

ROBERTSON RESEARCH (NORTH AMERICA) LIMITED

EXPLORATION REPORT NO. 28

THE MICROPALAEONTOLOGY, PALYNOLOGY AND STRATIGRAPHY OF

PACIFIC ET AL ROLAND BAY L-41 WELL

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INTRODUCTION

This report comprises a summary of the results obtained from the micropalaeontological, palynological and stratigraphical analyses of material received from the interval 10' - 9030' of Pacific et al Roland Bay L-41 Well, under Project No. RRNA/047.

Location of the test is in the Yukon Territory at $69^{\circ} 29' 30''$ N. Lat., $138^{\circ} 56' 55''$ W. Long. The drill site is 16 miles north-northwest of Imperial M-58 Spring River, abandoned March, 1971, at 7009'.

The stratigraphical interval covered by this report ranges in age from Lower Cretaceous to Lower Jurassic, with an overlying cover of Quaternary sediments. The well spudded in a sandstone sequence of Recent - sub-Recent age and subsequently penetrated a seemingly uninterrupted sequence of mudstone, shales and siltstones of Lower Cretaceous, Upper Jurassic, Middle Jurassic, and Liassic ages.

We wish to acknowledge the co-operation and assistance received from the various members of Pacific Petroleum Limited, with whom we have been associated during the course of this work.

A summary of the sequence penetrated in this well can be seen overleaf in Table I.

SUCCESSIONTABLE I

<u>Interval</u>	<u>Thickness</u>	<u>Assemblage Zones/ Formation Equivalent</u>	<u>Age</u>
10' - 50'	+40'	-	Recent - sub-Recent
50' - 410'	360'	-	-
400' - 800'	400'	-	Lower Cretaceous, possibly Albian
800' - 2010'	1210'	-	Lower Cretaceous, undifferentiated
2010' - 3310'	1300'	<u>Glomospira corona</u> Zone	Neocomian, Barremian - ?Hauterivian
3310' - 4200'	890'	<u>G. milleri/leffingwelli</u> Zone	Lower Neocomian
4200' - 6203'	2003'	<u>B. kingakensis/barrowensis</u> Zone	Upper Jurassic
6203' - 6900'	697'	<u>M. phragmites/Lenticulina</u> <u>dilecta</u> Zone	Upper - ?Middle Jurassic, Oxfordian - ?Calloviaian
6900' - 7980'	1080'	-	Middle Jurassic
7980' - 8660'	680'	<u>"L." aspera/silicea</u> Zone	Middle - Lower Jurassic, Bajocian - Toarcian
8660' - 9030' (T.D.)	+370'	-	Lower Jurassic, Liassic undifferentiated

N.B.: The above stated depth figures are in general approximate only; the zonal boundaries are mainly established on evidence derived from cuttings samples.

MATERIALS AND METHODS

Under Project No. RRNA/047, 10' cuttings samples were available from interval 10' - 9030' together with core samples from intervals 2198' - 2221', 2221' - 2258', 3200' - 3235', 4200' - 4230', 5198' - 5228', 6203' - 6223', 7224' - 7254', and 8448' - 8478'. The examination comprised both detailed palynological and micropalaeontological studies. For specific information reference is made to the micropalaeontological analysis charts, enclosures 1 and 2.

A tentative interpretation of the environments of deposition is indicated on the micropalaeontological analysis charts and discussed in the text following Hedgpeth 1957 (see Appendix 1). The interpretation of a probable environment is based on the use of a combination of factors; included are the faunal and floral diversity and dominance; stratigraphic distribution; the comparison of species, genera and assemblages with analogous components in the Recent and fossil record, and the lithological characteristics of the intervals studied. It should be realized that the information is mainly derived from cuttings samples and, therefore, only a generalized interpretation of the environment is feasible throughout the well section.

The prepared samples and recorded information are now curated in the confidential files of the Calgary laboratory of Robertson Research (North America) Limited.

QUATERNARYINTERVAL 10' - 50'; Recent-sub-RecentGeneral Lithology

This unit is lithologically distinct, comprising sands which are composed mainly of quartz grains, together with coal and shale fragments.

Micropalaeontology

The presence of numerous calcareous foraminifera, including Elphidium incertum, E. orbiculare and vars., Elphidiella groenlandica, Nonion depressulua and others, indicates a Recent to sub-Recent age.

The base of the unit has been chosen at the lithological break at 50', rather than on the overall occurrence of the foraminifera, which occur in lower samples but are almost certainly the result of caving.

Palynology

This interval is barren of recognizable palynomorphs.

Environment of Deposition

The foraminiferal association is indicative of a shallow marine, probably littoral, environment of deposition.

INTERVAL 50' - 410'

General Lithology

The dominant lithology in this interval is dark grey shale/mudstone, which may be silty. Some quartz grains also occur, but are considered to be caved from the overlying interval.

Micropalaeontology

With the exception of the caved foraminifera, mentioned above, no microfauna was recorded from this interval, and its age cannot be determined.

Palynology

A few recent palynomorphs are present at approximately 100' - 190'; these may represent either contaminants or are derived from cavings. Some long-ranging taxa, as well as presumably reworked Paleozoic spores, comprise the remainder of the assemblage here. No age diagnostic palynomorphs are observed in this interval.

CRETACEOUS

INTERVAL 400' - 800'; lower Cretaceous, possibly Albian

General Lithology

This interval comprises a succession of dark grey shales, mudstones, siltstones and rare fine grained sandstones.

Micropalaeontology

The uppermost samples from this interval, down to 600', contain a restricted agglutinating foraminiferal fauna, comprising large Ammodiscus sp., together with Trochammina spp., some of which have been designated Trochammina sp. "410", Haplophragmoides sp., and several indeterminate forms. This microfauna suggests a late Lower Cretaceous age, which supports the tentative palynological age determination below.

Samples from the lower part of the interval are barren.

Palynology

The very few palynomorphs isolated from this interval, including Klukisporites cf. foveolatus, aff. Klukisporites variegatus, and Lycopodiumsporites cf. reticulumsporites, suggest a Lower Cretaceous age. This determination can possibly be refined due to the presence at 710' - 790' of a spore comparable to Cicatricosisporites annulatus, a palynomorph typical of the Albian strata. The highly carbonized and corroded nature of the palynomorphs in this and subsequent intervals, however, makes positive determinations of the various taxa difficult at best.

INTERVAL 800' - 2010'; Lower Cretaceous, undifferentiated.

General Lithology

As in the overlying unit, a monotonous succession of dark grey, fine grained clastic sediments comprise this interval.

Micropalaeontology

This entire interval can be regarded as virtually barren of foraminifera; only one specimen of Haplophragmoides sp., was recovered.

An undifferentiated Lower Cretaceous age has been assigned to this interval, based on its stratigraphical position.

Palynology

With the exception of an occasional long-ranging palynomorph, this interval is barren.

Environment of Deposition

The interval from 50' to 2202', composed mainly of mudstones and shales and practically devoid of both microplankton and foraminifera except for interval 400' to approximately 580', suggests deposition in supralittoral and littoral environments.

INTERVAL 2010' - 4200'; Lower Cretaceous; Barremian - Hauterivian 2010' to 3310',
Lower Neocomian 3310' to 4200'

General Lithology

This interval continues the succession of dark grey shales, mudstones and siltstones. Core #2 exhibits a sandy interval between 2246' and 2254', and Core #3 proved to be pyritic, especially near the base at 3235'.

Micropalaontology

In the interval from 2010' to 2202', the top of Core #1, a restricted assemblage was found, with species of Glomospirella and Haplophragmoides. This may be part of the underlying assemblage zone.

Diverse agglutinated foraminiferal assemblages characterize Core #1 and #2 and the underlying cuttings samples. Large numbers of Bathysiphon spp., B. brosgai, B. vitta, Ammobaculites spp., Haplophragmoides spp., Glomospira corona group, together with Glomospicella spp., G. cf. gaultina, Reophax spp., Lituotuba spp., Saccamina spp., and rare calcareous forms are present in the upper part of this interval. This upper unit has been designated the Glomospira corona Assemblage Zone, based on the dominant foraminiferal species.

In the unit from approximately 3400' to the base of the interval at 4200', several new species of foraminifera dominate the microfaunas. Most notably, these are Gaudryina milleri/leffingwelli, Haplophragmoides kingakensis/barrowensis, both of which occurred very sporadically above, Ammobaculites alaskensis/barrowensis, Recurvooides spp., Trochammina globigeriniformis, T. canningensis and the calcareous form Epistominina aff. sp. 5. Genera and species recorded from the overlying unit continue to occur but in less significant numbers. This lower unit has been designated the Gaudryina milleri/leffingwelli Assemblage Zone, as this group of species occurs persistently through the unit and only sporadically above and below.

Few ostracoda are present in this interval. The forms present include Doloccytheridea? sp. 3, and Monoceratina? sp. 3 which suggest a Neocomian age at approximately 3600'. The presence of Kirkbyacea gen. indet./sp. 1 and Hungarella spp., from Core #1 and lower cuttings samples respectively, would indicate in view of the other evidence, reworking of Triassic sediments at these levels.

This interval has been dated as Lower Cretaceous, Neocomian based primarily on the microfaunas present. The Glossosira corona Assemblage Zone shows considerable similarity with the microfaunas described from the Mount Goodenough section by Charney (1969), which was dated as Barremian. This interval is regarded as Upper Neocomian in age, Barremian and possibly Hauterivian. The lower unit, the Gaudryina milleri/leffingwelli Assemblage Zone, has been identified in samples from the Canadian Arctic, and is generally Lower Cretaceous - uppermost Jurassic in age. The base of this zone, possibly as low as 4400' may be Jurassic in age, but it is predominantly Lower Cretaceous, Lower Neocomian in age.

Palynology

A marked improvement in the quality of preservation of the palynomorphs is observed in the section below 2100'. Typical Lower Cretaceous to Jurassic forms such as Tsugaepollenites dampieri, Eucorniidites troedssonii, Periapollenites elatoides and Cerebropollenites mesozoicus, are found associated with the Upper Neocomian, dinoflagellate taxon Pseudoceratium? nudum. Corrugatisporites amplexiformis, a spore most abundant in the Middle and Lower Jurassic, but occasionally found in strata as young as the Neocomian, is present at 3100' - 3190'.

In addition to the dinoflagellate mentioned above, this interval contains the microplankton taxa Chlamydothorella sp. and Pterospermopsis cf. australiensis, both abundant in the Lower Cretaceous of Arctic Canada. Microdinium opacum, an Albian to Upper Neocomian dinoflagellate, is abundant in Core #2, as are various species of Canningia, a dinoflagellate genus frequently encountered in the Lower Cretaceous of the Canadian Arctic.

Environment of Deposition

The character of the microfaunal assemblages present in a nearly uninterrupted sequence of mudstones, shales and siltstones suggests deposition in inner and outer sublittoral environments; outer sublittoral depositional environment is probably predominant in the interval from 2202' to 3300', expressed by the concurrence of abundant specimens of Glomospira, Glomospirella and Bathysiphon species. These genera are presently known to occur in outer shelf and bathyal environments.

JURASSIC

INTERVAL 4200' - 6203'; Upper Jurassic

General Lithology

The lithology of this interval is similar to that above. However, the two levels from 4600' to 4920' and from 5420' to 5710', there are large amounts of loose quartz sand in the shale/sandstone, and at the higher of the two levels, the shales grade into very fine grained argillaceous sandstones. Pyrite occurs sporadically, notably around 4600' and in the interval from 4920' to 5410'.

Micropalaeontology

In this interval, which has been designated the Haplophragmoides kingakensis/barrowensis Assemblage Zone, relatively few species occur for the first time. The microfaunas are dominated by H. kingakensis/barrowensis, Haplophragmoides spp., Trochammina spp., Reophax sp., and Ammobaculites alaskensis/barrowensis. The assemblages are therefore restricted in their diversity, especially below 4800'. Among the foraminifera recorded for the first time in this interval are "Involutina" orbis, Ammobaculites aff. vetusta, Reophax suevica/densa and Trochammina sp. 9, and these are most commonly Jurassic in age.

The interval from 5980' to 6203' proved to be virtually barren of foraminifera. It is included in the Upper Jurassic, primarily on its stratigraphical position, but is, however, excluded from the assemblage zone.

Palynology

Typical Jurassic-Cretaceous palynomorphs, such as Obtusisporites juncta, Osmundacidites wellmanii, Classopollis clavigoides, Cyathidites australis, Perinopollenites elatoides, Dictyophyllidites mortoni, Todisporites minor, Lycopodiumsporites austroclavitudites, etc. dominate the pollen assemblages of this interval. Chomotriletes fragilis and forms attributable to Cicatricosisporites are also encountered. C. fragilis is more indicative of the lowermost Cretaceous, although it quite possibly extends into the Upper Jurassic. Cicatricosisporites, although commonly found in the Cretaceous, does indeed extend down into the Upper Jurassic. Specimens attributable to the Lower Cretaceous to Middle Jurassic dinoflagellate, Paroodinia ceratophora, have also been found here.

Environment of Deposition

The depositional environments of the sedimentary sequences in this interval appear to fluctuate from predominantly littoral to mainly inner sublittoral as indicated on the microfaunal distribution chart, enclosure No. 1.

It is probable, as expressed by both microfaunal distribution and lithofacies, that littoral environments are especially predominant in approximate intervals 6203' - 5980', 5710' - 5420', 4920' - 4600'. The remaining intercalated sections show a more marine, inner sublittoral, aspect.

INTERVAL 6203' - 6900'; Upper - Middle? Jurassic, Oxfordian - Gildovian?

General Lithology

Dark grey to black shales/mudstones, which contain isolated lenses of

sand/sandstone continue through this interval.

Micropalaeontology

This interval is marked by microfossils which are dominantly agglutinating but with more diverse and more numerous calcareous foraminifera. Several of these calcareous forms are diagnostic of the Oxfordian-Callovian interval, and they include Lenticulina cf. dilecta, L. dilecta, L. cf. audax, Nodosaria lirulata, Marginulina prima and Marginulinopsis phragmites. The most abundant forms are species of Ammebaulites and Haplophragmoides which are also present in the overlying interval, and also Lenticulina spp.

Palynology

Highly carbonized long-ranging palyomorphs, such as Vitreisporites pallidus, Alisporites sp., Stereosporites antiquasporites, Distalanulisporites sp., etc., comprise the major part of the assemblages in this interval. Chomotriletes minor, possibly restricted to the Middle to Upper Jurassic, is found at 6600' - 6690'.

Environment of Deposition

Mainly inner sublittoral environments of deposition prevail in this part of the well section. The substantial number of calcareous specimens, mostly lenticulines, tends to suggest deposition under more favourable, open marine conditions; this is probably also associated with a relatively slower rate of deposition.

INTERVAL 6900' - 7980'; Middle Jurassic

General Lithology

Dark grey shales/mudstones like those above continue through this interval.

Micropalaeontology

Species of Ammobaculites and Haplophragmoides increase in abundance in this interval. They are associated with an otherwise very restricted microfauna, comprised mainly of forms recorded above.

The microfaunal evidence supports the Middle Jurassic age determination, based on palaeontological evidence and the stratigraphical position of the interval.

Palynology

As with the above interval, the pollen assemblages here are comprised mainly of such long ranging taxa as Osmundaecidites wellmanii, Lycopodiumsporites austroclavaticidites, Stereosporites antiquasporites, etc. The presence of Neoraistrickia cf. gristhorpensis at 7400' - 7490' tentatively suggests a Middle Jurassic age for this interval.

Environment of Deposition

The section from 6900' to total depth at 9030' contains an impoverished microfossil assemblage and the interpretation of depositional environments can therefore only be of a tentative nature. In conjunction, however, with the presence of a nearly continuous sequence of shales and mudstones, a littoral to inner sublittoral environment of deposition is suggested to occur.

INTERVAL 7980' - 8660'; Middle - Lower Jurassic, Bajocian - Toarcian

General Lithology

Dark grey to black shales/mudstones are present in this interval.

Micropalaeontology

This interval is characterized by the presence of "Involucina" aspera/silicea in a microfauna which closely resembles that from the overlying interval, although fewer specimens are present.

Although a long-ranging species, "Involucina" aspera/silicea often appears to reach an abundance peak in Bajocian - Toarcian times of Arctic Canada and it is this acme which is distinguished here.

Palynology

As with the preceding intervals, the palynofloras here are sparse, highly corroded, and comprised of such long-ranging palynomorphs as Stereisporites antiquasporites, Cyathidites australis, Podocarpidites sp., Vitreisporites pallidus, etc. A fragment, possibly attributable to the Jurassic dinoflagellate genus Nannoceratopsis, occurs in Core #8 (8448').

INTERVAL 8660' - 9030' (T.D.); Lower Jurassic, Liasic undifferentiated

General Lithology

Black shales continue to the base of the well. The presence of some quartz sand in the lowest sample may be the result of caving.

Micropaleontology

This interval is characterized by restricted microfossils dominated by forms occurring in the overlying strata, so that their occurrence in this typically poorly fossiliferous unit may be due to caving. The only species recorded for the first time in this well from this interval is Nodosaria regularis at 8660' - 8710' which has been described by Tappan (1955) from shales of "Late Pliensbachian age" in North Alaska.

Palynology

With the exception of a few long-ranging palynomorphs and some highly corroded, carbonized, and thus unidentifiable spores, this interval is barren.

STRATIGRAPHICAL REMARKS

A presumed uninterrupted sequence of Jurassic and lower Cretaceous mudstones, shales and minor siltstone occurrence characterizes the Roland Bay L-41 Well. A relatively high rate of shale deposition, in a predominantly inner sublittoral environment, contemporaneous with a basin floor subsidence, may explain the presence of massive sequences of shales and mudstones. The microfaunal associations in the well section from approximately 3300' to 2200' probably express the most distinctly marine aspect of a transgressive phase; a deep water, open marine, environment, i.e. outer sublittoral, is visualized during deposition of the shales and mudstones in this interval of the well section.

The palynomorph assemblages are rendered of limited biostratigraphical value by a high degree of organic metamorphism. This carbonization effect, observed throughout the drilled section, precludes exact age determinations based solely on palynological evidence. Repeated macerations of sample material using different techniques, however, occasionally resulted in the retrieval of recognizable forms.

The microfaunal distribution in this well appears more conclusive; several distinct and regionally recognizable microfaunal assemblage zones are established; although not entirely restricted to certain stages, they proved, nevertheless, datums from which remaining depositional intervals can be observed.

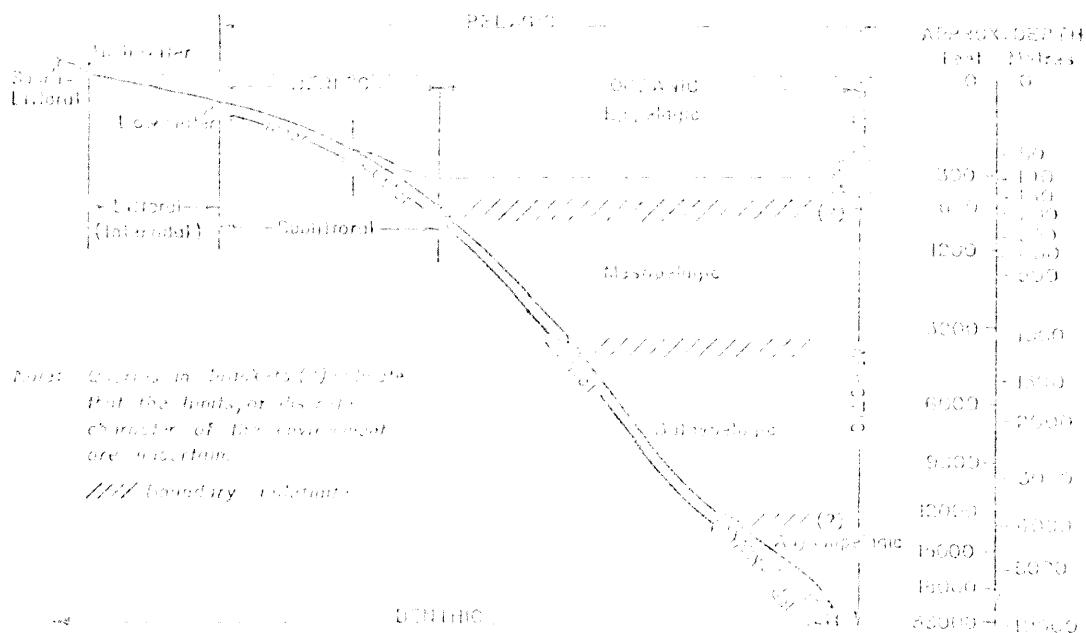
Lower and Middle Jurassic sequences (9030' - 6900') are considered to represent marine Bug Creek Formation shale equivalents.

The Middle but mainly Upper Jurassic shales and minor sandstones, (6900' - 3300') can be correlated with the Husky Formation; the section from approximately 6900' to 6200' presumably represents an expression of the early Husky Formation transgression, whereas, the interval from 6200' to 4200' shows, both through lithofacies changes and microfaunal impoverishment, that regressive pulses occur from approximately 5980' to 5400' and from 5000' to 4600'.

From 4200' to 3300' a characteristic and often prolific Lower Neocomian microfaunal assemblage is observed, probably representing a stratigraphically younger marine expression of the Husky Formation.

The "upper shale/siltstone division" of Hauterivian - Barremian age (Jeletzky 1958, 1960, 1961), and the "shale/siltstone division" of Albian age are represented at 3300' - 400'. The sequence of sedimentation is completed with a cover of sandstones of Quaternary age.

CLASSIFICATION OF MARINE ENVIRONMENT



The classification of marine environments used in this report is presented in diagrammatic form above. Pelagic (water) and Benthic (bottom) environments are recognized.

PELAGIC

- Narctic
- Oceanic
 - Epipelagic
 - Mesopelagic
 - Bathypelagic
 - Abyssal

BENTHIC

- Supralittoral
- Littoral (Intertidal)
- Sublittoral
 - Inner
 - Outer
- Bathyal
- Abyssal
- Hadal

The classification is after Hedgpeth (1957) and results from several years discussion by a Committee of the Division of Earth Sciences, National Research Council, National Academy of Sciences, Washington, D.C.

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