COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS
1956, No.130

ELECTRICAL LOGGING OF NO. 4 BORE, ASSOCIATED AUSTRALIAN OILFIELDS N.L., ROMA, QUEENSLAND

by

S. GUNSON and D.L. ROWSTON

RECORDS 1956, NO. 130

ELECTRICAL LOGGING OF NO. 4 BORE, ASSOCIATED AUSTRALIAN OILFIELDS N.L., ROMA, QUEENSLAND

by

S. GUNSON & D.L. ROWSTON

CONTENTS

ILLUSTRATIONS

ABSTRACT

Roma Bore No. A.A.O.4, drilled by Associated Australian Oilfields N.L., was logged by the Bureau of Mineral Resources to a depth of 3,900 feet in May and June, 1954, by self-potential and resistivity methods, using the single-electrode technique. The complete hole was logged on a vertical scale of 100 feet to the inch, and the bottom 300 feet was also logged on a scale of 20 feet to the inch.

Good correlation was obtained with earlier bores in the area, major formations were clearly defined, and accurate depth measurements were obtained to formations to be tested.

It is recommended that a multi-electrode logging device be used if a quantitative estimate of oil or gas content is required.

1. INTRODUCTION

Roma Bore No. A.A.O.4 was the fourth drilled in the Roma area by Associated Australian Oilfields, N.L., in their search for oil and/or gas. It is located on the Roma showground, 120 feet north-west of the south-east corner post.

At an early stage of the drilling, the Company asked for the services of the electrical well-logging unit operated by the Bureau of Mineral Resources. As a result of this request, self-potential and resistivity logging of the hole were undertaken in May and June, 1954, by S. Gunson and D.L. Rowston, geophysicists of the Bureau.

2. OPERATIONS

The equipment used was the same as that used to log Roma Bore No. A.A.O.3 (Wiebenga and Gunson, 1955), and the reader is referred to that report for a description of the equipment, the method, and the fundamentals of electrical log interpretation.

The complete hole was logged electrically to a depth of 3,900 feet on a vertical scale of 100 feet to 1 inch (Plate 1), and this log was used for correlation of results. In addition, the bottom 300 feet of the hole was logged at certain stages of the coring and testing programme on a vertical scale of 20 feet to 1 inch (Plate 2). The purposes of this large-scale log were to supplement the core log and to assist in the selection of the best depths for packer tests.

3. INTERPRETATION OF RESULTS

(a) General

The interpretation of electric logs has been dealt with fully in an earlier report (Wiebenga and Gunson, 1955). To assist the reader to follow the description of the log the following brief notes are provided :-

(i) Sandstones and conglomerates.

The magnitude of the self-potential values depends mainly on the permeability of the formation and on the salinity contrast between the pore solutions and the drilling mud. The resistivity depends mainly on the porosity of the formation and the salinity of the pore solutions. Hence conglomerates and unsorted, coarse sandstones usually, because of their high permeability and low porosity, show high potentials and high resistivities. They mark the water yielding formations (aquifers). Well-sorted sandstones, often fine-grained, are, because of their lower permeability and higher porosity, characterised by moderate to high self-potentials and moderate resistivities. Oil and gas-bearing sandstones are, because of their lower water content, characterised by moderate self potentials and high resistivities.

(ii) Shales.

The self-potential value of shales is customarily used as the zero reference line. Because shales are characterised by high porosities, their resistivity is normally the lowest in the section.

(iii) Coals.

High-grade, unfractured coal seams have a high resistivity and a low or negligible self-potential. The sharply jagged appearance of the characteristic resistivity curve of coal seams is caused by interbedded shales. Shaley, low grade coals show a low to moderate resistivity. The quality of the coal is generally well indicated by the magnitude of the resistance and the number of shale bands, as indicated by the jagged curve. Fractured, weathered coals show a moderate resistivity with a high self-potential.

(b) Description of the electric log.

The interpretation now given has been made from the electric log (Plate 1). The geological (ditch sample) log of the hole is shown alongside the electric log as a comparison.

The boundaries of geological systems and formations were selected by the Company geologist, Mr. Derrington, on the evidence of both logs and the general geology of the area.

Surface - 300 feet: Casing shoe at 300 feet. Electric log useless in cased section.

300 - 535 feet: Mainly shale with some sandstone.

535 - 735 feet: Mainly sandstones and conglomerates with some shale. This section could contain water-bearing beds.

735 - 910 feet: Mainly shale with a little coal and some coaly shales. Sections with coal have jagged resistance pattern (745 - 780 feet).

910 - 1405 feet: Mainly sandstones with interbedded shales. Greatest amount of shale in section between 1020 and 1200 feet. Resistance curve indicates variations in porosity.

The resistance change at the lower boundary of this section is very sharp and is a good marker for correlation purposes.

1405 - 2675 feet: Mainly shale with numerous thin coal beds (note jagged resistance log) and two conspicuous sandstone beds at 1605 - 1640 feet and 1835 - 1890 feet. Apart from these the S.P. log is featureless.

The resistance change at the lower boundary of this section is well defined, and is a good marker. It is the boundary between Jurassic and Upper Triassic sediments.

<u>2675 - 3288 feet</u>: Sandstones with interbedded shales. The resistance change at the lower boundary of this section is sharp and an excellent marker. It is the boundary between Upper and Middle Triassic sediments.

<u>3288 - 3631 feet</u>: Mainly shale, but some thin coal seams shown by their characteristic resistance pattern.

<u>3631 - 3891 feet</u>: (see Plate 2). This section contains the gas sands and is described in more detail.

The hole was cored from 3645 feet to the bottom (3891 feet). The cores, in conjunction with the electric log, were used to select positions for formation tests. The following logging results were obtained :-

<u>3682 - 3699 feet</u>: High S.P. with moderate resistance. Both core and electric log show a sandstone capped by shale.

Formation test : range 3676 ft. to 3699 ft; recovery 1.5 gallons of drilling mud.

<u>3700 - 3717 feet</u>: Both S.P. and resistance are higher than in the previous interval. Sandstone with shale floor.

Formation test : range 3693 ft. to 3714 ft; gasflow, rate estimated at 1,500,000 cubic feet per day.

<u>3819 - 3828 feet</u>: Low S.P. and moderate resistance. Sandstone with shale cap and base. Core sample showed presence of gas.

Formation test : range 3791 ft. to 3831 ft; recovery one gallon of drilling mud.

<u>3866 - 3879 feet</u>: High S.P. and high resistance. Coarse sandstone with shale cap and base.

Formation test : range 3834 ft. to 3891 ft; recovery salt water flow under sufficient pressure to reach the surface, and thought to originate in the sandstone indicated on the electrical log between 3866 - 3879 feet. The water contained 2,500 parts per mill. of chloride, and its measured resistivity was 1.2 ohm-metres.

The fact that the salt water sand (3866 - 3879 feet) has an electric log almost identical with that of the productive gas sand at 3700 ft. to 3717 ft. calls for comment.

The comparison of the electric logs of two sands indicates their relative reservoir potential only if the sands have similar physical properties (e.g. porosity and permeability).

The resistivity of a rock depends on its porosity, the resistivity of its fluid content and the percentage saturation of the voids. It is possible for two sands containing the same fluids, whether water, oil, or gas, to have different resistivities.

As a corollary to this it is evident that two sandstones could contain different formation fluids and yet have equal resistivities.

Though the packer test from 3834 ft. to 3891 ft. covered a large interval, the only portion which can be considered as an aquifer is the sandstone from 3865 ft. to 3879 ft. Only 2 feet of core was recovered from this section and it has been classified as a coarse-grained sandstone (the gas sand at 3700 ft. to 3714 ft. is a medium-grained sandstone).

It is suggested therefore that the medium-grained sandstone (3700 - 3714 feet) that produces gas has a higher porosity than the coarse-grained sandstone (3866 - 3879 feet) that produces salt water but, because the medium-grained sandstone is partly saturated with gas, the amount of water per unit volume in the two sandstones is approximately the same.

It is well known that an increase in grain size will increase permeability but often reduce porosity due to a poorer sorting as the grain size increases (porosity is a maximum for a well-grained sand). This lends support to the explanation offered and emphasises the need for caution when interpreting an electric log.

It is pertinent to remark that the term "high resistance" is used in this record to denote values which are high relative to the remainder of this particular log. It may not be considered high when compared with resistivities measured on other oilfields or even in other parts of the same field.

(c) Correlation.

The use of the log (Plate 1) for correlation is straight-forward, as the major formations are clearly defined in both depth and predominant rock type. The major formations are indicated alongside the potential log, and it can be seen for example that the Bundamba Sandstones (2675 ft. to 3290 ft.), are readily distinguished from the Moolayember shales. The log shown on Plate 1 has been used in conjunction with the geological log of A.A.O. No. 4, and the electrical logs of A.A.O. No. 2 and A.A.O. No. 3, to correlate the three bores. This correlation is shown in the following table :-

Depth of marker (ft.)			Description of marker	Level difference (ft.) A.A.O.3 to A.A.O.4
A.A.O.2	A.A.O.3	A.A.O.4		
1067	1107	1407	Boundary between Upper Walloon Coal Measures and Middle Walloon Coal Measures at the bottom of the Garnet Sandstone	-350
2260	2288	2675	Unconformity between Lower Walloon Coal Measures (Jurassic) and Bundamba Sandstone (Upper Triassic)	-437

Depth of marker (ft.)			Description of marker	Level difference (ft.) A.A.O.3 to A.A.O.4
A.A.O.2	A.A.O.3	A.A.O.4		
3094	3056	3290	Unconformity between Bundamba Sandstone (Upper Triassic) and Moolayember Shales (Middle Triassic)	-284
3469	3474	3630	Top of petroliferous zone (sandstone and shaley sands) within Moolayember Series	-206
3597	3596	3890	Top of granite wash above basement (A.A.O.2 and A.A.O.3). Top of decomposed metamorphic rock (A.A.O.4)	-344

Note: 1. Depths are measured below rotary table, which is 4'6" above ground level.

2. Elevation of rotary table at A.A.O.No.2 = 1087 ft.
" " " " " " No.3 = 1090 ft.
" " " " " " No.4 = 1040 ft.

(d) Depth Measurements

For the purpose of setting the packer, depths were obtained from the large-scale log (Plate 2), on which depth measurements are accurate to within one foot. The depth measuring device on the "Widco" logger is accurate, and the only possible errors, namely cable stretch and slip, can be allowed for.

4. CONCLUSIONS

The electrical logging of A.A.O. No. 4 bore was successful in providing good correlation with earlier bores, and in giving accurate depth measurements for formations to be tested.

The single electrode electric log is also useful when core recovery is poor. During the drilling at A.A.O. No. 4, the core from 3866 ft. to 3880 ft. was lost. The electric log showed that it was probably a sandstone and that its electrical characteristics were similar to those of the gas sand between 3700 ft. and 3714 ft.

When the section between 3834 ft. and 3891 ft. was tested, it yielded only brackish water thought to originate in the coarse sandstone at 3865-3879 ft. This experience shows that although rock types (sand, shale, coal, etc.) can be fairly accurately identified by means of the single electrode electric log, it is not possible to make any quantitative estimate of the oil or gas content of a formation. If such estimates are required from well-logging data, a multi-electrode device is essential, although the interpretation of the logs obtained with such devices is not entirely reliable.

5. REFERENCE

Wiebenga, W.A. and Gunson, S., 1956 - Electrical Logging of No. 3 Bore, Associated Australian Oilfields N.L., Roma, Queensland. Bur. Min. Res. Geol. & Geophys., Records 1956, No. 3.

....

WELL LOGGING, ROMA, QUEENSLAND.
ASSOCIATED AUSTRALIAN OILFIELDS N.L.

No. 4 BORE

SELF-POTENTIAL AND SINGLE-POINT RESISTANCE LOGS

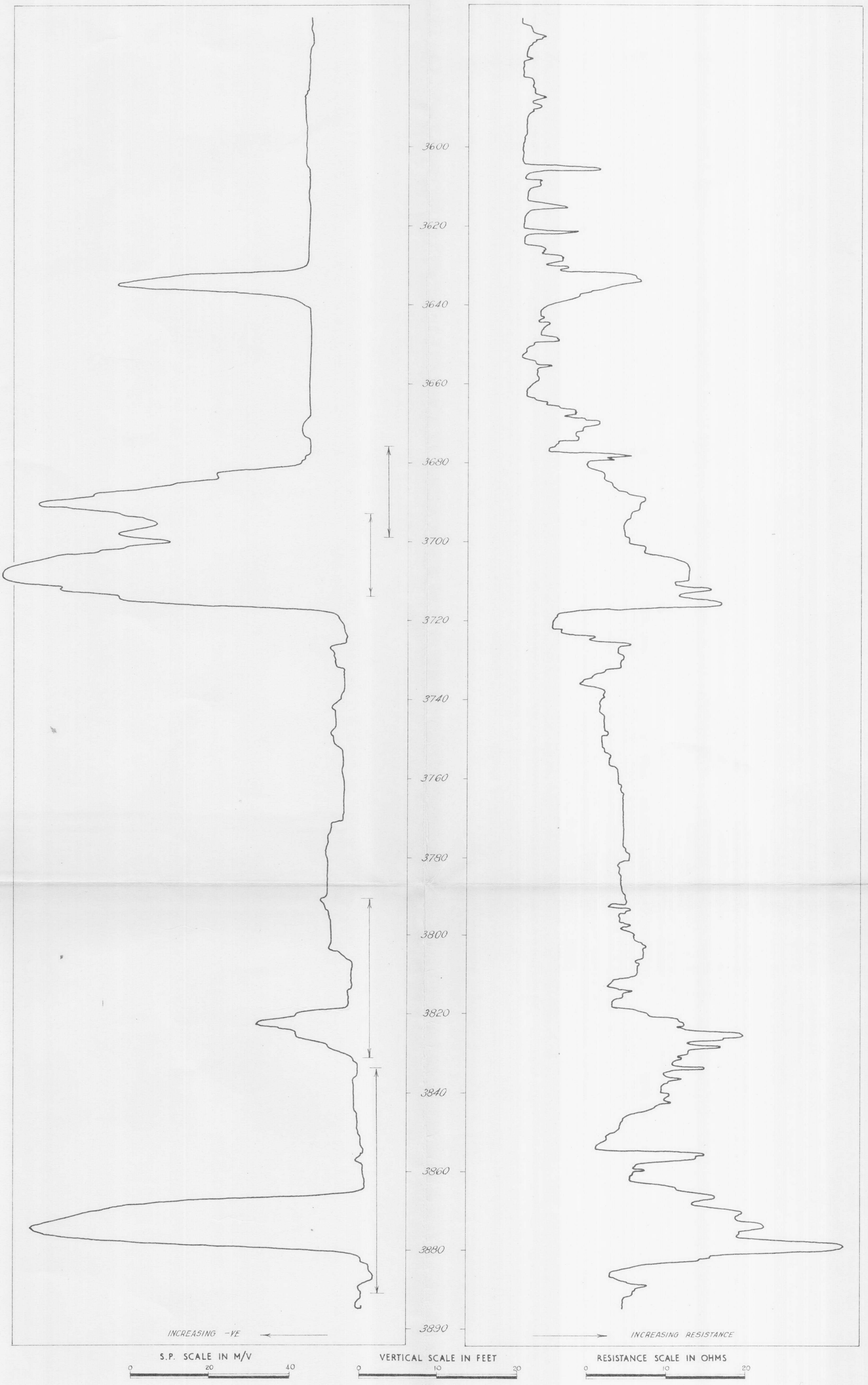
REFERENCE

- Mudstone
- Sandstone
- Shale
- Coal
- Conglomerate
- Sandy limestone
- Limestone

GEOPHYSICIST

BIT DIAMETER: SURFACE TO 3462′ = 7⅞″
3462′ " 3791′ = 7⅝″
3791′ " 3831′ = 5½″
3831′ " 3891′ = 5⅜″

MUD RESISTIVITY 5-6 OHM-METRES AT 76°
DEPTHS ARE BELOW ROTARY TABLE (ELEVATION 1040′)
ROTARY TABLE 5′ ABOVE NATURAL SURFACE
CABLE STRETCH 15″ PER 1000′ (SUBTRACT FROM LOG DEPTH)



WELL LOGGING ROMA, QUEENSLAND

ASSOCIATED AUSTRALIAN OILFIELDS N.L.

No. 4 BORE

SELF-POTENTIAL AND SINGLE-POINT RESISTANCE LOGS

BIT DIAMETER : 3600' TO 3791' = 7⅝".
3791' " 3831' = 5½".
3831' " 3891' = 5⅜".

MUD RESISTIVITY 5-6 OHM METRES AT 76°.
DEPTHS ARE BELOW ROTARY TABLE (ELEVATION 1040').
ROTARY TABLE 5' ABOVE NATURAL SURFACE.
DEPTHS ADJUSTED FOR CABLE STRETCH.

↕ ZONES IN WHICH FORMATION TESTS WERE CARRIED OUT.

GEOPHYSICIST