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BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

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PROGRESS REPORT

ON

GEOPHYSICAL SURVEY, ROMA, QUEENSLAND.

BY

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REPORT No. 1948/71: GEOPHYSICAL SERIES 1948/11.

GEOPHYSICAL SURVEY, ROMA, QUEENSLAND.

PROGRESS REPORT.

In November, 1947, at the joint request of the Queensland Government and four Companies* which are associated in the search for oil in the area, the Bureau of Mineral Resources, Geology and Geophysics commenced geophysical work in the Roma district of Central Queensland.

Since 1900, when gas was first discovered in drilling for water at Roma, approximately 40 bores have been drilled in the search for oil or gas. Some of those were drilled on what were believed to be minor geological structures in the near surface rocks, determined either by scout drilling to shallow depths or from outcrop evidence. It has not been demonstrated, however, whether or not these shallow structures, even if they did exist, persist to the depth of the oil and gas horizons. There is, therefore, no evidence that any of the bores which have been drilled, penetrated a structure which would be favourable to the accumulation of oil or gas or both.

Encouraging signs of gas and oil have, however, been found at widely scattered parts of the Roma area and it seems a reasonable assumption that if a closed structure can be found at a depth where oil and/or gas could have migrated into it, there is a reasonable chance that it may contain commercial quantities.

Geophysical methods provide a direct approach to the problem of mapping geological structures at depth and their application in the known oil fields of the world is, today, the biggest single factor in discovering new oil pools. The application of these methods in the Roma area is therefore a matter of applying standard procedures developed elsewhere to this particular problem.

The first phase of the geophysical operations is the application of gravity and magnetic methods in a reconnaissance of a large area with the object of disclosing gravity or magnetic anomalies which might be related to geological structures. These anomalies might take the form of gravity or magnetic "highs" due to buried hills or ridges in the basement rocks or the "highs" may be due to an increase in density in the sediments which overlie the basement rocks caused by folding. In many of the known oil fields of the world, the geological structures which provide the reservoirs for oil or gas are associated with gravity or magnetic "highs" but, there is seldom so close a correlation that the details of the structure can be determined by these means. However, the gravity and magnetic surveys should indicate the broader structural elements of the sedimentary basin in which the oil and gas occur and enable areas to be selected for investigation by more exact methods.

It is intended that reconnaissance survey of the Roma area by gravity and magnetic methods will be followed by the application of seismic methods. The seismic method is, however, somewhat slow and costly in operation and it is for these reasons that the more rapid and cheaper methods are being used in the first phase of the operation.

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* Roma Blocks Oil Company N.L.
Kalimna Oil Company N.L.
Australian Oil Development Company N.L.
Roma North Oil Company N.L.

To date approximately six months field work has been done and it is intended that the reconnaissance will continue until the end of the year (1948) when the field party will be withdrawn to analyse the results.

Initially an area bounded on the south by the railway between Roma and Blythdale and extending north for approximately 10 miles was covered with a relatively close network of stations. However, as the survey progressed it became apparent that the principal variations in gravity and magnetic field strength were due to causes other than basement topography. The cause of the principal variations has not been established but it seems likely that they can be ascribed either to variations in density and magnetic properties in the basement rocks or to regional effect; of deep seated origin.

In order to gain a better knowledge of this regional effect, which must be eliminated from the observed readings before the gravity anomalies can be recognized, the survey has been extended along roads and railways radiating from Roma for distances of 20 to 30 miles. A plan of the area covered by the gravity methods up to September 17th, 1948, is shown on the accompanying plan, No. G38-2.

Magnetic intensities have been determined at each station but, like the gravity results, these too are disturbed by regional effects.

Gravity and magnetic readings have been taken at all the bores which encountered bed rocks in the Roma area but owing to the regional effect there is no direct correlation between the readings and known depth to basement. However, it is hoped that these readings may provide a useful guide for evaluating the regional effect.

The Bureau has taken delivery of seismic equipment which will be used in the second phase of the operations but, owing to difficulty in obtaining experienced staff, it has not been possible to date to train a crew to use it. However, it is expected that crews will be trained and the equipment field tested before it is required for use about the second quarter of 1949.

If the gravity and magnetic work should fail in their object of indicating suitable areas for applying the seismic method, then a program of broad reconnaissance by the seismic method will have to be undertaken. This may delay considerably the completion of the exploratory program and for this reason it is very difficult to estimate when the exploratory program will be completed.

It may happen that the geophysical investigations fail to locate a drilling target, i.e. a suitable structure, in the Roma area. There is no certainty that such a structure exists nor is it certain that if it does exist the geophysical methods will reveal it. However, the geological problem is not easily solved by other means and until a suitable structure has been located and tested, the potentialities of the Roma area remain, virtually, untested.

In this Report the results of the survey to date are not discussed in any detail. Such a discussion could, at this stage of the investigation, give rise to misleading conclusions or unwarranted inferences. However, the Report will attempt to state clearly the geological problem and the geophysical methods adopted in an attempt to solve it.

II. Geology of the Roma Area.

The following notes and geological sections which are used for illustration, are based on a recent report by Dr. Frank Reeves ♯, and on discussions with the consultant geologist of the four Companies, Mr. Derek Pitman.

The geological section in the immediate vicinity of Roma is illustrated by the section line (A-A) plate /. which passes North-South through Roma and close to Hutton Creek and Arcadia Bores.

The basement rocks at Roma are intersected at a depth of approximately 4,000 feet and are metamorphic rocks (slates and indurated shales) of indeterminate age. At other places, e.g. AROL No.3 on this Section, and near Blythdale, the basement rock is granite.

Immediately overlying the basement rocks at Roma are moolayember shales of Middle Triassic age and correlated with the Ipswich Series. These shales attain a thickness of over 1,000 feet in places but near Roma itself they are little over 100 feet thick. This variation in thickness can be explained in part by erosion to which they were subjected between the time they were deposited and emplacement of the overlying Bundamba Series (Upper Triassic) upon them. It is believed that this disconformity may be of some significance in relation to possible oil or gas structures and reference will be made to it later in this Report.

The Bundamba Series comprise interbedded sandstones and shales which at Roma have a total thickness of approximately 1,000 feet. These rocks are in turn overlain conformably by Jurassic sandstones and shales and finally by Lower-Cretaceous sediments of marine origin (the Roma Series.)

To the north of the Roma area (see section A-A) in the vicinity of Hutton Creek and Arcadia, there are thick sections of Permian sediment which are probably not present in the immediate vicinity of Roma. It is believed that such oil and gas as has been found in the Roma area has migrated from Permian rocks which lie outside the area under discussion. However, nothing is known of the geological section well to the south of Roma and Permian source beds could exist there. It is possible also that the so called basement slates and indurated shales encountered at several places in the Roma area are of Permian age and that their metamorphism is due to - or took place at about the same time as - intrusion of granite of late Permian or early Triassic age. There is at present no fossil evidence to support this possibility but granites of this age intrude Permian rocks at many places in Queensland. That oil and gas have migrated into the Roma area seems probable because none of the rocks in the immediate vicinity are likely source beds.

According to Dr. Reeves, the main showings of oil and gas in the Roma area came from quartz-pebble grits and coarse grained sandstone near the base of the Bundamba sandstones At Blythdale most of the showings are in coarse quartz-pebble conglomerate and weathered granite overlying the granite basement. Apparently therefore the most favourable structures for oil and/or gas accummulation are those developed in the Bundamba sandstone or bedrock highs overlain by weathered granite.

♯ Frank Reeves - Geology of Roma District, Queensland, Australia Bulletin of the American Association of Petroleum Geologist Vol. 31 No.8 Aug. 1947.

III Possible Oil-Bearing Structures in the Roma Area.

As a working principal it has been assumed that if a closed structure can be found at or near the base of the Bundamba sandstone, then this structure would be a favourable one. It is not inferred that such structures would be the only favourable ones. On the contrary, the presence of some oil and gas in the coarse conglomerate and weathered granite immediately overlying granite bedrock suggests that migration may have occurred through such permeable material and consequently any granite hill covered by weathered granite and in turn by impervious shales could conceivably act as a trap. Such a structure could be at the base of the middle Triassic and not necessarily reflected in the Bundamba. Other types of structures could provide traps; for example where sedimentary beds are lenticular as they appear to be in the Roma area, a porous sandstone grading laterally into impervious shale, or perhaps pinching out against a basement hill or ridge could provide such a trap. However, the most attractive assumption is the first one mentioned, namely, that a closed structure at or near the base of the Bundamba sandstones would be favourable for the accumulation of oil and/or gas. It is proposed therefore to consider briefly the probability of such a structure existing and if it does exist, what geophysical technique can be used to find and map it.

One possibility is that the Bundamba sandstones have been involved in what David calls the epi-Permian folding of late Permian and early Triassic age. To the north of Roma the Permian strata are folded into several pronounced anticlines, notably the Serocold, Consuello, Woolsack and Arcadia anticlines.

At Hutton Creek, Triassic strata overlying the Permian are mildly folded into an asymetric dome, called the Hutton Dome, which has a closure of 200-300 feet. According to Dr. Reeves a plunging anticline, definitely indicated in the Triassic, extends south from the Hutton Dome for at least 20 miles and it it is probable that much more pronounced folding exists in the underlying Permian. Although the absence of pronounced markers makes the mapping of structures in the Jurassic uncertain, the mapping of various beds in the Jurassic indicates that the folding to which the Permian and Triassic strata were subjected was completed before the Jurassic beds were laid down. If this is correct, and there are adequate reasons for believing it, then structures could exist in the Bundamba sandstones (Upper Triassic) which, in the Roma area, would not persist through Jurassic and Cretaceous sediments to the surface.

It is possible that structures of small closure may occur over buried hills or ridges due to differential compaction of the overlying sediments. Such structure could exist in the middle Triassic (Ipswich) strata which immediately overlie basement rocks in the Roma area, but as these are mostly dense shales the chances of a porous bed within such a structure providing a suitable reservoir is not good. If any such structure occurred, moreover, the erosion to which these beds were subjected prior to the overlying sediments being deposited would preclude the possibility of any surface or near surface indication of their presence.

Hills or ridges may be present in the eroded surface of the Ipswich series in which case structures due to compaction folding over them could be present in the overlying Bundamba sandstones. The fact that only a thin section of the Ipswich series remains near Roma suggests the possibility of hills of basement rocks existing above their eroded surface. If structures due to compaction folding do exist in the Bundamba sandstones, it is possible that some sign of them would be visible in the surface rocks. The minor domal structure with

a closure of about 30 feet which, it is claimed, was mapped near Warooby by scout drilling may have signified a closed structure due to compaction folding of the type described, but there seems to be some doubt whether even this near surface structure exists.

The foregoing is not intended to be an exhaustive examination of all possible types of structures, but merely to emphasise that favourable structures can and possibly do exist at considerable depth in the Roma area of which there would be no surface indication and which could only be found by either deep scout drilling with careful logging or by geophysical methods.

Dr. Reeves comments on the absence of suitable key beds in the Jurassic sediments, and the logging of even deep scout bores might be difficult by normal geological means. However, electrical or radio-active logging might prove adequate for determining the structure.

IV. Geophysical methods as applied to the possible structures in the Roma Area.

The seismic reflection method is the one most commonly used for mapping structure at depth. In this method an explosive charge is detonated in the near surface rocks and elastic waves, reflected from the interface between rocks of substantially differing elastic properties, are recorded by sensitive seismographs. Their time of travel is also recorded, and from a knowledge of the velocity of travel in the rocks it is possible to determine the depth to the reflecting surface or surfaces. If any individual or group of reflecting surfaces persists over a large area, it is possible to draw structural contours of the surface or group. Given a suitable reflecting horizon at about the depth at which oil and gas are known to exist and could accumulate, the seismic method provides a direct approach to structural mapping.

The Bundamba sandstone, comprising interbedded shale and sandstone, could contain suitable reflecting horizons, and mapping of structures in it by seismic reflection methods is a definite possibility. However, until field tests are undertaken, it is not possible to predict whether or not such reflections will be obtained. Where the velocities of the various strata are known with high accuracy, as in many oil provinces in the United States, structural closures of as little as 25 feet at a depth of several thousand feet, are readily accepted as suitable drilling targets. However, in an unknown area like Roma, structural closures of the order of 100 feet or more would need to be indicated before reliance could be placed on the results.

The cause of the folding that has produced the structures, e.g. whether it has been caused through lateral thrust as in the Permian and Triassic sediments to the north of Roma, or by compaction folding over buried bedrock highs, is immaterial in the application of the reflection method.

In the less direct approach, by using magnetic, gravity and some application of the refraction seismic technique, however, the cause of the folding is material to the problem.

In some area, where folding has been caused through lateral pressure, the folded sediments are rendered more dense than normal on the crest of the fold and a minor gravity anomaly results. However, any folding in the Bundamba sandstone or Ipswich series due to lateral pressure in late Triassic times would most likely be gentle and the effect mentioned above would be of little significance or use in locating such folds. If on the other hand closed structures exist due to compaction folding

over a core of dense basement rocks, then the presence of this dense core (or basement hill) would give rise to a gravity high. Its size would depend on the dimensions of the hill and the density contrast between it and the overlying sediments. Calculations show that a circular granite hill one mile across the base, 750 feet high at a depth of 3,000 feet would give a rise to an anomaly of 0.5 milligals, whereas a similar hill of metamorphic rocks would give a slightly bigger anomaly. At a depth of 4,000 feet the anomaly would be slightly more than 0.3 milligals. Anomalies of this order should be readily detectable and hills of this magnitude protruding into the Bundamba sandstone could give rise to structures due to compaction folding. It is hoped, of course, that even bigger hills and ridges may exist in the basement rocks, increasing not only the chances of finding them by geophysical means, but also of favourable structures being developed over them.

Results to date.

As mentioned earlier in this report, the work is only in its preliminary stages, although a considerable area has been covered.

An inspection of the gravity and magnetic contour patterns revealed by the work shows that the principal effects cannot be related to any of the known geology and it is tentatively assumed that a pronounced regional effect is present. This regional effect may be due to variations in density or magnetic susceptibility within the basement rocks. However, in the gravity results, this regional effect seems to have a systematic pattern and it is hoped that it will not obscure the anomalies due to variation in thickness of the sedimentary rocks.

The field party will be withdrawn towards the end of the year to carry out a thorough investigation of the results obtained and until this investigation is completed any comment on the results beyond the broad outline given above is not possible.

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Melbourne
December 1st, 1948.

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS.

Reference	G/55-15, 124, 125, 134, 135, 144, 145.
Datum	ROC No 1 Oil bore with assumed value of Royal Aust. Survey Cps. grid.
Survey	Some traverses in and around Roma and along roads to Mt. Bassett.
Reliability	Balance of work plotted from blow up of Royal Aust. Svy. Cps. 4 mile map of area with graphically determined co-ordinates from parish maps and coal property surveys. Levelling accuracy ±1ft. per mile based on State Lands Dept. datum.

R. J. Stroger
(Superintending Geophysicist)

Scale: 2 miles to 1 inch

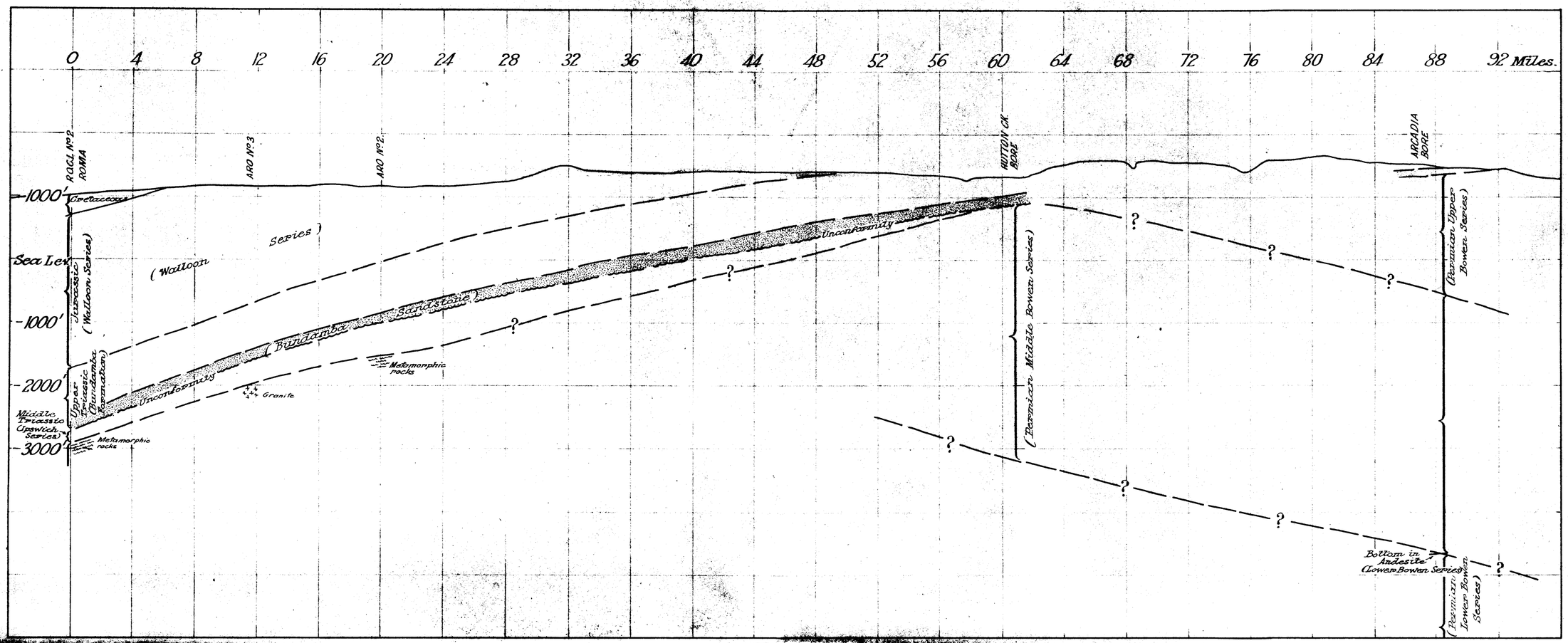
0 1 2 3 4 5 6 7 8

Area covered by detailed gravity and magnetic survey.

Area covered by reconnaissance gravity and magnetic survey.

SKETCH MAP
ROMA, QLD.
SHOWING AREA COVERED BY GEOPHYSICAL SURVEY AS AT 17-9-48

G 38-2



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Note!
Section prepared from information from report by Frank Reeves, "Geology of Roma District, Qld.".

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ROMA QLD.

GEOLOGICAL SECTION AA
DESCRIBED IN REPORT OF
1-12-48.

G38-3