COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

**BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS**



RECORD No. 1964/77



# A PETROLOGICAL STUDY OF THE SEDIMENTS FROM FROME - BROKEN HILL, PORT CAMPBELL No. 1 AND 2 WELLS, OTWAY BASIN, VICTORIA



*by*

*J. DELLENBACH and P. HAWKINS*

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# A Petrological Study of the Sediments from Frome - Broken Hill Port Campbell Numbers 1 and 2 Wells; Otway Basin Victoria

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NOTE: This report contains information obtained prior to 8th May, 1964.

## Summary

The study of the sediments from the Port Campbell No. 1 and No 2 wells has produced new information to support the following points:

1 There is a major break in sedimentation and an unconformity between the equivalent of the Nelson Formation (originally observed in the Nelson Bore), and the top of the Wangerrip Group.

2 Subdivisions within the Wangerrip Group and the Paaratte Formation can be justified only on the basis of the granularity and cementing media. The iron oxide content has also been studied and could prove of great value for further correlations. The cementing media are described and related to the electric log characteristics.

3 The affinities between the "Belfast Mudstone" and the "Flaxmans Beds" are pointed out. No recognizable break was observed between these two units.

4 The presence of 80 feet of "Flaxmans Beds" in the Port Campbell No. 1 well is postulated.

5 An unconformity exists between "Flaxmans Beds" and Waarre Formation, and represents a period of erosion.

6 The nature of the porosity of the Waarre Formation reservoir is studied.

7 Examination of the "Otway Group" sediments shows their affinities to the "Belfast Mudstone" and the "Flaxmans Beds" as far as the terrigenous content of the sediments is concerned.

# INTRODUCTION

The sedimentary petrology of the Port Campbell No. 1 and Port Campbell No. 2 wells, which were drilled approximately two miles apart in the Otway Basin of Victoria for Frome-Broken Hill Proprietary Limited has been studied. Some details of the two wells are given below :

| Port Campbell No. 1 Well | Port Campbell No. 2 Well |
|---|---|
| 38°34'57"S, 142°57'50"E | 38°35'55"S, 142°59'27"E |
| Colac (J54/12) 1:250,000 sheet. | Colac (J54/12) 1:250,000 sheet. |
| 5965 feet total depth | 8846 feet total depth |
| Subsidized from surface to total depth. | Subsidized from 7130 feet to total depth. |

Samples of all cuttings caught and approximately 17% of all cores recovered were available from the full section of Port Campbell No 1 well. Cores and cuttings were available, however, only from 7130 feet to the bottom of Port Campbell No. 2 well. The completion report (Frome-Broken Hill 1964) was the most complete reference, but other reports were referred to wherever relevant.

In broad terms, the objects of the work were twofold:

1 To evaluate the petroleum possibilities of this portion of the Otway Basin

2 To determine the best approach to the problems of correlation within the basin.

The detailed work has been directed principally towards defining more completely the various units encountered, and determining the relationship between the units.

## "OTWAY GROUP"

The sediments of this stratigraphic unit, encountered in the Port Campbell No. 2 Well from the bottom (8846 feet) up to 8520 feet, are characterized by the abundance of lithic fragments set in a chloritic matrix.

Dark greenish grey siltstones with coaly bands alternate with angular, very fine grained, well sorted feldspathic sandstones* set in a silty, argillaceous chloritic matrix.

As much as 20% of the sandstone consists of feldspar-albite and oligoclase some of which shows zoning. Much biotite and rock fragments are also present; making up the latter are volcanic rocks - possibly andesites, chloritic schists, microquartzite and chert grains. The matrix of the sandstone is silty, kaolinitic and chloritic. Red spots mentioned in a previous report (Frome-Broken Hill, 1964) represent diagenetic alteration products of pyroclastic material and may possibly be related to the zeolites described by Baker and McAndrew (1961) from the Flaxmans No. 1 Well.

Silicified arenaceous foraminifera, with pyrite infillings, mentioned by Crespin (see Evans 1964) occur in core No. 16, at 8562 feet.

The lithologies and the presence of foraminifera both suggest a marine environment for the "Otway Group" sediments in the Port Campbell No. 2 Well. It is possible at the present time, only to infer the type of deposition. The relative freshness of the lithic components suggests a rapid burial of the sediments. Further study of this Group in other wells should show if, as reported by Taylor (1964), the major part of the Group is non-marine.

* The feldspathic, lithic sandstones of the "Otway Group" have been described as arkoses by a number of workers. The nature and composition of these sandstones would indicate that they could be more correctly considered as "graywacke" (Pettijohn 1957)

## WAARRE FORMATION

The Waarre Formation was found in Port Campbell No.1 between 5965 feet (the bottom of the hole) and 5650 feet, and in Port Campbell No.2 between 8520 feet and 8120 feet; the intervals agree with those recorded in the Well Completion Report (Frome-Broken Hill 1964).

The Waarre Formation can be divided into two major intervals in the Port Campbell No.1 Well.

In the lower interval from the bottom (5965 feet) to 5670 feet, the lithology is a grey siltstone containing some more argillaceous layers, and spotted with carbonaceous matter. Fine to medium grained, subangular to subrounded quartzitic sandstones containing clay cement are also present. Minor dolomitic, ankeritic sandstone and siltstones with glauconite, occur between 5920 and 5850 feet, and indicate a marine environment.

The top interval is from 5670 to 5650 feet and its upper limit is well marked in the drill cuttings and also on the electric log. Unfortunately, the samples of core No.22 (5660 - 5670 feet) in the Port Campbell No.1 collection do not include the top six inches of conglomerate mentioned in the log and report by Frome-Broken Hill (1964). The cuttings between 5670 and 5656 feet contain chips of quartz pebbles, indicating that pebbles of up to 20 mm. diameter occur together with very coarse angular-grained feldspathic sandstones.

In previous studies it has been mentioned that the so called "Flaxmans Beds" were missing above the Waarre Formation in the Port Campbell No.1 Well. Evidence to support the opposite view - that the "Flaxman Beds" do occur in the Port Campbell No.1 Well - will be stressed in the chapter dealing with that unit.

In the past, emphasis has been given to the high porosity and permeability encountered at 5656 feet in the Port Campbell No.1 Well. This should not be regarded as indicating the reservoir quality of the whole Waarre Formation. It must be kept in mind that these sands and conglomerates are just below the unconformity (possibly erosional) with the "Flaxmans Beds". As a result, they might represent only an erosional surface of the Waarre Formation.

In Port Campbell No.2 Well, 400 feet of alternating dark, pyritic, argillaceous silts rich in organic matter, and grey quartzitic sandstones, make up the Waarre Formation. The quartzitic sandstones, as shown by core No.10, are angular to subrounded, fine to very coarse grained, interlocking, show quartz overgrowths, and bear the marks of pressure solution and tension fracturing. The kaolinitic cement is restricted to disseminated patches, possibly as a result of a secondary process. Although the porosity has been reduced considerably by the secondary quartz, the permeability has remained.

Pyritized plant debris and lenses of silty clays rich in organic matter are common, though erratically distributed, in these sandstones.

In both Port Campbell No 1 and No.2 Wells, electric logs and the examination of cuttings suggest that the Waarre Formation was formed in a paralic environment possibly close to a river mouth. The overall lithology consists of rapid alternations of pyritic siltstones containing carbonaceous matter, with fine to medium grained feldspathic sandstones in most places. In the Port

Campbell No.1 and No.2 Wells, core 23 and core 9 respectively, show churned and slightly slumped bedding. Although terrigenous influences are strong throughout, the environment seems to have remained that of a lower deltaic to inner neritic type.

Relationship between the Waarre Formation and the "Otway Group"

In Port Campbell No.2 Well an unconformity has been postulated at 8520 feet between the Waarre Formation and Otway Group (Frome-Broken Hill, 1964). On the basis of the study of the cuttings, there is no definite evidence for an unconformity. The difference in lithology between the Waarre Formation and the Otway Group and the absence of chloritic elements, (which were very abundant in the Otway Group) from the Waarre Formation may be indicative however, of an unconformable relationship.

## "FLAXMANS BEDS"

These beds occur in the Port Campbell No.1 Well from 5650 to 5570 feet and in the Port Campbell No.2 Well from 8120 to 7900 feet. In the Well Completion Report (Frome-Broken Hill, 1964) 200 feet of sediments (8110 to 7910 feet) have been ascribed to this unit in the Port Campbell No.2 Well.

### The "Flaxmans Beds" in the Port Campbell No.2 Well

In the present study the "Flaxmans Beds" have been recognised in the Port Campbell No.2 Well from cores 6, 7 and 8, after comparison with core No.20 from the Flaxmans No.1 Well. The 220 foot section found in Port Campbell No.2 Well, is made up of a distinctive lithological character, that can be easily recognized in the cores but is less obvious in the cuttings. These sediments are marine, consisting of angular to subrounded, very fine to coarse grained, feldspathic and lithic sandstone, that are silty and poorly sorted. The other terrigenous components are feldspars, chert, volcanic rock fragments (andesite), chloritic schists, quartzites (metaquartzite), pegmatite, chlorite, biotite, muscovite and minor heavy minerals (zircon, tourmaline). The matrix is mainly silty, argillaceous and chloritic, with pyrite, glauconite and a number of alteration products (sericite, calcite, clay). An ankeritic-sideritic, slightly phosphatic cement, with chloritic material occurs at 7904 feet in core No.6 from Port Campbell No.2 and accounts for increased resistivity on the electric log. It is assumed that a number of other high resistivity peaks also represent strongly cemented intervals, but the only material now available for examination from these intervals is cuttings.

### Evidence for the presence of "Flaxmans Beds" in Port Campbell No.1 Well

A close study of the cuttings from Port Campbell No.1 and No.2 Wells shows that the same lithology is responsible for the high resistivity peak in each case; unfortunately the electric logs from the two wells differ so greatly in quality that they cannot be used for a comparison.

At 5580 feet in the Port Campbell No.1 Well, the lithology corresponding to the marked resistivity peak is a sandstone with sideritic cement and chamosite ooliths which are replaced by calcite. The correlated depth in Port Campbell No.2 is approximately 7830 feet, and is also marked by high resistivity; the lithology in this case is a sandstone with sideritic cement and chamosite ooliths, some of them replaced by calcite.

The second resistivity peak at 5630 feet in Port Campbell No.1 Well is due to a highly cemented sandstone. The cement is sideritic, and glauconite pellets occur together with abundant chamosite ooliths containing detrital quartz nuclei. In the Port Campbell No.2 Well, a high resistivity interval occurs around 8070 feet, which can be correlated with the peak at 5630 feet in the Port Campbell No.1 Well; the rock at this depth also contains chamosite ooliths with detrital quartz nuclei, in a siderite and chamosite matrix; some of the chamosite ooliths have been replaced by calcite.

The comparative study of the cuttings of the two wells from the intervals (5650 to 5570 feet in the Port Campbell No.1 and 8120 to 7900 feet in the Port Campbell No.2 Well), shows that the lithologies are very similar, especially those responsible for increased resistivity at corresponding depths. It is therefore probable that 80 feet of "Flaxmans Beds" occur in Port Campbell No.1 Well and 220 feet in Port Campbell No.2 Well. As additional evidence for this

interpretation, it should be pointed out that the ratio of the thicknesses for the "Flaxmans Beds" thus defined, in Port Campbell No.1 and No. 2, is about the same as the ratio of thicknesses of the overlying "Belfast Mudstone".

Relationship between "Flaxmans Beds" and Waarre Formation

It has been stated that the Waarre Formation "underlies unconformably the Belfast Mudstone at the Port Campbell No.1 and No.3 wells and conformably underlies the Flaxmans Beds in Port Campbell No.2 and Flaxman No.1 wells" (Frome-Broken Hill, 1964). (Port Campbell No.3 was excluded from the present study because representative material was not available from the Bureau collection).

As a result of the postulated presence of "Flaxmans Beds" in the Port Campbell No.1 Well, the same relationship between Waarre Formation and "Flaxmans Beds" should hold in both Port Campbell No.1 and No.2 Wells. For the reasons given below, it is suggested that there was a period of erosion between the depositions of the two formations.

There are marked differences in the types of sediments of the Waarre Formation and the overlying "Flaxmans Beds" in Port Campbell No.2, pointing to a sudden change from a deltaic (Waarre Fm.) to a more marine environment in which quite different terrigenous material was deposited; there is also evidence of an erosional surface in the Port Campbell No 2 Well, indicating an unconformable relationship between Waarre Formation and "Flaxmans Beds". The fact that dips of 15 to 20° have been recorded within the Waarre Formation and Otway Group (Port Campbell No.2, cores 15, 16,17) could also be significant; the laminar appearance of the core makes it unlikely that these dips are due to cross-bedding, as suggested in the completion report (Frome-Broken Hill, 1964).

## "BELFAST MUDSTONE"

This unit occurs in Port Campbell No.1 between 5570 and 4930 feet, and in Port Campbell No.2 from at least 7900 feet up to 5810 feet (upper limit of samples available). The intervals for the "Belfast Mudstone" given in the completion report (Frome-Broken Hill 1964) are 5656 to 4930 feet in Port Campbell No.1, and 7910 to 5810 feet in Port Campbell No.2.

The intervals are very homogeneous both in electric log characteristics and in the cuttings themselves. The rock is a very compact dark grey mudstone with much authigenic glauconite, finely divided pyrite, and chloritic and organic matter; minor brownish dolomitic streaks with some slightly phosphatic and sandy patches occur in Port Campbell No.1 between 5110 and 5000 feet, and at 7710 and 7250 feet in the Port Campbell No.2 Well. The fossils that have been reported are mainly small pelecypods, gastropods, annelids, arenaceous foraminifera, together with a few ostracods, fish teeth and scales and pyritic burrows.

The "Belfast Mudstone" has been considered as a possible source rock for petroleum, but although the abundance of glauconite is related to presence of organic matter, reducing conditions which would not favour a great density of marine life seem to have been dominant at the time of deposition. Both the relative paucity of the fossils and the nature of the faunal assemblage present, are suggestive of poorly aerated conditions - resulting from a restricted environment - at the time of deposition. The "Belfast Mudstone" and the underlying "Flaxmans Beds", proved to be a good cap-rock in the Port Campbell No.1 Well.

The increase in thickness of the Belfast Mudstone between the two wells is an important observation, the "Belfast Mudstone" is represented by 640 feet in Port Campbell No.1 and 2090 feet in Port Campbell No.2. If it assumed that the "Flaxmans Beds" are represented by 80 feet of sediments in Port Campbell No.1 and 220 feet of sediments in Port Campbell No 2 (about the same increase ratio), and the upper limit of the "Belfast Mudstone" is of the same age in each well, then the increase of thickness can best be explained by means of a flexure or a fault acting continuously during "Flaxman Beds" and "Belfast Mudstone" times.

The conditions at the time of deposition of the "Belfast Mudstone" were probably constant, both in a lateral and vertical sense, producing a "humid restricted" environment over a wide area.

Relationship between "Belfast Mudstone" and "Flaxman Beds".

A "ferruginous siltstone with limonite pellets, pyrite and yellow-brown stained quartz fragments, and some chert pebbles fragments" has been reported at the contact of the "Belfast Mudstone" and "Flaxmans Beds" in the Port Campbell No.2 well, (Frome-Broken Hill, 1964). A close petrographic examination of the core No.5 (7887 - 7889 feet) shows, however, that the limonite has resulted from the late alteration of chamosite pellets or ooliths in a sandy pyritic and chloritic matrix. This type of limonite in no way indicates a strongly oxidizing environment and a possible break in sedimentation; in this case limonite pellets would be forming in situ under oxidizing conditions and would be unlikely to contain pyrite but would rather show high energy characteristics (corrosion, sorting, etc). In addition, chamosite pellets (as they occur in core No. 5) and iron silicates, in general form over a far broader range of Eh values than do iron oxides.

A close comparison between cores of "Belfast Mudstone" and "Flaxmans Beds" shows that there was no major change in environmental conditions; only the proportions of lithic elements differ, from 5% in the "Belfast Mudstone" to 20 - 25% in the "Flaxmans Beds".* From this point of view it is suggested that the "Flaxmans Beds" should be considered as a member of the "Belfast Mudstone" Formation.

It is very striking that the lithologies of the "Flaxmans Beds" and also to some extent those of the "Belfast Mudstone" are very similar to the lithologies of the "Otway Group". It is suggested that there was a common origin for the terrigenous material by the continued erosion of the one landmass, made up of metamorphic and volcanic rocks during "Otway Group" time and Flaxmans - Belfast time.

* Chemical analyses of samples of the "Flaxmans Beds" at 7904 feet, and of the "Belfast Mudstone" at 7690 feet, in the Port Campbell No.2 Well, were made by G. Baker (1963). The results of the analyses are very similar and support the affinities between the two lithologies that have been noted above.

## PAARATTE FORMATION

This formation occurs in Port Campbell No.1 between 4930 and 4250 feet and, as judged from the electric log, in Port Campbell No.2 between 5810 and 5000 feet. (These are also the intervals quoted in the Well Completion Report (Frome-Broken Hill 1964).

On the basis of the electric log this unit is characterized by a low resistivity and a positive S.P. It is a sandy formation that contains a high proportion of silts and clays.

The various lithologies can be discussed by reference to the various intervals within Port Campbell No.1 Well.

### Interval 4940-4670 feet

The sediment consists of very fine grained and in places coarse grained feldspathic sandstones, dark grey mottled silty sandstones, and siltstones with patches of organic matter; the cement is dolomitic and sideritic; Pyritic and limonitic spots and minor brownish streaks also occur.

### Interval 4670-4470 feet

The grey silty sandstones of this interval contain very fine laminations of clay together with organic matter. Core 16 is a light grey laminated micaceous siltstone with very fine dark argillaceous pyritic silt interealations, and pyritic burrows. Towards the top of the interval the rock becomes more sandy, and porosity increases.

### Interval 4470-4250 feet

The top interval shows churned bedding and rapid alternations of very fine to medium grained sandstones and dark argillaceous pyritic siltstones rich in organic matter and containing some plant debris.

From the paleontological view point, the Paaratte Formation has been considered as a "transition zone" between Cretaceous and Eocene.

Microplankton recognised by Evans (1964) in material from Port Campbell No.1 over the interval 4291 to 4280 feet (cores 14 and 15) constitute an Upper Cretaceous assemblage. It is a reasonable assumption that the remaining 30 feet of the Paaratte Formation is also Upper Cretaceous. There is no indication as to whether the bottom part of the Wangerrip Group also belongs to the Upper Cretaceous or is of Tertiary age.

### Relationship between the Paaratte Formation and the "Belfast Mudstone"

Although the commencement of deposition of sediments of the Paaratte Formation represents an important change from inner neritic to paralic or interdeltaic conditions, there is no evidence for an unconformity at the bottom of the Paaratte Formation.

## WANGERRIP GROUP

This group occurs in Port Compbell No.1 and No.2 in the intervals 4250 to 1375 feet, and 5000 to 1230 feet respectively; thus the thickness of the unit is 2875 feet in Port Campbell No.I. (These are the same intervals as determined earlier in the completion report (Frome-Broken Hill 1964).

The Wangerrip Group overlies the Paaratte Formation with little change in sedimentary character; the upper limit of the group is marked by a strong unconformity occuring at 1375 feet in Port Campbell No. 1; the overlying rocks consist of the Heytesbury Group.

The lithology of the Wangerrip Group, consisting mainly of sandstones, can best be considered by reference to the various intervals within the Port Campbell No.1 Well:

### Interval 4250-4010 feet

This section is composed of rocks ranging from fine grained sandstones to very fine silty sands. The quartz grains are angular and in most cases well sorted, and the matrix is mainly argillaceous but with some pyrite. Some coal fragments in the cuttings indicate minor coal layers although the electric log gives no indication of them - probably due to the thinness of the horizons. The equivalent interval in Port Campbell No.2 Well also shows indications of thin layers of coal.

### Interval 4010-3725 feet

This interval is less silty than the underlying material, and has produced a series of strong resistivity peaks - due to the presence of coal layers. Angular to subangular coarse grained feldspathic micaceous sandstones containing minor amounts of clay and pyritic cement, alternate with dark pyritic siltstone that contains layers of coal and fossil wood fragments. Core 13 (3997-4009 feet) consists of a light grey very fine to silty sandstone containing cross-beds dipping at 15-20°, and scour-and-fill textures. Intercalations of dark siltstone layers occur rarely exceeding 1cm, in thickness. The fine sandstone shows signs of slump structures. The porosity of the rock is high. Minor amounts of angular to subrounded grey quartz grains - some very coarse grained - are scattered through the core and muscovite is present throughout. The bottom 2 feet of core show very irregular bedding probably resulting from deposition under turbulent conditions.

The upper 40 feet (3745-3725 feet) - the junk basket core (3740-42 feet) - show layers of light grey silts with convolutions, scour-and-fill textures, and cross bedding dipping at up to 20°. Over the interval 3850 to 3745 feet marked positive S.P. peaks together with sharp fluctuations in the resistivity log, - especially the one from Port Campbell No.1 - would indicate a type of cyclic deposition; this conclusion is supported by a study of the cuttings. However, no more precise discription of the depositional process is possible at this stage.

### Interval 3725-3550 feet

This interval is made up of grey, fine-grained, angular to subangular feldspathic sandstone, well sorted in most cases; the matrix is of clay. Minor coarse sandy streaks occur within the feldspathic sandstone. At about 3700, 3640 and 3590 feet, white argillaceous limestone occurs, probably representing cavings; at 3630 feet and at 3570 feet, coal fragments are present. Core 11 (3618-3600 feet) consists of sandy siltstone with minor amounts of very coarse quartz grains scattered throughout; no definite bedding can be seen, but signs of scouring and convolutions are common.

Interval 3550-3280 feet

Between 3360 and 3550 feet, angular to subangular, coarse to very fine-grained grey sandstones occur, containing many white argillaceous intercalations and coal debris.

The white argillaceous siltstone and dark mudstone observed in the interval 3360 to 3280 feet is not the true lithology. The samples examined are apparently crushed and ground by the drilling bit and are contaminated by drilling mud. The original rock was probably very similar to the siltstone that contains siderite and chamosite ooliths in core No. 10 3333 to 3340 feet*. No previous mention has been made of sideritic silty mudstone from Port Campbell No.2 although the cuttings log does show an increase in silt content.

The interval (3550 - 3280 feet) contains coaly intercalations which can be correlated with coaly intercalations at similar stratigraphic interval in Port Campbell No.2 Well (see completion report, Frome-Broken Hill, 1964).

Interval 3280-2910 feet

This interval shows a generally low resistivity on the electric log and is characterised by a high proportion of very coarse to conglomeratic components; from the 38 cutting samples examined, 22 contain over 40% of very coarse to conglomeratic-sized grains. The sandy rocks alternate with siltstones and are marked by low resistivity and positive S.P. values; these deposits might also represent cyclic sedimentation.

Core 9 (3148-3167 feet) shows very poor sorting of these very coarse to gritty sands and would indicate a polygenetic origin for the grains; among the pebbles are fine-grained siliceous rocks. The cement is argillaceous. Silty argillaceous layers appear to be interbedded with the sandstone.

At 3151 feet (core No.9) there is an angular, fine to medium grained slightly feldspathic sandstone, well sorted in parts, but with abrupt changes to very poorly sorted patches of coarse to gritty sands. A characteristic feature is the limonitic coating, acting in places as a cement, bonding the silt-sized particles. The patchy development of this limonitic coating and the fact that the coarser grains are not entirely covered, does not preclude a possible late depositional or secondary origin of this feature.

Core 8 (2915 - 2933 feet) is a loose, angular to subangular, very coarse grained sandstone; it does not contain any cement, but there is a significant amount of clean silt present.

According to the Completion Report (Frome-Broken Hill, 1964) the corresponding interval in Port Campbell No.2 Well - from about 3650 to 3300 feet - is less conglomeratic.

Interval 2910 - 2325 feet

From 2910 to 2840 feet the coarse grained sandstone is characterised by an abundance of iron oxide pellets ranging in diameter from .5 mm. up to 1 mm., and forming 15 - 20% of the volume of the cuttings. The binding medium is a phosphatic cement, brownish, and consisting of both ooliths and collophane matrix and becoming sideritic in places. The siderite shows secondary growth due to recrystallisation.

Between 2840 and 2790 feet the lithology is similar to the rock from the interval immediately below; however the grain size has decreased and more than 50% of the loose particles are medium to fine grained. The amount of iron oxide has also decreased to a few precent, but there are signs that some layers were originally cemented by siderite, ankerite, primary phosphate, and pyrite. The quartz grains also show better sorting and a greater degree of angularity. At 2830 feet iron stained recrystallised siderite occurs with collophane.

* This chamosite horizon is similar to a horizon of chamosite ooliths found during the study of the Mt. Salt Well from 3130 to 3240 feet ("Bahgallah Formation"), and referred to as the "Bahgallah Formation" (Oil Development N.L., 1963).

It appears that the oxidizing conditions of the agitated water, indicated by the interval 2910-2840 feet, gradually became less pronounced, and the hydrodynamic environment became progressively quieter - as shown by the interval 2840-2790 feet. The horizon rich in iron oxide (2910-2790 feet) can be compared, and possibly correlated with, an iron oxide-rich layer that occurs at 3690-3746 feet in the Nelson Bore.

Between 2790 and 2620 feet there is an upward decrease in the grain size of the brownish sands, and an increase of silty streaks which possibly form the cement for some of the layers within this interval.

From 2620 to 2530 feet the material in general, ranges from fine to very coarse grained uncemented sandstone. Particular horizons - possibly at 2540-2560 feet and 2580-2590 feet - are cemented by phosphatic matter and contain phosphatic ooliths. These horizons are still very porous and contain fresh water. A similar fresh water interval was observed in Port Campbell No.2 Well; in this case however, the thickness of the particular sand body seems to have increased. (It is unlikely that this is due to repetition through faulting).

From 2530 to 2325 feet the lithology shown by the cuttings is not very different from the material lower in the unit, but there is a considerable decrease in grain size together with an increase in the proportion of clay matrix. This can be seen from an examination of core No.7 (2450-2466 feet) which is a dark clayey pyritic sandy siltstone. The great contrast between lithologies recorded from the cuttings and those from the core result from the softness of the rock which has lead to the complete break up of material into sand or silt grains, and clays; the latter are diluted with drilling mud and for the most part are not recovered as cuttings.

Interval 2325-2110 feet

This interval consists of alternating fine and very coarse sandstones, characterised by the great quantity of angular quartz grains coated with greenish alteration products which are especially common towards the base of the interval. The green mineral has filled embayments or pits, or formed vermicules within or on the surfaces of quartz grains; and proved to be of a kaolinitic type resulting from the alteration of chloritic minerals of possibly metamorphic rock origin.

In Port Campbell No.2 Well, this interval is more silty and according to the completion report (Frome-Broken Hill, 1964) much more pyritic. A considerable amount of brownish silty sandstone with recrystallized siderite cement, pyrite, and minor phosphatic pellets, forms tight layers that correspond to high resistivity peaks on the electric log; an example occurs at 2810 feet.

Interval 2110-1860 feet

From the study of the cuttings, the core, and the electric log, it appears that the interval consists of alternating sandstone and dark brown argillaceous siltstone. The sandstone is grey to brownish, subrounded to subangular, fine to coarse grained, and is in some cases bonded by a pyritic cement. Associated with the finer grained horizons are minute pellets or ooliths of siderite and phosphate, and with sideritic, dolomitic, and in some cases pyritic cement (Core No.6 at 1978 feet). In the Port Campbell No.2 Well the bottom portion of the equivalent interval (2214-20 feet) contains fresh water.

Interval 1860-1580 feet

The interval 1860-1580 feet is characterized by an important increase in the percentage of very coarse quartz grains. Although this might not give a true picture of the lithology because of the possibility of cavings in the cuttings, there is undoubtedly an increase in overall grain size. Despite this the electric log does not show consistent differences in resistivity and S.P. values from those for the previous interval.

The S.P. curve between 2110 and 1580 feet can be regarded as rather typical for marine sands that alternate with silty argillaceous, and even pyritic intervals, and presumably indicate a cyclic deposition.

Over the intervals 1710-1780 feet and 1810-1860 feet white argillaceous limestones, in places pyritic appear. They probably formed very fine intercalations, and would not give well defined electric log characteristics. These lithologically distinctive intercalations are also present in the Port Campbell No.2 Well over the interval from 1940 to 2030 feet.

Interval 1580-1375 feet

The dominant lithology of this interval may be seen between 1475 and 1493 feet in cores 4 and 5 It is sandstone with limonite-carbonate cement and with iron oxide (or silicate) pellets and glauconite. The quartz grains are very poorly sorted, fine to very fine grained, rounded to subrounded, and coated with brown iron oxide The iron oxide pellets are generally fine grained. The lithology would indicate that there was a tendency towards oxidizing conditions in agitated water that was not present towards the bottom of the interval. At 1510 feet intercalations of pyritic siltstones with organic matter occur, together with minor white argillaceous sandy limestone streaks containing some phosphatic pellets.

A comparison between the thickness of this unit in Port Campbell No.1 and in Port Campbell No.2 shows that there is a difference of 580 feet - the intervals being 1220 feet thick and 1800 feet respectively. The distinctive character of the electric log recorded over this interval in both wells, could indicate a surface of erosion at the top of the Wangerrip Group.

Taken as a whole, the Wangerrip Group can be considered as a succession of sediments ranging in their depositional environment from restricted inner neritic, to paralic or interdeltaic, with marine influences always predominant.

There is no evidence for any discontinuity in sedimentation between the Paaratte Formation and the overlying Wangerrip Group. However, the interval showing chamosite ooliths (3360 to 3280 feet), occuring at 890 feet above the supposed upper contact of the Wangerrip Group with the Paaratte Formation (at 4250 feet) could well represent an equivalent of the so-called "Bahgallah Formation" reported from other wells in the basin, including Mt. Salt (Oil Development N.L. 1963)

A regional unconformity between the Wangerrip Group and the overlying Heytesbury Group has been widely recognized in the basin; the evidence from the two wells studied however, was not conclusive one way or the other.

A comparison of the thickness of the Wangerrip Group in the two wells considered, shows that there is a lateral increase from Port Campbell No.1 (2875 feet) to Port Campbell No.2 (3770 feet). However, the poor quality of the electric logs does not permit a close correlation of the various intervals discussed above. There is also the possibility of some repetition at about 3000 feet in the Port Campbell No.2 Well. However, the change of thickness of

equivalent intervals (2500 to 3280 feet in Port Campbell No.1, and 2600 to 3700 feet in Port Campbell No.2) is probably due to a facies change from conglomeratic in the No.1 well, to a more sandy and thicker unit in the No.2 well.

The major changes of thicknesses of equivalent intervals noted above in the two wells would certainly have necessitated earth movements during the deposition of the Wangerrip Group.

## HEYTESBURY GROUP

This group occurs in Port Campbell No.1 from 1375 feet to the surface, and in Port Campbell No.2 from 1230 feet to the surface, as noted in the completiong report (Frome-Broken Hill 1964). It overlies, with a marked unconformity, the sediments of the Wangerrip Group.

Again, the lithologies can be considered by reference to the section of Port Campbell No.1.

### Interval 1375-1050 feet

A basal marl and sandy calcarenite unit occurs immediately above the unconformity and shows up as a well-marked horizon on the electric log and the calcimetry log; it is also very apparent from the examination of the cuttings, due to the high iron oxide and iron silicate content.

From 1375 to 1100 feet there are glauconitic marls that show a purplish colour due to very finely divided iron oxide or iron silicate. Spots of pyrite and associated gypsum and sulphides are also present. Between 1300 and 1350 feet minor bands of white limestone occur; the increasing calcium carbonate content of the rock is not reflected in any appreciable change in the electric log and may not be real, but due to cavings.

The sample representing the interval 1075-1050 feet is a brown sandy glauconitic calcarenite, strongly cemented with much iron oxide, and containing iron silicate pellets; the sample has a high calcium carbonate content and is marked by an increased resistivity. This sample is from the top of the glauconitic-iron oxide sequence (1375-1050 feet) and can be correlated with the "Nelson Formation" in the Nelson Bore (Baker, 1961).

### Interval 1050 feet to surface *

This top interval shows a range in lithologies from creamy polyzoal limestone and grey marls, to light grey marls that are argillaceous and gypsiferous towards the base. Pyrite nodules or pyritized burrows occur throughout the interval.

The Heytesbury Group has been ascribed to the Oligocene-Miocene on the basis of its faunal content. The rich fauna present in the two wells consists of echinoderms, pelecypods, gastropods and bryozoa debris, together with rotaliform foraminifera, globigerinids, miliolids, gypsinids, lagenids and also less abundant ostrocods. This assemblage is indicative of open shelf conditions of sedimentation.

* There is not definite evidence in the Port Campbell No. 1 Well of an uncomfortable relationship between the abovementioned equivalent of the Nelson Formation (1075 - 1050 feet) and the sequence from 1050 feet to the surface.

## Conclusions

There is a possibility that an unconformity exists between the "Otway Group" and the overlying Waarre Formation, although the evidence is not conclusive. However strong evidence has been found for an unconformity between the Waarre Formation and the overlying "Flaxmans Beds".

From a study of the lithologies and of the electric logs, it can be established that the "Flaxmans Beds" occur in Port Campbell No.1 as well as in Port Campbell No.2 and immediately overlie the Waarre Formation. No evidence was found of the unconformity that has been postulated between the "Flaxmans Beds" and the "Belfast Mudstone"; in fact, these two units are so similar lithologically, that they hardly warrant the separation into two units. The significance of the unconformity between the Wangerrip Group and the overlying Heytesbury Group, as far as the Tertiary geology of the Otway Basin is concerned, could not be determined; however, studies over a wider area should make this clearer.

As far as petroleum possibilities are concerned, the major interest is in the Waarre Formation, which is capped by the tight "Belfast Mudstone"; the Waarre Formation differs markedly from both underlying and overlying units, and probably formed in a very different environment with a different source for the detrital material. Further studies of the lateral extent and also the detailed characteristics of the Waarre Formation should be made. The sediments of the Wangerrip Group and the Paaratte Formation are for the most part porous, and strongly influenced by the marine environment of the basin proper; however there is a possibility that these sediments have been flushed with fresh water.

The "Belfast Mudstone" was formerly considered a likely source bed, but the result of the present study did not support this suggestion.

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Lat.: 38° 34' 57" S.
Long.: 142° 57' 50" E.
Elevation: 337 feet (G.L.) 346.6 feet (R.T.)
Scale: 1" = 100 feet
B.M.R. Index No. 155

# COMPOSITE WELL LOG

# PORT CAMPBELL No.1

**PLATE 1**
(SHEET 1)

Company : FROME-BROKEN HILL Pty. Ltd.
State : VICTORIA
Basin : OTWAY

## LEGEND

Conglomerate
Sandstone
Sandstone } different type
Siltstone
Claystone
Limestone
Dolomite
Marl
Coal
Gypsum
Glauconite
Pyrite
Limonite
Phosphate
Pebbles
Pellets
Skeletal debris (mainly Polyzoa)

Fossil occurrence
1 Shell debris
2 Polyzoa and tubes
3 Foraminifera
4 Ostracods
● Abundant
o Present

GRAIN SIZE (mm) (Wentworth) — SAND: Very Fine, Fine, Medium, Coarse, V. Coarse; Granule
CARBONATE LOG % — Calcite, Dolomite
GRAIN-SIZE % — fine, v.fine, v.coarse, medium
CUTTINGS LOG % of Lithologies
COLOUR — HUE, Tone (L, MD)
SPONTANEOUS POTENTIAL — 150 Millivolts
RESISTIVITY 16" Normal — 50 Ohms m²/m

| DEPTH R.T. | CUTTINGS DESCRIPTION | Fossil occurrence | DEPTH cores | INTERPRETED LITHOLOGY | DESCRIPTION OF INTERPRETED LITHOLOGY | CHEMICAL CONSTITUENTS |
|---|---|---|---|---|---|---|
| 100' | ① Creamy limestone and light grey finely granular limestone with minor amounts of coarse quartz grains, some pink, some euhedral; very fine-grained glauconite; skeletal debris. (cream) | | | | *Limestone*: Creamy limestone and light grey finely granular limestone with minor amounts of coarse quartz grains, some of which are pink, some euhedral (authigenic) and slightly reworked, very fine glauconite grains and scattered pyrite, many skeletal fragments. Grey marly limestone with some limonitic spots and streaks, minor amounts of quartz, mica flakes disseminated throughout. | |
| 200' | ② Grey marly limestone with some limonitic spots and streaks, and minor amounts of quartz grains; finely disseminated mica. (cream, grey, ,,) | | | | | |
| 300' | ① Light grey marl with gypsum euhedra and some pyrite and glauconite. (grey) ② Abundant skeletal debris and fossils, siliceous sponges spicules. (lt.grey, ,,) | | | | *Marl*: Light grey ~~marl with gypsum euhedra, some pyrite~~ and glauconite, much skeletal debris; siliceous sponge spicules, polyzoa, foraminifera. | |
| 400' | ① Light grey marl with increased proportion of limonitic layers and spots, some pyrite and pyritized casts of fossils, minor gypsum. (lt.grey) ② Abundant skeletal debris, and fossils (foraminifera, ostracods, polyzoa, ? serpula, gastropods). (lt.grey, lt.grey) | | 421' 1 439' | | *Marl*: Light grey polyzoal marl with limonitic layers and pyritized burrows and casts, gypsum, many skeletal fragments and fossils (foraminifera, ostracods, polyzoa, gastropods, serpula. | |
| 500' | | | | | | |
| 600' | ① Light grey marl and grey to grey-brown marly limestone, with pyrite spots and pyritized fossils; some gypsum, minor layers of limonitic marly limestone. (lt.grey) ② Abundant skeletal debris and fossils (foraminifera, ostracods, polyzoa, ? serpula, gastropods). (lt.grey, ,,) | | | | *Marl*: Light grey marl containing grey to grey-brown marly limestone layers; pyritic spots, pyritized fossils and burrows, some gypsum, minor layers of limonitic marly limestone. | |
| 700' | | | | | | |
| 800' | | | | | | |
| 900' | ① Light grey marly limestone, with gypsum spots; limonitic and pyritic burrows and fossils. (lt.grey) ② Abundant skeletal debris and fossils (foraminifera, ostracods, polyzoa, ? serpula, gastropods). (lt.grey, ,,) | | 900' 2 918' | | *Limestone*: Light grey marly limestone very fossiliferous (polyzoa), with limonitic pyritic burrows and casts; gypsum spots. | |
| 1000' | ① Increased limonite and glauconite content in grey-brown marly limestone. (lt.grey) | | | | *Limestone*: Light brown-grey marly limestone, limonitic, gypsiferous and glauconitic. | |
| 1100' | ① Brown, sandy calcarenite with limonite and glauconite pellets, gypsum, pyrite; rounded quartz grains (5%), well sorted, very fine-grained with minor coarse grains, brownish resinous (generally reworked authigenic quartz). (brown, brn.grey, purp.brn.) ② Purplish brown, glauconitic marl, with minor (?) reworked authigenic quartz grains; spots of gypsum and pyrite. (purp.brn., ,,) | | 1067' 3 1077' | | *Calcarenite*: Brown sandy, clayey calcarenite with limonite and glauconite pellets, gypsum, pyrite | |
| 1200' | | | | | *Marl*: Purplish brown glauconitic marl with minor (?) reworked authigenic quartz grains, spots of gypsum associated with pyrite, limonite and glauconite pellets. | |
| 1300' | ② As lithol. ② above, with increased pyrite spots associated with gypsum, limonite, pellets, glauconite. (purp.brn., ,,) ③ Minor pure clear limestone fragments. (lt.grey, ,,) | | | | | |
| 1400' | ① Brown, rounded to subrounded, medium to coarse quartz grains, some authigenic euhedra, glauconite pellets, pyrite. (lt.grey, lt.brn.) ② Calcareous sandstone with limonite pellets. (brown, ,,) | | 1457' 4 1493' 5 | | *Sandstone*: Medium to coarse-grained sandstone, rounded to subrounded, with poor to medium sorting, brownish coatings on grains; calcitic cement; much limonite pellets, glauconite, pyrite, Abundant polyzoa. | Calcite Pyrite (Limonite) (Phosphate) |
| 1500' | | | | | | |
| 1600' | ① Loose quartz grains as ① above. (brown, lt.brn.) ② Brown, medium to coarse-grained sandstone, with dark limonitic clayey cement with minor carbonate, some pyrite, some authigenic quartz (grains rounded to subangular, coated with brownish iron oxide). (lt.grey brn., ,,) | | | | *Sandstone*: Medium to coarse quartz grains, brownish coated, rounded to subangular, poorly sorted, limonitic clayey calcareous cement, some pyrite, authigenic quartz. | Clay Calcite (Quartz authigenic) |
| 1700' | ① Same lithology as ① above. (lt.grey) ② Same lithology as ② above with increased pyrite and iron oxide content. (dk.brn.) ③ Minor white clayey glauconitic limestone, porous. (lt.brn.grey, ,,) | | | | *Limestone*: White, porous, clayey, glauconitic limestone, alternating with fine to medium-grained brownish sandstone, containing pyrite cement and some clay. | Pyrite Clay |
| 1800' | | | 1800' | | *Sandstone*: Subangular to subrounded, coarse to very course-grained sandstone with patches of pyritic and clayey cement, minor calcareous limonitic or white cement. | Clay |
| 1900' | ① Same lithology as ① above with increased amount of loose quartz grains with resinous lustre. (lt.brn.grey, ,,) ② Same lithology as ② above. (brn.grey, ,,) ③ Minor white clayey limestone, and sandy limestone fragments. (m.brn.grey, ,,) | | 1969' 6 1987' | | *Sandstone*: Dark brown, subangular to subrounded fine to coarse grained, poorly sorted sandstone, brown iron coated quartz, brownish pyritic clay cement, in places sideritic-limonitic cement, with phosphatic pellets. Minor white clayey limestone | Pyrite Siderite Limonite Clay (Phosphate) |
| 2000' | | | | | | |
| 2100' | ① Dark brown fine to very coarse-grained, subangular to subrounded, poorly sorted quartz grains. (m.brn.grey, ,,) ② Dark brown sandstone with clay and pyrite cement, in places (e.g. 1978') sideritic cement, with limonite. (m.brn.grey, ,,) ③ Some minor white clayey limestone fragments. (m.brn.grey, ,,) ② Dark brown-grey sandstone with pyritic cement and minor amounts of sandstones with carbonate-limonite cement. (m.brn.grey, brn.grey) | | | | | |
| 2200' | ① Loose greenish quartz grains (stained by ? iron oxide), subrounded to rounded, medium sorted. (brn.grey, ,,) ② Silty sandstone with dark clayey pyritic cement, and minor carbonate cement, tourmaline, muscovite. (m.brn.grey, brn.grey) | | | | | |
| 2300' | ① Silty sandstone with minor coarse to very coarse subrounded sandstone streaks. (brn.grey, ,,) ② Clayey sandstone with dark pyritic cement containing organic matter. (,,) | | | | | |
| 2400' | ① Fine to very coarse-grained silty sands. (,,) ② Fine to very coarse-grained silty sandstone with pyrite, organic matter, siderite and clay cement. (m.brn., ,,) | | 2450' 7 2466' | | *Siltstone*: Dark brown siltstone with minor amounts of medium to very coarse grained quartz coated with iron oxide, clayey pyritic cement with abundant organic matter, siderite | Clay Org matter Siderite |
| 2500' | | | | | | |
| 2600' | ① Subangular to angular coarse to very coarse-grained sand; minor amounts of silts. (,,) ② Coarse to very coarse-grained sandstone with silty pyritic and dark phosphatic cement and minor amounts of siderite cement, glauconite, chert grains. (dk.brn., ,,) | | | | *Sandstone*: Very fine to coarse-grained brown quartz sandstone with subangular to subrounded grains, silty pyritic phosphatic cement, some glauconite Fracture porosity inferred. | Pyrite Phosphate Siderite |
| 2700' | ① Subrounded to subangular very coarse grained sands, coated with brown iron oxide. (grey brn., ,,) ② Silty sandstone, with pyritic, sideritic cement. (yel.brn., dk.brn.) | | | | *Siltstone*: Dark brown siltstone and silty sandstone, pyrite, clay, and phosphate cement, with organic matter | Pyrite Phosphate |
| 2800' | ① Silty sands, ranging from clean to clayey with minor amounts of pebbles up to 2cm across; grey to red cryptocrystalline siliceous rocks, black and greenish schists (to 3280'). (yel.brn., dk.brn., ,,) ② Fine to coarse-grained sandstone with limonite pellets and silty phosphatic cement, quartz grains subangular to subrounded. (ochr.brn., ,,) | | | | *Sandstone*: Coarse to very coarse-grained sandstone with subrounded to subangular brown-coated quartz grains; some limonite pellets, pyritic, clayey phosphatic cement. | Pyrite Siderite |
| 2900' | | | 2900' 8 2915' 2933' | | *Silty Sandstone*: Subangular to subrounded fine to medium-grained silty quartz sandstone with iron oxide, layers of glauconitic siltstones. | |
| 3000' | ① Very coarse-grained to gritty sands (dk.brn.) ② Sandstone as lithology ② above but with pyritic cement. ③ Pyrite and lignite fragments. | | | | *Sandstone*: Medium to very coarse-sanastone with brown coated angular to rounded poorly sorted quartz grains; limonite pellets, minor layers of phosphatic and siderite cement, glauconite | Phosphate Pyrite Siderite |
| | | | | | *Sandstone*: Subangular to subrounded very coarse-grained to conglomeratic sandstone, pebbles of red and grey cryptocrystalline siliceous rocks, black and greenish schists, lignitic debris, cement patchily developed; pyritic silty clayey material. | Pyrite |

## STRATIGRAPHY

| DESCRIPTION of UNIT | INFORMAL UNIT | FORMATION | GROUP | AGE & (stage) |
|---|---|---|---|---|
| Creamy limestone | | | 1375 feet | OLIGOCENE — MIOCENE (JANJUKIAN) |
| Fossiliferous marls and marly limestones, with gypsiferous marl layers. | Bb | NELSON equivalent | GAMBIER = HEYTESBURY = GLENELG | |
| Sandy with limonite pellets | | | | |
| Purplish limonitic glauconitic, pyritic marls. | Bc | | | |
| Sandstones; grains coated with iron oxide, clayey pyritic cement. | | | 2875 feet | |
| Green stained sandstones and siltstones | Db | | KNIGHT | EOCENE (ANGLESEAN) |
| Alternating sandstone and siltstones with pyritic phosphatic cement; limonite pellets at base of interval. | | | WANGERRIP | |

Geologists : J. DELLENBACH
P.J. HAWKINS

Drawn by : G.J. VERBURG

JULY, 1964

To accompany Record Nº 1964/77.

# PLATE 1 (SHEET 2)

**DEPTH R.T.**

**GRAIN SIZE (mm) (Wentworth)** — SAND: Clay–Silt, Very Fine, Fine, Medium, Coarse, V. Coarse; Granule

**GRAIN-SIZE %** — △—△ fine & v. fine —— medium ——— v. coarse

**CUTTINGS LOG % of Lithologies**

**COLOUR** — HUE; Tone: L M D

**CUTTINGS DESCRIPTION**

Fossil occurrence (1 2 3 4)

**SPONTANEOUS POTENTIAL** — 150 Millivolts

**DEPTH cores**

**INTERPRETED LITHOLOGY**

**RESISTIVITY** 16" Normal — 50 Ohms $m^2/m$

**DESCRIPTION OF INTERPRETED LITHOLOGY**

**CHEMICAL CONSTITUENTS**

**STRATIGRAPHY**

| DESCRIPTION of UNIT | INFORMAL UNIT | FORMATION | GROUP | AGE & (stage) |
|---|---|---|---|---|
| Very coarse-grained to conglomeratic sandstone with lignite fragments. | Db | | | |
| Siltstones and angular grained sandstone with pyritic clayey matrix and minor coal. | Dd | BAHGALLAH EQUIVALENT | | |
| Sandy siltstones and sandstones with coal, pyritic cement. | Gb | | | |
| Angular to subrounded fine to medium-grained feldspathic sandstone principally with carbonate cement; dark clayey siltstone with organic matter. | Gd | P A A R A T T E 680 feet | WANGERRIP = KNIGHT 2875 feet | E O C E N E (A N G L E S E A N) |
| Dark grey compact silty mudstone, glauconitic, with finely divided pyrite, organic matter; minor brownish dolomitic streaks. | Gf | B E L F A S T 640 feet | | U. CRETACEOUS – EOCENE ? |
| Sandy mudstone | Gh | FLAXMANS BEDS 80ft | | |
| Fine to medium-grained sandstone and pyritic silty mudstone, with coal. | | W A A R R E 315 feet | | L. CRETACEOUS UPPER CRETACEOUS |

RUN 2 · RUN 3 · RUN 4

T.D. 5965'

Geologists : J. DELLENBACH, P.J. HAWKINS

Drawn by : G.J. VERBURG

JULY, 1964

To accompany Record Nº 1964/77.

PLATE 2

Lat : 38° 36' 55" S
Long : 142° 59' 27" E
Elevation: 282 feet (G.L.) 266 feet (R.T.)
Scale : 1" = 100 feet
B.M.R. Index No. 155

# COMPOSITE WELL LOG

# PORT CAMPBELL No. 2

* 7100 – 8846 feet

Company : FROME-BROKEN HILL Pty. Ltd.
State : VICTORIA
Basin : OTWAY

Conglomerate · Sandstone · Siltstone · Claystone · Limestone · Dolomite · Coal · Glauconite · Pyrite · Phosphate

Notes :
-The cutting description is based on the results from the deviated hole only.
*-This was the total interval by which samples were available for this study.

DEPTH R.T.

GRAIN SIZE (mm) (Wentworth): Clay–Silt | SAND: Very Fine, Fine, Medium, Coarse, V.Coarse | Granule

CUTTINGS LOG % of Lithologies

COLOUR: HUE | TONE: L, M, D

CUTTINGS DESCRIPTION

SPONTANEOUS POTENTIAL — ← 100 Millivolts →

DEPTH cores

INTERPRETED LITHOLOGY

RESISTIVITY 16" Normal — ← 20 ohms m²/m →

DESCRIPTION OF INTERPRETED LITHOLOGY

STRATIGRAPHY: DESCRIPTION of UNIT | INFORMAL UNIT | MEMBER | FORMATION | GROUP | AGE

| Depth (R.T.) | Colour (HUE) | Cuttings description | Description of interpreted lithology | Description of unit | Informal unit | Member | Formation | Group | Age |
|---|---|---|---|---|---|---|---|---|---|
| 7100' | dk.grey | ① Dark grey glauconitic pyritic clayey siltstones with minor brownish streaks. Some inoceramus prisms. | Mudstone: Dark grey mudstone, with finely divided organic matter, tiny mica flakes, but non-glauconitic. | Dark argillaceous pyrite, silty, slightly sandy, generally glauconitic mudstone with increased content of chloritic matter and chamosite pellets basewards | Gf | | BELFAST MUDSTONE | | UPPER CRETACEOUS |
| 7200 | brn.grey | ① As above in lithology ① | | | | | | | |
| | brn.grey | ① As above in lithology ①<br>② Brownish limonite silty dolomite. | | | | | | | |
| 7300' | dk. grey | ① As above in lithology. ①<br>② Minor white clayey limestone. | | | | | | | |
| 7400' | | ② Minor reddish silty dolomite fragments. | Mudstone: Dark silty mudstone, compact, glauconite, with minor brownish ankeritic, siderific, phosphatic silty layers. | | | | | | |
| 7500' | dk.grey | | | | | | | | |
| | brn.grey | ① As above lithology ①<br>② Brown to reddish calcite and dolomite. Some amber, fragments of pelecypods, gastropods. | | | | | | | |
| 7600' | | | | | | | | | |
| 7700' | | ① As above in lithology ①<br>② Medium to coarse, white to brown coated, subangular to subrounded quartz grains.<br>③ Brown to reddish dolomitic phosphatic siltstone. | Mudstone: Dark silty and in part sandy mudstone with glauconite, chloritic elements; some chlorite grains coated with chamosite. Chamosite oolliths with quartz nuclei; silty argillaceous chloritic, pyritic matrix; minor layers with increased dolomite-siderite phosphate cement. | | | | | | |
| 7800' | | | Siltstone: Angular to subrounded, fine to medium-grained sandy argillaceous siltstone with chloritic elements showing transition to chamosite pellets or oolliths; silty, argillaceous, pyritic, chloritic matrix. | | | | | | |
| 7900' | grey | ① As above in lithology ① | | | | | | | |
| | brn.grey | ② Fine to medium grained sands and silts with limonitic cement and glauconite. | | | | | | | |
| | grey | ③ Minor brown to reddish phosphatic and dolomitic sandstone. | Sandstone: Angular to subrounded, fine to medium-grained feldspathic, glauconitic, silty sandstone with minor pebbles and fragments (quartzite, chalcedonitic rock, schists, andesite, glass). Kaolinitic-chloritic, sericitic alteration products in clay, pyrite, chlorite, matrix; in places ankeritic, siderific cement. | Lithic sandstones with mainly chloritic matrix. | Gh | Flaxman's Beds 200 feet | | | |
| 8000' | | | | | | | | | |
| 8100' | lt. grey | ① Dark glauconitic sandy siltstone as above ① with very abundant pyrite, minor coal fragments.<br>② Coarse to pebble sized white quartz grains (up to 5mm across). | | | | | | | |
| 8200' | dk.brn.grey | ① Dark brownish pyrite siltstone, some coal debris.<br>② Coarse quartz grains, some pebbles (up to 5mm across). | Siltstones and Sandstones: Dark siltstone alternating with very thin white sandstone laminations and fine grey sandstones showing churned bedding (same as core 23 Port Campbell 1). Pyrite nodules, coaly matter, amber. | Dark siltstones; quartzitic sandstones with coal fragments. | J | | WAARRE 400 feet | | LOWER CRETACEOUS |
| 8300' | | ① Dark brownish pyritic siltstone, some coal debris.<br>② Coarse quartz grains, some pebbles (up to 5mm across) | Sandstone: Angular grained, fine to very coarse-grained sandstone; grains with overgrowth; cross bedded, with coaly pyritic spots or layers; some wood fragments, minor kaolinitic cement | | | | | | |
| 8400' | dk.brn.grey | ① Dark brownish grey siltstone.<br>② Clean quartzitic fine-grained sandstone, minor grit, pure kaolinitic cement. | Dark clayey pyritic siltstone, slightly slumped with, finely divided pyrite and pyritic nodules, alternating with fine-grained sandstones with kaolinite cement. | | | | | | |
| 8500' | | | | | | | | | |
| 8600' | rd.brn.grey<br>brn.grey | ① Dark brownish grey glauconitic or (chloritic) pyritic siltstone, minor fine-grained sandstones.<br>② Reddish brown phosphatic dolomitic rock fragments. | Siltstone: Dark grey-greenish siltstone with clayey and chloritic matrix; some coaly matter<br>Sandstone: Angular fine to coarse-grained, poorly sorted quartzitic sandstone with fragments of microquartzite, chert, chloritic schists. Dark grey laminations containing mica and organic matter, kaolinitic cement and minor ankerite spots. | Dark siltstones and poorly sorted lithic sandstones with chloritic matrix. | M | | | OTWAY | L.CRETACEOUS-JURASSIC |
| 8700' | | ③ Sandstone with minor carbonate cement.<br>① Dark brownish grey siltstone<br>② Angular, medium-grained quartz grains slightly overgrown with quartz, minor carbonate cement | | | | | | | |
| 8800' | | ① Made up of admixture of matrix material and drilling mud.<br>② As above in lithology ② | | | | | | | |

RUN 6 · RUN 7 · RUN 8 · RUN 9

T.D. 8846'

Geologists : J. DELLENBACH ( I.F.P. )
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