COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1963/167

STUDY OF THE NELSON BORE SEDIMENTS,

OTWAY BASIN, VICTORIA

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CONTENTS

ILLUSTRATIONS

TEXT FIGURES

PLATES

SUMMARY

The petrological study of these sediments has revealed some new information concerning the conditions of sedimentation in the Nelson Bore area, and the mineral constituents and cementing media of the sediments.

The Nelson Bore sediments have been divided into the following informal units:-

Unit Bb (equivalent to Mt Gambier Formation)
Unit Bc (equivalent to Nelson Formation)
Unit Db (equivalent to Dartmoor Formation)
Unit Dd (equivalent to Bahgallah Formation)
Unit Gb
Unit Gd (equivalent to Paaratte Formation)

Marine conditions prevailed during the deposition of sediments in Unit Gd time and these were followed by deltaic-type conditions during Unit Gb time. Unit Dd sediments indicate shallow water transgressive conditions but a reversion to a paralic environment occurred during Db time. Another shallow marine transgression occurred during Bc time; this was followed by marine shelf conditions during which Unit Bb sediments were deposited.

A major unconformity has been recognized at the base of Unit Bc at 992 feet. Other possible breaks may occur at the base of Unit Dd at 3746 feet, and around 4500 feet where weathered kaolinite occurs.

I. INTRODUCTION

The Nelson Bore was drilled in the Otway Basin, and near the town of Nelson, in Victoria - approximately 270 miles by road west of Melbourne, and 3 miles from the Victorian-South Australian border. It was sited about 250 yards west-north-west from the western edge of the bridge over the Glenelg River, ¼ mile west of the Nelson township (Lat: 38°03' 20"S, Long: 141°00'10"E). The precise position of the bore is given in the Boring Records of Victoria (D.M.V., 1946).

This bore was drilled to test the possible presence of a structure and a stratigraphic sequence which might be suitable for oil accummulation. The project was financed by the Commonwealth and Victorian Governments. Rotary drilling operations commenced in 1941 and the well was abandoned in 1945 at a depth of 7305 feet without any hydrocarbon shows being encountered.

The current study of the Nelson Bore sediments was undertaken as part of the review of the Otway Basin by the subsurface section of the Petroleum Exploration Branch, Bureau of Mineral Resources (B.M.R.). All the core and cuttings samples held in the B.M.R. collection were examined - amounting to 365 core and 83 cuttings samples. The cores range in diameter from 2 inches in the upper part to approximately 1½ inches near the bottom of the bore; the lengths of the core samples range from ½ inch to 2 inches. Though the Nelson Bore was fully cored (Crespin, 1954) gaps of up to 200 feet occur in the material available for study. These gaps are due to non-recovery of cores and occur mainly below 4000 feet. The deepest core sample recovered was from 6999 feet; below this level only cuttings are available. Although a total of 957 feet 4 inches of core was initially recovered (Baker, 1961), only 47 feet is now available at the B.M.R. Core and Cuttings Laboratory for study.

Work carried out on the sediments includes a binocular microscopic examination of all the available material and thin section analysis of selected cores and cuttings (see Appendix 1.). A calcimetry log was prepared for the carbonate sequence. Staining tests for phosphate and potash feldspar were carried out on selected samples. X-ray examination of clay matrices in sandstone at 4920 and 4500 feet were undertaken.

II. PREVIOUS INVESTIGATIONS

The first description of the sediments of the Nelson Bore is given in the Boring Records of the Department of Mines, Victoria, (D.M.V., 1947); this is a very generalized (drillers) log but useful for providing information in the gaps which occur in the material now available (see Appendix 1 and Plate 2).

Crespin prepared preliminary reports on the microfossils (Crespin, 1947, and in Reeves & Evans, 1949), and her final report (1954) gives descriptions of bore samples and their foraminiferal content. Her stratigraphy is summarized and compared with the work of others including our own determinations in Plate 3. Boutakoff and Sprigg (1953) briefly discuss the Nelson Bore sediments in relation to the geology of the "Mount Gambier Sunklands"; although they are not formally described, several new stratigraphical units are named in this paper; "Bahgallah and Dartmoor Formations", "Nelson Formation" and others.

The results of studies of the microflora and microplankton of selected samples from the Nelson Bore by Cookson and others are incorporated in a paper by Baker and Cookson (1955). Upper Cretaceous marine microfossils were recognized below 4500 feet. The Upper Cretaceous and Lower Tertiary was later divided into 3 zones by Douglas (1961) on the basis of microplankton (Deflandreidae).

Baker's (1961) work on 98 selected samples from the Nelson Bore was mostly a detailed study of the sedimentology; a small chapter (p. 9) outlines the geology of the Nelson region.

III. DESCRIPTION OF LITHOLOGICAL UNITS

The sediments in the Nelson Bore have been divided into lithological units based on their composition and texture. It was considered that this would simplify correlation work in the future. All the boundaries of these units were delimited by observed lithological changes shown in the samples; however, the gaps in the material available makes these boundaries somewhat tentative. Unfortunately no electrical log was run in this hole.

The detailed rock descriptions are given in Appendix 1. The lithologies are also shown on the composite well log (Plate 1, Sheets 1 and 2) and in summary form on Plate 2. A letter/number system has been adopted to designate the lithological units in the Nelson Bore, and these are compared with the stratigraphical divisions of other workers, in Plate 3. The stratigraphic names which we consider are equivalent to our informal units are also shown in Plates 1 and 2, and left hand column of Plate 3.

UNIT G

In the Otway Basin Unit G represents the section which lies between the major unconformity at the top of our "Unit J" (equivalent to the Waarre Formation) and the unconformity at the base of Unit D (the rocks of which comprise the Knight Group - mainly sandstones and carbonaceous siltstones). Unit G may include equivalents of the Flaxmans Beds, Belfast Mudstone, and Paaratte Formation.

In the Nelson Bore two subdivisions, Gd and Gb, have been recognized.

Unit Gd

In the Nelson Bore Unit Gd occurs from 7305 (T.D.) to 4500 feet and consists mainly of sandstones. On micropalaeontological evidence (Baker and Cookson, 1955), Gd is Upper Cretaceous in age, at least in part.

Further subdivision has been possible into Gd_2 (7305 to 5708 feet) - compact sandstones with carbonate cement and silty matrix, and Gd_1 (5708 to 4500 feet) - cleaner sandstones with kaolinitic matrix.

Sub-unit Gd_2 - 7305 to 5708 feet

Lithology: Sandstones form the dominant lithology of sub-unit Gd_2. Those in the upper part are dirty with clay and silt matrices; they are generally moderately to poorly sorted. In the lower part of the sequence (7305 to 6129 feet) the sandstones are cleaner, compact, cemented and moderately to well sorted. The sediments are fine-grained in the lower part of the sequence but became more coarse-grained in the higher intervals. The finer grained sediments show a marked degree of angularity of the grains whereas the coarser grained sediments possess subangular and rare subrounded grains.

Mineral Constituents: The major constituent of the sandstones is quartz, (strained quartz, metaquartzite together with minor chalcedony) and it forms 72 to 78 percent of the rock. Orthoclase, microcline and albite are rare, generally forming only 5 percent of the constituents, and at 5861 feet, 10 percent. Lithics occur in minor amounts - 2 to 10 percent - and consist mainly of chlorite, chlorite schist, and quartzite.

The chlorite is present in the form of ovoid pellets and as isolated granules. An abundance of these pellets, which range from very pale green to green, occur in a fine to medium-grained sideritic sandstone from 5784 to 5782 feet and in a medium to coarse-grained siderite-cemented sandstone at 5914 feet. The chlorite in pellets is pale green where occurring with siderite cement; in uncemented sections chlorite is present as green granules. The pellets are thought to be of detrital origin - unlike the chlorite occurring in the matrix which is definitely authigenic. Some of the pellets have been squeezed and altered. Proof of some late alteration of chlorite is to be found in a sandstone at 6418 feet, where kaolinite, which is the alteration product of a chlorite pellet, transgresses into the adjacent siderite cement. Glauconite occurs as well as chlorite, but is not as common.

Micas occur in minor amounts (1 percent), muscovite predominating over biotite. In thin section some of the micas show a marked degree of bending and squeezing. Biotite ranges from fresh brown flakes through various stages of alteration to bleached end stages (Baker 1961). At 6233 feet biotite flakes carry numerous minute rhombohedra of dolomite (Baker, op. cit.); the dolomite is part of the authigenic cement.

Pyrite occurs as an authigenic mineral in the form of crystal aggregates, and as finely disseminated crystals in the matrix and on quartz crystal faces. It is closely associated with carbonaceous horizons. A small amount of collophane occurs in a carbonaceous shale lamination at 6751 feet

Accessory minerals include zircon, tourmaline and rutile. Baker has also recorded rare occurrences of cassiterite, andalusite, kyanite, hornblende, garnet and epidote, together with considerable amounts of opaque minerals (6296 feet and 6520 feet).

The cementing media consist chiefly of siderite with dolomite, pyrite, rare chlorite and silica, and minor amounts of kaolinite matrix. The cement and matrix of the compact sandstones constitute 10 to 25 percent of the rock. The friable sandstones contain detrital clay and silt matrices.

Lithification: It is evident that in many of the sandstones there has been little change in composition and texture since deposition, for most of the sandstones contain detrital clay and silt matrices. The only changes that have affected the composition and texture after deposition have been due to the cementation of the coarser grained sediments during diagenesis.

In the indurated sandstones, the cementing medium is generally siderite, with minor amounts of calcite, dolomite and pyrite. The siderite appears to have been deposited as a primary precipitate. The observation that these sandstones have been cemented during early diagenesis is borne out by the presence of "floating" quartz grains in the fine-grained siderite cement; some quartz grains have been corroded. A relationship appears to exist between the chlorite pellets and the siderite-cemented sandstones, for where the chlorite pellets make up at least 5 percent of the mineral constituents, siderite forms the primary cement.

Between 6485 and 6298 feet there is evidence that dolomitization occurred after the precipitation of siderite. This is shown by siderite occurring along detrital grain boundaries with dolomite having crystallized out between the siderite rims. At 6336 feet dolomitization was accompanied by recrystallization of pyrite as a cement. Pyrite-cemented sandstones also occur at 6999 and 7231 feet.

Some authigenic quartz was recognized and, in some parts, encloses sideritic material. At 5914 feet, compaction of the sandstone after cementation is shown by microstylolites which have formed by pressure solution along quartz grains.

Baker (op. cit.) also mentions the presence of phosphate cement (collophane) in nodular form at 6192, 6236 and 6298 feet in sandy sediments.

Sedimentary structures: Observed bedding characteristics showed mainly thin sub-horizontal beds with some laminated micaceous and carbonaceous shales and claystones - particularly between 6300 and 5835 feet. Some laminations are wavy and at 6067 feet convolutions occur. Cross-bedding of the planar type (McKee and Weir 1953) with a low angle (5 to 10 degrees) and emphasized in part by carbonaceous shale laminations and very fine-grained thin sandy interbeds, occurs between 6250 and 5900 feet.

Structures which appear to be associated with slumping are particularly well marked between 6751 and 5782 feet. Such structures consist of "curled up", thin, clean, fine-grained sand lenses in a dark siltstone. It is suggested that these structures formed as follows:-

(i) Sand lenses, with shaly laminations along outer margins, were laid down in the siltstone during sedimentation.

(ii) Some lateral movement of the sediments, while still in the plastic state, caused the sand lenses to fold over on themselves.

(iii) Subsequent compaction of sediments caused flattening of the "curled up" sand lenses, accompanied by extrusion of silty material, from within the overfold, through a narrow gap.

In other places thin, clean fine-grained sandstone occurs in silty sediments in lenses similar to the "sand nests" of Bouma, (1962). "Sand nests" are rounded bodies of clean quartz sand enclosed in a bed of fine sand and are thought to have resulted from sporadic turbulent conditions in an area where fine material was being deposited under quiet conditions.

Fine to medium-grained, silty carbonaceous sandstones show churned bedding and unusual markings between 6754 and 6000 feet. These markings consist of irregularly branching tubes - 3 mm. in diameter - of fine clean sands and occur along the bedding. It is thought that they represent burrows from which organic material has been extracted.

Baker (1961) refers to similar markings which occur in sediments in the Princetown area and which he attributed (1953) to burrowing organisms.

Sub-unit Gd_1 - 5,708 to 4,500 feet

Lithology: Sandstones are again dominant throughout sub-unit Gd_1; they are well washed, quartzose and contain a clay matrix with minor amounts of cementing medium. Fine to medium-grained mature lithic sandstones - protoquartzites (Pettijohn 1957) or mature subgreywackes (Folk 1961) - predominate and these are compact (cemented) to friable, and well sorted; some coarser sediments occur but are poorly sorted. The angularity of grains making up the fine sediments is high, but the coarse sediments contain, principally, subangular to subrounded grains. Between 5,400 and 4,500 feet feldspar is present and some subarkoses (Pettijohn op. cit.) occur.

Mineral Constituents: The chief mineral constituent of the sandstones is quartz, (including metaquartzite, stressed quartz, rare chert and chalcedony), and it makes up from 75 to 86 percent of the rock. Feldspar-orthoclase, microcline and albite - constitutes 5 to 10 percent of the sandstones. Lithics range from 2 to 10 percent and consist of chlorite, quartzite and rare schist fragments.

The chlorite, which occurs in the form of pellets, shows some alteration to kaolinite and some of the pellets are squeezed. Biotite and muscovite occur more commonly (rare to 5 percent) in these sandstones than in sub-unit Gd_2. Both squeezed and shredded muscovite are common features.

Both authigenic glauconite and pyrite are present, with glauconite occurring as scattered grains, and pyrite being in the form of finely disseminated grains, aggregates, and as crystals on quartz grains.

Accessory minerals include tourmaline and zircon which are common throughout, and restricted occurrences of staurolite, garnet and collophane. In addition to these minerals, opaque minerals occur together with rare rutile and epidote (Baker, 1961).

The cementing media consist mainly of kaolinitic clay with siderite, dolomite, calcite, silica and pyrite being present in lesser amounts. The matrix and cement constitute 10 to 25 percent of these sandstones.

Lithification: Cementation of the sediments occurred during diagenesis, mainly by kaolinite but some silica and carbonate cement was noted; some lithification in the finer grained sediments was a result of compaction.

Kaolinite is an important matrix-forming constituent as some if not all was deposited with the detrital grains. It is generally poorly crystallized but where recrystallization has taken place well-developed kaolinite books occur. Powdered clay samples from sediments at 4,500 and 4,920 feet were submitted for X-ray diffraction analysis. Dickite - kaolinite peaks were obtained from the sample at 4,500 feet, but pure kaolinite only was indicated from the sample at 4,920 feet (Pers.comm.S.C.Goadby B.M.R. Laboratory).

At 4,809 feet the sandstone is cemented by pyrite and minor amounts of phosphatic matter which appear to be - in part at least - depositional in origin; there is no evidence to show that the pyrite is a replacement of an earlier carbonate cement. However, minor amounts of recrystallized dolomite do occur as a later diagenetic precipitate. Etching of some quartz grains is apparent in pyrite-cemented sandstones, the embayments being filled with pyrite. The quartz grains appear to be floating - showing little grain contact - except where a little welding of some quartz grains has occurred.

At 4,792 feet sideritic clayey lenses occur in a sandstone with calcite cement. The lenses probably formed from sideritic muddy layers that were squeezed, partly as a result of pressure from above and partly due to the crystallization of calcite cement during diagenesis. Other features present include quartz overgrowths, pressure solution effects, and bending of mica along quartz interfaces - all indicating the importance of pressure.

In most of the other sandstones between 5,708 and 4,500 feet, kaolinite occurs together with minor amounts of silica cement; both minerals are thought to be of depositional origin. However, in some other cases the origin of the kaolinite and silica cement is not clear due to the diagenetic changes that have taken place. Quartz overgrowths are present in these sandstones, some growths occurring during early diagenesis and others forming at a later stage. However, where carbonate cements are also present many of the overgrowths are corroded. Quartz welding also occurs in these sandstones.

Due to diagenetic changes the initial porosity of the sandstones of sub-unit Gd_1 has been considerably reduced, in many cases to less than 10 percent.

Sedimentary Structures: Laminations are common between 5,708 and 4,700 feet and consist of thin (0.25-1mm.) carbonaceous siltstone and dark carbonaceous micaceous shale layers within fine to medium-grained quartzose sandstone. Cross-bedding of the simple type (McKee & Weir, 1953) with a low angle (10 degrees) and marked by thin carbonaceous shale laminae occurs at 4,792 feet.

Scour-and-fill is present at 4,792 feet in the form of a channel, with a concave base and flat top, filled with fine-grained sand and clay material, the scour is through thin laminations in the sandstone.

Unit Gb - 4,500 to 3,746 feet

This unit has been differentiated from the underlying Unit Gd by a marked increase in the argillaceous content in the sequence in the form of interbedded shales and siltstones, and by the marked increase in the carbonaceous matter. On micropalaeontological evidence Gb is Lower Tertiary (Palaeocene to Lower Eocene) in age. This unit is overlain (unconformably) by Unit Dd.

Lithology: Sandstones with subordinate interbedded shales and rare siltstones occur in Unit Gb. The sandstones are friable, quartzose and contain a clay matrix; subangular to subrounded, medium to very coarse-grained, moderately to poorly sorted sandstones predominate. The shales are compact, fissile, with some sand laminations and are carbonaceous. At 3,850 feet a reddish-brown, sandy, haematitic siltstone occurs.

Mineral Constituents: The major constituent of the sandstones is quartz; most grains between 4,209 and 4,180 feet are ironstained. Feldspar is rare, as also lithic fragments. Muscovite flakes are present in most of the sandstones. Authigenic pyrite occurs in the form of disseminated grains. Accessory minerals include rare tourmaline and zircon, together with the opaque minerals and rare garnets observed by Baker (1961).

No cementing media were observed in these sediments although Baker (1961) mentioned a phosphatic silty mudstone at 4,366 feet. He also records the presence of carbonate in silty mudstones at 4,025 and 4,366 feet.

Lithification: The major changes which took place in this sequence after deposition were in the form of compaction, especially in the argillaceous sediments. There is little indication that cementing media existed in these sandstones, although depositional haematite forms the matrix of the compact siltstone at 3,850 feet.

Sedimentary Structures: Laminations occur between 4,302 and 3,747 feet and consist of fine-grained clean sand. Scour-and-fill occurs at 3,850 feet in red siltstone. The base of the scour is concave and filled with very fine-grained clean sand.

Environment of deposition of Unit G: The accumulation of predominantly arenaceous sediments throughout Unit Gd is thought to have taken place in a shallow water inner neritic marine environment; isolated marine organisms, carbonate cement, kaolinite, chlorite, pyrite and to a lesser extent glauconite occur in these sediments. The presence of potash feldspar in the sandstones from the upper part of Unit Gd would indicate rapid erosion, transportation and burial.

Below 5,708 feet the sandstones are cemented with siderite and dolomite which would indicate that the pH conditions were suitable for the precipitation of carbonate. Above 5,708 feet, however, kaolinite becomes the important bonding mineral in the sandstones with only very minor amounts of carbonate cement, suggesting a change from alkaline to more acid conditions together with a decrease in marine influence.

At 4,500 feet the kaolinite appears to be weathered; this was borne out by the X-ray pattern of a clay sample at 4,500 feet where a mineral presumed to belong to the kaolinite group and thought to represent a possible weathering product was identified. This weathered zone may indicate an unconformity at the top of Unit Gd, but there is no indication of an angular unconformity, as such.

Unit Gb, which consists of sandstones and shales, represents a regressive facies where marine conditions were being replaced by a paralic environment and deltaic conditions. This change is marked by an influx of carbonaceous matter. Quiet reducing conditions existed during the sedimentation of carbonaceous shales.

At the top of Unit Gb another change appears to take place, where a transgressive facies exists. Although there is no physical evidence for the existence of an angular unconformity between Unit Gb and the overlying Unit Dd an erosional unconformity at least, is thought to occur.

Stratigraphic Relationships: The age relationship between Unit Gd and Unit Gb is still uncertain. The results of studies of planktonic micro-organisms by Baker and Cookson (1955) and Douglas (1961) have shown that, at least, part of Unit Gd is Upper Cretaceous in age - the top 500 feet being of uncertain age due to lack of fossil evidence. Similarly, the age of the lower part of Unit Gb is still uncertain. However, the upper part of Unit Gb is thought from microplankton evidence to be similar in age to Unit Dd which is regarded as Palaeocene to Eocene (after Baker and Cookson 1955, and Douglas 1961). Unit Gd is equivalent to the Paaratte Formation, Gb is an unnamed unit.

UNIT D

The interval in the Otway Basin which lies between the unconformity at the top of our Unit G and the major unconformity at the base of Unit B (the rocks which comprise the Glenelg Group) has been designated Unit D. It may include the equivalents of the Bahgallah and/or Pebble Point Formations and Dartmoor Formation.

Two subdivisions, Dd and Db, have been recognized in the Nelson Bore.

Unit Dd - 3,746 to 3,690 feet

Lithology: Sandstones form the dominant lithology of Unit Dd. Between 3,746 and 3,712 feet the sandstone is compact with carbonate and pyrite cement and silty matrix, poorly sorted, angular to subrounded, and very fine to very coarse-grained. The sandstone between 3,712 and 3,690 feet is oolitic, compact, well-cemented, and poorly sorted. The sand grains are subangular to subrounded quartz mainly and are medium to very coarse-grained; ooliths are of carbonate.

Mineral Constituents: The most abundant constituent of the sandstones is quartz (strained quartz) and with minor chalcedony forms 46 to 52 percent. Orthoclase, microcline and acid plagioclase are not abundant, and only form between 5 and 8 percent of the rock. Lithics occur in minor amounts - 2 to 12 percent - and consist mainly of microquartzite, quartzite and chlorite. The carbonate ooliths have been included with the cement when assessing percentages.

Minor amounts of muscovite mica are present. Authigenic pyrite occurs as finely disseminated grains. Accessory minerals include tourmaline, zircon, and opaques.

The cementing media which constitute 25 to 30 percent of the rock, comprises calcite, dolomite, siderite, phosphate, limonite and pyrite.

Lithification: The main change which took place in these sediments was in the form of cementation during diagenesis. In the sandstone between 3,746 and 3,712 feet siderite and pyrite were deposited in patches as primary cements; recrystallized calcite and dolomite were formed later, during diagenesis and have a granular texture.

The sandstone occurring between 3,712 and 3,690 feet contains phosphate and pyrite coated nuclei and pyrite rimmed carbonate ooliths; pyrite, iron oxide and dolomite are the cementing media. The ooliths, with quartz and detrital limestone nuclei appear to have been formed locally and deposited in a cement of phosphate, pyrite and carbonate. Dolomitization of the ooliths during diagenesis caused corrosion and replacement of many of the quartz nuclei; only the pyritic rims of quartz grains now remain in some cases.

The diagenetic processes in these sandstones have reduced the porosities to about 5 percent.

Sedimentary Structures: Burrow markings occur in a carbonaceous silty sandstone at 3,718 feet: Elongated and bifurcating structures, consisting of clean digested sand, are present on the bedding plane.

Unit Db

In the Nelson Bore this unit occurs from 3690 to 992 feet and consists of interbedded shales, siltstones and sandstones. On micropalaeontological evidence (Baker and Cookson, 1955), Unit Db is regarded as Eocene in age.

Further subdivision of Unit Db has been possible into Db_2 (3690 to 2681 feet) - compact shales and friable sandstones, and Db_1 (2681 to 992 feet) - sandstones with interbedded carbonaceous siltstones.

Sub-unit Db_2 - 3690 to 2681 feet

Lithology: Sandstones and shales with minor siltstone interbeds occur in sub-unit Db_2. The shales, which are more common than sandstones above 3,100 feet, are fissile, compact and finely laminated. The sandstones, which are present below 3,100 feet, are friable and range from dirty, coarse-grained poorly sorted argillaceous sandstones to clean, quartzose fine-grained moderately to well-sorted sandstones; rare compact, cemented, fine to medium-grained sandstones occur. The finer grained sediments exhibit a higher degree of angularity than do the coarser grained. Finely divided organic matter occurs scattered throughout the sediments.

Mineral Constituents: The chief mineral constituent of the sandstones is quartz - quartz with overgrowths - and with chert constitutes 40 to 50 percent of the rock. Feldspar - orthoclase, microcline, and acid plagioclase - ranges from 2 to 5 percent. Lithics vary between 10 and 20 percent and comprise quartzite, chlorite and chlorite schist fragments.

Mica, which occurs throughout this sequence, is predominantly muscovite and commonly shows bending; rare amounts of biotite occur. Authigenic minerals include a small amount of glauconite and some pyrite which occurs in clusters or as finely disseminated crystals. Accessory minerals are tourmaline and zircon, together with the opaques, rare cassiterite, and rutile observed by Baker (1961).

The cementing media and clay matrix present in the minor compact sandstone intervals range between 20 and 40 percent. The cement comprises siderite, dolomite, chlorite, phosphate and pyrite, and the clay is limonitic.

Lithification: The principal form of lithification in this sequence has been by compaction although some diagenetic changes in the form of cementation occur in isolated fine and coarse-grained sandstones.

In a sandstone at 3,230 feet pellicular chlorite cement is present which is thought to have been depositional. In addition, globular siderite, phosphate and rare patches of kaolinite occur which are possibly late diagenetic products. At 2,920 feet limonitic clay, pyrite and recrystallized dolomite form the cementing media in the sandstone. The presence of limonitic clay in thin laminations would indicate a depositional origin which allowed preferential arrangement of the clay. The sandstone at 2,886 feet reveals a primary sideritic clay matrix with calcite recrystallized during later diagenesis and accompanied by pyrite. Much dissolution of quartz grains is shown at 2,830 feet where carbonate cement occurs; embayments in quartz show replacement by calcite. The carbonate cement may have been primary calcite which during later diagenesis was recrystallized and partly dolomitized. A lens of microcrystalline siderite which is thought to be a primary precipitate occurs at 3,655 feet.

Other features present include minor quartz overgrowths, quartz welding, and small amounts of pressure solution shown by microstylolites at 2,886 feet. Porosity is negligible in these cemented sandstones although at 3,230 feet about 10 percent interstitial porosity exists.

Sedimentary Structures: Laminations are common between 3,244 and 2,735 feet and consist of thin (0.03 - 0.25 mm.) clean, very fine-grained sand in shales; thin clay and silt laminations are present in some sandstones.

At 2,830 feet in a dolomitic sandstone, isolated clay lenses show broken undulating laminations. It would appear that the pattern of the laminations results from load effects by squeezing and re-orientation of the clay. A definite load cast structure is present in shale at 3,123 feet. Scour-and-fill occurs in a compact siltstone at 3,587 feet. The scour is 17 mm. wide by 4.5 mm. deep and the fill is slightly convex at the top. The fill is fine-grained clean sand which shows microcross - bedding.

Sub-unit Db_1 - 2,681 to 992 feet

Lithology: Carbonaceous sandstones and argillaceous sandstones with interbedded carbonaceous siltstones occur in sub-unit Db_1. The sandstones which are friable or may be partly compacted near the base, range from dirty, coarse-grained, poorly sorted to fine-grained and well-sorted. Rare compact, cemented, fine-grained sandstones occur. The fine-grained sandstones show marked angularity of grains whereas the coarser grained sandstones consist of subangular to subrounded grains. The siltstones are sandy and contain abundant carbonaceous matter.

Mineral Constituents: The most abundant constituent of the sandstones is quartz, (in part coated with iron oxide), which forms 40 percent of the rock. Feldspar - orthoclase and plagioclase, some altered - is rare, and ranges between 1 and 5 percent. Lithics which occur as chert fragments constitute 10 percent of the rock. Opaques are an important mineral constituent and also form 10 percent of the sandstones.

Muscovite and biotite are common throughout the interval. Authigenic pyrite and glauconite occur - pyrite in the form of disseminated crystals and clusters and glauconite as grains. Limonite and siderite pellets occur at various horizons between 1943 and 1241 feet. The accessory minerals present consist of zircon, tourmaline, rutile, epidote, chlorite, chloritiod and staurolite, glaucophane, anatase, phosphate and garnet. (For details of the heavy minerals see Baker, 1961).

The important bonding media in these sandstones are clay and silt which make up 35 to 40 percent of the rock. Minor cement occurs in the form of dolomite, anhydrite and siderite.

Lithification: Little diagenetic change has taken place in the composition and texture of the sandstones and they remain friable and porous. Finely divided primary haematitic clay forms the matrix in a siltstone at 2,681 feet. In a sandstone at 2,296 feet diagenetic dolomite with spots of anhydrite cement occur. At 2,017 feet granular microcrystalline siderite forms 80 percent of the sediment, with isolated sandy patches. The siderite was a primary deposit and some areas were slightly recrystallized during later diagenesis. In the sandy patches, later diagenetic changes have taken place which resulted in calcite being formed; corrosion of the quartz grains occurred.

Where the sediments are cemented the porosity is less than 5 percent. Elsewhere, in the friable sediments, porosities are between 15 and 20 percent.

Sedimentary Structures: Laminations are common and are formed by dark carbonaceous silt, clean fine-grained sand and clay.

Burrow markings which are common between 2,200 and 992 feet are characteristic features in the fine-grained carbonaceous sandstones and carbonaceous sandy siltstones. They have irregular branching structures which commonly cross one another and appear to consist of clean digested fine-grained sand in matrices containing organic matter. These features are to be found along and through the bedding planes.

Environment of deposition of Unit D: The accumulation of both arenaceous and argillaceous sediments throughout Unit D is thought to have taken place in a predominantly paralic environment, where interfingering of marine and deltaic facies occur; isolated marine organisms, gastropods, rare fish teeth, plant remains together with rare carbonate cement, pyrite, glauconite and carbonaceous matter are present in these sediment.

At the base of Unit D and between 3712 and 3690 feet oolitic, coarse-grained sandstones occur which are cemented by carbonate, phosphate and pyrite. This sequence is thought to represent a short transgressive phase where the waters were sufficiently alkaline for the precipitation of carbonate cement together with the formation of carbonate ooliths, but where slightly reducing conditions prevailed for the formation of siderite and phosphate cements. The angular to subrounded nature of the grains together with the ooliths would seem to indicate that these sediments were deposited in a zone where high energy currents were active.

Between 3,690 and 992 feet Unit Db sediments represent a regressive facies where deposition has taken place under predominantly deltaic conditions accompanied by minor marine influxes. The sediments between 2,681 and 992 feet contain abundant carbonaceous material accompanied by pyrite, phosphatic fragments and glauconite; this would indicate stagnant conditions resulting from poor circulation and a loss of oxygen as a result of decaying terrigenous organic matter (Baker 1961). Thus the waters of this paralic environment were of a reducing nature during the deposition of sub-unit Db_1. The pH of the waters was such that very little primary carbonate cement was precipitated, indicating more neutral alkaline conditions during sedimentation.

A form of cyclic sedimentation is thought to have occurred throughout Unit Db due to the recurrence of coarse and fine-grained carbonaceous sediments. The mechanism necessary for sedimentation of this type could be either step subsidence or a migrating river across a sinking delta.

At the top of Unit Db another change takes place, where a transgressive sandstone facies occurs. Although no angular unconformity appears to exist there is physical evidence in the form of a basal conglomerate for an erosional unconformity between Unit Db and the overlying Unit Bc.

Stratigraphic Relationships: The age relationship between Unit Db and Unit Dd appears to be known. The results of studies carried out by Baker and Cookson (1955) and Douglas (1961) have shown that Unit Dd is Palaeocene to Lower Eocene in age and that Unit Db is all Eocene. However, the relationship of Unit Db to the overlying Unit Bc is still uncertain as some workers (Crespin 1954) considered Unit Bc to be Upper Eocene. Baker and Cookson (1955) although uncertain of its age, regarded it as being pre-Janjukian (this would be pre-Oligocene according to Carter, 1958). Other workers, (Boutakoff and Sprigg, 1953) consider that Unit Bc has closer affinities to the Oligocene than Upper Eocene.

UNIT B

In the Otway Basin Unit B represents the interval which occurs above the major unconformity at the top of our Unit D. Equivalents of the Nelson and Mt. Gambier Formations (Glenelg Group), as described by Boutakoff and Sprigg (1953), are represented in Unit B.

Two subdivisions, Bc and Bb, have been recognized in the Nelson Bore: Bc from 992 to 812 feet - conglomerate and green to brown sandstone with pellets, and Bb - limestones and dolomites - from 812 to 108 feet. Unit Bc is probably equivalent to the Nelson Formation and Bb is part of the Mt. Gambier Formation.

Unit Bc - 992 to 812 feet

Lithology: Unit Bc is an arenaceous sequence consisting of sandstones with a conglomerate at the base. The conglomerate, which occurs between 992 and 986 feet, is compact, well cemented, poorly sorted with well rounded pebbles of quartz, microquartzite, chert and quart-mica-pegmatite.

Below 953 feet the sandstones are green, friable, fine-grained, moderately to well-sorted with carbonate cement and silty matrix; above 953 feet the sandstones are reddish-brown, compact, fine to medium, and coarse to very coarse-grained, gritty, bimodal, moderately sorted, with cement and minor clay matrix. The very coarse-grained sediments possess subrounded to rounded grains whereas the finer sediments show marked angularity of grains.

Mineral Constituents: The most important detrital constituent of the sandstones and conglomerate is quartz, (quartz with vermicules of kaolinite and chlorite, pitted quartz, iron oxide and chamosite coated quartz) and forms 20 to 40 percent of the rock. Feldspar - microcline - is rare, ranging from 1 to 5 percent. Lithics, in the form of chert, quartzite, microquartzite, with rare quartz-mica-pegmatite and microgranite fragments, are important constituents and form between 10 and 15 percent of the rock. Pellets are important constituents throughout Unit Bc; these consist of limonite, haematite, chamosite and goethite, often with quartz nuclei. Baker (1961) mentions that X-ray patterns of material from brown ooliths at 976 feet revealed goethite.

The cementing media and matrix material present in both friable and compact sandstones range between 35 and 50 percent; the cements consist of dolomite, siderite, calcite and pyrite, with a trace of phosphate.

Lithification: The main change which affected the texture and composition of these sediments was due to cementation.

In most of the sandstones, dolomite is the cement and has formed during diagenesis. The dolomite and dolomite/ankerite cement which is recrystallized and coarse-grained often forms 40 to 50 percent of the rock so that it probably had its origin as a primary carbonate cement. The primary origin of the cement, as at 902 feet, is suggested by its abundance (50 percent) and the scarcity of grain contact even though the original outlines of grains are in most parts preserved. "Ghosts" of echinoderm remains and shells indicate that some diagenetic changes have taken place.

Siderite cement is only found between 992 and 963 feet. In the conglomerate at 986 feet recrystallized, fine-grained siderite is the principal cement with isolated patches of calcite; iron oxide infills the interstices and boundaries between the closely packed siderite crystals. Abundant pellets composed of haematite - limonite and chamosite occur in this conglomerate. In the sandstone at 963 feet recrystallized sideritic patches are present within a dolomite cement; iron oxide pellets (goethite) also occur. Pyrite and a trace of phosphate occur as later diagenetic cementing media in the conglomerate at 986 feet. The pellets present throughout this sequence were thought to have been formed by a slight current or wave action on a fine-grained precipitate. The limonite coating of quartz grains at 902 feet is considered a primary precipitate.

Porosity is low - about 5 percent - in the cemented sandstones.

Unit Bb - 812 to 108 feet

Lithology: Predominantly bryozoal limestones with subordinate dolomitized limestones and dolomites occur in Unit Bb. The limestones below 646 feet are grey, chalky to crystalline, argillaceous, with rare dolomitized and silicified streaks; bryozoa debris occurs in this interval. Between 646 and 528 feet dolomites and dolomitized limestones occur. The dolomites are pink, compact, sucrosic and coarsely crystalline; the dolomitized limestones are green to cream, chalky, sucrosic, fine-grained, bryozoal. The limestones above 528 feet are grey to cream, soft, chalky, bryozoal, with thin bands of compact silicified limestone throughout.

Mineral Constituents: Detrital mineral constituents are rare; scattered detrital and authigenic quartz occur in the limestones. Granules of authigenic glauconite, rare pyrite, and biotite flakes are present in the sediments. In a limestone between 736 and 730 feet there is evidence of bryozoa fragments having been partially filled with phosphatic material. At other horizons glauconitic infillings of foraminifera tests occur, especially at 811 feet.

Lithification: In this limestone sequence the changes that have taken place have been primarily due to lithification by compaction, although some diagenetic recrystallization, dolomitization and silicification have occurred. Dolomitic replacement of limestone is shown in one sample (560 to 528 feet) in which dolomite crystals are coated with clay, and palimpsest structures of former fossils are preserved. In another sample (587 to 580 feet) sucrosic dolomite occurs with relics of bryozoa. A number of silicified fossiliferous horizons occur in the sequence.

Medium to high porosity - 15 to 20 percent - is present where the limestones contain an abundance of fossil debris. Vuggy porosity occurs in the dolomites.

Environment of Deposition of Unit B: Conditions of sedimentation during Unit B times were markedly different from those existing in Unit Db times. Unit Bc appears to be a transgressive facies which represents an intermediate phase in the change from paralic to the deeper neritic conditions of Unit Bb. A number of features give some idea of the conditions during Bc time, but the sequence of events is not clear. Firstly, the basal conglomerate, because of the roundness of its pebbles, suggests a reworking or erosion of a pre-existing conglomerate. The conglomerate was overlain by sands which contained iron oxide pellets throughout. The presence of these pellets, together with iron oxide and chamosite-coated quartz and the general rounded nature of the detrital grains would point to high energy conditions in shallow oxygenated water. The Eh conditions must have been positive for the precipitation of the iron oxide which subsequently coated grains and formed pellets. However, increase in pH and quieter conditions must have occurred for the precipitation of carbonate to take place. The red-brown compact sandstone at the top may indicate a period of oxidation due to weathering.

The marked lithological break at the base (812 feet) of Unit Bb suggests a marine transgression over a shallow shelf area. Throughout the deposition of the limestone sequence, a neritic marine environment prevailed; the depth, temperature, and salinity of the water was suitable for supporting abundant calcareous organisms. Little terrigenous material was being deposited; the carbonates were deposited under conditions of positive Eh where faunal development could be sustained and under high pH allowing for the precipitation of calcium carbonate to be maintained.

Stratigraphic Relationships: There is some doubt about the age of Unit Bc; its relationship with the overlying Unit Bb is still uncertain. On micropalaeontological evidence (Baker and Cookson, op.cit., and others) Unit Bc may be either Upper Eocene or Oligocene in age. If Unit Bc is considered as Upper Eocene then a time break may occur in the form of a non-depositional unconformity between Bc and Bb, for Unit Bb is regarded as Oliogocene in age by most workers. Although no samples were collected between 108 feet and the surface, Baker and Cookson (1955), regarded the top 816 feet as being composed of Janjukian (Oligocene) limestones and marls. However, Boutakoff (1951) regarded these sediments (108 feet to surface) as belonging to the Balcombian stage (Miocene).

IV COMMENTS ON THE SORTING OF CRETACEOUS AND TERTIARY SEDIMENTS

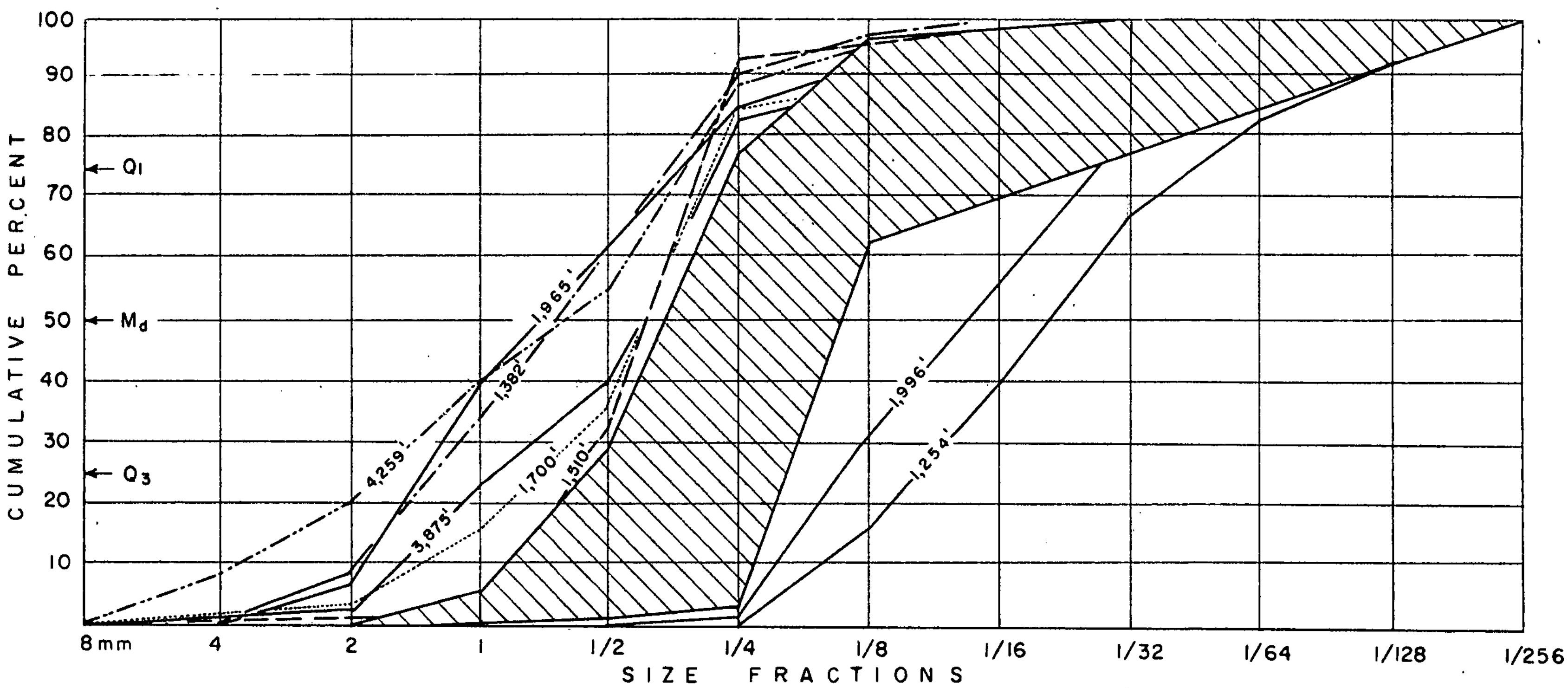
Detailed mechanical analyses of particle grade sizes were carried out by Baker (1961) on 48 samples from the Nelson Bore. Proportions of the various grade sizes in uncemented or slightly cemented sediments were shown by histograms, and average values for the sorting, skewness and kurtosis were calculated for the intervals 990 to 4500 feet and from 4500 to 7305 feet. The results were averaged and matched against the stratigraphical sequence. Provided that the sampling was carried out over intervals of uniform composition, and that completely representative material was analysed, the grouping of sediments on the basis of granulometric parameters is valid.

Figure 1

CUMULATIVE FREQUENCY

CURVES OF SIZE FRACTIONS IN FRIABLE TERTIARY SEDIMENTS

Modified after Baker 1961



Area containing cumulative frequency curves of 17 samples with grain size not greater than 2 mm.
Curves for samples at 1,382, 1510, 1,700, 1,965, 3,875 and 4,259 feet with grain size greater than 2 mm.
Curves for samples at 1,254 and 1,996 feet with grain size not greater than 1/2 mm.

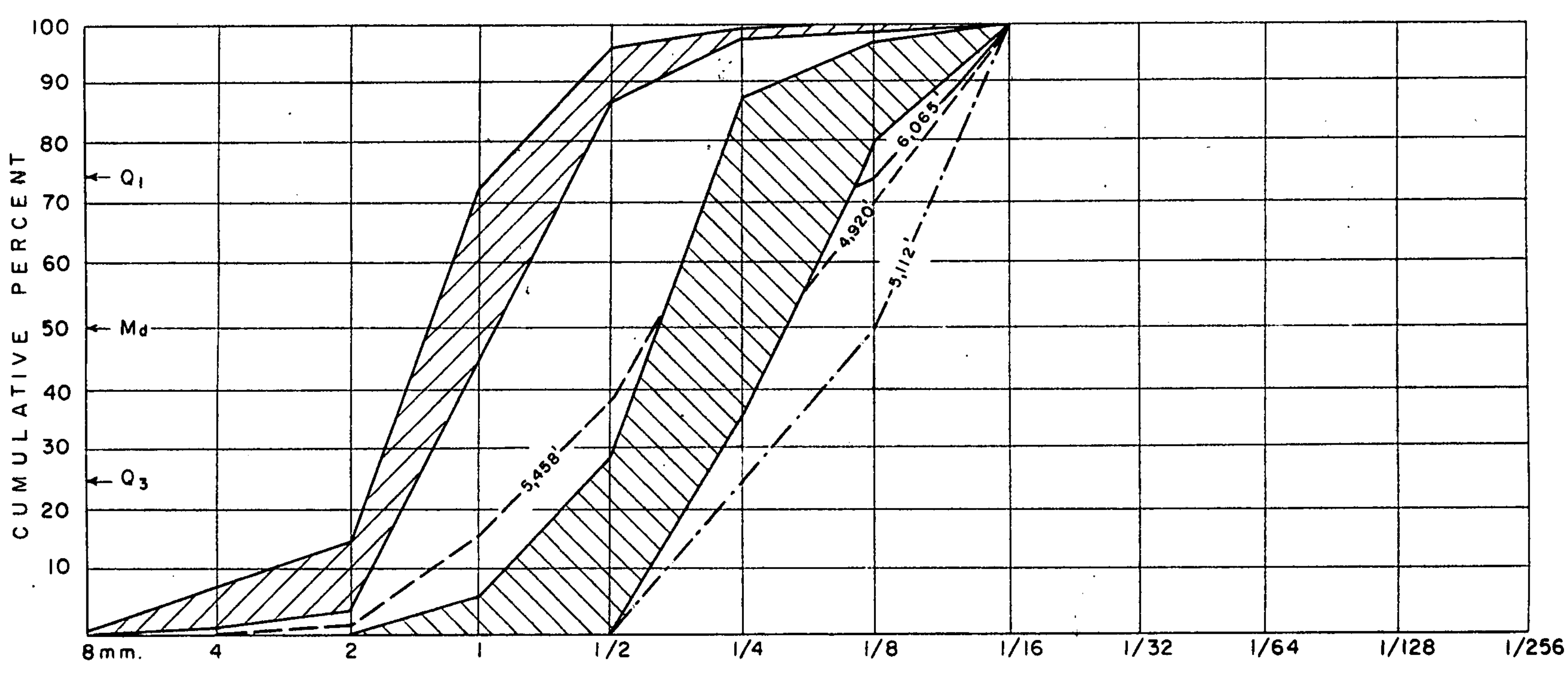
INTERVAL 900 - 4,500 feet

Figure 2

CUMULATIVE FREQUENCY

CURVES OF SIZE FRACTIONS IN FRIABLE CRETACEOUS SEDIMENTS

Modified after Baker 1961



Area containing cumulative frequency curves of 4 samples with grain size greater than 2mm.
Curve for sample at 5458 ft. with intermediate values.
Area containing cumulative frequency curves of 11 samples with grain size not greater than 2mm.
Curves for samples at 4,920, 5,112 and 6,065 feet with low sorting coefficients.

INTERVAL 4,500 - 7,305 feet

Bureau of Mineral Resources,
Geology and Geophysics. September 1964.

X AUS - 2 - 26

LP

TABLE 1

DEPTH	SORTING		
	Fine - Med.	Coarse - V.C.	Av. So.
990 to 4500 feet	1.6	1.49	1.58
4500 to 7305 feet	1.55	1.37	1.49

The grade size percentages given by Baker for the 48 samples analysed can be divided into fine to medium-grained sands (up to 0.5 mm.) and coarse to gritty sands. The sorting coefficient figures of these graded sands are given in Table 1 together with the average sorting coefficients. However, the samples apparently contained little or no material of silt-size or less, whereas petrological analysis shows interbedding of mudstones with sandstones over the intervals analysed, moreso in the upper interval. The figures, therefore, do not give true sorting coefficients for the intervals.

The sorting of the finer sandy material for each interval is comparable - and poor; the coarse material is much better sorted in the lower interval than the upper - though both are well sorted. The relative "cleanness" of the coarse sands below 4500 feet is also apparent from the study of the cores, and points to a greater maturity of these sediments.

It is probable that the bathymetric and energy conditions during the deposition of the lower (Cretaceous) interval may have been only slightly different to the conditions during the deposition of the upper (Tertiary) sequence; however, the differences in the quantity of silt and clay size material present in the two intervals makes the two sequences quite distinct.

V COMMENTS ON FOSSIL ASSEMBLAGES

Detailed micropalaeontological studies have already been carried out on the Nelson Bore sediments by a number of workers; the stratigraphic significance of their results are summarized on Plate 3.

Crespin (1954) discussed the foraminiferal assemblages which occurred in the various lithological units in the Nelson Bore. Abundant foraminifera were present in the interval we referred to as Unit Bb, and were also present, but scarce, in Unit Db. Crespin placed the interval between 7305 and 5304 feet - which contained no foraminifera - tentatively as (?) Palaeocene; she considered the sequence from 5304 to 992 feet to be Middle Eocene and between 992 and 112 feet as Upper Eocene (cf. Plate 3).

The studies carried out by Deflandre and Cookson on selected sediments from the Nelson Bore, revealed the presence of planktonic micro-organisms, dinoflagellates and hystrichosphaerids which "provide further proof of the marine environment of this theatre of sedimentation" (Baker & Cookson, 1955). Conclusions reached by the above authors were that sediments between 3650 and 992 feet were identical to those of the upper section of the "Wangerrip Group" in the Moonlight Head-Princetown area to which a Lower Eocene age has been assigned. (This interval is approximately equivalent to our Unit Db).

Sediments from the Nelson Bore between 4025 and 3650 feet yielded microflora and microplankton characteristic of the "Pebble Point Formation" at the base of the "Wangerrip Group" in the Moonlight Head - Princetown district; Baker in 1950 and 1953 regarded the "Pebble Point Formation" as being of Lower Eocene age but with Palaeocene affinities (Baker & Cookson, op. cit.). Sediments between 4500 and 4250 feet were also thought to be Palaeocene to Lower Eocene by the above authors.

Deflandre and Cookson isolated a sporomorph and two micro-plankton species from the interval 6192 to 5782 feet; these microfossils "occur in Australian Upper Cretaceous sediments, but have not so far been found in Australian Tertiary deposits". (Baker & Cookson, 1955).

Douglas (1961) studied the microplankton occurring in the Nelson Bore but considered the Tertiary microplankton to be of little stratigraphic interest. He has delimited three zones - based on the occurrences of Deflandreidae - within the lower half of the Nelson Bore (see his correlation chart, P. 27 and our Plate 3):

Zone 1	*Deflandrea bakeri*	: Palaeocene to L. Eocene
Zone 2	*Nelsoniella* sp.	: Upper Cretaceous
Zone 3	*Deflandrea* sp.	: Upper Cretaceous

From the work of Deflandre and Cookson (as summarized in Baker & Cookson, op. cit.), Douglas (1961), and P.R. Evans (pers. comm.) there seems little doubt that some Upper Cretaceous sediments do occur in the lower half of the Nelson Bore. However, P.R. Evans (pers. comm.) considers that insufficient detailed sampling of the (?)Upper Cretaceous sections has been done to justify the establishment of microplankton zones at this stage.

Evans (1962) has shown that in Flaxman's No. 1 and Port Campbell No. 1 wells, the pollen *Xenikoon australis* occurs at the top of the Upper Cretaceous sequence - above Zone 2 as defined by Douglas (1961). Evans (pers. comm.) has not found *Xenikoon australis* in the Nelson Bore, and it is possible that its absence may point to either a break in sedimentation or, more likely, to a lack of samples at about 4500 feet - at the boundary of sub-unit Gd_1 and the overlying Unit Gb.

Despite the palaeontological work carried out, there is still considerable doubt as to the age of the upper limit of the "Paaratte Formation" (Unit Gd equivalent). However, there is a marked lithological change at 4500 feet which has been taken as the top of Unit Gd.

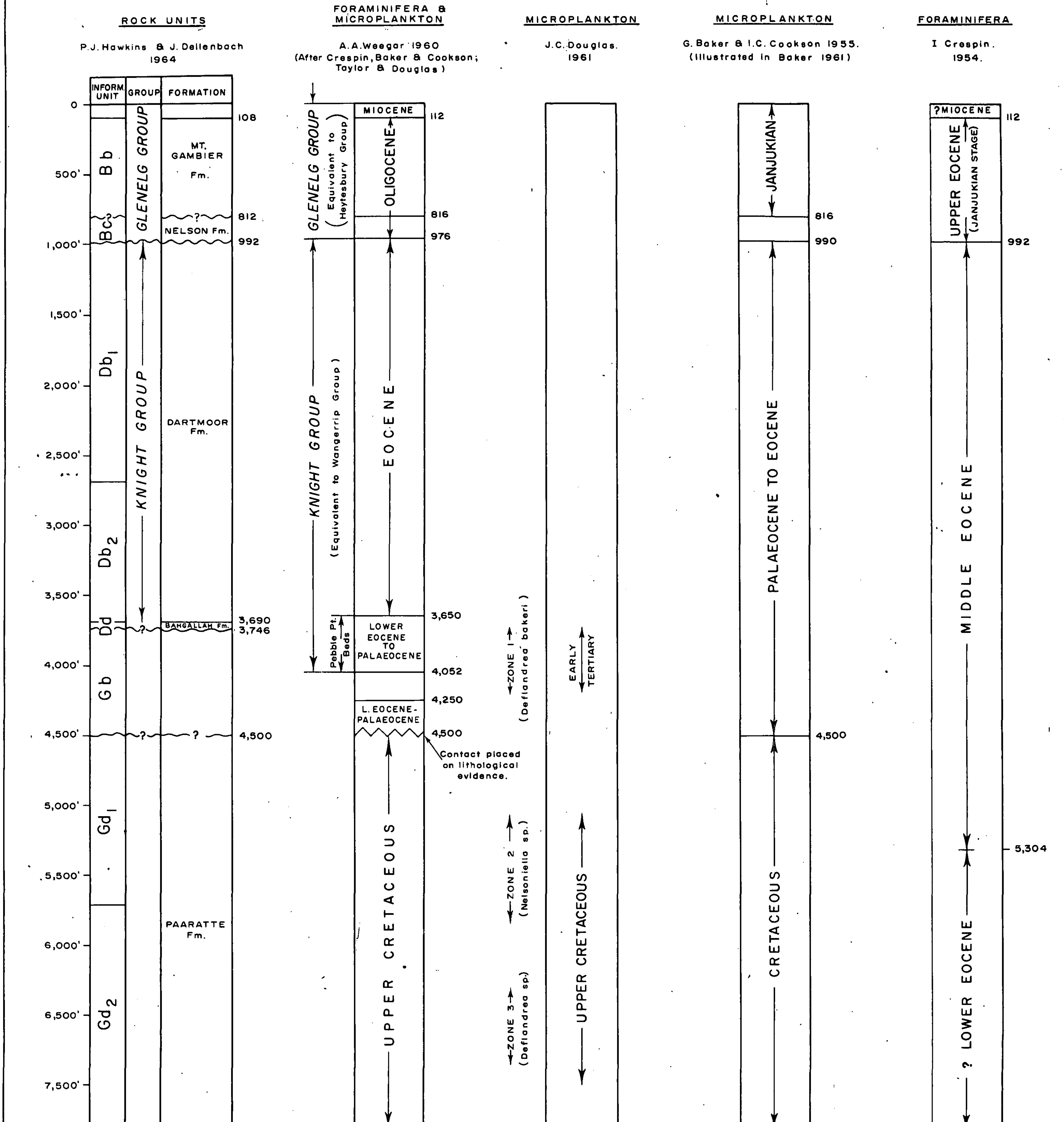
The palaeontological work of Baker and Cookson (1955) and Douglas (1961) may provide evidence for a time break at approximately 3650 feet - this depth roughly corresponding to the upper limit of the

PLATE 3

NELSON BORE

TABLE OF STRATIGRAPHICAL DATA

GROUND ELEVATION: 10 feet A.S.L.



Bureau of Mineral Resources, Geology and Geophysics. August 1964.

TO ACCOMPANY RECORD 1963/167

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Reduce line A-C(19) to AB (13¼)

oolitic sandstones of Unit Dd, and correlated with the "Bahgallah Formation" by the present authors; a tentative correlation of this type was suggested by Baker and Cookson. The sediments which form the "Bahgallah Formation" have been correlated by Kenley (1951) with the ferruginous grits of the "Pebble Point Beds" in the Princetown-Moonlight Head district; he assigned an Eocene age to these "Bahgallah Formation" sediments.

The age of Unit Bc (equivalent to the Nelson Formation) is now in some doubt. Crespin (1954) placed the interval 992 to 112 feet - Units Bc and Bb (equivalent to the Nelson Formation and Mt Gambier Formation) - in the Janjukian Stage of the Upper Eocene; considerable importance was placed on the presence of Victoriella plecte. Boutakoff and Sprigg (1953) have placed the "Nelson Formation" in the Oligocene and this view has been indirectly supported by the work of Carter (1958), who carried out a study of the ranges of the Tertiary foraminifera in Victoria. This Oligocene age for Unit Bc has been adopted in this study. However, Baker and Cookson (1955) are not certain of the age of the "Nelson Formation" but state that it is pre-Janjukian; they have also suggested that the lithological break at 816 feet is indicative of a time break separating pre-Janjukian from Janjukian sediments: this corresponds with our break at 812 feet. Some doubts about the significance of the Nelson Formation have arisen as a result of work carried out by Frome-Broken Hill Co. Pty. Ltd. (Leslie, pers. comm. 1964). Unit Bc as defined in the Nelson Bore may represent a condensed time break facies made up of both Eocene and Oligocene sediments that elsewhere have been subdivided into separate "formations". The major break recognized in the present lithological study occurs at 992 feet; Baker and Cookson recognized another lithological change at 990 feet.

According to Baker and Cookson (op. cit.) the sequence from 7305 to 990 feet in the Nelson Bore can be considered as partly Upper Cretaceous and partly Palaeocene to Lower Eocene, though the exact position of the Mesozoic-Tertiary boundary remains in doubt.

VI CONCLUSIONS

The thick accumulation of sediments in the Nelson Bore area suggests a strong influx of terrigenous material into an area of deposition which was sinking up until Oligocene times; during the Oligocene, more stable conditions prevailed and limstones were deposited on a shelf area.

Sedimentation in Unit Gd times - Upper Cretaceous - took place in a shallow water inner neritic marine environment; deposition occurred under both quiet and rough water conditions together with variations in the pH and Eh as revealed by the cementing media. At 4500 feet an unconformity may occur in the form of a non-depositional break between Unit Gd and the overlying Unit Gb. The sediments in Unit Gb represent a regressive facies where essentially deltaic conditions prevailed and where there was in influx of carbonaceous material. The upper part of this unit is Palaeocene to Eocene in age from microplankton evidence.

Between Unit Gb and Unit Dd a disconformity is thought to occur. The oolitic sandstones of Unit Dd are thought to represent a transgressive facies, where the sediments were deposited in a near shore high energy zone. However, the overlying sediments of Unit Db-Palaeocene to Eocene in age - represent a regressive facies where deposition took place in a paralic environment, accompanied by an influx of carbonaceous material. Throughout this sequence a form of cyclic sedimentation is thought to occur; the most appropriate mechanism for this type of sedimentation is thought to be a migrating river across a sinking delta.

At 992 feet a marked erosional unconformity occurs between Unit Db and the overlying Unit Bc. The arenaceous sediments of Unit Bc represent a transgressive facies where sandstones were deposited under high energy conditions in a well oxygenated littoral zone. At 812 feet - the base of Unit Bb - a marked lithological change occurs suggesting a marine transgression over a shallow shelf area. The limestones of Unit Bb were deposited in a neritic marine environment on a stable shelf where little terrigenous material was accumulating. Temperature, salinity, Eh and pH were important factors in sustaining faunal development and for the precipitation of calcium carbonate.

The mineral composition of the arenaceous sediments below 812 feet points to a mainly granitic-metamorphic provenance. The evidence from the heavy mineral content would suggest that the processes of erosion of similar source rocks was maintained throughout the sequence. The composition and texture of these sediments indicated that the land relief was sufficient for continuous erosion to take place and a steady supply of detritus to be transported to the area of accumulation; there was little indication that long distances or long periods of transportation were involved.

The oil potential of the sediments in the Nelson Bore area is difficult to assess. No indications of source rocks were observed, but large intervals in the section were not available for examination and may have contained some indication. Likewise reservoir conditions may or may not be present; similarly, porosity may be far more extensive in these sediments than is known. Porosities of between 10 and 15 percent exist in some sandstone beds in Unit Gd (equivalent to Paaratte Formation) but permeability appeared to be low as a result of patchy cementation. Generally speaking, the cleaner, coarser sands below 4500 feet would indicate better reservoir possibilities. Impermeable zones and caprock conditions are indicated in the sediments, particularly in Unit Db (equivalent to Dartmoor Formation).

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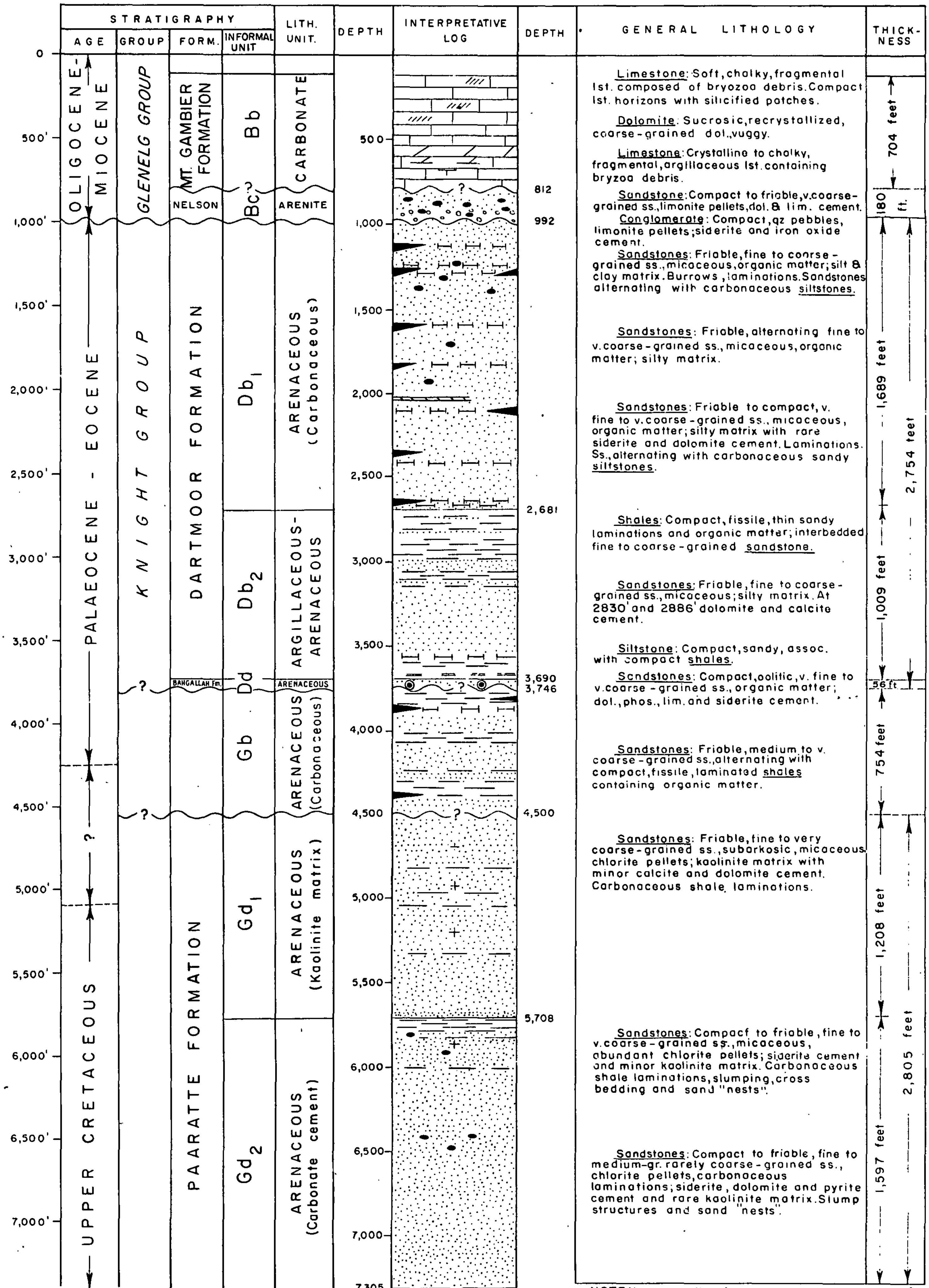
PLATE 2

NELSON BORE

GENERALIZED STRATIGRAPHICAL SEQUENCE

G.L. ELEVATION: 10 feet. A.S.L.



NOTE: Log compiled from current results, supplemented by Boring Records of Victoria (D.M.V., 1947) and Bulletin 58 (Baker 1961, Geological Survey Victoria.)

Bureau of Mineral Resources, Geology and Geophysics. July 1964.

TO ACCOMPANY RECORD 1963/167

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Reduce line A-C (19) to A-B ($13\frac{1}{4}$)

B

APPENDIX 1.

DETAILED DESCRIPTION OF SAMPLES

Detailed lithological descriptions of all the samples examined in the Nelson Bore are given below. No samples had been collected until the bore had reached a depth of 108 feet. According to Boutakoff (1951) the bore passed through polyzoal limestones, dolomite and marls of "Balcombian stage" down to 108 feet. When gaps occur in samples, details have been taken from the boring records (D.M.V., 1947, 26) and are shown in brackets.

0 to 108 feet	No samples over interval.

UNIT Bb (equivalent to Mt. Gambier Formation)

108 to 132 feet (Core)	Limestone: Light grey, chalky, fragmental limestone composed of bryozoa debris; scattered angular quartz grains, dolomite rhombs, rare glauconite and pyrite. Abundant bryozoa and foraminifera. At 112 feet, compact, silicified limestone.
132 to 152 feet (Core)	Limestone: Medium grey, chalky, marly limestone, rarely fragmental; scattered calcite crystals, and glauconite. Abundant bryozoa and foraminifera. At 152 feet, compact silicified limestone.
152 to 453 feet (Core)	Limestone: Light grey, fragmental, chalky limestone, argillaceous intervals; scattered dolomite rhombs, rare angular quartz grains, rare glauconite and pyrite. 15 to 20 percent porosity where abundant bryozoa debris in limestone, especially at 310 and 390 feet. Bryozoa and foraminifera present. Compact silicified limestones at 198, 230, 348 and 410 feet.
453 to 465 feet (Core)	Limestone: Medium yellow, chalky limestone composed of bryozoa debris, with compact silicified patches and scattered dolomite rhombs.
465 to 474 feet (Core)	Limestone: Light to medium grey, marly limestone with bryozoa debris, anddolomitic streak; some fine subrounded authigenic quartz grains, rare biotite and glauconite. Bryozoa present.
474 to 528 feet (Core)	Limestone: Light cream, soft, marly limestone with bryozoa debris; some dolomite euhedra, rare quartz grains, rare glauconite. 10 to 15 percent porosity at 494 feet.
528 to 560 feet (Core)	Dolomite: Medium pink, compact, sucrosic, recrystallized, coarse-grained, vuggy dolomite; rare quartz grains, dolomite crystals coated with clay, vugs sometimes rimmed with clay matter, scattered pyrite crystals. 5 to 10 percent porosity.
560 to 580 feet	Limestone: Light pink, compact, recrystallized limestone composed of bryozoa debris; shells filled with coarse calcite crystals, some crystals of coated dolomite. Bryozoa and pelecypod fragments present.
580 to 587 feet (Core)	Dolomite: Medium pink, compact, sucrosic, recrystallized, coarse-grained dolomite, calcitic, with relics of bryozoa.

587 to 607 feet (Core)

Limestone: Light cream, chalky, sucrosic, fragmental, fine-grained limestone, dolomitic, composed of bryozoa debris; dolomite content decreasing basewards. 5 percent porosity. Bryozoa present.

607 to 625 feet (Core)

Limestone: Light pink, chalky, fragmental medium-grained limestone composed of bryozoa debris; dolomitic intervals. 10 to 15 percent porosity.

625 to 646 feet (Core)

Limestone: Light green, chalky, sucrosic, fine-grained limestone, dolomitized; dolomite crystals in chalky matrix, rare quartz grains and glauconite. 5 percent porosity. Bryozoa relics.

646 to 689 feet (Core)

Limestone: White, chalky limestone with bryozoa debris, argillaceous at top; scattered dolomite crystals, rare quartz grains. 5 to 10 percent porosity.

689 to 812 feet (Core)

Limestone: Light grey, chalky to crystalline limestone with argillaceous intervals; scattered dolomite euhedra in chalky matrix, rare quartz and mica, scattered glauconite. Bryozoa and foraminifera present. At 730 to 736 feet compact, bryozoal limestone, with bryozoa partly filled with impure phosphate. At 770 to 779 feet more massive limestone with silicified organic debris and spicules. At 770 and 812 feet sucrosic, crystalline limestone dolomitized.

TOP OF UNIT Bc (equivalent to Nelson Formation)

812 to 857 feet (Core)

Sandstone: Medium reddish-brown, compact, very coarse-grained, subrounded grains, poor to moderately sorted ss., with quartz pebbles (2-4 mm.), pellets of limonite, iron oxide pellets with quartz nuclei, chamosite around quartz grains, some glauconite; coarse-grained dolomite cement with limonite, and clay matrix. 5 percent porosity.

857 to 939 feet (Core & Cuttings)

Sandstone: Light brown, compact, very coarse-grained, subrounded grains, moderately sorted ss., with subrounded quartz pebbles (3-5 mm.), limonite pellets at 874 to 885 feet, iron oxide pellets at 923 feet, some iron staining on quartz grains, rare glauconite; calcite, coarse-grained dolomite and ferruginous cement. 5 percent porosity.

939 to 953 feet (Core & Cuttings)

Sandstone: Medium khaki-brown, friable, fine to coarse-grained, subangular to rounded grains poorly sorted ss., with limonite coated/dolomite rhombs and quartz grains, iron oxide pellets, glauconite; dolomite and limonite cement. 5 percent porosity.

953 to 986 feet (Core & Cuttings) — **Sandstone:** Green to dark brownish-green, friable, very fine-grained, angular grains, moderate to well sorted ss., with iron oxide pellets at 963 feet, limonite pellets at 976 feet, limonite coated quartz grains, mica flakes, abundant glauconite; dolomite, siderite cement with silt in matrix.

986 to 992 feet (Core & Cuttings) — **Conglomerate:** Medium brown, compact, poorly sorted conglomerate with well rounded pebbles of quartz, pellets of limonite and chamosite, and rare glauconite; fine-grained siderite and iron oxide cement with minor patches of calcite.

———————— UNCONFORMITY ————————

Unit Db_1 (equivalent to Dartmoor Formation)

992 to 1032 feet (Core & Cuttings) — **Sandstone:** Medium brown, friable, very fine to fine-grained, subangular grains, moderate to well sorted ss., micaceous, with altered feldspar, limonite, glauconite, epidote and pyrite, and carbonaceous matter; silt and clay matrix. 5 percent porosity. Clay laminations, abundant burrows at 1012 feet. *Cyclammina* sp.

1032 to 1042 feet (Core) — **Siltstone:** Medium brown, sandy with mica flakes. 5 percent porosity.

1042 to 1099 feet (Core) — **Sandstone:** Medium to light brown, friable, very fine to fine-grained, angular to subangular grains, well sorted ss., micaceous, with altered orthoclase and plagioclase at 1079 to 1089 feet, some glauconite, epidote, tourmaline hornblende, chalcedony, limonite, and some phosphatic matter in organic material. 10 to 15 percent porosity.

1099 to 1155 feet (Core) — **Sandy Siltstone:** Medium brown, very fine to medium, angular quartz grains, micaceous, altered feldspar, with zircon, tourmaline, rutile, glauconite, pyrite and chalcedony; lamination (5 mm. thick) of silt and organic matter at 1099 feet. 5 percent porosity. Burrows at 1119, 1139 and 1145 feet. *Cyclammina* sp.

1155 to 1241 feet (Core) — **Sandstone:** Light brown, friable, very fine to medium-grained, subangular to subrounded grains, moderate to well sorted ss., micaceous, with rare feldspar, glauconite, tourmaline, zircon (well rounded at 1211 feet), chlorite, garnet, staurolite and rutile, and finely divided carbonaceous matter near the base; clay matrix. 5 percent porosity. *Cyclammina* sp.

1241 to 1300 feet (Core) — **Siltstone:** Light to dark brown, compact, fine to medium, subangular quartz grains; mica flakes, rounded quartz granules at 1280 feet, with siderite pellets at 1241 feet, glauconite at 1241 and 1270 feet, finely disseminated pyrite at 1270 feet together with tourmaline, zircon, chloritoid and opaque minerals. 5 percent porosity. Burrows at 1254, 1270 and 1280 feet and thin sand laminations at 1280 feet. *Cyclammina* sp.

1300 to 1320 feet (Core)	<u>Sandstone</u>: Light brown, friable, fine to medium-grained, subangular grains, well sorted ss., micaceous (muscovite & biotite), rare feldspar, limonite pellets, rare glauconite, zircon and opaque minerals and dark carbonaceous clay streaks. 10 to 15 percent porosity. <u>Cyclammina</u> sp.
1320 to 1341 feet (Core)	<u>Sandstone</u>: Light brown, friable, fine to very coarse-grained, subangular to subrounded grains, poorly sorted ss., micaceous. Foraminifera present.
1341 to 1382 feet (Core)	<u>Sandstone</u>: Light to medium brown, friable, fine to medium-grained, angular to subrounded grains, well sorted ss., micaceous (muscovite & biotite), rare feldspar, some reddish quartz grains, glauconite, anatase, phosphate, rare tourmaline, opaque minerals, finely disseminated pyrite at 1360 feet, and dark carbonaceous laminations at 1341 feet; silty matrix. 5 percent porosity.
1382 to 1410 feet (Core)	<u>Sandstone</u>: Light to dark brown, friable, medium to very coarse-grained, subrounded grains, poorly sorted ss., some quartz grains coated with iron oxide, limonite pellets (1 mm.), abundant glauconite at 1382 feet, abundant dark carbonaceous matter at 1403 feet. <u>Cyclammina</u> sp.
1410 to 1449 feet (Core)	<u>Sandstone</u>: Light brown, friable, very fine-grained, subangular grains, well sorted ss., thinly bedded with siltstone streaks; micaceous, rare euhedral quartz grains, rare zircon, glauconite, phosphatic fragments, pyrite clusters and dark carbonaceous laminations at 1410 feet. 5 percent porosity. Clay laminations. <u>Cyclammina</u> sp.
1449 to 1510 feet.	No sample over interval; (1356-1602 ligneous sandy clay)
1510 feet (Core)	<u>Sandstone</u>: Light brown, friable, fine-grained, subangular grains, well sorted ss., micaceous (muscovite), rare feldspar, rare euhedral quartz crystals, zircon.
1510 to 1533 feet	No sample over interval; (1356-1602 ligneous sandy clay)
1533 to 1553 feet (Core)	<u>Sandstone</u>: Dark brown, friable, fine to coarse-grained, subangular to subrounded grains, poorly sorted ss., micaceous (muscovite & biotite), subrounded quartz granules at 1553 feet, glauconite, and abundant organic matter; silty matrix. 20 to 25 percent porosity. Rare burrows at 1553 feet.
1553 to 1583 feet (Core)	<u>Siltstone</u>: Dark brown, sandy, fine, subangular grains of quartz, micaceous, rare glauconite, carbonaceous matter. Thin sand laminations at 1573 feet.
1583 to 1610 feet (Core)	<u>Sandstone</u>: Medium brown, friable, fine-grained subangular grains, well sorted ss., micaceous, pyrite and glauconite, and carbonaceous matter. 15 to 20 percent porosity at 1595 feet. <u>Cyclammina</u> sp.

1610 to 1644 feet	No sample over interval; (1602-1625 ligneous sand -1632 grey sand -1640 ligneous sandy clay. -1668 sand and gravel)
1644 feet (Core)	Sandstone: Dark brown, friable, fine to very coarse-grained, subangular to subrounded grains, poorly sorted ss., with scattered subrounded quartz granules (2-4 mm.), mica flakes and pyrite.
1644 to 1669 feet	No sample over interval; (1640-1668 sand and gravel. -1690 fine grey micaceous sand)
1669 feet(Core)	Sandstone: Medium brown, friable, fine to medium-grained, subangular grains, moderately sorted ss., mica flakes, rare pyrite, and carbonaceous matter; silty matrix.
1669 to 1700 feet	No sample over interval; "1669-1700 friable light-grey sandstone, with fine to coarse quartz grains, carbonaceous material and glauconite", (Crespin 1954).
1700 feet(Core)	Sandstone: Light brown, friable, medium to coarse-grained, subrounded grains, moderate to poorly sorted ss., with pellets of iron oxide, reddish quartz grains, glauconite and opaque minerals. Cyclammina sp., ostracods and rare fish teeth.
1700 to 1733 feet	No sample over interval; (1690-1732 coarse sand with thin gravel bands. 1732-1832 fine grey micaceous sand).
1733 to 1752 feet(Core)	Sandstone: Light brown, friable, fine-grained, subangular grains, well sorted ss., micaceous (muscovite & biotite), glauconite, and pyrite and organic matter.
1752 to 1782 feet(Core)	Sandstone: Medium brown, friable, fine to coarse-grained, subangular grains, poorly sorted ss., with iron oxide coated quartz grains, limonite and glauconite; silty matrix. Cyclammina sp. and gastropods.
1782 to 1830 feet(Core)	Sandstone: Light brown, friable, fine to medium-grained, subangular grains, well sorted ss., micaceous (muscovite & biotite), clear quartz; silty matrix. 15 to 20 percent porosity at 1799 feet.
1830 to 1845 feet(Core)	Sandstone: Dark brown, compact, very fine to very coarse-grained, subangular grains, poorly sorted ss., thinly bedded, with subrounded quartz granules at 1830 feet, mica flakes, pyrite, zircon, rutile and glauconite, and carbonaceous matter; silty matrix. 5 percent porosity. Burrows at 1830 and 1835 feet. Cyclammina sp.
1845 to 1901 feet(Core)	Sandstone: Light to medium brown, compact, very fine-grained, subangular grains, moderate to well sorted ss., micaceous, pyrite and glauconite, and carbonaceous clay laminations at 1878 feet; silty matrix. 5 percent porosity. Cyclammina sp. At 1855 feet claystone with thin micaceous ss. laminations containing organic matter.

1901 to 1903 feet(Core)	Sandstone: Medium brown, friable, fine to very coarse-grained, subangular to subrounded grains, poorly sorted ss., with finely disseminated pyrite.
1903 to 1924 feet(Core)	Sandstone: Light brown, friable, very fine-grained, subangular grains, well sorted ss., micaceous. 5 percent porosity. Rare Cyclammina sp. At 1903 feet shale, fissile containing mica and pyrite.
1924 to 1943 feet(Core)	Sandstone: Light brown, friable, medium to coarse-grained, subrounded grains, poorly sorted ss., with rare feldspar, brown limonite pellets, some quartz grains coated with iron oxide, and glauconite. Shell fragments and ostracods.
1943 to 1953 feet(Core)	Siltstone: Medium brown, sandy patches with fine, subangular quartz grains, mica flakes and rare organic matter.
1953 to 1990 feet	No sample over interval; (1943 - 1963 micaceous sandy clay. - 1979 grey friable sand. - 1980 consolidated sand. - 2016 grey micaceous sand)
1990 to 2000 feet(Core)	Sandstone: Light brown, friable, very fine-grained, subangular grains, well sorted ss., with glauconite and carbonaceous matter; silty matrix. Cyclammina sp.
2000 to 2016 feet(Core)	Sandstone: Dark brown, friable, very fine to coarse-grained, subangular grains, poorly sorted ss., with rare glauconite and abundant organic matter. Cyclammina sp.
2016 to 2056 feet(Core)	Sandstone: Light brown, friable, very fine-grained, subangular grains, well sorted ss., micaceous (muscovite & biotite), pyrite clusters at 2017 feet, rare glauconite and rutile at 2047 feet, and thin laminations containing scattered carbonaceous matter; silty matrix. 5 percent porosity. At 2017 feet siderite compact, granular, microcrystalline, with scattered sandy patches of very fine, subangular to subrounded quartz grains.
2056 to 2092 feet(Core)	Siltstone: Medium to dark brown, compact, sandy, with very fine to coarse, subangular to subrounded quartz grains, mica flakes, pyrite, and carbonaceous lamination containing phosphatic fragments at 2056 feet. Burrows at 2066 feet and thin sand laminations at 2069 feet.
2092 to 2105 feet(Core)	Sandstone: Light brown, friable, fine to very coarse-grained, subangular to subrounded grains, poorly sorted ss.
2105 to 2126 feet(Core)	Sandstone: Light brown, friable, fine to medium-grained, subangular to subrounded grains, moderately sorted ss., micaceous.
2126 to 2136 feet(Core)	Sandstone: Light brown, friable, fine to very coarse-grained, subangular to subrounded grains, poorly sorted ss., micaceous.
2136 to 2146 feet(Core)	Sandstone: Medium to dark brown, friable, fine to coarse-grained, subangular to subrounded grains, poorly sorted ss., with mica flakes, rare glauconite, coaly matter containing phosphatic fragments at 2136 feet; silty matrix.

2146 to 2186 feet(Core)	Sandstone: Light to medium brown, friable, very fine-grained, subangular grains, well sorted ss., siltstone interbeds, micaceous, rare zircon, finely divided organic matter near base. 5 percent porosity. Burrows at 2176 feet and thin clay laminations at 2166 feet.
2186 to 2238 feet	No sample over interval; (2132-2212 dark micaceous sandy clay -2258 grey sand and gravel with pyrites)
2238 to 2248 feet(Core)	Sandstone: Light brown, friable, very fine to fine-grained, subangular grains, well sorted ss., micaceous (muscovite & biotite), rare rutile, and finely divided organic matter. 10 to 15 percent porosity.
2248 to 2278 feet	No sample over interval; "2236-2278 fine-grained grey micaceous sandstone with pyrite" (Crespin 1954).
2278 to 2295 feet(Core)	Sandstone: Light brown, friable, very fine-grained, subangular grains, well sorted ss., with rare glauconite and rutile, and fine organic matter; silty matrix at base.
2295 to 2306 feet (Core)	Sandstone: Light to dark brown, friable, very fine-grained, subangular grains, well sorted ss., micaceous with pyrite, rare glauconite, zircon and rutile, lignite at 2295 feet and abundant finely divided organic matter at 2299 feet; silty matrix. 5 percent porosity. Clay laminations at 2299 feet. At 2296 feet sandstone compact, very fine-grained, well sorted, with orthoclase & plagioclase feldspar (5%); dolomite and minor anhydrite cement.
2306 to 2363 feet (Core)	Sandstone: Light to medium brown, friable, very fine-grained, subangular grains, well sorted ss., micaceous with rare glauconite and scattered organic matter at 2330 feet. 5 percent porosity. Below 2350 feet sandstone compact; silty matrix.
2363 to 2365 feet (Core)	Sandstone: Light brown, friable, very fine to very coarse-grained, subangular to subrounded grains, poorly sorted ss.; silty matrix.
2365 to 2408 feet (Core)	Sandstone: Light to medium brown, compact, fine to medium-grained, subangular grains, moderately sorted ss., micaceous; silty matrix. 10 to 15 percent porosity. Below 2390 feet sandstone friable, micaceous, with thin dark laminations of finely divided organic matter.
2408 to 2427 feet (Core)	Siltstone: Medium brown, compact, sandy, very fine, subangular quartz grains, and mica flakes.
2427 to 2519 feet	No sample over interval; (2427-2477 grey sand and water worn gravel -2538 fine micaceous sand)
2519 feet (Core)	Sandstone: Light brown, friable, very fine to coarse-grained, subangular to subrounded grains, poorly sorted ss., micaceous, with organic matter.

2519 to 2544 feet (Core)	Sandstone: Light to medium brown, friable, fine-grained, subangular grains, well sorted ss., micaceous, with organic matter; silty matrix.
2544 to 2563 feet (Core)	Sandstone: Medium brown, friable, very fine to medium-grained, angular grains, moderately sorted ss., micaceous, with pyrite clusters and organic matter; silty matrix. 15 to 20 percent porosity.
2563 to 2582 feet (Core)	Sandstone: Light to medium brown, compact, very fine-grained, angular grains, moderately sorted ss., micaceous (muscovite & biotite) rare glauconite, pyrite clusters and organic matter; silty matrix. 10 to 15 percent porosity. Thin clay laminations. Cyclammina sp.
2582 to 2600 feet (Core)	Siltstone: Medium brown, compact, sandy, fine to very coarse, subangular quartz grains, with mica flakes, pyrite and organic matter.
2600 to 2647 feet (Core)	Sandstone: Light to medium brown, compact, very fine to fine-grained, angular grains, moderately sorted ss., micaceous (muscovite & biotite) with garnet, and lignite fragments at 2622 feet; silty matrix. 5 percent porosity.
2647 to 2662 feet (Core)	Siltstone: Dark brown, sandy, fine subangular quartz grains, with mica flakes and finely divided organic matter containing phosphatic fragments.
2662 to 2671 feet (Core)	Sandstone: Light brown, friable, fine-grained, angular grains, well sorted ss., micaceous. 10 to 15 percent porosity.
2671 to 2681 feet (Core)	Siltstone: Dark brown, sandy, very fine, angular quartz grains, with mica flakes and finely divided organic matter; finely divided haematitic clay in matrix. Cyclammina sp.

TOP OF UNIT Db_2 (equivalent to Dartmoor Formation)

2681 to 2735 feet	No sample over interval; (2639-2682 dark micaceous sandy clay. -2737 grey sand)
2735 to 2787 feet (Core)	Shale: Light to medium brown, compact, fissile shale with mica flakes, glauconite, pyrite and limonite. Thin sand laminations (.03 mm.) and lenses. Cyclammina sp., ostracods and gastropods. At 2758 feet sandstone compact; pyrite cement.
2787 to 2790 feet (Core)	Sandstone: Light brown, friable, coarse to very coarse-grained, subangular to subrounded grains, poorly sorted ss., with mica flakes, iron coated quartz grains and organic matter. Cyclammina sp.
2790 to 2820 feet (Core)	Shale: Medium brown, compact, fissile shale, with mica flakes. Thin sand laminations.
2820 to 2837 feet (Core)	Sandstone: Light brown, friable, fine to coarse-grained, angular to subrounded grains, poorly sorted ss., with mica flakes, rare feldspar, and pyrite; silty matrix. Undulate clay laminations. At 2830 sandstone compact; dolomite cement.

2837 to 2906 feet (Core)	Shale: Medium brown, compact, fissile shale, mica flakes, phosphatic fragments and organic matter in sand laminations. At 2874 feet pyritized plant remains and pelecypod shells. At 2886 feet sandstone compact; argillaceous siderite and recrystallized calcite cement Microstylolites.
2906 to 2920 feet (Core)	Sandstone: Light to medium brown, friable, very fine to fine-grained, angular to subangular grains, moderately sorted ss., micaceous. At 2920 feet sandstone compact, with abundant organic matter in laminations; recrystallized dolomite cement and limonitic clay matrix.
2920 to 2942 feet (Core)	Shale: Medium brown, compact, fissile shale, with mica flakes, pyrite clusters, and laminations of organic matter at 2925 and 2942 feet. Thin sand laminations.
2942 to 2979 feet	No sample over interval; (2932-3046 dark micaceous banded siltstone with pyrites)
2979 to 2997 feet (Core)	Shale: Medium brown, compact, fissile shale. Thin sand laminations.
2997 to 3024 feet (Core)	Sandstone: Light to medium brown, friable, fine to coarse-grained, angular to subrounded grains, poorly sorted ss., with mica flakes, rare zircon and pyrite; silty matrix increasing basewards.
3024 to 3047 feet	No sample over interval; "3024-3059 hard to friable dark-grey to black micaceous lignitic sandstone with foraminifera". (Crespin 1954)
3047 feet (Core)	Sandstone: Medium brown, compact, fine-grained, subangular grains, moderately sorted ss., with mica flakes; silty matrix.
3047 to 3080 feet (Core)	Shale: Medium brown, compact, poorly fissile shale, with mica flakes and scattered organic matter. Thin sand laminations.
3080 to 3102 feet	No sample over interval; (3059-3100 dark banded siltstone with hard sand bands and pyrites. 3100-3102 consolidated grey micaceous sand)
3102 to 3123 feet (Core)	Sandstone: Light brown, friable, medium to coarse-grained, angular to subangular grains, moderately sorted ss., micaceous; silty matrix. 15 to 20 percent porosity.
3123 to 3136 feet (Core)	Shale: Medium brown, compact, poorly fissile shale with mica flakes and pyrite. Thin sand laminations and load cast at 3123 feet.
3136 to 3154 feet (Core)	Sandstone: Light brown, friable, fine-grained angular to subangular grains, well sorted ss., micaceous, with finely divided organic matter; silty matrix increasing basewards. 15 to 20 percent porosity. Thin clay laminations.
3154 to 3205 feet	No sample over interval; (3154-3174 hard siltstone and pyrites -3209 grey micaceous sand.)

3205 feet (Core)	Sandstone: Medium cream, friable, fine to very coarse-grained, subangular to subrounded grains, poorly sorted ss., with mica flakes.
3205 to 3230 feet	No sample over interval; (3174-3209 grey micaceous sand. -3240 fine grey micaceous sand with solid bands and pyrite.)
3230 feet (Core)	Sandstone: Medium yellowish-fawn, friable, fine to very coarse-grained, subangular grains, poorly sorted ss., with mica flakes, chlorite, glauconite, and pyrite; recrystallized siderite, and phosphate cement with rare patches of kaolinite matrix. 15 to 20 percent porosity.
3230 to 3244 feet (Core)	Sandstone: Light brown, friable, fine-grained, subangular grains, moderate to well sorted ss., micaceous. 10 to 15 percent porosity. Silty laminations.
3244 to 3300 feet	No sample over interval; (3240-3245 dark micaceous sandy clay. -3246 hard cemented sand. -3260 soft micaceous sand. -3265 cemented sand. -3390 soft grey micaceous sand.)
3300 to 3321 feet (Core)	Sandstone: Light brown, friable, fine-grained, subangular grains, moderate to well sorted ss., with mica flakes.
3321 feet (Core)	Sandstone: Light brown, friable, fine to medium-grained, subangular to subrounded grains, moderately sorted ss., with mica flakes.
3321 to 3360 feet	No sample over interval; (3265-3390 soft grey micaceous sand.)
3360 feet (Core)	Sandstone: Light brown, friable, fine to medium-grained, subangular to subrounded grains, moderately sorted ss., micaceous. 10 to 15 percent porosity. Thin silty laminations.
3360 to 3566 feet	No sample over interval; (3265-3390 soft grey micaceous sand -3549 hard cemented sand. -3565 dark sandy clay. -3594 dark sticky sandy clay with fossil plant remains.)
3566 to 3587 feet (Core)	Siltstone: Medium brown, dark grey at base, compact, sandy patches, with mica flakes, pyrite, and minute carbonaceous matter. Scour-and-fill at 3587 feet. Rare *Cyclammina* sp.
3587 to 3603 feet (Core)	Sandstone: Light grey, compact, fine-grained, angular to subangular grains, well sorted ss., with mica flakes. *Cyclammina* sp. and pelecypod casts.
3603 to 3650 feet (Core)	Shale: Dark grey at top, becoming light brown, compact, fissile shale, silty, with mica flakes, pyrite, and pyritized organic matter at 3618 and 3625 feet. Thin sand lamination at 3617 feet. Plant remains.
3650 to 3655 feet (Core)	Siltstone: Dark grey, compact, sandy, with coarse, subrounded quartz grains, mica flakes, and finely divided organic matter. Burrows.

3655 feet (Core)	Siderite lens: Medium brown, compact, granular, microcrystalline, siderite with scattered silt sized, angular to subangular quartz grains, and pyrite.
3655 to 3690 feet	No sample over interval; (3631-3662 dark sandy clay, fossiliferous and micaceous. -3678 sandy clay with hard bands. -3716 dark grey cemented pyritic sand.)

TOP OF UNIT Dd. (equivalent to Bahgallah Formation)

3690 to 3712 feet (Core)	Sandstone: Dark grey, compact, oolitic, medium to coarse-grained, subangular to subrounded grains, poorly sorted ss., with orthoclase feldspar, microquartzite, abundant pyrite, and ooliths containing quartz and detrital limestone nuclei. Carbonate ooliths show recrystallization and dolomitization, and pyrite rims. Calcite, dolomite, siderite phosphate, pyrite and iron oxide cement. 5 percent porosity.
3712 to 3746 feet (Core)	Sandstone: Dark grey, compact, very fine to very coarse-grained, angular to subrounded grains, poorly sorted ss., with mica flakes, plagioclase, chlorite and pyrite, and organic matter; siderite and dolomite cement and silty matrix. Burrows at 3718 feet, and microstylolites.

TOP OF UNIT Gb. (equivalent to Unnamed Unit)

3746 feet (Core)	Shale: Medium grey, compact, fissile shale with mica flakes, pyrite, and organic matter. Thin sand laminations.
3746 to 3795 feet	No sample over interval; (3716-3763 dark micaceous sandy clay with thin layers of grey sand. -3766 hard sandy clay. -3804 soft sandy clay).
3795 to 3814 feet (Core)	Shale: Medium grey, compact, fissile shale with mica flakes, and organic matter. Fine-grained ss., laminations and lenses.
3814 to 3850 feet	No sample over interval; (3813-3829 micaceous sandy clay. -3832 cemented sand. -3850 fine and coarse micaceous sand.)
3850 feet (Core)	Siltstone: Medium reddish-brown, compact, thinly bedded, sandy, with quartz grains showing preferred orientation parallel to bedding plane, mica flakes, abundant organic matter; haematitic mud matrix with pyrite. Scour-and-fill.
3850 to 3875 feet	No sample over interval: (3850-3868 sandy clay with hard bands. -3873 grey sand. -3887 brown micaceous sandy clay.)

	3875 feet (Core)	Sandstone: Light brown, friable, medium to very coarse-grained, subangular to subrounded grains, moderately sorted ss.
3875 to	3920 feet	No sample over interval; (3873-3887 brown micaceous sandy clay. -3917 grey sand with bands of gravel. - 3951 sandy clay with bands of soft sand).
	3920 feet (Core)	Sandstone: Light brown, friable, medium to very coarse-grained, subangular to subrounded grains, poorly sorted ss., with mica flakes.
3920 to	3955 feet	No sample over interval; (3917-3951 sandy clay with bands of soft sand. -3965 cemented sand.)
	3955 feet (Core)	Sandstone: Light brown, friable, medium-grained subangular to subrounded grains, well sorted ss., with mica flakes.
3955 to	4025 feet	No sample over interval; (3951-3965 cemented sand. -3976 grey sand with bands of sandy clay. -3992 soft grey sand. -4003 cemented sand. -4012 soft sand. -4022 sand with cemented bands. -4041 dark sandy micaceous clay).
	4025 feet(Core)	Shale: Medium grey, compact, fissile shale with mica flakes and organic matter. Thin sand laminations and streaks.
4025 to	4180 feet	No sample over interval; (4022-4041 dark sandy micaceous clay. -4052 sands with bands of sandy clay. -4057 consolidated sand. -4072 soft sand. -4085 consolidated sand. -4095 soft sand. -4209 consolidated sand with pyrites.)
4180 to	4209 feet (Core)	Sandstone: Medium brown to light grey at base, friable, medium to very coarse-grained, subangular to subrounded grains, poor to moderately sorted ss., with some iron coated quartz grains.
4209 to	4302 feet	No sample over interval; (4209-4216 soft grey sand. -4221 medium-grained white siliceous sand. -4223 dark micaceous sandy clay. -4291 grey coarse-grained cemented sand. -4302 soft sand with bands of sandy clay.)
	4302 feet (Core)	Shale: Medium brown, compact, fissile shale with mica flakes. Thin, fine-grained ss., laminations.
4302 to	4366 feet	No sample over interval; (4302-4317 brown sandy micaceous clay. -4358 sticky brown sandy clay. -4361 compact sand. -4365 sandy clay -4375 brown sandy micaceous clay with pyrites.)

4366 feet (Core)	Shale: Medium grey, compact, fissile shale with mica (muscovite & biotite) flakes, pyrite clusters, and organic matter. Fine-grained ss., patches.
4366 to 4500 feet	No sample over interval; (4365-4375 brown sandy micaceous clay with pyrites. -4380 brown sandy clay. -4419 grey sand. -4428 grey sand with bands of sticky clay. -4500 grey sand with hard bands.)

TOP OF UNIT Gd_1 (equivalent to Paaratte Formation)

4500 to 4506 feet (Core)	Sandstone; Light grey, friable, fine-grained, angular to subangular grains, clean, well sorted ss., micaceous (muscovite & biotite), pyrite, and organic matter; soft white kaolinite matrix. 15 to 20 percent porosity.
4506 to 4681 feet	No sample over interval; (4503-4524 fine grey micaceous sand. -4555-6" sandy clay. -4788 cemented sand.)
4681 feet (Core)	Sandstone: Light grey, friable, fine to medium-grained, subangular grains, well sorted ss., subarkosic, orthoclase, mica flakes, pyrite, and pyrite on some quartz grains; kaolinite in matrix. 15 to 20 percent porosity.
4681 to 4743 feet	No sample over interval; (4555-6" - 4788 cemented sand).
4743 to 4746 feet(Core)	Sandstone: Light grey, compact, fine-grained, subangular grains, clean, well sorted ss., micaceous, (muscovite & biotite), rare glauconite, and thin carbonaceous silty laminations at 4746 feet; minor calcite cement and soft kaolinite matrix. 10 to 15 percent porosity.
4746 to 4792 feet	No sample over interval; (4555-6"-4788 cemented sand. -4793 medium-grained sand with green grains and carbonaceous bands.)
4792 feet(Core)	Sandstone: Medium grey, compact, very fine-grained, subangular grains, well sorted ss., micaceous, pyrite, collophane fragments, glauconite, and dark carbonaceous laminations; sideritic mud lenses and calcite cement. Scour-and-fill and cross-bedding.
4792 to 4809 feet(Core)	Sandstone: Light grey, friable, medium to very coarse-grained, angular to subangular grains, gritty, poorly sorted ss., with orthoclase (5%); kaolinite matrix. 15 to 20 percent porosity. At 4809 feet sandstone compact; pyrite and dolomite cement.
4809 to 4839 feet	No sample over interval; (4808-4811 medium angular-grained siliceous sand with green pyritic grains. -4816 sandy clay. -5154 grey micaceous sand with thin layers of clay and cemented bands.)
4839 feet(Core)	Sandstone: Light grey, friable, coarse-grained, subangular to subrounded grains, moderately sorted ss., with pyrite on quartz grains; patches of pyrite cement. 20 to 25 percent porosity.

4839 to 4867 feet	No sample over interval; (4816-5154 grey micaceous sand with thin layers of clay and cemented bands.)
4867 to 4869 feet(Core)	Sandstone: Medium to light grey, friable, medium to coarse-grained, angular to subangular grains, moderately sorted ss., with pyrite. 10 to 15 percent porosity. Fine shale laminations and cross-bedding. At 4868 feet sandstone compact.
4869 to 4920 feet	No sample over interval; (4816-5154 grey micaceous sand with thin layers of clay and cemented bands.)
4920 feet(Core)	Sandstone: Light grey, compact, fine-grained, angular to subangular grains, clean, well sorted ss., subarkosic, orthoclase, mica flakes, chlorite, pyrite, and scattered organic matter; kaolinite matrix with minor chlorite and dolomite cement. 15 to 20 percent porosity.
4920 to 5112 feet	No sample over interval; (4816-5154 grey micaceous sand with thin layers of clay and cemented bands.)
5112 feet(Core)	Sandstone: Medium grey, compact, medium-grained, angular to subangular grains, well sorted ss., silty streaks; kaolinite matrix. 15 to 20 percent porosity.
5112 to 5191 feet	No sample over interval; (4816-5154 grey micaceous sand with thin layers of clay and cemented bands. -5192 hard fine grey sandstone.)
5191 feet(Core)	Sandstone: Medium grey, friable, fine-grained, angular to subangular grains, well sorted ss., subarkosic, orthoclase, micaceous; kaolinite matrix. 15 to 20 percent porosity.
5191 to 5304 feet	No sample over interval; (5154-5192 hard fine grey sandstone. -5233 soft sand. -5293 soft sand with hard bands. -5305 consolidated micaceous sand with sandy mudstone bands.)
5304 feet(Core)	Sandstone: Light grey, compact, medium-grained, angular to subangular grains, well sorted ss., with mica flakes, chlorite, pyrite, zircon, and dark carbonaceous shale laminations; kaolinite matrix and layers of pyritic clay. 15 to 20 percent porosity.
5304 to 5391 feet	No sample over interval; (5293-5305 consolidated micaceous sand with sandy mudstone bands. -5312 sandy mudstone. -5319 cemented sand. -5374 soft sand -5391 cemented sand.)
5391 feet(Core)	Sandstone: Light grey, friable, fine-grained, subangular grains, well sorted ss., subarkosic, orthoclase, muscovite flakes; kaolinite matrix. Brown clay laminations. 15 to 20 percent porosity.
5391 to 5427 feet(Core)	Sandstone: Medium to light grey, friable, medium to very coarse-grained, subangular to subrounded grains, poorly sorted ss., with rare euhedral quartz grains at top, and pyrite. 5 percent porosity.

5427 to 5458 feet	No sample over interval; (5391-5489 coarse sand with micaceous particles.)
5458 to 5468 feet(Core)	Sandstone: Light grey, compact, medium to coarse-grained, subangular grains, gritty, poorly sorted ss., with feldspar, chlorite, mica flakes; kaolinite matrix with recrystallized siderite, dolomite and pyrite cement. 5 percent porosity.
5468 to 5536 feet	No sample over interval; (5391-5489 coarse sand with micaceous particles. -5494 soft sand. -5510 cemented sand. -5589 fine-grained siliceous pyritic sand.)
5536 feet(Core)	Sandstone: Medium brown, compact, fine to medium-grained, angular grains, well sorted ss; silty matrix and pyrite cement.
5536 to 5597 feet	No sample over interval; (5510-5589 fine-grained siliceous pyritic sand. -5596 grey pyritic sand. -5638 soft fine grey sand.)
5597 feet(Core)	Sandstone: Light grey, compact, fine-grained, angular to subangular grains, well sorted ss., micaceous (muscovite & biotite), rare chlorite, pyrite, and brown clay lenses containing fine organic matter; calcite cement and kaolinite in matrix. 5 percent porosity.
5597 to 5708 feet	No sample over interval; (5596-5638 soft fine grey sand. -5640 cemented sand. -5675 soft sand -5676 cemented sand -5698 soft grey sand -5708 sand with bands of micaceous sandy clay.)
5708 feet(Core)	Sandstone: Light grey, compact, fine to medium-grained, angular grains, well sorted ss., with orthoclase, rare glauconite, tourmaline, chlorite, thin micaceous,carbonaceous shale laminations and coal lens; kaolinite matrix. 15 to 20 percent porosity.

TOP OF UNIT Gd_2 (equivalent to Paaratte Formation)

5708 to 5782 feet	No sample over interval; (5708-5733 sand with mudstone bands. -5774 sand with clay bands. -5785 sand with mudstone bands.)
5782 to 5784 feet(Core)	Sandstone: Medium grey, compact, fine to medium-grained, angular grains, moderately sorted ss., mica flakes, microcline, chlorite pellets (3mm.) (10%); siderite cement with minor kaolinite in matrix. Near vertical mineralized hair fractures-calcite on fracture planes. Clean ss. lenses and nodules. "Rolled" ss. lenses showing thin concentric clay laminations around them, and slump structures.
5784 to 5835 feet	No sample over interval; (5774-5785 sand with mudstone bands. -5843 grey consolidated sand.)

5835 feet(Core)	Sandstone: Medium grey, compact, very fine to fine-grained, angular grains, moderately sorted ss., with thin dark, micaceous, carbonaceous shale laminations.
5835 to 5861 feet	No sample over interval; (5785-5843 grey consolidated sand. -5866 grey sand with bands of greyish mudstone.)
5861 feet(Core)	Sandstone: Light grey, friable, fine to medium-grained, angular to subangular grains, well sorted ss., subarkosic, orthoclase, micaceous (muscovite & biotite), rare rutile and glauconite.
5861 to 5914 feet	No sample over interval; (5843-5866 grey sand with bands of greyish mudstone. -5915 consolidated brown sand.)
5914 to 5915 feet (Core)	Sandstone: Light to medium grey, compact, medium to coarse-grained, angular to subangular grains, moderately sorted ss., with orthoclase, chlorite pellets (7%), mica flakes and pyrite; recrystallized siderite cement and minor kaolinite and silt in matrix. 10 to 15 percent porosity. Clean ss. lenses, cross-bedding and microstylolites.
5915 to 5972 feet	No sample over interval; (5915-5916 soft grey sand. -5974 cemented sand.)
5972 feet(Core)	Sandstone: Light grey, friable to compact, fine to medium-grained, subangular grains, moderately sorted ss., with orthoclase, chlorite pellets (5%), mica flakes and pyrite; patches of siderite cement and minor kaolinite matrix. 15 to 20 percent porosity.
5972 to 6000 feet	No sample over interval; (5916-5974 cemented sand. -6007 brownish sandy clay and pyrites.)
6000 feet(Core)	Sandstone: Medium grey, compact, fine to medium-grained, subangular grains, moderately sorted ss., with mica flakes, and dark carbonaceous shale laminations; silty matrix. Burrows, clean ss. lenses and sand "nests".
6000 to 6065 feet	No sample over interval; (5974-6007 brownish sandy clay and pyrites. -6062 consolidated sand. -6236 dark grey micaceous sand and pyrites.)
6065 to 6089 feet(Core)	Sandstone: Medium grey, compact, fine to very coarse-grained, angular to subrounded grains, poorly sorted ss., with rare mica flakes, glauconite, and finely disseminated organic matter; silt and clay matrix. 5 percent porosity. Convolute clay lamination at 6065 feet; "rolled" ss. lenses, sand "nests", slump structures and cross-bedding from 6065 to 6069 feet.
6089 to 6129 feet	No sample over interval; (6062-6236 dark grey micaceous sand and pyrites).
6129 feet (Core)	Sandstone: Medium grey, compact, fine to medium-grained, angular to subangular grains, moderately sorted ss., with mica flakes and dark carbonaceous shale laminations.
6129 to 6233 feet	No sample over interval; (6062-6236 dark grey micaceous sand and pyrites.)

6233 to 6236 feet(Core)	Sandstone: Light grey, compact, fine to medium-grained, subangular grains, moderate to well sorted ss., with mica flakes, glauconite, and thin dark micaceous carbonaceous clay laminations; patches of siderite cement. 10 to 15 percent porosity. Cross-bedding.
6236 to 6250 feet(Core)	Sandstone: Light grey, friable, coarse to very coarse-grained, angular to subangular grains, moderately sorted ss.
6250 to 6291 feet	No sample over interval; (6236-6260 dark grey micaceous sand, pyrites, with traces of glauconite. -6287 consolidated sand with pyrites -6298 dark grey micaceous sand with light grey streaks and traces of glauconite.)
6291 to 6298 feet(Core)	Sandstone: Light grey, compact, medium to very coarse-grained, angular to subangular grains, poorly sorted ss., with mica flakes, orthoclase, rare chlorite, pyrite; dolomite, siderite, pyrite and rare chlorite cement with minor kaolinite matrix. 10 to 15 percent porosity. Thin dark micaceous shale lamination.
6298 to 6328 feet	No sample over interval; (6298-6336 soft sand.)
6328 feet(Core)	Sandstone: Medium grey, compact, medium-grained, angular to subangular grains, moderate to well sorted ss.; pyrite cement and silty matrix.
6328 to 6337 feet(Core)	Sandstone: Light cream, speckled, compact, medium to coarse-grained, subangular grains, moderately sorted ss., with feldspar, chlorite and pyrite; fine-grained siderite, recrystallized dolomite and pyrite cement.
6337 to 6418 feet	No sample over interval; (6337-6542 cemented sand.)
6418 feet(Core)	Sandstone: Light brown, compact, medium to coarse-grained, angular grains, poorly sorted ss., with orthoclase, chlorite (5%), mica flakes and glaucophane; recrystallized siderite and dolomite cement, with minor kaolinite in matrix. 5 percent porosity.
6418 to 6485 feet	No sample over interval; (6337-6542 cemented sand.)
6485 feet (Core)	Sandstone: Light brown, compact, medium to very coarse-grained, angular to subangular grains, poorly sorted ss., with mica flakes, chlorite (5%) and pyrite; siderite and dolomite cement with rare kaolinite patches.
6485 to 6520 feet	No sample over interval: (6337-6542 cemented sand.)
6520 to 6533 feet (Core & Cuttings)	Sandstone: Light grey, friable, coarse to very coarse-grained, subangular grains, moderately sorted ss., with glauconite.
6533 to 6565 feet (Core & Cuttings)	Sandstone: Light cream, compact, fine-grained, angular to subangular grains, well sorted ss., with glauconite; calcite cement and minor clay matrix.

6565 to 6654 feet (Core & Cuttings)	<u>Sandstone</u>: Light to medium grey, compact to friable, very fine to medium-grained, angular grains, moderate to well sorted ss., with mica flakes, finely disseminated pyrite, and wavy silty carbonaceous laminations at top; clay and silt matrix. At 6576 feet, pseudo-nodular structures with concentric clay laminations around them, nodules of clean sand, clean ss. streaks and "nests" and slump structures.
6654 to 6682 feet (Core& Cuttings)	<u>Sandstone</u>: Light grey, friable to compact, fine to very coarse-grained, angular to subangular grains, moderate to well sorted ss., with glauconite and pyrite and wavy carbonaceous silty streaks. At 6678 feet <u>sandstone</u> compact; dolomite cement.
6682 to 6751 feet	No sample over interval; (6676-6823 consolidated fine sand with pyrites.)
6751 to 6818 feet (Core & Cuttings)	<u>Sandstone</u>: Medium grey, compact, (becoming friable basewards), very fine to fine-grained, angular to subangular grains, moderate to well sorted ss., micaceous. At 6751 feet, <u>sandstone</u> with pyrite and glauconite; carbonaceous shale laminations; silty matrix. Burrows, thin clean ss. lenses - normal, "rolled" and slumped - and ss. "nests".
6818 to 6843 feet	No sample over interval; (6676-6823 consolidated fine sand with pyrites. -6844 soft sand.)
6843 to 6911 feet (Core & Cuttings)	<u>Sandstone</u>: Light brownish-grey, compact to friable, very fine to medium-grained, angular to subangular grains, well sorted ss., with glauconite; silty matrix. 5 percent porosity. At 6843 feet <u>sandstone</u> compact; calcite cement and clay matrix.
6911 to 6939 feet	No sample over interval; (6875-6975 soft sand.)
6939 to 6999 feet (Core & Cuttings)	<u>Sandstone</u>: Light grey, compact to friable, very fine to fine-grained, angular to subangular grains, moderate to well sorted ss., thin carbonaceous clay laminations at 6939 feet.
6999 feet (Core)	<u>Sandstone</u>: Medium grey, compact, fine-grained, angular grains, moderate to well sorted ss., with thin carbonaceous streaks; pyrite cement.
6999 to 7062 feet	No sample over interval; (6975-7050 consolidated sand with pyrites. -7093 soft sand.)
7062 to 7091 feet(Cuttings)	<u>Sandstone</u>: Light grey, compact to friable, very fine to fine-grained, angular to subangular grains, moderate to well sorted ss., with scattered dolomite rhombs, glauconite and pyrite; silty matrix.
7091 to 7147 feet	No sample over interval; (7050-7093 soft sand. -7094 copper pyrites -7132 soft sand. -7174 consolidated sand.)
7147 to 7209 feet (Cuttings)	<u>Sandstone</u>: Light grey, friable, very fine to medium-grained, angular to subangular grains, moderately sorted ss., with mica flakes, rare glauconite, pyrite, and finely disseminated organic matter; clay and silt matrix.

7209 to 7240 feet (Cuttings)	<u>Sandstone</u>: Light grey, compact, fine to coarse-grained, angular to subangular grains, moderate to poorly sorted ss., with rare glauconite; dolomite cement.
7240 to 7291 feet (Cuttings)	<u>Sandstone</u>: Medium grey, compact, fine to very coarse-grained, angular to subrounded grains, moderately sorted ss., with scattered organic matter; silty matrix. At 7250 feet <u>sandstone</u> compact; pyrite cement.
7291 to 7305 feet (Cuttings)	<u>Sandstone</u>: Medium grey, compact, fine to medium-grained, angular to subangular grains, moderate to well sorted ss.; pyrite cement.

Lat: 38° 03' 20" S.
Long: 141° 00' 10" E.
Elevation: 10' (G.L.)
Scale: 1" = 100 Feet
B.M.R. Well Index No. 298

COMPOSITE WELL LOG
NELSON BORE

PLATE 1 Sheet 1

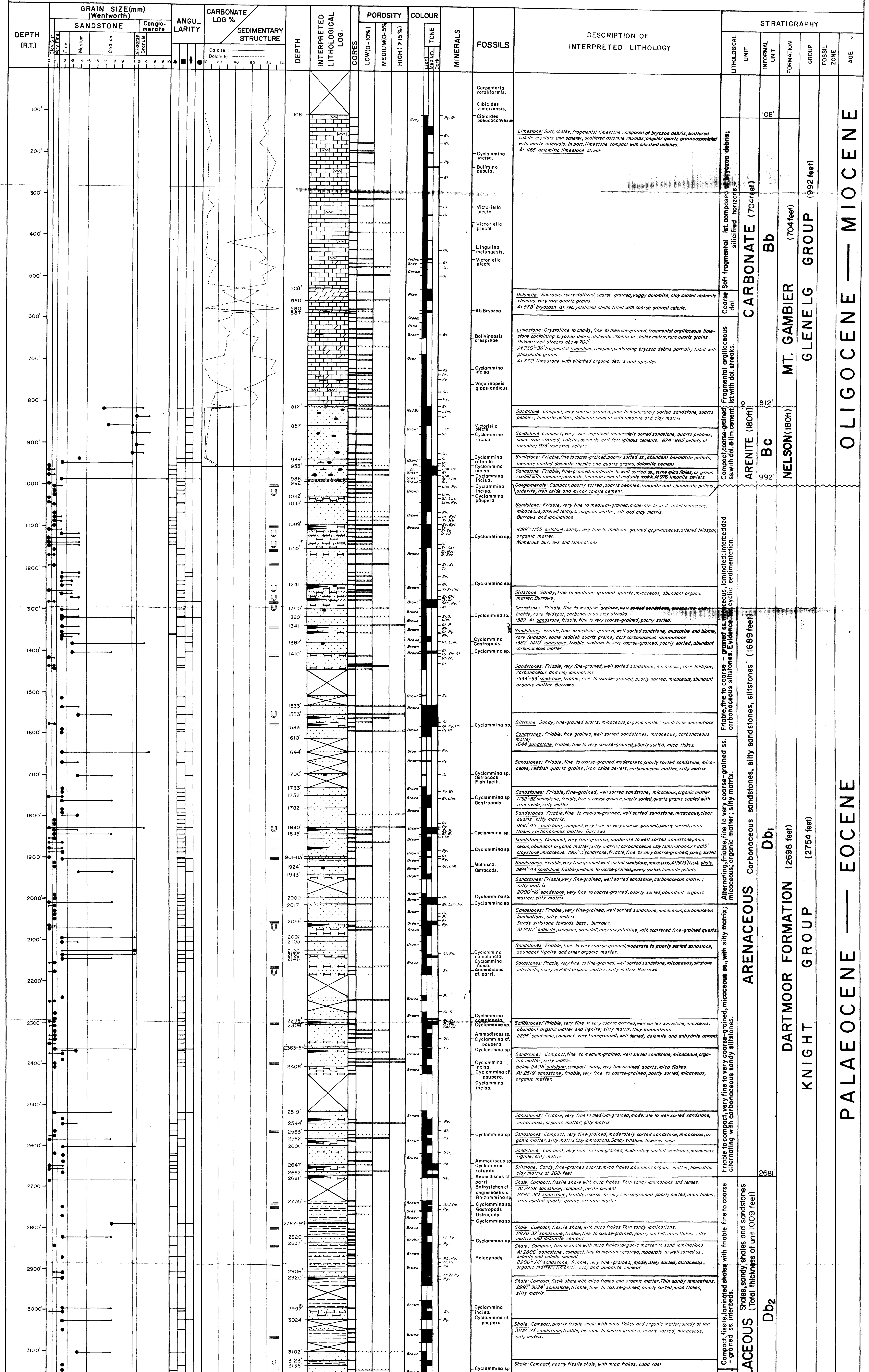
Drilled for: COMMONWEALTH and VICTORIAN GOVERNMENTS
State: VICTORIA
Basin: OTWAY

LEGEND

Burrow; Cross bedding; Scour and fill; Lamination; Convolute lamination; Load cast; Slump structure; Sand "nest"; Conglomerate; Sandstone; Subarkose; Pellets; Siltstone; Claystone; Shale; Ooliths; Limestone; Dol. limestone; Dolomite; Siderite; Marl; Carbonaceous matter; Limestone, in part silicified

MINERAL ABBREVIATIONS

Py.	Pyrite	Zr.	Zircon
Gl.	Glauconite	R.	Rutile
Ph.	Phosphate	Gar.	Garnet
Lim.	Limonite	Chl.	Chlorite
He.	Haematite	Str.	Staurolite
St.	Siderite	Col.	Collophane
Epi.	Epidote	Glc.	Glaucophane
Hb.	Hornblende	Tr.	Tourmaline



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TO ACCOMPANY RECORD 1963 / 167.

August, 1964

PLATE 1 Sheet 2

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TO ACCOMPANY RECORD 1963/167

MARCH, 1964.