COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1965/167

PETROLOGICAL STUDIES ON THE SEDIMENTS FROM PLANET TULLICH NO. 1 WELL, OTWAY BASIN, VICTORIA.

by

J. DELLENBACH, I.K. KRAITSOWITS, S. OZIMIC and P.J. HAWKINS

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

Bureau of Mineral Resources

Geology & Geophysics

Record No. 1965/167

Petrological studies on the sediments from Planet Tullich No.1 Well, Otway Basin, Victoria.

by

J. Dellenbach, I.K. Kraitsowits,

S. Ozimic, P.J. Hawkins

SUMMARY

Tullich No.1 Well was drilled to test for hydrocarbons in the "Heathfield Sand" within the Otway Group.

Petrological studies show that within Unit M (Otway Group equivalent) are two porous sands; the upper one (2974 - 3094 feet) is the "Heathfield Sand" equivalent.

The well bottomed in Unit P which conformably underlies Unit M.

No Upper Cretaceous sediments were recognized. The Tertiary succession is thin. Unit Dd is developed (168 feet); units Db, Bc and Ab are thin and Unit Bb is absent.

The two porous sands in Unit M were the only reservoir prospects; these yielded only gassy salt water on test.

CONTENTS

	Page
SUMMARY	
INTRODUCTION	1
PART 1	2
Study of the Lower Cretaceous sediments	
Conclusions	7
PART 2	8
Study of the post-Lower Cretaceous sediments	8
Conclusions	10
REFERENCES	11

Illustrations

Fig. 1: Relation of results from dipmeter survey to position of the "Heathfield Sand" in the Tullich No.1 and the Heathfield No.1 wells. (facing p. 6)

Plate 1: Tentative correlations of lithological intervals of Unit M (Merino Group) in the Tullich No.1, Heathfield No.1 and Geltwood Beach No.1 wells.

Plate 2: Composite log of the post-Lower Cretaceous sediments.

Studies have been made on samples from Tullich No.1 in the following manner:

(1) J. Dellenbach a report on the petrological study of the Lower Cretaceous sediments (Units P and M);

(2) I.K. Kraitsowits a study of post-Lower Cretaceous sediments (Units D, B and A) with a report and interpretative log;

(3) S. Ozimic a cuttings percentage log for the Lower Cretaceous sediments (Units P and M);

(4) P.J. Hawkins a comparison between units and intervals of the Lower Cretaceous in the Tullich No.1 and Heathfield No.1 wells.

INTRODUCTION

Tullich No.1 Well was drilled for Planet Exploration Company Pty Ltd., approximately 7 miles northwest of Heathfield No.1 Well and 17 miles west-north-west of Casterton. Details of the well and its location are given below.

Location: Latitude 37° 31' 00" S.
Longitude 141° 09' 00" E.

1:250,000 sheet. Hamilton J54-7.

Elevation: Ground level - 258 feet A.S.L.
Kelly Bushing - 272 feet A.S.L.

Total depth: 5363 feet.

Completion date: 4th September 1964.

The drilling operation was subsidized under the Petroleum Search Subsidy Act, 1959-61.

Samples of all cuttings collected and approximately 18% of all the cores taken were received by the Bureau of Mineral Resources; a study of all the samples was carried out and where necessary thin sections were made.

The composite log and the well completion report (Cundill 1964) were the principal references for this study.

The study was undertaken as part of the review of the Otway Basin by the Subsurface Section of the Petroleum Exploration Branch, Bureau of Mineral Resources. J. Dellenbach was responsible for the interval 5363 - 418 feet and K. Kraitsowits, the interval 418 feet to the surface; the entire study was supervised by J. Dellenbach.

PART I

A short study of the Lower Cretaceous sediments of Tullich No.1 as compared with those of Heathfield No.1 and Geltwood Beach No.1.

Unit P

Unit P was defined simultaneously by Edworthy (1965) for Eumeralla No.1 and Dellenbach (1965) for Geltwood Beach No.1; it is a unit containing:

- conspicuous grains of pink garnet;
- a mixture of fresh fragments of metamorphic rocks and of volcanics;
- angular to subrounded, fine to coarse detritus of moderate sorting;
- preponderance of subgreywackes (Pettijohn, 1957);
- recurrent high-energy features; ripples, strong cross-bedding with foresets, moderate sorting.

In the Tullich No. 1 well the first occurrence of abundant pink garnet is in the sample at 4770-4780 feet. This depth is very close to the marked change in electric log character at 4841 feet which led the company to envisage a unit from 5363 (T.D.) to 4841 feet.

Description of the sediments of Unit P (4770-5363 feet, T.D.)

According to the cuttings percentage log, shales are predominant in the Unit P.

The shales are chloritic micaceous and illitic. They contain abundant divided carbonaceous matter and some pyrite. Rhombs, spherules, aggregates, and cryptocrystalline patches of carbonate of the siderite-group are abundant. Opaque clay material (montmorillonitic clay?) is present in some samples.

The sandstones are moderately-sorted, angular, medium to fine-grained subgreywackes. Recurrent samples are very rich in overgrown quartz and show less abundant lithic fragments. These could be termed proto-quartzites" (Pettijohn, 1957) or more generally "lithic sandstones". The lithic constituents are mainly of metamorphic origin (schist, phyllite, metaquartzite) but comprise conspicuous fragments of opaque and chloritic rock (some of which show a flow-rock texture) at recurrent depths. The contents of lithic fragments is estimated at 15 to 20%. The quartz grains (30-35%) are strongly intergrown, and strongly corroded particularly in the carbonate cemented sandstones.

Calcite cement is common in the sandstones rich in quartz and metamorphic rock fragments. The clean, recrystallized calcite forms an extensive cement (40%), and contains patches of cryptocrystalline kaolinite and (re)crystallized illitic aggregates. Other sandstone cuttings display a chlorite-detritus-clay matrix with abundant pyrite, mica and carbonaceous matter.

Garnet, zircon, apatite, sphene, leucoxene, tourmaline, chloritoid and opaque minerals are abundant in the sandstones and especially in the clean lithic sandstones; they are fairly abundant also in the sandstones with chloritic matrix and even in the shales. The garnets are angular, corroded and in many instances shattered.

Examination of core 13 (4841-4850 feet) shows interlaminated siltstones or shales and indurated very fine-grained sandstones to be present. Thin laminations, cross-bedding (some at high angles), disrupted bedding, undulations, microfaults and small-scale slumps are observed. Coal flakes are abundant. The overall dip is apparently 15°. The comparison of sediments of Unit P in the Tullich No.1 well with Unit P in the Geltwood Beach No.1 and Heathfield No.1 wells is limited by the small part of Unit P intersected in Tullich No.1. Facies comparison suggests that the influence of the quartz-metamorphic source is stronger in the Tullich No.1 well than in Geltwood Beach Nq. 1, Heathfield No.1 and Eumeralla No.1 wells. An unconformable relationship between sediments of Unit P and of units above is not apparent in the Tullich No.1 well.

Unit M

Unit M (equivalent to the Merino Group) has been intersected from 4770 feet to 3418 feet. Eight intervals have been recognized and tentatively correlated with similar lithological intervals in the Geltwood Beach No.1 and the Heathfield No.1 wells (Plate 1).

Interval 4770-3814 feet

This interval comprises essentially mudstones and shales which are now markedly rich in clay material, chlorite, and carbonaceous material; siderite, and spherulitic replacement siderite are also present in the mudstones.

The minor sandstones are subgreywackes and greywackes (35% lithics, 20% feldspar, 25% quartz) with abundant impure calcite and siderite cement, or clay-chlorite matrix (in the greywacke).

The cores taken over this interval display sedimentary structures which indicate alternating quiet and slightly turbulent conditions in a paralic environment. Coal fragments are very abundant and seams are present in core No. 10 (3994-3995 feet). This interval compares with the interval 7408-5602 feet in Heathfield No.1 and the interval 8955-7000 feet in the Geltwood Beach No.1.

Interval 3814-3530 feet

Strong microlog resistivity peaks mark this interval; a 45 feet sand horizon of markedly different composition to that of the bulk of sediments of Unit M occurs at the base.

The cuttings percentage log of the basal sandstone shows a build-up of clear loose fine to very coarse grains of quartz and potash feldspar. Granules and pebbles are also present. Thin sections of isolated grains show the presence of quartz and undulose quartz with minor linear sets of vacuoles, rare muscovite, tourmaline and apatite inclusions. Composite quartz is present. Quartz-K-feldspar rock some of which shows perthitic intergrowth is abundant. Minor acid feldspar (albite) is associated with the latter rock fragments. Isolated grains of microcline are abundant. Remnants of a dark (dirty) clay and chlorite matrix are observed around some of the grains.

All these characters point to a granitic-pegmatitic source for the sandstone and would warrant the name arkosic sandstone; this strongly contrasts with the greywackes-subgreywackes of mixed origin and the volcanic sandstones found above in the same interval and in intervals below. The reason for the placing of this particular sand in an interval comprising greywackes-subgreywackes is that the lower limit of the sand is well marked and probably has local unconformable relationship to sediments below it,

whereas the upper limit is gradational. The influence in the sand of the granitic source weakens from 3780 to 3750 feet and conversely admixtures of constituents of greywacke-subgreywackes increase together with the occurrence of chloritic-sideritic shales.

The prevalence of the influx of material of volcanic origin above the arkosic sandstone at 3769-3814 feet is well substantiated in thin sections of cuttings between 3700 and 3750 feet. These display subgreywacke and greywacke with abundant detritus of andesitic nature, and fragments of sideritic mudstone very rich in devitrified or calcitized glass shards, concave-convex fragments of the glass walls of bubbles and also some calcitized crystals (feldspar). Some of these cuttings are so rich in glass shards and fragments that they may be termed reworked vitric tuff with sideritic cement. The sedimentary nature of these rocks is emphasized by the presence of minute fragments of coaly plant tissue with cells. Thus the origin of the tuffaceous material is thought to be a nearby cource (although one might object that fragments of vitric tuffs may be carried-airborne over great distances).

The geological setting for this type of sedimentation could be:

(1) a diastrophic event, possible mild epeirogenic faulting;

(2) influx of coarse material of granitic (and metamorphic) origin from the landmass (to the north);

(3) volcanic activity induced from faulting, with without the building up of craters. Influx of ejecta in the Tullich No. 1 area the flow-rocks close to the vents.

(4) penecontemporaneous erosion of the pyroclastic deposits and flow-rocks.

The early erosion of the flows could explain in part why no flows have yet been found in the different wells intersecting Unit M in the Otway Basin. The emphasis has been on the relations between the occurrence of arkosic sandstones and of volcanic material because they are of great value in the interpretation of the geological history of Unit M.

Except for the presence of the arkosic sandstones and sideritic mudstone with abundant volcanic material the remainder of the sediments of the interval 3814-3530 feet are not markedly different from those in the interval below. However there is a higher frequency of calcite-siderite cemented subgreywacke-horizons in the 3814-3530 feet interval.

Interval 3530-3094 feet

This interval comprises 60% of mainly mudstone and shale and 40% of sandstone (subgreywacke and some greywacke). Particular to this interval is the occurrence between 3270 and 3170 feet of subgreywacke with abundant cryptocrystalline calcite and possible siderite cement corroding and replacing the framework to varying extent. Patches of recrystallized kaolinite are present together with abundant coaly plant fragments. The available part of core No.8 (3479-3482 feet) shows strong cross-bedding, disrupted bedding, slumping and very thin laminations with flaky carbonaceous matter. Very big (several inches long) plant fragments are present.

Interval 3094-2974 feet

This interval of sandstone has been dealt with separately from the overlying sediments because of its important thickness and the marked break at its top. Similarly to the basal arkosic sandstone in the 3814-3530 feet

interval, local unconformable relationship may exist at the bottom of the sandstone. On the basis of two dipmeter readings (No.37 and 38) the inferred unconformity is between 3178 feet and 3221 feet. This discrepancy between the zone of dip change (3178-3221 feet) and the lithological lower boundary of the "Heathfield Sand" (Cundill, 1964) at 3094 feet indicates a structural event after which the supply of terrigenous materials was modified. Similar conditions exist in Heathfield No.1 well (Fig.1). It is difficult to compare the "Heathfield Sand" with the lower sandstone (3814-3769 feet) in the absence of core in the latter. However it is apparent that the sandstone at 3094-2974 feet is richer in lithic fragments of low-grade metamorphic origin. Percentage estimates in a thin section from core No.7 at 2992-2982 feet are as follows:

- quartz 40%
- feldspar 7% (plagioclase and some untwinned feldspar)
- lithics 20% - 25% (fragments of phyllite, schist, metaquartzite, also rounded chlorite fragments);
- bleached micas (biotite mainly) and carbonaceous matter (3%)
- matrix (chlorite, clay, detritus) 20%-25%.

The analysed rock is between a protoquartzite and a greywacke (Pettijohn). The important fact is that no volcanic rock-fragments are present among the lithic fragments which belong to a homogeneous low-grade metamorphic source, the location of which was close (Cambro-Ordovician to the North East?).

Fragments of quartz-feldspar rock, rock with graphic intergrowth of feldspar and quartz, composite and undulose quartz derived from a granitic-pegmatitic source are present among the loose constituents of cuttings (3040-3012 feet) though apparently less abundant than in the lower sand (3814-3769 feet). A few very coarse fragments of a strongly devitrified welded tuff were noticed at 3040-3050 feet. (This unusual rock is though to be derived from Upper Palaeozoic volcanics known elsewhere in Victoria).

It should be emphasized that only thin-section study allows ready recognition of lithic fragments of metamorphic origin from those of volcanic origin.

Correlation with the "Heathfield Sand" of the Heathfield No.1 well (4144-4115 feet) is evident. The lithology is very similar. The possibility exists of a correlation with sandstones occurring between 6080 and 6050 feet in Geltwood Beach No.1, where up to 10% of the cuttings are loose, very coarse grains of quartz, and metaquartzite. Mudstones belonging to this interval in Geltwood Beach No.1 also contain abundant erratically distributed coarse to very coarse quartz and metaquartzite grains.

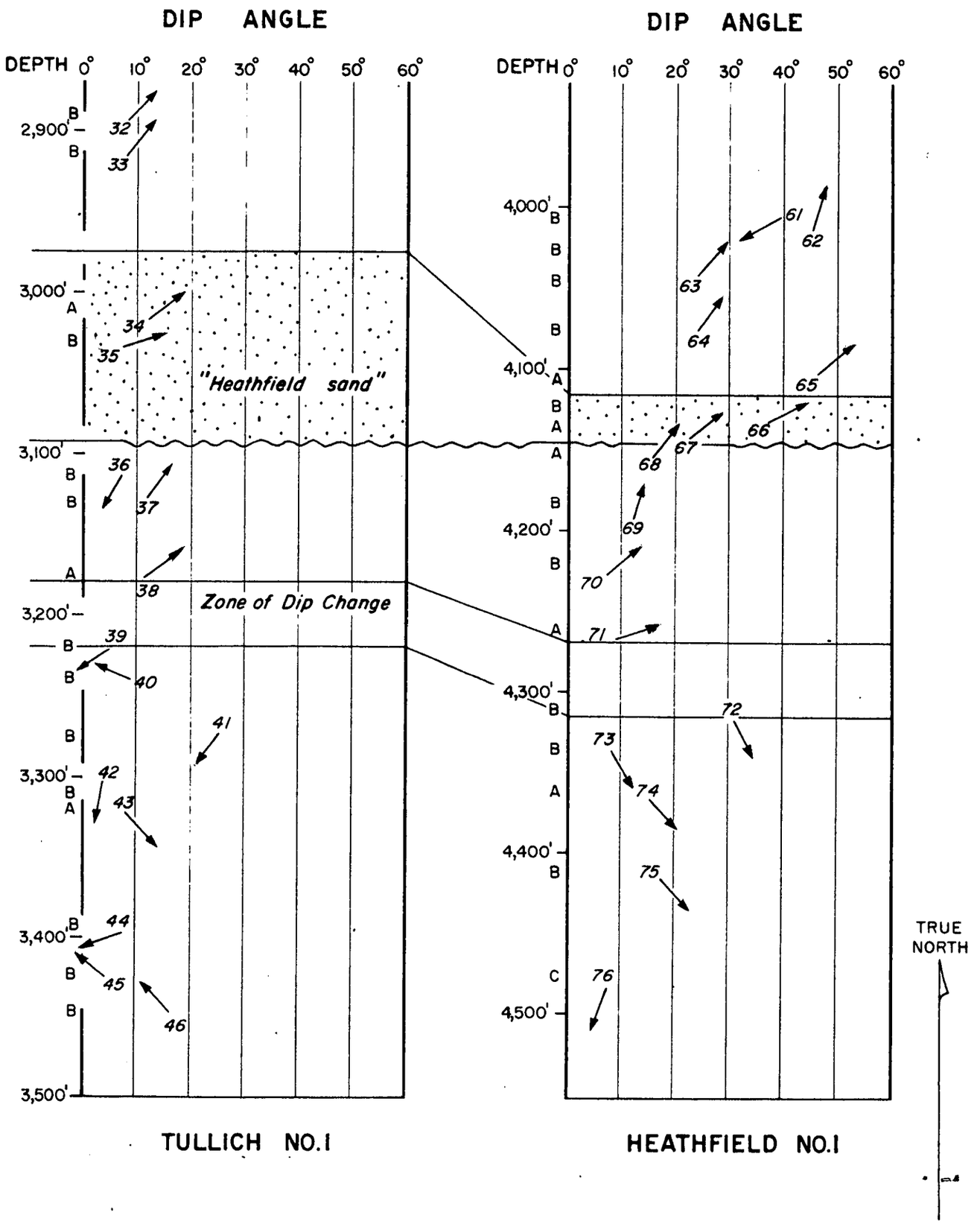
Interval 2974-2000 feet

This interval comprises a succession of subgreywackes and volcanic sandstones together with minor mudstones-similar to the mudstones below and containing abundant carbonaceous matter. Roots and rootlets are present in cores Nos. 5 and 4. The sandstones are more variable in composition than average sandstones of intervals below. Volcanic sandstones* and subgreywackes

---

* The difference between volcanic sandstone and subgreywacke (or greywacke) has been based on the definition that volcanic sandstone contains 2/3 or more of volcanic rock fragments in the lithic components.

Example:	Lithics	35%		Metcs. 11%, Volcanics 24% of total rock -
	Feldspar	20%		or metcs. 1/3, volcanics 2/3 of total
	Quartz	15%		lithics)
	Cement/Matrix	30%	=	Volcanic sandstone.



RELATION OF RESULTS FROM THE DIPMETER SURVEY TO POSITION OF THE "HEATHFIELD SAND" IN THE TULLICH NO.1 AND HEATHFIELD NO.1 WELLS

Correlation Class A:Good B:Fair C:Possible

Bureau of Mineral Resources, Geology and Geophysics August 1965 To accompany Record 1965/167

containing abundant volcanic material, opaque glass and clay material are recurrent. They may be porous or cemented with calcite. Up to 20% of fragments of "replacement limestone" (subgreywacke in which carbonate has caused corrosion and replaced the constituents) are present between 2390 and 2340 feet. The porosity of some of these sandstones is very high but it is assumed that strong lateral variations occur which limit the extent of the porous zones.

This interval correlates with the interval 4115-3184 feet in Heathfield No.1 and 6050-5250 feet in Geltwood Beach No.1 (in both wells zeolite is present in the interval).

Interval 2000-1308 feet

This interval is characterized by the presence of subgreywacke with chloritic coatings on grains (porous subgreywackes) or matrix. However mudstones and siltstones with abundant carbonaceous matter are predominant over the interval. Cavings are abundant. Comparative intervals exist from 3184 to 2610 feet in Heathfield No.1 and 5250-4350 feet in Geltwood Beach No.1.

Interval 1308-634 feet

The great increase in the content of fresh volcanic rock-fragments and mafic minerals in volcanic subgreywackes and sandstones, is important between 1308 and 634 feet. Fresh rounded fragments of phyllite are also recurrently abundant. The local derivation of material from penecontemporaneous vulcanism is attested by:

- the abundance and freshness of fragments of volcanic rocks (andesite, glass with microlites, glass with opaque material, magnetite);
- the presence of abundant crystals and fragments of hornblende, apatite, magnetite, chlorite, brown opaque material being possibly altered mafic minerals (iddingsite), big biotite flakes, and zoned plagioclase;
- the occurrence at recurrent depths of a colloform, subopaque to translucent, high birefringence, low refringent clayey "cement" which can be termed montmorillonoid** clay. ("Cement" is used here to designate a non-detailed depositional binding material, thought to have been deposited with the clasts as a colloid).

However detritus of a metamorphic source (phyllite mainly and minor metaquartzite) is still present in the 1308-634 feet interval in subgreywackes. Carbonaceous material and plant fragments are abundant. Big roots and rootlets are present in a mudstone in parts of core No.3 (1051-1053 feet).

This interval corresponds to interval 2610-2050 feet in Heathfield No.1 and 4350-4000 feet in Geltwood Beach No.1. The lower limit marks a recrudescence of volcanic activity (without a distinctive unconformity) which is widespread throughout the Otway Basin (and apparently also the Gippsland Basin). The relative abundance of fresh volcanic constituents (and especially the first occurrence yet reported of abundant mafic minerals) suggests close volcanic sources or vents. On the other hand the extent of the volcanic influxes throughout the basin in the upper part of Unit M and the thickening

---

** (X-ray analysis is recommended; see also Lerbekmo, 1957).

of this volcanic material towards the east (and possibly S.E.) implies that the main loci of volcanic activity were in the East or probably along a broad north-south belt between Tasmania and Victoria, and between the meridians 146° and 148°E. Possible loci may also be present in the shallow basement area between King Island and Phillip Island. Although much information is available on the Jurassic igneous rocks of Tasmania, very little is known of the igneous activity in (Lower) Cretaceous times.

Interval 634-418

This interval comprises similar sediments to those in the interval 1308-634 feet. Constituents of metamorphic origin are less abundant than below. Conversely volcanic glass and rock fragments are more abundant and so are the volcanic sandstones. Volcanic sandstones with chlorite, illite coatings on grains, show very good porosity, but some infilling with non-poikilitic zeolite occurs. Horizons of carbonaceous matter cemented with grains of zeolite (from a reworked zeolite crystal - tuff) are present. Carbonaceous plant fragments and amber is abundant.

From the top of the interval to 510 feet in the cuttings and to 450 feet on the electric log, the sediments are strongly calcitized. The replacement limestone and subgreywacke fragments are ascribed beyond any doubt (even in the presence of cavings of sandy limestone from the Tertiary above) to Unit M because of the presence of some volcanic glass, rock particles, and feldspar, and the similarity of these altered sediments with underlying occurrences of Unit M. This horizon with introduced calcite must be considered as a "pan" or crust developed below the unconformity at 418 feet (not necessary under continental conditions).

Correlative intervals are 2050-1680 feet in the Heathfield No.1 and 4000-3670 feet in Geltwood Beach No.1.

Conclusions on the study of sediments from the Lower Cretaceous in the Tullich No.1 well.

Important findings are:

- the presence of Unit P from 4770 feet to 5363 feet (T.D.) (no indication as to thickness of Unit P is possible);
- the nature of the two very porous sands (3820-3725, and 3094-2974 feet) and their relation to the sediments of Unit M;
- the evidence of volcanic activity, in particular in the topmost intervals of Unit M;
- volcanic-rich intervals may be related to similar volcanic-rich intervals in Geltwood Beach No.1 and Heathfield No.1 wells.

From the reservoir point of view the presence of porous sands in Unit M is of great interest. However these sands represent near-shore, probably wedge-shaped bodies. They do not extend far basinwards. The well intersected only 593 feet of the top of Unit P and it is possible that a greater sequence of sediments is present below. Except for the porous sands in Unit M it is suggested that the main reservoir prospects still lie at the bottom of Unit P or in possible sedimentary units below.

PART II

A study of post-Lower Cretaceous sediments of the Tullich No.1 well.

By I.K. Kraitsowits

Introduction

Tullich No. 1 well penetrated Unit Ab sediments from surface to 70 feet, and Unit Bc to 140 feet. The interval between the unconformity at the base of Unit Bc, and the disconformity at the top of Unit M (Merino Group) is equivalent to Unit D.

In the absence of electric logs, four subdivisions of Unit D have been made on the basis of the cuttings; Db_1 and Db_2 sub-units are considered to be Eocene, Dartmoor Formation equivalents, whilst Dd_1 and Dd_2 sub-units are possibly Palaeocene, Bahgallah and/or Pebble Point equivalents.

Sub-unit Dd_2 418-330 feet

Loose quartz sand predominates in this interval. The sand is coarse-grained, subrounded, slightly lithic, fairly well-sorted, with polished euhedral grains of clear, milky or grey quartz.

The lower boundary of the sub-unit can be detected from the Gamma-ray Log, and by the appearance of the Lower Cretaceous, Unit M sediments in the cuttings below 418 feet.

The bottom part of the sub-unit between 418 and 400 feet, may represent sediments on a surface of disconformity. Here, the relatively better sorting and the sudden increase in the grain-size coincides with the appearance of abundant, broken shell fragments, possibly indicating reworked sediments. Five to ten percent oolite cavings can be detected throughout Dd_2, and ten percent of the cuttings from the top part of the sub-unit are cement cavings.

Sub-unit Dd_1 330-250 feet

This sub-unit comprises layers of sandy-oolite and sideritic silty-sand. The oolite ranges from greenish-grey to light orange-brown. The nuclei of the ooliths are either quartz grains, or flakes of microcrystalline ferriferous chlorite (greenalite?), surrounded by concentric layers of ferriferous chlorite and haematite. In most cases, however, the concentric structure cannot be observed due to excessive haematization of the ooliths. Some ooliths are calcitized.

The fossil content associated with the ooliths is in the form of numerous, rounded organic fragments or pseudo-ooliths, which in part have been calcitized, or replaced by the different iron compounds present. Loose shell fragments are increasingly coated with ?greenalite and haematite towards the base of the sub-unit.

The cuttings can be distinguished by bonding media and occur in three forms:

(i) Bonded by microgranular or microcrystalline ferriferous chlorite cement. The pale-green, slightly calcareous and micaceous, fresh, silty, ferriferous chlorite provides a good bond for the ooliths, pseudo-ooliths and quartz grains present in about 25 percent of the cuttings. Only a minor amount of silt is associated with these sediments.

(ii) Cemented with siderite, in about five per cent of the cuttings. The silt content is more pronounced, and no ferriferous chlorite is apparent in the cementing media in this portion of the cuttings. Only limonite or haematite occurs as concentric layers in the ooliths.

(iii) Loosely bonded by silt. Up to 70 per cent of the cuttings are poorly-sorted, loose sand, consisting of angular, frosted, clear and milky quartz-grains, with coatings of silty material. The lack of good bonding may be due to the originally low percentage of ferriferous chlorite in the silty matrix.

The lower boundary of Dd_1 is difficult to assess, because of the absence of electric logs, and the large amount of cavings in the cuttings (due to the reaming, casing and cementing operations carried out at 322 feet).

When the two sub-units are viewed in general, the following differences have been recognized:

In Dd_1 the percentage of the oolite in the cuttings is relatively high (30 per cent) while in Dd_2 it is so low that they are most probably cavings only. The sand in Dd_1 is silty and the quartz grains are angular and frosted. Dd_2 is marked by an absence of silt, and the quartz grains of the sand are better sorted, subrounded and polished. These results indicate higher energy conditions, (with less precipitation of ferriferous chlorite) in Dd_2 time.

Sub-unit Db_2 250-160 feet

Dark brown to dark grey, well-sorted silty sand, consisting of grains of quartz embedded in silt. The sand fraction is composed of sub-angular to subrounded, coarse to granule-sized, polished (and some frosted) clear white or grey quartz. The silt is argillaceous, calcareous, sideritic, carbonaceous and micaceous. Molybdate tests revealed traces of phosphate.

Sub-unit Db_2 is divisible into two intervals: an arenaceous sequence above, and a sideritic, argillaceous sequence below 210 feet. In the lower part, the coarse-grained sand content sharply decreases, with the silt and very-fine sand becoming the main mode; this is accompanied by an increase in the fossil content. Between 250 and 210 feet, the silt-sized grains are generally cemented with siderite, and in places by limonite. The lower boundary of the sub-unit is marked by the appearance of the first ooliths found in the sample marked 240-250 feet.

Sub-unit Db_1 160-140 feet

Poorly sorted, medium to very coarse-grained sand composed of quartz and feldspar occurs in this interval. The sand grains are coated and in places cemented together by microcrystalline pyrite. The feldspar is mainly microcline.

Unit Bc 140-70 feet

In Unit Bc, loose clayey sands predominate. The arenaceous sequence consists of angular to subrounded, coarse to granule-sized, clear and milky, fossiliferous quartz sand. The quartz grains are frosted, sometimes polished and occasionally coated with iron oxide - especially in the top part of the unit.

Between 120 and 100 feet, the sand is slightly lithic - containing up to 4 percent metaquartzite, with feldspar, radiolaria chert, limonite pellets and some brown coal fragments. The carbonaceous, slightly calcareous, micaceous, clayey matrix occurs in the cuttings, mainly as infillings in well preserved fossils, and as coatings on the sand grains. These sediments are rich in Foraminifera and Gastropoda, Lamellibranchia and Polyzoa fragments.

The age of Unit Bc is doubtful (see Hawkins and Dellenbach, 1963, p.17). It is considered in part to be equivalent of the Compton Conglomerate, regarded as Oligocene in age (Ludbrook 1961).

Unit Ab 70-240 feet

The sediments consist of yellowish orange to light brown calcarenite, bio-calcarenite and sandy limestone, with some loose quartz grains and worn, sand-sized shell fragments. Both the loose and the cemented quartz are coarse-grained, subrounded and well sorted, clear, white or frosted. In some cuttings, calcite veins are present. The cementing media of the calcareous sediments comprise microcrystalline siderite, dolomite and calcite.

It is apparent that there is a gradual decrease of calcarenite and increase in the sandy limestone towards the base of the unit. In spite of the absence of electric logs over this interval, it is thought that cyclic deposition of these sediments occurred; this has been inferred from the cuttings percentage log. Unit Ab is considered to be equivalent of the Whaler's Bluff Formation of Pliocene to Pleistocene age, encountered in the Heathfield No.1 well.

Conclusion

The post-Lower Cretaceous sequence in Tullich No.1 is marked by alternating, periodically active, mechanical and chemical processes. A disconformity separates the Lower Cretaceous, Unit M sediments from the younger sequence. Following the time gap represented by the disconformity, the high-energy environment of the arenaceous Dd_2 evolved into a depositionally inactive period, which favoured chemical precipitation, and formation of ooliths in Dd_1. The accumulation of terrigenous material in units Db and Bc was followed by a low energy chemical environment when calcarenites and bio-calcarenites were deposited, represented by Unit Ab.

References

CUNDILL, J.R., 1964 - Planet Heathfield No.1, Completion Report for Planet Exploration Company Pty Ltd (unpubl.).

DELLENBACH, J., 1965 - A petrological study of sediments from Beach Petroleum N.L. Geltwood Beach No.1 Well, Otway Basin, S. Australia. Bur.Min.Resour.Aust.Rec. 1965/41 (unpubl.).

EDWORTHY, K.J., 1965 - A petrological study of the sediments from Frome-Broken Hill Eumeralla No.1 well, Otway Basin, Victoria. Bur.Min.Resour.Aust.Rec. 1965/76 (unpubl.).

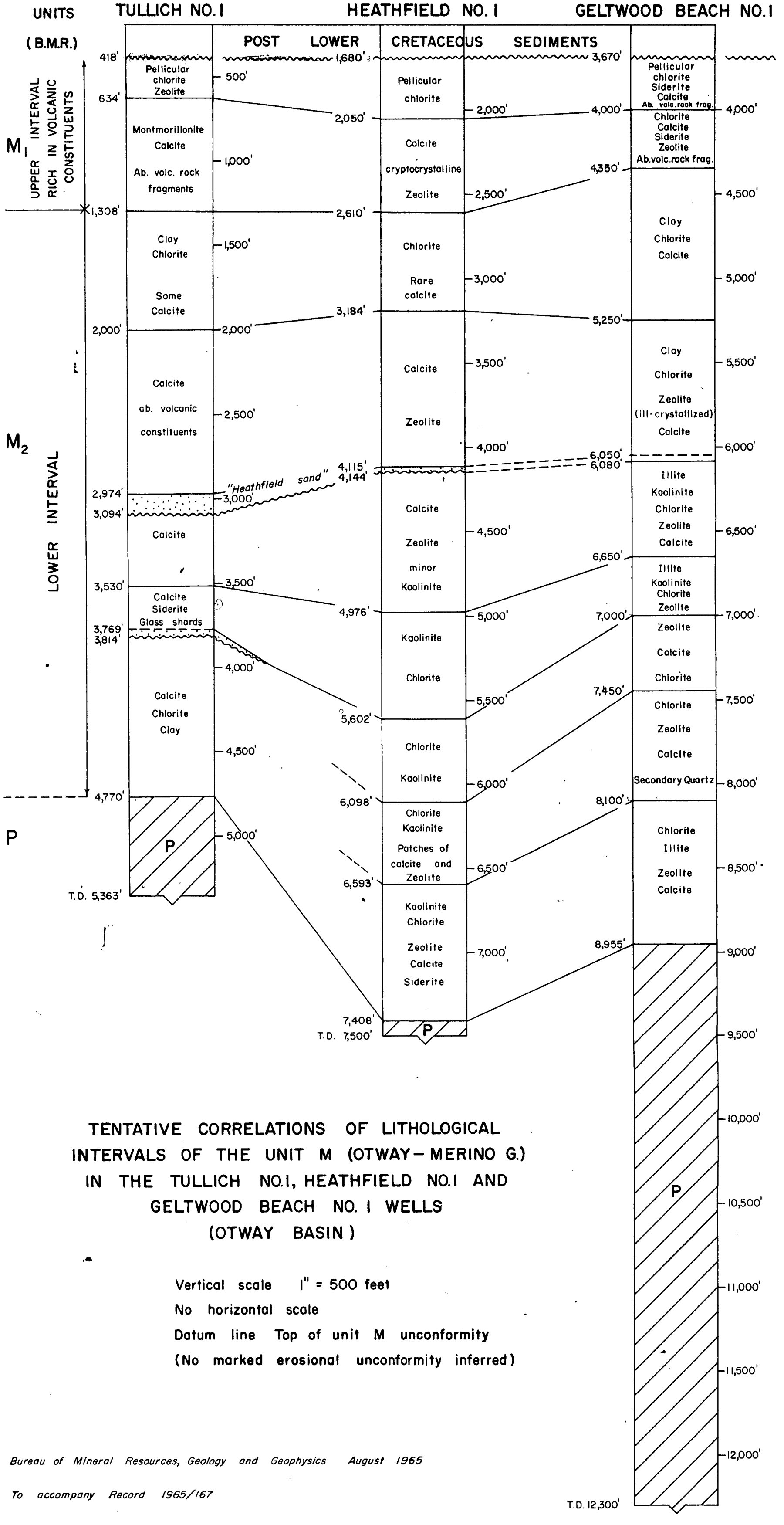
HAWKINS, P.J., 1965 - A Petrological Study of the sediments from Planet Heathfield No.1 Well, Otway Basin, Victoria. Bur.Min.Resour.Aust.Rec. 1965/100 (unpubl.).

HAWKINS, P.J., and DELLENBACH, J. - Study of the Nelson Bore Sediments. Bur.Min.Resour.Aust.Rec. 1963/167.

LERBEKMO, J.F., 1957 - Authigenic montmorillonoid cement in andesitic sandstones of central California. J. Sed. Petrol. 27, (2), 298-305.

LUDBROOK, N.H., 1961 - Stratigraphy of the Murray Basin in S.A. Bull. geol.Surv. S.Aust. 36.

O.D.N.L., 1963 - Completion Report for Oil Development N.L. Anglesea Well No.1 P.P.L. 256, Victoria (unpubl.).



TENTATIVE CORRELATIONS OF LITHOLOGICAL INTERVALS OF THE UNIT M (OTWAY – MERINO G.) IN THE TULLICH NO.1, HEATHFIELD NO.1 AND GELTWOOD BEACH NO. 1 WELLS (OTWAY BASIN)

Vertical scale 1" = 500 feet

No horizontal scale

Datum line Top of unit M unconformity

(No marked erosional unconformity inferred)

Bureau of Mineral Resources, Geology and Geophysics August 1965

To accompany Record 1965/167

COMPOSITE WELL LOG OF POST-LOWER CRETACEOUS SEDIMENTS

TULLICH No.1

Lat: 37° 31' 00" S.
Long: 141° 09' 00" E.
Elevation: 272' (KB), 258' (G.L.)
Scale: 1 inch = 100 feet.

B.M.R. well index No: 251.
(Core & Cuttings Laboratory)

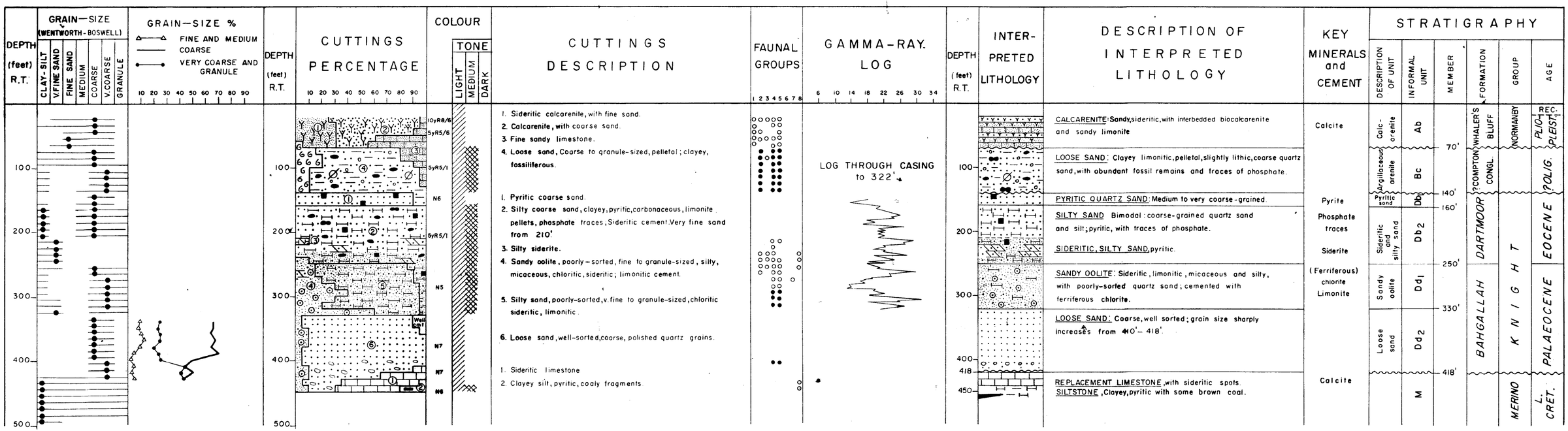
Company: PLANET Expl. Co. P/L.
Basin: OTWAY.
State: VICTORIA.

REFERENCE

- GRANULE AND CONGLOMERATE
- COARSE TO V. COARSE SAND
- FINE TO MEDIUM-GRAINED SAND AND SANDSTONE
- SILT AND SILTSTONE
- CLAY AND CLAYSTONE
- FINE SANDY CALCARENITE
- COARSE SANDY CALCARENITE
- FINE SANDY LIMESTONE
- SIDERITE
- SILTY SIDERITE
- BROKEN FOSSIL FRAGMENTS
- SEAM OR LENS FRAGMENTS } COAL
- OOLITH
- PELLET
- PHOSPHATE
- LIMONITE
- PYRITE

FAUNAL GROUPS

1 ALGAE
2 FORAMINIFERA
3 POLYZOA
4 GASTROPODA
5 LAMELLIBRANCHIA
6 ECHINOID
7 FISH TEETH
8 PLANT REMAINS
(• ABUNDANT, ○ PRESENT)



Bureau of Mineral Resources, Geology and Geophysics. October 1965.

To accompany Record No. 1965/167

(Compiled by: I.K. Kraitsowits)

X AUS - 2 - 67

LP