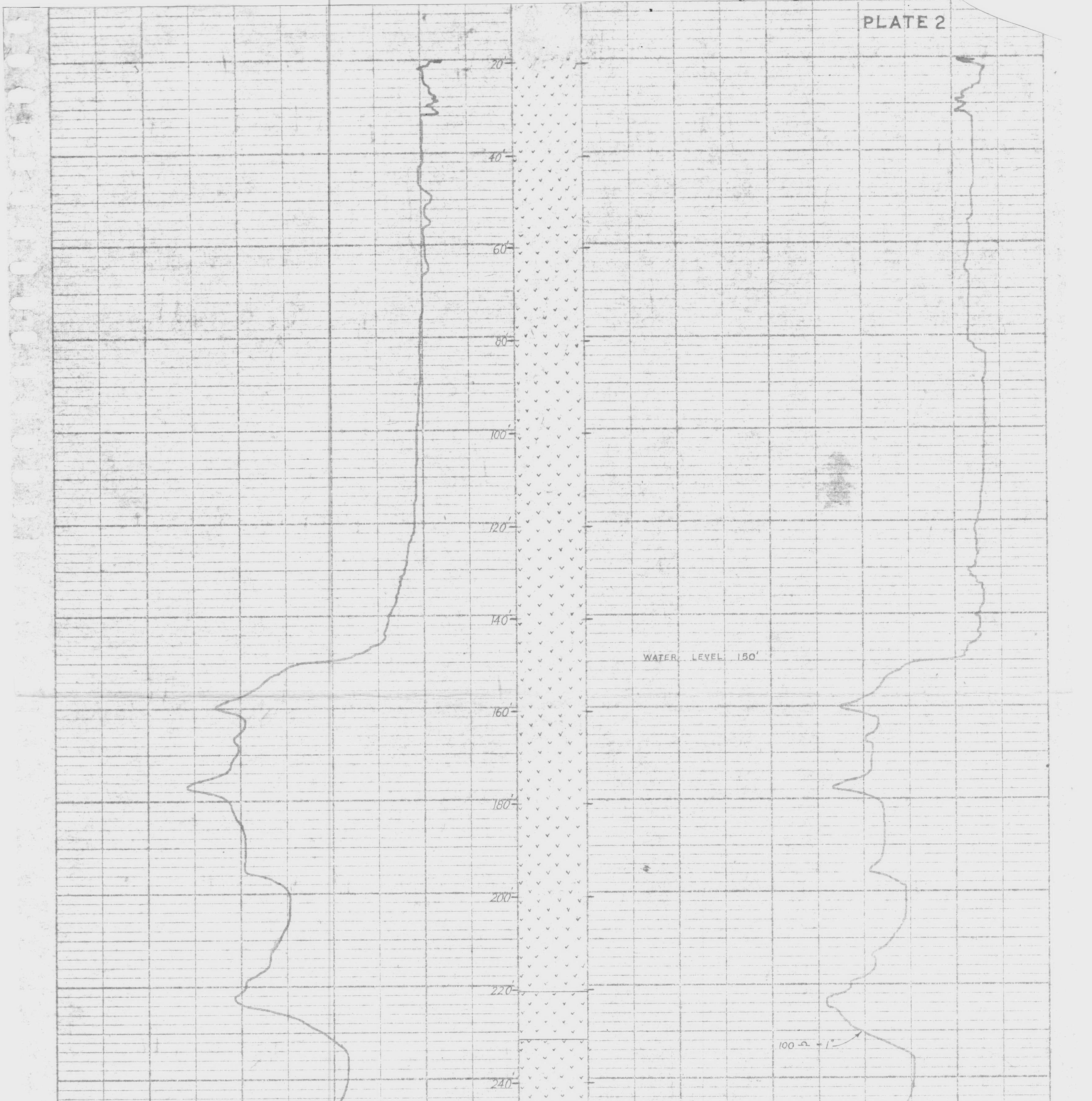
If electrical logging is to be used in this area a 2,000 ft. logging equipment would probably be adequate. A unit of this size can be mounted in a light vehicle, thus overcoming the difficulties experienced in negotiating bad roads and tracks.

PLATE I

WELL LOGGING — NEBO COLLIERY
WOLLONGONG, N.S.W.

LOCALITY MAP

Geophysical Section Bureau of Mineral Resources, Geology and Geophysics G 37-8



WELL LOGGING WOLLONGONG N.S.W.

NEBO COLLIERY No. 10 BORE

SELF POTENTIAL AND SINGLE-POINT RESISTANCE LOG

BIT DIAMETER 3"

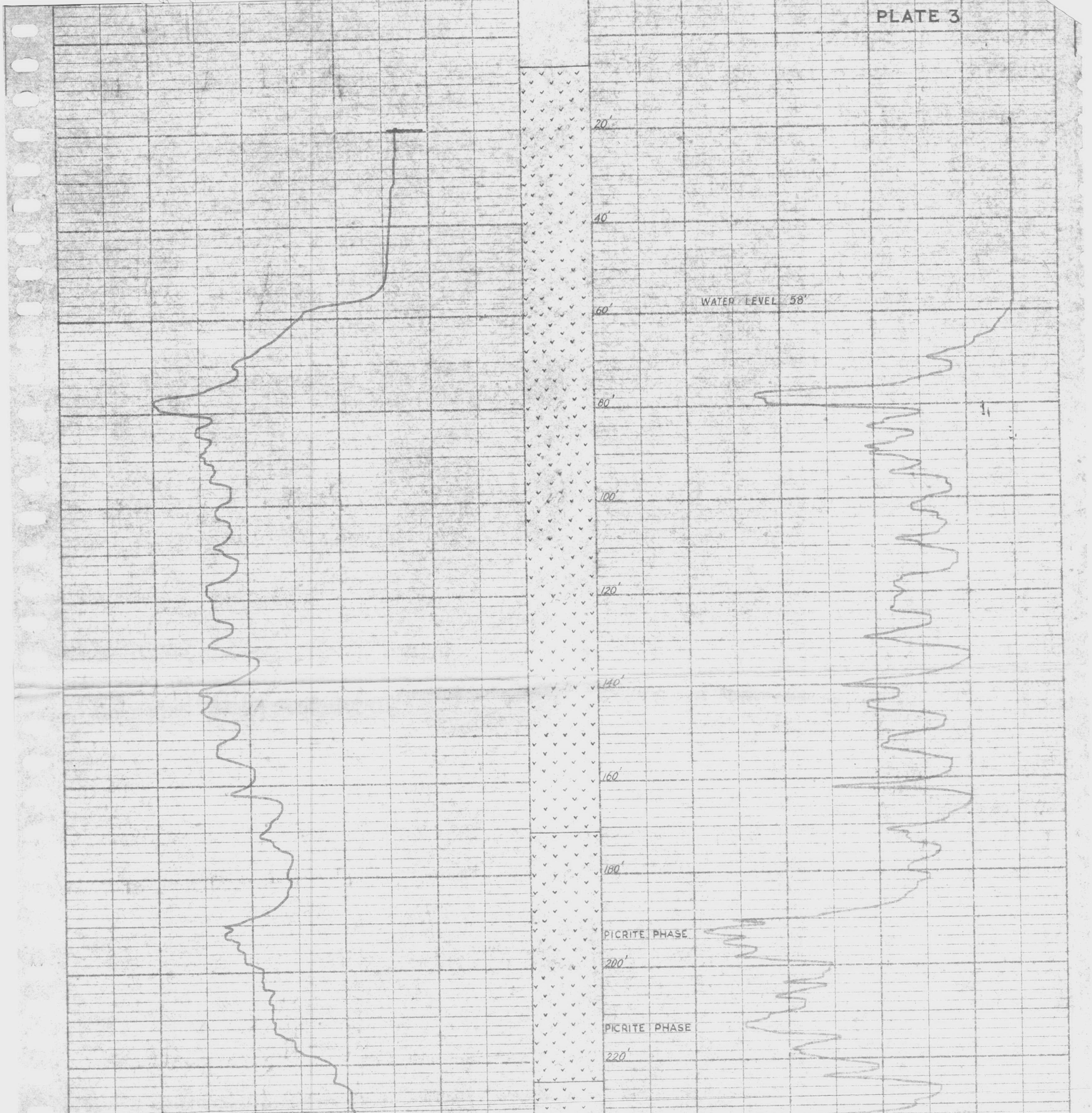
LEGEND

- SHALE
- SANDSTONE
- SHALY SANDSTONE
- CONGLOMERATE
- GRITS
- BASALT
- COAL
- CLAY

G 37-4

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics

PLATE 3



WELL LOGGING WOLLONGONG N.S.W.

NEBO COLLIERY No. 11 BORE

SELF POTENTIAL AND SINGLE-POINT RESISTANCE LOG

BIT DIAMETER 3"

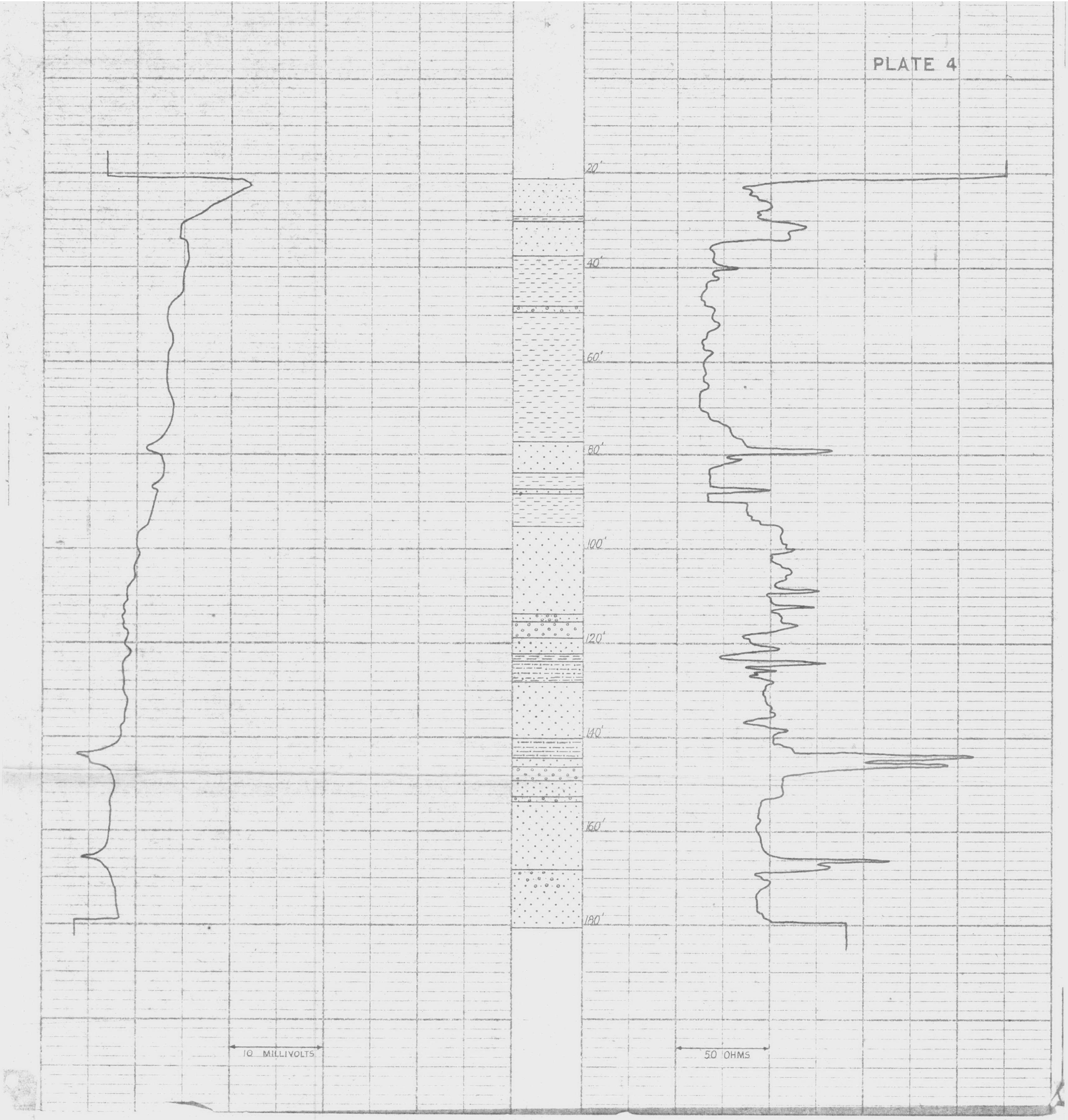
LEGEND

- SHALE
- SANDSTONE
- SHALY SANDSTONE
- CONGLOMERATE
- GRITS
- BASALT
- COAL
- CLAY

G 37-5

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics

PLATE 4



WELL LOGGING WOLLONGONG N.S.W.

NEBO COLLIERY No. 12 BORE

SELF POTENTIAL AND SINGLE-POINT RESISTANCE LOG

BIT DIAMETER 3"

LEGEND

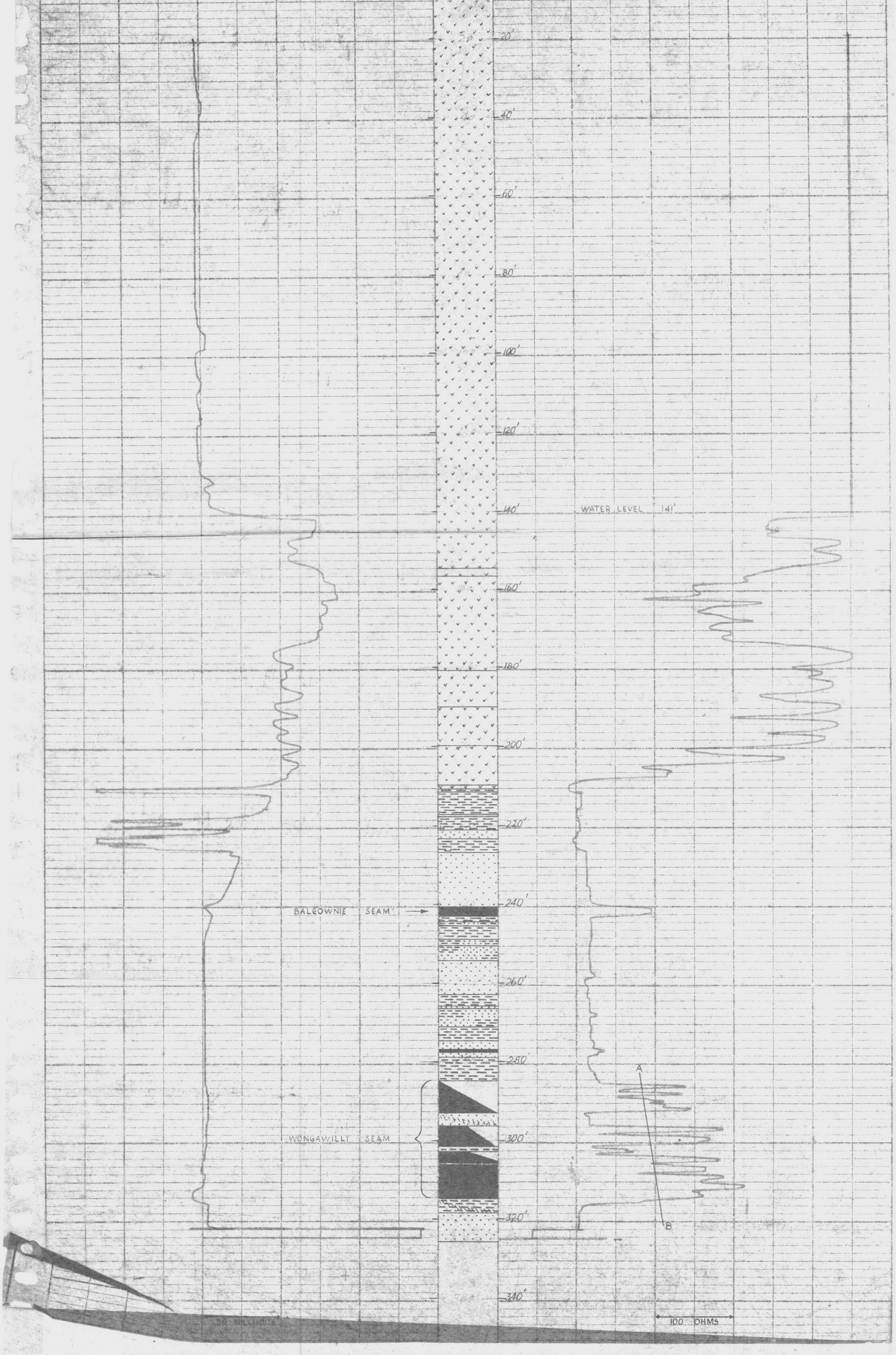
SHALE	GRITS
SANDSTONE	BASALT
SHALY SANDSTONE	COAL
CONGLOMERATE	CLAY

PLATE 4

G 37-6

Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics.

PLATE 5



WELL LOGGING WOLLONGONG N.S.W.

NEBO COLLIERY No. 13 BORE

SELF POTENTIAL AND SINGLE-POINT RESISTANCE LOG

BIT DIAMETER 3'

LEGEND

SHALE	GRITS
SANDSTONE	BASALT
SHALY SANDSTONE	COAL
CONGLOMERATE	CLAY